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IMPACT SENSOR

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(56) Prior Art Documents
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(57) Claim

1. An impact sensor comprising:
a piezoelectric element adapted to provide a voltage of a magnitude corresponding to a pressure applied thereto;
an inertial mass for applying a pressure to said piezoelectric element and having an end surface;
a pair of electrodes disposed to sandwich said piezoelectric element, pressure exerted from said inertial mass being applied to one of the pair of electrodes;
a biasing member disposed to press said inertial mass toward said piezoelectric element; and
a pressure receiving element disposed between said one electrode and said inertial mass for transmitting pressure from said inertial mass to said one electrode, said pressure receiving element having a recess, said end surface of the inertial mass contacting the recess so that when impact is imparted to said inertial mass, said piezoelectric element is pressed with a pressure of a level corresponding to the impact and said piezoelectric element provides a voltage of a level corresponding to the pressure applied thereto.

13. An impact sensor according to claim 1, further including means for receiving an output voltage from said piezoelectric element and determining whether said output voltage is greater than a predetermined

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level, said means providing a signal to inflate an airbag when said output voltage exceeds said predetermined level.

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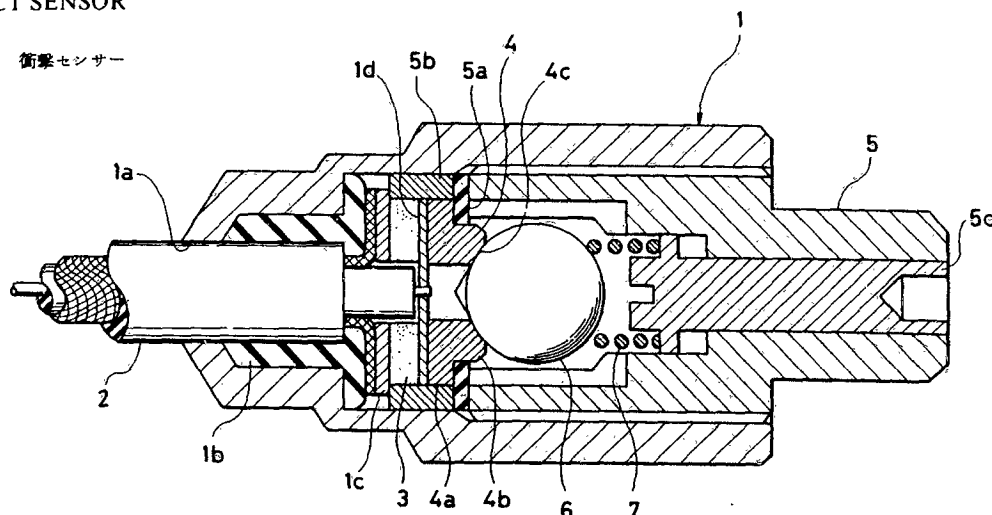
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(54) Title: IMPACT SENSOR

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(57) Abstract

This invention relates to an impact sensor which does not have any electric contacts exposed to the open air and any moving portions but has high durability and high reliability and can reliably detect collision of a car for a long period even when mounted on a car. The impact sensor comprises a piezoelectric element (3, 13) which, when compressed, generate a voltage corresponding to the compressive force, a pair of electrodes (1c, 1d, 11c, 14) sandwiching the piezoelectric element, an inertia member (6, 16) for applying the compressive force to one of the electrodes and a biasing member (7, 17) for biasing the inertia member (6, 16) towards the piezoelectric element (3, 13). When an impact force is applied to the inertia member (6, 16), the inertia member (6, 16) compresses the piezoelectric element (3, 13) with the compressive force corresponding to this impact force and the piezoelectric element (3, 13) generates the voltage corresponding to the compressive force.

(57) 要約

本発明は大気中に晒される電気接点がなく、しかも可動部分がなく、耐久性に優れ、信頼性が高く、長期間車両に搭載されていても確実に車両の衝突を検知できる衝撃センサーであって、圧迫されると、圧迫力に応じた大きさの電圧を発生する圧電素子（３，１３）と、該圧電素子を挟んでいる１対の電極（１ｃ，１ｄ，１１ｃ，１４）と、一方の電極に圧迫力を加えるための慣性体（６，１６）と、該慣性体（６，１６）を圧電素子（３，１３）に向う方向に押圧している付勢部材（７，１７）と、を備え、衝撃力が慣性体（６，１６）に加えられると慣性体（６，１６）が衝撃力に応じた大きさの押圧力で圧電素子（３，１３）を圧迫し、圧電素子（３，１３）から圧力に応じた大きさの電圧が発生される。

情報としての用途のみ

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SPECIFICATION

IMPACT SENSOR

TECHNICAL FIELD

The present invention relates to an impact sensor suitable for use with a vehicle airbag constructed to protect a vehicle occupant from impact in the event of a vehicle collision.

BACKGROUND ART

In order to protect a vehicle occupant from impact, a vehicle airbag has recently come into increasing use.

Such an airbag is inflated instantaneously when a vehicle collision is detected, and its operation depends heavily on the performance of an impact sensor.

United States Patent No. 4,827,091 discloses an acceleration sensor designed to detect a substantial change in the speed of a motor vehicle in the event, for instance, of a vehicle collision and comprises a cylindrical body formed of an electrically conductive material, a magnetic inertial mass mounted for axial movement within the cylindrical body, an electrically conductive element attached to at least one axial end of the magnetic inertial mass, a pair of electrical terminals mounted to one axial end of the cylindrical body and electrically bridged upon contact with the electrically conductive element of the magnetic inertial mass, and a mag-



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netic biasing body mounted to the other end of the cylindrical body and adapted to magnetically bias the magnetic inertial mass.

