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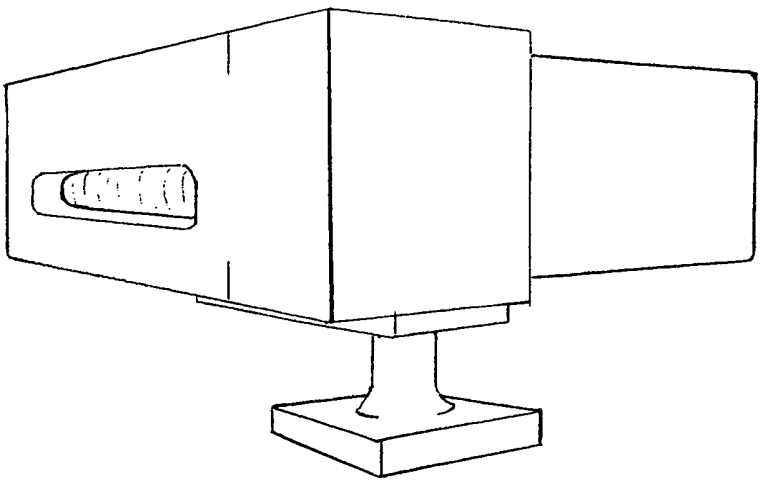
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(54) **Title:** INTERACTIVE CASINGS FOR THE PROTECTION AND REMOTE CONTROL OF INSTRUMENTS SUITABLE FOR AGGRESSIVE INDUSTRIAL ENVIRONMENTS OR AGGRESSIVE CLIMATIC CONDITIONS



(57) **Abstract:** An interactive casing is described for the protection and remote control of instruments selected from sensors, television cameras, thermo-cameras, emitters, actuators, and/or instruments for the elaboration of signals, in a single body or separate bodies, having a door- chamber and an instrument -chamber, containing the instruments to be preserved, electric or electronic means for providing the power supply, electronic means for collecting signals, means for the injection of gas or compressed air, characterized in that the door-chamber contains a chamber and a door, selected from a revolving door having a cylindrical, or truncated conical or spherical shape, or a wedged linear door, consisting, in the case of revolving door, of a cylinder, of a truncated cone or sphere containing a passthrough hole to allow the input and output of signals, a relative housing with a separation cavity and driving means of said cylinder, truncated cone or sphere, in the case of a wedged linear door, consisting of a wedge, a wedged housing and driving means of said wedge. A remote-controlled high-speed open/close valve for fluids is also described.

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INTERACTIVE CASINGS FOR THE PROTECTION AND REMOTE CONTROL OF INSTRUMENTS, SUITABLE FOR AGGRESSIVE INDUSTRIAL ENVIRONMENTS OR AGGRESSIVE CLIMATIC CONDITIONS

The present invention relates to interactive casings for the protection and remote control of instruments, suitable for aggressive industrial environments and/or with aggressive climatic conditions, and the relative preparation process. A remote control valve for fluids is also described.

The industrial production of quality and the convenience of reducing the number of products rejected to the minimum, has led to the massive use of sensors for the simple recording of the process parameters. The use of recording systems interacting with the process for its control and simultaneous regulation under operation, is less frequent, due to their cost. Among the above systems, those which can effect recordings in aggressive industrial environments or contaminating environments due to an early reduction in the life of the instruments used for the registrations (sensors, emitters, actuators, instruments), are rare. Another important situation to be faced is recording operations to be effected under aggressive climatic conditions.

Patent application IT-BO2002A0004888 of Baraldi Chem Gruop Srl claims a recording process of the temperature

distribution during the running of a technological process. Said patent application specifies that, whereas the use of sensors for occasionally detecting the temperature parameters is known, the invention claimed therein, on the contrary, allows by means of an adjustable equipment connected to a structure provided with shutter, the detection of the temperature parameters, their visualization and recording, and the control and regulation of temperatures during the running of the process.

We have now found a casing which allows instruments to be protected, at the same time ensuring a longer life for said instruments and the casing itself.

The purpose of the casing is to prevent a premature reduction of the life of the instruments used for the detection and/or to allow measurements having an adequate reproducibility comparable with each other.

The invention presented in this patent application has several functions. The interactive casing can house and protect sensors only, actuators only, emitters only, instruments only, or a combination thereof. There are several industrial fields of application (foundries of non-ferrous alloys, steelworks, building industry, chemical industry, oil industry, onshore and offshore pipeline constructions, etc..): in short, fields that have characteristics of environment aggressiveness or contamination.

The interactive casing, object of the present invention, for the protection and remote control of instruments, selected from sensors, television cameras, thermo-cameras, emitters, actuators, and/or instruments for the elaboration of signals, in a single body or separate bodies, having a door-chamber and an instrument-chamber, containing the equipment to be preserved, electric or electronic means for providing the power supply, electronic means for collecting signals, means for the injection of gas or compressed air, characterized in that the door-chamber contains a chamber and a door, selected from a revolving door having a cylindrical, or truncated conical shape or sphere, or a wedged linear door, consisting, in the case of a revolving door, of a cylinder, a truncated cone or sphere containing a pass-through hole to allow the input and output of signals, a relative housing with a separation cavity and driving means of said cylinder, truncated cone or sphere, in the case of wedged linear door, consisting of a wedge, a wedged housing and driving means of said wedge.

The casing, object of the present invention, can consist of two bodies (an "instrument body" containing the instrument chamber for protecting sensors and/or actuators and a "door body" containing the door-chamber for the driving of the door) to facilitate the maintenance and the "in loco" installation of the entire spare parts or it can con-

sist of a single body with two chambers (instrument chamber and door chamber). In the case of a door-body, said body alone can represent an independent accessory, useful for being installed in and protecting industrial equipment, already existing on the market for recording and measuring.

The casing can preferably be made of metal or plastic materials.

The instruments can be selected from sensors, television cameras, thermo cameras, emitters, actuators and/or instruments for the elaboration of signals.

In particular, the following can be used:

- Sensors and television cameras for detecting the spectrum of Infrared Rays (IR), the visible spectrum and Ultra Violet (UV) spectrum. Average temperature values can be obtained from the spectra, as well as colour coordinates, and other parameters referring to a pixel or to an area unit or a zone.
- Emitters: laser pointers, lasers for telemetry, lasers for levelling grounds, lasers for topography and virtual elaborations.

Both the wedged linear door and the revolving door prevent or limit the entry of water, oil, powder, metal sprays, chemical substances or other pollutants into the casing and open only for the time necessary for reading the sensors and/or for the action of the actuators.

The injection of gas or compressed air prevents or limits the entry of water, oil, powder or other pollutants into the casing: this is preferably obtained by the presence of an overpressure in both chambers and consequently, in case of separate bodies, it is advisable to have injection means also in the door-chamber.

In the case of a revolving door, the flow of air introduced leaves the casing through the air space, ensuring the property of a sealed casing.

The body or bodies which form the casings, can be produced, for example:

- in aluminum alloys or other metal alloys starting from (a) massive block(s) and excavating the cavities (housing for the door, door activation, instruments and valves) with a miller cutter having numerical control;
- in plastic materials obtained by injection, using aluminum matrices. This avoids welding to have an absolutely sealed room and fine thicknesses can be obtained for lightened, when necessary, the overall weight of the casing.

The lightening is at its maximum when the casing must operate on the arm of a production robot. The installation of robots allows the reading in very particular moments of a productive process and exploration in spaces which cannot

often be reached with fixed instrumentations. The box can be heavier when it has to work from fixed positions.

The manufacturing of the casing and/or parts of the same made of metal alloy can also be envisaged through plastic deformation and assembled in various ways: welding, rivetting, fixing with screws and bolts, insertion, etc..

The manufacturing of the casing and/or parts of the same can also be envisaged in the case of a large number of units by means of the die-casting technology (injection of Al, or Zn or other metal based alloys).