With this acceleration sensor, the magnetic inertial mass is magnetically biased toward the magnetic biasing body. When the acceleration sensor is subject to no or little accelerating force, the magnetic inertial mass is fixed in place in the other end of the cylindrical body.

When the acceleration input is of sufficient magnitude, the magnetic inertial mass is displaced against the biasing force of the magnetic biasing body. At this time, an electric current is induced in the cylindrical body to provide a magnetic force to return the magnetic inertial mass or to retard the displacement of the magnetic inertial mass. This results in a decrease in the speed of the magnetic inertial mass.

When the acceleration input is less than a predetermined (threshold) level, the magnetic inertial mass does not reach the one end of the cylindrical body and then returned to the other end of the cylindrical body from any other position short of the one end of the cylindrical body by a biasing force of the magnetic biasing body.

When the acceleration input is greater than a predetermined (threshold) level (for example, a vehicle incorporating this acceleration sensor is crashed), the magnetic inertial mass reaches the one end of the cylindrical body. The



electrically conductive element or end surface of the magnetic inertial mass is then brought into contact with the both terminals to electrically bridge the two terminals. If a voltage has previously been applied between the two terminals, an electric current flows between the terminals when the two terminals are short-circuited. This electric current shows a vehicle collision.

In the sensor of United States Patent No. 4,827,091, the magnetic inertial mass is advanced to a full extend so as to contact a pair of electrodes. This electrically bridges the two electrodes. In order for the sensor to properly operate for a prolonged period of time, the inner surface of the cylindrical body within which the magnetic inertial mass is slidably moved must be totally flat and free of friction and corrosion. Additionally, the ends of the electrodes and the magnetic inertial mass must be totally free of rust or corrosion. Therefore, the cylindrical body should be made of a material which provides high resistance to corrosion, and its inner surface should also be finely abraded. This results in a substantial increase in the production cost. Also, the electrodes should be plated with gold so as to fully prevent corrosion. This further increases manufacturing costs.

DISCLOSURE OF THE INVENTION

It is the object of the present invention to overcome or substantially ameliorate the above disadvantages.

There is disclosed herein an impact sensor comprising:

a piezoelectric element adapted to provide a voltage of a magnitude corresponding to a pressure applied thereto;

an inertial mass for applying a pressure to said piezoelectric element and having an end surface;



a pair of electrodes disposed to sandwich said piezoelectric element, pressure exerted from said inertial mass being applied to one of the pair of electrodes;

5 a biasing member disposed to press said inertial mass toward said piezoelectric element; and

a pressure receiving element disposed between said one electrode and said inertial mass for transmitting pressure from said inertial mass to said one electrode, said pressure receiving element having a recess, said end surface of the inertial mass contacting the recess so that when
10 impact is imparted to said inertial mass, said piezoelectric element is pressed with a pressure of a level corresponding to the impact and said piezoelectric element provides a voltage of a level corresponding to the pressure applied thereto.

15 Preferably, the inertial mass is in direct contact with the electrode, or a pressure receiving element is disposed between the electrode and the inertial mass to transmit the pressure from the inertial mass to the electrode.

Preferably, the inertial mass has a semispherical end in contact with the electrode or the pressure receiving element.

20 Preferably, the electrode or the pressure receiving element has a recess shaped to diverge gradually toward its top, and the inertial mass has an end surface in contact with the inner surface of the recess.

Preferably, the recess is, for example, a groove of a V-shaped or cone-shaped section, or has a round surface.

25 There may be provided a means for receiving an output voltage from the piezoelectric element and determining whether the output voltage is greater than a predetermined (threshold) level. A signal may be provided to inflate an airbag when the output voltage exceeds the predetermined level.



The inertial mass may, for example, be a ball. Also, the inertial mass may have a semispherical end and a continuous cylindrical portion. The cylindrical portion may include a recess at its rear end to receive a spring as a biasing member.

5 The inertial mass may be formed from a magnetic material. An electromagnetic unit may be included to apply a magnetic force to the inertial mass to move the inertial mass away from the piezoelectric element. An electric current may be delivered to the electromagnetic unit to move the inertial mass away from the piezoelectric element and
10 then, stopped. The piezoelectric element may be operable to provide a voltage upon the delivery and stoppage of the electric current so as to test the operation of the impact sensor.

BRIEF DESCRIPTION OF THE DRAWINGS

15 A preferred form of the present invention will now be described by way of example with reference to the accompanying drawings, wherein:

Fig. 1 is a sectional view, in plan, of an impact sensor according to a first embodiment of the invention;

Fig. 2 is a perspective view of major components used in the impact sensor;

20 Fig. 3 is a view showing a waveform of an output voltage in the event of a vehicle collision;

Fig. 4 is a view showing a waveform of an output voltage in the event of a rear-end collision;

25 Fig. 5 is a sectional view, in plan, of an impact sensor according to a second embodiment of the invention;

Fig. 6 is a view showing a waveform of an output during testing;

Fig. 7 is a sectional view, in perspective, of an electrode plate or a pressure receiving plate 41;



Fig. 8 is a sectional view, in perspective, of an electrode plate or a pressure receiving plate 43; and

Fig. 9 is a diagram of an airbag system incorporating the impact sensor.

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BEST MODE FOR CARRYING OUT THE INVENTION

Fig. 1 is a sectional view, in plan, of an impact sensor. Fig. 2 is an exploded view of the principal part of the impact sensor.

With reference to Fig. 1, 1 is a cylindrical housing.

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The housing 1 has an opening 1a through which one end of an output cable 2 extends into the housing 1.

Within the housing 1, a cylindrical electrode holder 1b, a doughnut-shaped cathode plate 1c, a piezoelectric element 3, and an anode plate 1d are fit around the output cable 2 in that order.