The inputs and outputs of the door-chambers and instrument-chambers (electricity cables for the power supply; cables for electronic signals; feeding tubes for compressed air; tubes for the lubrication of devices in movement; water pipes for casings in which cooling is required) when there are two bodies, are introduced separately into the two bodies in order to facilitate the maintenance and replacement of any body.

In the case of the use of a wedged linear door, it is preferable that:

- the sealing be assured by a gasket housed on one of the walls of the cavity or on the wedge;
- the door be driven with a linear and fast opening and closing movement, obtained through compressed

air valves or double effect valves (hydraulic or with compressed air) or electro-valves and springs. In the short moments (for example tens or hundreds of milliseconds) in which the door is open to allow the reading and the actions of the actuators (input and output of electromagnetic waves or other signals), the use of an air overpressure inside the casing prevents the entry of powder, water vapour, oil-air and other aggressive chemical agents. During the lengthy remaining time, the gasket physically closes the door.

This door having a linear movement avoids a problem generated by doors which open in a conventional way (with a vertical side or horizontal axis, lower or upper). The latter, in the presence, for example, of a cloud of oil-air, have the defect of creating turbulence near the object being measured, modifying its properties.

In the case of the use of a revolving door, it is preferable that:

- the cylinder or the truncated cone be supported on two bearings integral with the housing;
- the door be pneumatically driven in a rotating "forward"-"backward" movement. "Forward": the hole is aligned with the axes of the measuring cones or the symmetry axes of the laser beams, or simply

open door for other types of signals. "Backward": the hole is perpendicular to the above-mentioned axes.

- there be a space smaller than a tenth of mm or approximately tenths of mm between the cylinder and the cylindrical cavity.

In turn the revolving door is able to avoid a possible drawback which could be created by a contact door with a gasket, such as a linear door.

A very long stop could cause the non-opening of the wedged door due to the adhesion between the gasket and the mobile section; in this latter case a button can be envisaged for the manual driving of the door after long stops, before the automatic and remote operation.

In the case of an interactive casing wherein the instrument-chamber contains sensors of electromagnetic waves inside a cone of a certain opening, in the same chamber there can preferably be the presence of two laser pointers each parallel to one of the two generatrices lying on a cone section which contains the axis of the same.

A spherical joint system or a system with horizontal coordinates (height and azimuth) can be used for the orientation of the casing. The latter system can allow the orientation operation to be effected automatically for a scanning on the surface under study.

Should the casing be used in remote places, without the availability of compressed air, the whole operations can be carried out electrically (or electronically) with a remote system:

- opening and closing of the door
- air overpressure inside the casing obtained by means of a fan and a filter:

The casing according to the invention, can be used in environments with relatively high temperatures, by the insertion - in order to prevent the sensors and actuators having a non-linear behaviour with temperature, from providing measurements which are not comparable with each other - of a regulation system of the temperature sensor, so that the service temperature is higher than the environmental temperature, and constant.

In the case of critical high temperature situations, the two metal bodies of the casing are cooled by means of an industrial water circuit.

A further object of the present invention relates to the same revolving-body-door which represents an independent accessory, useful for being installed in industrial equipment already existing on the market for detection and measurements, when said equipment must operate in aggressive or contaminating environments for long periods of time, without the deterioration of the instruments.

The cylindrical or truncated conical revolving-body-door, consists of a cylinder or a truncated cone containing a pass-through hole and terminating at the side surface of the same, a relative housing with a separation air space, driving means of said cylinder or truncated cone and means for injecting gas or compressed air into the air space.

The installation is effected by means of an adapter between the rotating-body-door and the conventional door of the existing equipment.

A further object of the present invention relates to the process for detecting electromagnetic and/or acoustic waves and/or physical and/or chemical magnitudes and/or emitting electro-magnetic and/or acoustic signals by the remote use of sensors, television cameras, thermo-cameras, emitters, actuators, and/or instruments specific for elaborating signals, which is characterized in that it uses the interactive casings described above and claimed in the present application.

We will now describe in particular the laser pointer system and relative process for determining the dimensions of the area measured by the sensors, regardless of the casing /surface distance to be recorded.