The output cable 2 is connected to the cathode plate 1c and the anode 1d, respectively.

The piezoelectric element 3 is constructed to produce a voltage in proportion to an external compressive force and is preferably a known piezoelectric ceramic that provides a constant voltage output.

4 is a pressure receiving element. The pressure receiving element 4 has a large diameter portion 4a, a flat side of which is in contact with the anode plate 1d, and a small diameter portion 4b in which a vertical groove 4c extends in a continuous fashion. The vertical groove 4c has a V-shaped or U-shaped section.

It is particularly important for the vertical groove 4c to extend in a vertical direction and have opposite open ends.

The sensitivity of the impact sensor with respect to lateral impact depends on the angle at which both sides of the vertical groove 4c intersect.

5 is a cap threaded into the housing 1 to close an



open end of the housing 1.

5a is a seal member, and 5b is an insulating ring.

The cap 5 is recessed to receive an inertial mass 6 in the form of a ball.

A spring 7 is disposed between the inertial mass 6 and the bottom of the cap 5 to normally urge the inertial mass 6 against the vertical groove 4c. This results in linear contact of the inertial mass 6 with the vertical groove 4c.

The force of the spring 7 can be adjusted by rotating an adjusting bolt 5c. The adjusting bolt 5c is threaded centrally into the cap 5.

The piezoelectric element 3 is subjected to a certain pressure under the influence of the spring 7 to thereby produce a certain voltage.

The impact sensor of the present invention is mounted in such a manner that the pressure receiving element 4 is positioned forwardly of the inertial mass 6 in the direction of advancement of a vehicle.

The pressure receiving element 4 is arranged such that the groove 4c extends in a vertical direction.

As shown in Fig. 9, the output cable 2 extends from the impact sensor 100 to an inflator actuating circuit 102 which is, in turn, operable to actuate a gas generator (inflator) 101. An electric current is applied to the inflator 101 to rapidly initiate chemical reaction. This results in



the generation of a substantial amount of gas. The gas is introduced into an airbag 103 as folded to rapidly inflate the airbag 103.

The inflator actuating circuit 102 compares an output voltage from the piezoelectric element 2 with a predetermined voltage (threshold level) and provides a current to actuate the inflator 101 only when the output voltage from the piezoelectric element 3 exceeds a predetermined (threshold) level.

Operation of the impact sensor thus constructed is as follows.

NO COLLISION

In the event of no collision, the static force of the spring 7 is transmitted from the inertial mass 6 through the pressure receiving element 4 and the anode plate 1d to the piezoelectric element 3. No peak voltage is output from the piezoelectric element 3 as such.

The impact sensor is thus rendered irresponsive in the event of no collision.

VERTICAL VIBRATIONS

When a vehicle is subject to vertical vibrations, the impact sensor is correspondingly vibrated in a vertical direction.

This results in sliding motion of the inertial mass 6 and the vertical groove 4c. The piezoelectric element 3 does not provide a voltage higher than a predetermined

(threshold) level since the force of the spring 7 to urge the inertial mass 6 against the vertical groove 4c remains substantially unchanged.

The impact sensor is thus irresponsive to vertical vibrations.

HEAD-ON COLLISION AND FRONT-END COLLISION

In the event of a head-on vehicle collision, there is a substantial increase in an acceleration force applied from the inertial mass 6 to the pressure receiving element 3.

The force thus applied to the pressure receiving element 4 is transmitted through the anode plate 1d to the piezoelectric element 3.

As a result, the piezoelectric element 3 provides a peak voltage, as at A in Fig. 3, which is greater than a predetermined (threshold) level. The inflator actuating circuit 102 is then operable to sense this peak voltage so as to actuate the inflator 101. This causes inflation of the airbag.

Also, when a vehicle is hit diagonally from ahead, a component of the acceleration input is applied to the opposite sides of the vertical groove 4c and then, transmitted to the piezoelectric element 3. Likewise, a peak voltage, greater than a predetermined (threshold) level, is output so that the inflator 101 may be actuated to inflate the airbag 103.

SIDEWAYS COLLISION



In the event of a sideways collision, the inertial mass 6 is caused to move either in an upward direction or a downward direction in Fig. 1. The resulting force creates a component force in the slant surfaces of the vertical groove 4c. This force presses the pressure receiving element 4. As a result, the pressure receiving element 4 is moved to the left in Fig. 1 so as to press the piezoelectric element 3 through the anode plate 1d, as in the case of a head-on collision. Now that this pressing force is small, the output voltage from the piezoelectric element 3 is less than a predetermined (threshold) level. Accordingly, the inflator is not rendered operative by the inflator actuating circuit, and no inflation of the airbag is initiated.

REAR-END COLLISION

In the event of a rear-end collision, impact is applied to the left side of the impact sensor in Fig. 1. This causes the inertial mass, then contacted with the pressure receiving element 4 under a certain pressure, to separate from the vertical groove 4c.

The piezoelectric element 3 is no longer subject to a force. This results in a substantial decrease in the output voltage from the piezoelectric element 3.

A waveform in Fig. 4 shows such a substantial decrease in the output voltage as at B.

Now that no positive peak voltage is supplied, the



inflator actuating circuit 102 does not provide an electric current to actuate the inflator 101.

Fig. 5 illustrates another embodiment of the impact sensor which performs a self-testing function to confirm whether or not the impact sensor is properly operating.

In the embodiment, as shown in Fig. 5, an electromagnetic unit 8 surrounds the inertial mass 6. An electric current is applied from a test circuit to a coil 8A.

In this embodiment, a housing 11 has an opening 10 in which a cathod plate or ring 11c is fit. A conductor or bolt 20 is threaded into the cathods plate 11c. A cathods lead terminal 21 is connected to the head of the bolt 20.