The system uses a pair of laser pointers which operate simultaneously. This innovation allows operators, during sighting operations (selection of the area to be measured

and dimensions of the same) or during production (constant verification of the selected area), to obtain information on the circle diameter from which the "rays" or the electromagnetic waves detected arrive, regardless of the sensor-surface distance.

The use of a single laser pointer has serious limits: it only provides information on the position of the center of a circle having a diameter Do (fixed, known) and only when a known distance is used, Lo (fixed). If necessary, in the place of the center, a point on the edge of the circle having a diameter Do, can be displayed.

In order to able to indicate the centre of the circle with a single pointer, regardless of the distance L, it would be necessary to interrupt the passage of the electromagnetic waves, which means interfering with the measurement, for example by means of a diagonal mirror. In this case, however, it is not possible to determine the diameter D.

Two pointers solve all of the above problems.

Fig. 2 shows the measuring cone having a diameter D (whatever it may be) and the distance L (corresponding to D; whatever it may be).

The angle β (or the tangent of β) is an intrinsic characteristic of the sensor optic, which is known. The distance w is a constructive characteristic of the sensor-

chamber (fixed and known). When using the casing in an industrial environment, it is sufficient to measure the distance Z, between the two light points on the surface of interest, in order to be able to obtain D and L.

D and L, in fact, can be calculated by means of the following equations:

$$D = Z - 2 \cdot w$$

$$L = (Z/2 - w) \cdot (1/\mathrm{tg}\ \beta)$$

wherein w and β are known values and Z is measured.

A further object of the present patent application consists of a remote-controlled valve for fluids with a high close/open rate, which consists of a body with a cylindrical or truncated-conical revolving-door, consisting of a cylinder or a truncated cone containing a pass-through hole and terminating at the side surface of the same, a relative housing with a separation air space, driving means of said cylinder or truncated cone and gaskets situated in said housing or housed in the cylinder or truncated cone.

Some embodiments are now described, with reference to figures 1-4, according to the invention.

Fig. 1a and 1b show a casing with a wedged linear-door with two separable bodies.

Fig. 1a is a perspective view, whereas fig. 1b is a sectional side view.

In Fig. 1b the first body (door-chamber) (C1) has a

wedged linear-door consisting of a housing or wedged cavity (1), a wedge (2), a gasket (3), driving means (4), means for the injection of gas or compressed air (5), means for the electric power supply (6), whereas the second body (instrument-chamber) (C2) contains the instruments to be preserved, i.e. a sensor for infrared rays (7) and two laser emitters (8) (only one shown), means for the electric power supply (9), means for injecting gas or compressed air (10), electronic means for obtaining signals (11).

Fig. 2a and 2b show a cylindrical casing with a rotating-door with two separable bodies.

Fig. 2a is a perspective view, whereas fig. 2b is a sectional view from above.

In fig. 2b, the first body (door-chamber) (C3) has a cylindrical revolving-door consisting of a housing (21), a cylinder (22), a pass-through hole (23), driving means (24), means for injecting gas or compressed air (25), means for the electric power supply (26), whereas the second body (instrument-chamber) (C4) contains the instruments to be preserved, i.e. a sensor for infrared rays (27), and two laser emitters (28) (only one shown), means for the electric power supply (29), means for injecting gas or compressed air (30), electronic means for obtaining signals (31).

In fig. 2c the possibility is schematised of effecting

a pointing of an infrared sensor by means of the simultaneous use of two lasers.

The measuring cone (CM) of the infrared sensor (IR) can be observed, together with the cone diameter or measured zone (D), the height of the cone (L) or distance between the sensor and zone measured, the distance (Z) between two luminous points originating from the lasers, the constant distance (w) between any laser beam and a cone generatrix, the semi-opening of the cone (β).

Fig. 3a shows a cylindrical revolving-body-door (C4), the same as that represented in fig. 2a (C3), and fig. 3b shows a sectional view of A-A'. Fig. 3b shows the housing (21), the pass-through hole (23) and the air space (32). The arrows (39) indicate the closing and opening positions of the door.

Fig. 4a and 4b show a remote-control valve for fluids with a high closing/opening rate.