A cap 15 is secured to one end of the housing 11 by screws 22. The electromagnetic unit 8 extends along the inner peripheray of the cap 15 and includes a coil 8A, and a cylindrical core 8B formed of a ferromagnetic material.

The core 8B is disposed in coaxial relation to the opening 10. A pressure receiving element 14 and an inertial mass 16 are disposed in coaxial relation to the core 8B and the opening 10. A piezoelectric element 13 is sandwiched between the pressure receiving element 14 and the cathods plate 11c. An insulating sleeve 15b is fit around the pressure receiving element 14 and the piezoelectric element 13.

The pressure receiving element 14 serves as a anode. A rod 24 is secured to the pressure receiving element 14 and



extends at right angles to the side of the pressure receiving element 14. A nut 25 is threaded onto one end of the rod 24. The pressure receiving element 14, like the receiving element 4 shown in Figs. 1 and 2, has a vertically extending groove 14a.

The inertial mass 16 has a semispherical end slidably engageable with the vertical groove 14a of the pressure receiving element 14. The inertial mass 16 is recessed as at 28 at the other, rear end to receive a spring 17. An adjusting bolt 15c is threaded into the cap 15. The spring 17 is compressed between the adjusting bolt 15c and the bottom of the recess 28. The semispherical end of the inertial mass 16 is urged against the vertical groove 14a under the action of the spring 17. The piezoelectric element 13 disposed between the pressure receiving element 14 and the cathods plate 11c is subject to a certain compressive force under the influence of the spring 17.

The impact sensor thus constructed is mounted in the same manner as the one shown in Figs. 1 and 2 and is operable in the same manner to sense impact so as to inflate the airbag.

Additionally, the impact sensor shown in Fig. 5 is able to test its operability itself.

To do this, an electric current is applied from the test circuit to the coil 8A for a short period of time.



Specifically, an electric current is applied to the coil 8A for a short period of time to generate a magnetic flux. This causes the inertial mass 19 to instantaneously retreat or move to the right in Fig. 5. The piezoelectric element 13 is then operable to provide a voltage of the form shown in Fig. 6.

When the inertial mass 16 is moved in a rearward direction instantaneously upon the delivery of an electric current, a lesser amount of force is applied from the spring 17 to the pressure receiving element 14. As a result, output voltage is drastically dropped as at C in the waveform shown in Fig. 6.

When the delivery of the electric current to the electromagnet 8 is stopped, a substantial amount of force is instantaneously applied to the piezoelectric element 13. As a result, a positive peak voltage is generated as at D in Fig. 6.

It will now be understood that the test circuit is operable to confirm, under the same condition as in the event of a rear-end collision (none collision) as well as a collision, whether a predetermined voltage is output from the piezoelectric element 13.

Based on a signal sent from the test circuit, a lamp or other means may be used to show whether the impact sensor is properly operating.



In the foregoing embodiments, the inertial masses 6 and 16 are both engageable with the grooves 4c and 14c of a V-shaped section. Alternatively, an electrode plate or pressure receiving element 41 may be used to have a cone-shaped recess 40 as shown in Fig. 7. Additionally, an electrode plate or pressure receiving element 43 has a round recess 42 as shown in Fig. 8. The recess 42 may have a spherical surface or a ellipsoidal surface.

INDUSTRIAL APPLICABILITY

With the sensor of the present invention, impact is rapidly transmitted since the inertial mass is normally pressed against the piezoelectric element.

The impact sensor is responsive in a quick manner.

The piezoelectric element provides a high voltage in response only to a pressure. This prevents erroneous operation of the sensor when no collision occurs (or in the event of a rear-end collision).

The impact sensor can readily be tested itself simply by incorporating the electromagnet so as to electrically move the inertial mass, and connecting the output cable with the test circuit.

The impact sensor is simple in structure, and is economical to manufacture.

The impact sensor is less subject to fatigue due to



vibrations since no movable components are included and thus can have a high natural frequency as a sensor. The impact sensor is free of friction and corrosion and never malfunctions. Additionally, the present invention has no electrical terminals exposed to an atmosphere and in no way suffers from inadequate electrical bridge due to corrosion of such electrical terminals. Under the circumstances, the impact sensor of the present invention never loses its characteristics even if it is loaded on a vehicle for a considerable period of time and is thus durable and is highly reliable.

In the present invention, impact is converted into electrical energy as an output.

Accordingly, record (impact data) can be taken in a continuous manner.

The operation of the impact sensor can readily be finely adjusted. The impact sensor is advantageously used for experimental and commercial purposes.



The claims defining the invention are as follows:

1. An impact sensor comprising:

a piezoelectric element adapted to provide a voltage of a magnitude corresponding to a pressure applied thereto;

5 an inertial mass for applying a pressure to said piezoelectric element and having an end surface;

a pair of electrodes disposed to sandwich said piezoelectric element, pressure exerted from said inertial mass being applied to one of the pair of electrodes;

10 a biasing member disposed to press said inertial mass toward said piezoelectric element; and

a pressure receiving element disposed between said one electrode and said inertial mass for transmitting pressure from said inertial mass to said one electrode, said pressure receiving element having a recess, 15 said end surface of the inertial mass contacting the recess so that when impact is imparted to said inertial mass, said piezoelectric element is pressed with a pressure of a level corresponding to the impact and said piezoelectric element provides a voltage of a level corresponding to the pressure applied thereto.

20 2. An impact sensor according to claim 1, wherein in case no impact is imparted to a vehicle, a static force of said biasing member is transmitted from said inertial mass to said piezoelectric element through said pressure receiving element and said one electrode so that said impact sensor is unresponsive.

25 3. An impact sensor according to claim 1, wherein in case vertical impact is imparted to a vehicle, said piezoelectric element does not provide a voltage higher than a threshold level so as to open an air bag so that said element sensor is unresponsive to the vertical impact.

30 4. An impact sensor according to claim 1, wherein in case linear impact is imparted to vehicle, when a force larger than a threshold level is applied to said piezoelectric element, said piezoelectric element provides a voltage so as to open an air bag.

35 5. An impact sensor according to claim 1, wherein in case a diagonal impact is applied from forwardly, a component of an acceleration input is applied to the opposite sides of said recess, which is transmitted to said piezoelectric element, so that said piezoelectric element provides a voltage to open an air bag.



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6. An impact sensor according to claim 1, wherein in case a sideways impact is applied, said inertial mass is urged to form a component force in slant surfaces of the recess of said pressure receiving element, which is too small to actuate said impact sensor.

5 7. An impact sensor according to claim 1, wherein in case an impact is applied from rearwardly, said inertial means which is in contact with said pressure receiving element under a certain pressure is separated from said recess and said piezoelectric element produces no voltage to open an air bag.

10 8. An impact sensor according to claim 1, wherein said inertial mass is in direct contact with one of said pair of electrodes.

9. An impact sensor according to claim 1, wherein said inertial mass has a semispherical end in contact with said pressure receiving element.

15 10. An impact sensor according to claim 1, wherein said recess is a V-shaped groove.

11. An impact sensor according to claim 1, wherein said recess has a conical surface.

20 12. An impact sensor according to claim 1, wherein said recess has a rounded surface.

25 13. An impact sensor according to claim 1, further including means for receiving an output voltage from said piezoelectric element and determining whether said output voltage is greater than a predetermined level, said means providing a signal to inflate an airbag when said output voltage exceeds said predetermined level.

30 14. An impact sensor according to claim 1, wherein said inertial mass is a ball or said inertial mass has a semispherical end and a continuous cylindrical portion, and a cavity at its end remote from said semispherical end.

35 15. An impact sensor according to claim 1, wherein said inertial mass is formed from a magnetic material, further including an electromagnetic unit adapted to apply a magnetic force to said inertial mass to move said inertial mass away from said piezoelectric element, whereby an electric current is delivered to said electromagnetic unit to move said inertial mass away from said piezoelectric element, and then, the delivery of said electric current is stopped, said piezoelectric



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element being operable to provide a voltage during a period from when said electric current is delivered until said electric current is stopped, and said voltage being used to test the operation of said impact sensor.

16. An impact sensor substantially as hereinbefore described with reference to the accompanying drawings.

DATED this FIFTH day of MAY 1992

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Patent Attorneys for the Applicant
SPRUSON & FERGUSON

A 5x5 grid of dots forming the letters 'E' and 'O'. The 'E' is formed by dots at (1,1)-(1,5), (2,1), (3,1), (4,1), (5,1), (1,2), (2,2), (3,2), (4,2), (5,2), (1,3), (2,3), (3,3), (4,3), (5,3), (1,4), (2,4), (3,4), (4,4), (5,4), and (1,5). The 'O' is formed by dots at (2,1), (3,1), (4,1), (2,2), (3,2), (4,2), (2,3), (3,3), (4,3), (2,4), (3,4), (4,4), (2,5), (3,5), (4,5), and (5,5).



ABSTRACT

The present invention provides an impact sensor which has neither electrical contacts exposed to an atmosphere nor any movable components, which is durable and highly reliable, and which is able to safely sense a vehicle impact even if loaded in a vehicle for a considerable period of time. The impact sensor comprises a piezoelectric element (3, 13) for generating a voltage of a magnitude in accordance with a pressure, a pair of electrodes (1c, 1d, 11c, 14) disposed to sandwich the piezoelectric element, an inertial mass (6, 16) adapted to apply a pressure to either one of the electrodes, and a biasing member (7, 17) for biasing the inertial mass (6, 16) toward the piezoelectric element (3, 13). When the inertial mass (6, 16) is subject to an impact, the inertial mass (6, 16) is biased to apply to the piezoelectric element (3, 13) a pressure of a level in accordance with the magnitude of the impact. The piezoelectric element (3, 13) then provides a voltage of a magnitude in accordance with the pressure applied thereto.

FIG. 1

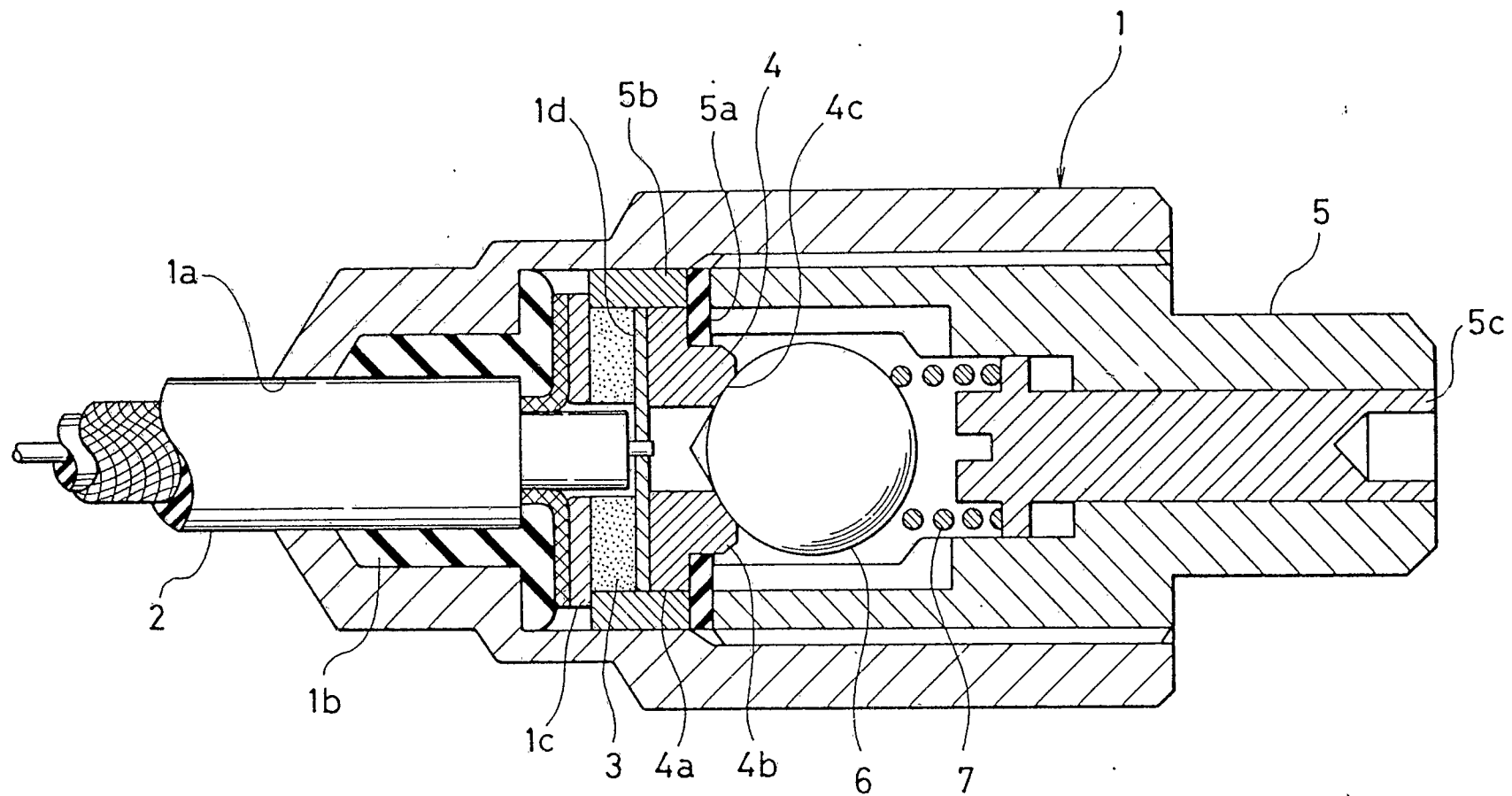


FIG.2

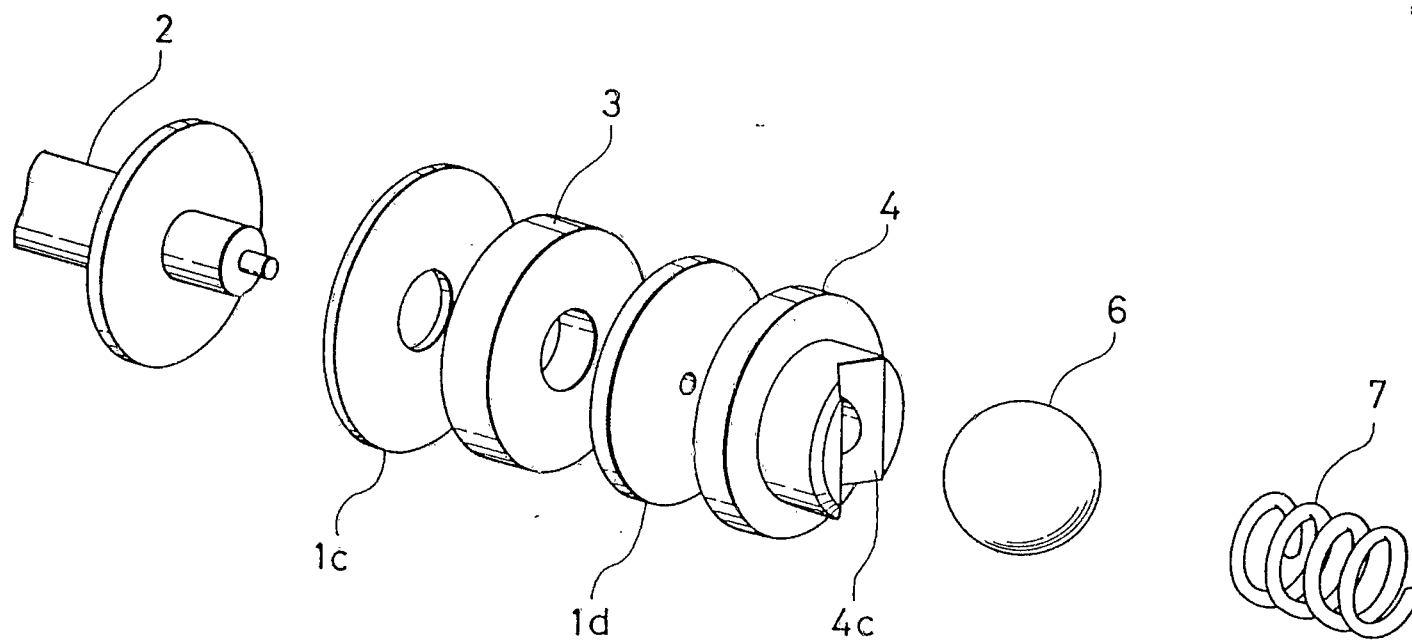


FIG.3

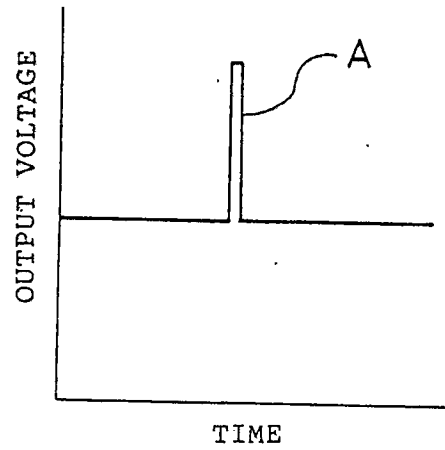


FIG.4

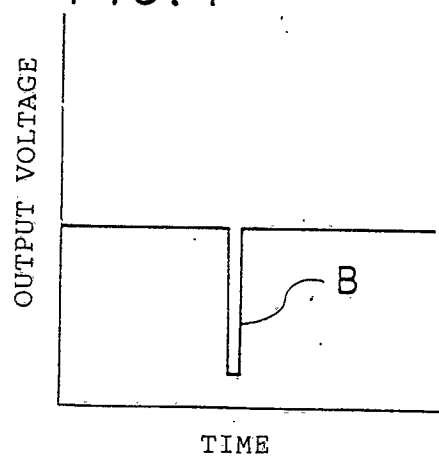


FIG.6

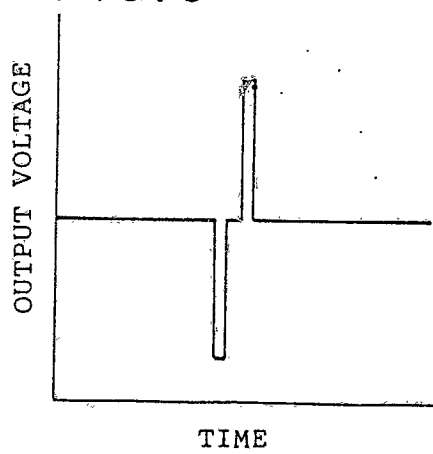


FIG.5

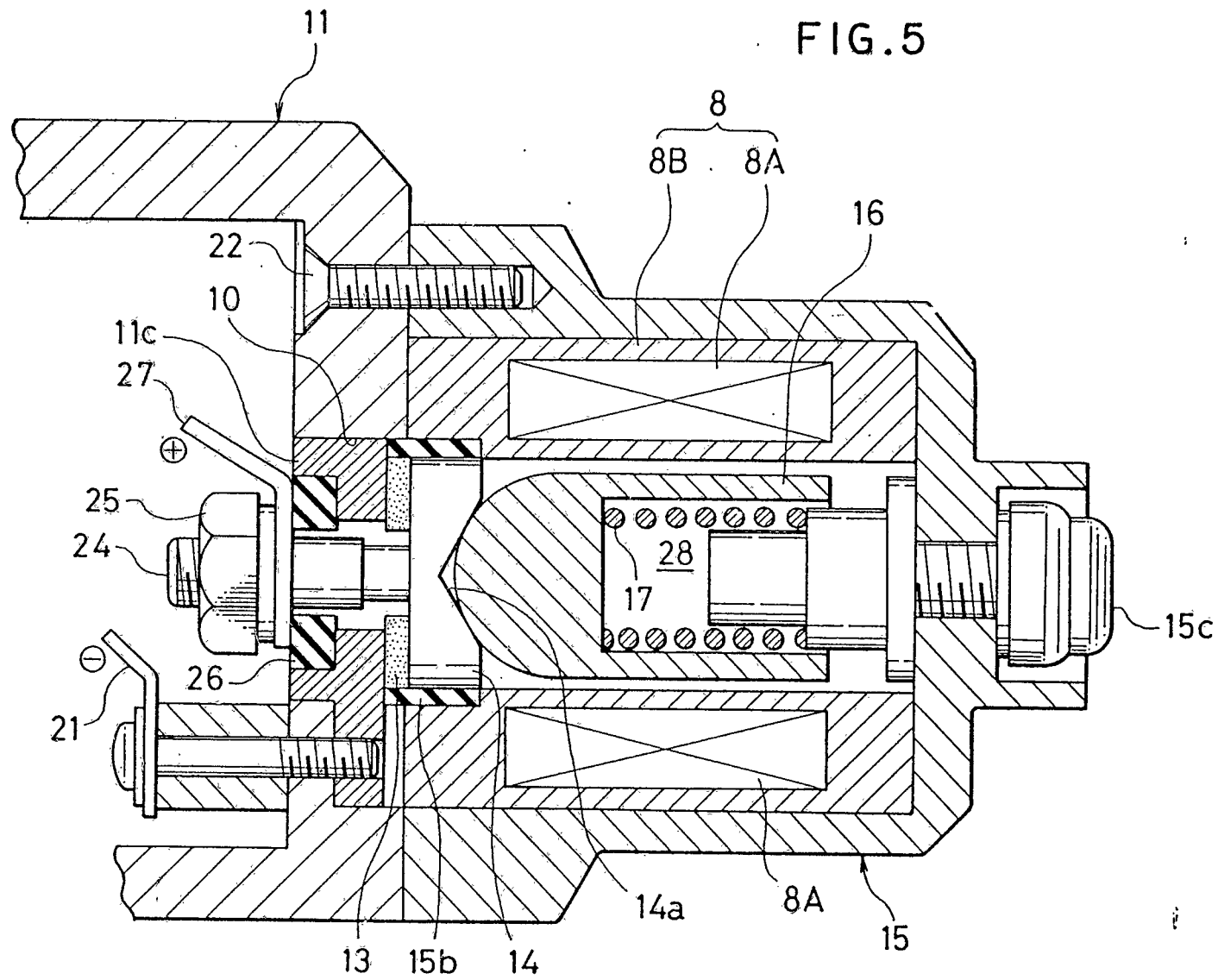


FIG. 7

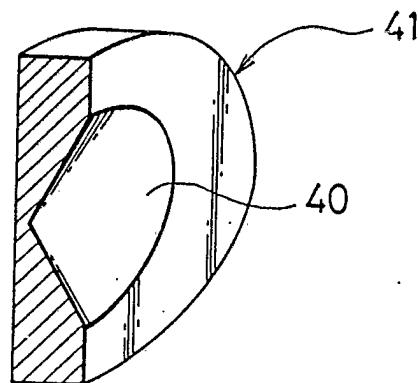


FIG. 8

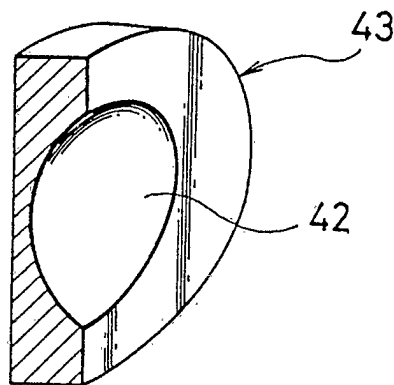
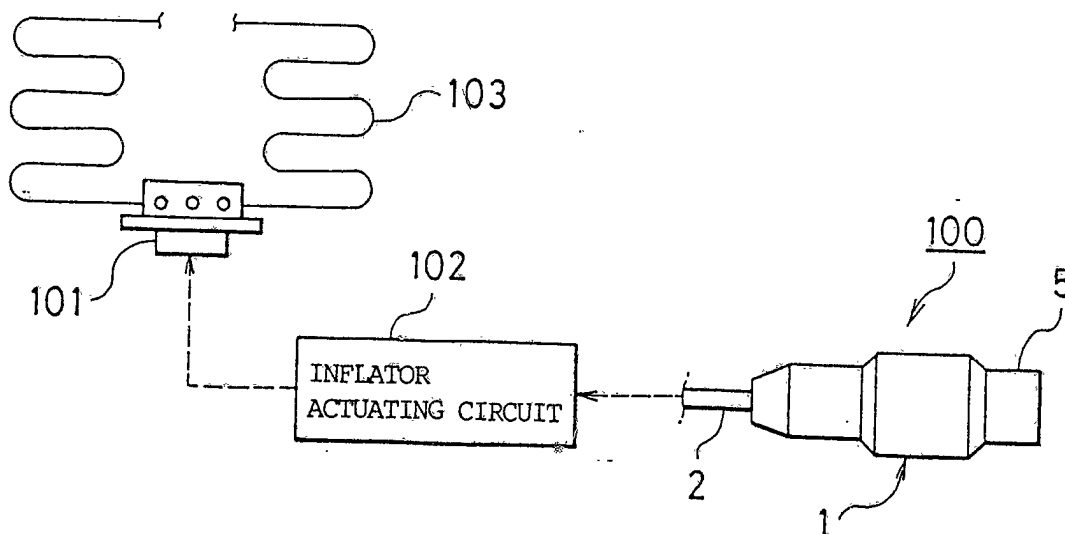


FIG. 9



INTERNATIONAL SEARCH REPORT

International Application No PCT/JP90/01281

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁴		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int. Cl ⁵ G01P15/00, G01P15/02, G01P15/09		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
IPC	G01P15/00, G01P15/02, G01P15/09	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
Jitsuyo Shinan Koho	1965 - 1990	
Kokai Jitsuyo Shinan Koho	1971 - 1990	
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹		
Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
X	JP, Y1, 50-14541 (Shin Meguro Keiki K.K.), 7 May 1975 (07. 05 75), Lines 18 to 30, page 1 (Family: none)	1
X	JP, U, 53-151442 (Nippon Gakki Seizo K.K.), 29 November 1978 (29. 11. 78), Lines 6 to 14, page 1 (Family: none)	1, 2
X	JP, Y2, 62-28523 (Oki Electric Industry Co., Ltd.), 22 July 1987 (22. 07. 87), Lines 2 to 18, page 1 (Family: none)	11
<p>¹⁰ Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"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)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"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</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"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</p> <p>"8" document member of the same patent family</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
December 10, 1990 (10. 12. 90)	December 17, 1990 (17. 12. 90)	
International Searching Authority	Signature of Authorized Officer	
Japanese Patent Office		

国 際 調 査 報 告

国際出願番号PCT/JP 90/ 01281

I. 発明の属する分野の分類		
国際特許分類 (IPC) Int. Cl. G01P15/00, G01P15/02, G01P15/09		
II. 国際調査を行った分野		
調 査 を 行 っ た 最 小 限 資 料		
分 類 体 系	分 類 記 号	
I P C	G01P15/00, G01P15/02, G01P15/09	
最小限資料以外の資料で調査を行ったもの		
日本国実用新案公報 1965-1990年 日本国公開実用新案公報 1971-1990年		
III. 関連する技術に関する文献		
引用文献の カテゴリー ※	引用文献名 及び一部の箇所が関連するときは、その関連する箇所の表示	請求の範囲の番号
X	JP, Y1, 50-14541 (新目黒計器株式会社), 7. 5月, 1975 (07. 05. 75), 第1頁第18-第30行 (ファミリーなし)	1
X	JP, U, 53-151442 (日本楽器製造株式会社), 29. 11月, 1978 (29. 11. 78), 第1頁第6-第14行 (ファミリーなし)	1, 2
X	JP, Y2, 62-28523 (沖電気工業株式会社), 22. 7月, 1987 (22. 07. 87), 第1頁第2-第18行 (ファミリーなし)	11
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IV. 認 証		
国際調査を完了した日 10. 12. 90	国際調査報告の発送日 17.12.90	
国際調査機関 日本国特許庁 (ISA/JP)	権限のある職員 特許庁審査官 白石光男	2 F 8 3 0 4