Fig. 4a represents a body with a revolving-door (C5) having a cylindrical revolving-door consisting of a housing (41), a cylinder (42), a pass-through hole (43), driving means (44), means for injecting gas or compressed air (45), means for the electric power supply (46), two gaskets (47) (only one shown), whereas fig. 4b shows the section B-B' in which the housing (41) can be seen together with the pass-through hole (43), the air space (48), the two gaskets

(47). The arrows (49) indicate the closing and opening position of the valve, and the arrows (50) the flow of fluids.

Two examples according to the invention are now provided.

Example 1

Duration and efficiency test.

A casing with a wedged linear-door was produced according to fig. 1a and 1b and tested in real aggressive industrial environments (foundry for the die-casting of aluminum alloys) for more than 1.5 years. The same was assembled on the arm of one of the production anthropomorphic robots, which assist the die-casting machines. It was subjected to accelerations, drops of water and lubricant, and entered into the hot space between the half moulds of a die every time a die-casting was effected (more than several thousand mouldings). The IR sensor and the laser actuators are still active after 1.5 years. The door is still working.

Example 2

The casing with a cylindrical revolving-door prepared as in fig. 2a and 2b, was tested in a laboratory and the door was activated several thousand times, with no wear problems or problems due to blockage of the "opening" function. This latter property is decisive when the information or the detection effected by the sensors controls or is part of a

productive cycle which must have "zero" errors.

This casing with a cylindrical revolving-door uses a pair of laser pointers operating simultaneously. This innovation was introduced to allow the operators to have information on the circle diameter from which the IR "rays" detected arrive, regardless of the sensor-surface distance, during the pointing phase (selection of the area to be measured and dimensions of the same) or during the production (constant verification of the selected area).

The use of a single laser pointer has serious limits: it serves only to give information on the position of the center of a circle having a diameter Do (fixed, known) and only using a known distance, Lo (fixed). If necessary, in the place of the center, a point on the edge of the circle having a diameter Do, can be displayed.

To be able to indicate the centre of the circle with a single pointer, regardless of the distance L, it would be necessary to interrupt the passage of the electromagnetic waves, which means interfering with the measurement, for example by means of a diagonal mirror. In this case, however, it is not possible to determine the diameter D.

Two pointers solve all of the above problems.

Fig. 2 shows the measuring cone having a diameter D (whatever it may be) and the distance L (corresponding to D; whatever it may be).

The angle β (or the tangent of β) is an intrinsic characteristic of the sensor optic, which is known. The distance w is fixed and known. It is sufficient to measure the distance Z, between the two light points on the surface of interest, in order to be able to obtain D and L.

The number of sensors can be: one, two, or more transducers. By using two sensors (or more) the reliability of the remote control operations is increased because the readings are then compared in order to check repeatability, loss of accuracy due to electronic drift of the sensor itself or any other electronic component.

Two sensors work in tandem together with two laser in order to keep the capability of a reliable and simple orientation of the sensors as described for one sensor in Fig. 2c.

In the case of two or more sensors each sensor can alternatively be placed together with its own laser on a rotating support. Each sensor can be orientated in this case independently from the others. Another convenient feature is that the orientation is done without the need of the aperture of the casing.

The capabilities and descriptions concerning sensors apply as well to cameras, thermo-cameras, array of sensors, emitters, actuators, and/or instruments for the elaboration of signals.

CLAIMS

1. An interactive casing for the protection and remote control of instruments selected from sensors, television cameras, thermo-cameras, emitters, actuators, and/or instruments for the elaboration of signals, in a single body or separate bodies, having a door-chamber and an instrument-chamber, containing the instruments to be preserved, electric or electronic means for providing the power supply, electronic means for collecting signals, means for the injection of gas or compressed air, characterized in that the door-chamber contains a chamber and a door, selected from a revolving door having a cylindrical, or truncated conical or spherical shape, or a wedged linear door, consisting, in the case of a revolving door, of a cylinder, of a truncated cone or sphere containing a pass-through hole to allow the input and output of signals, a relative housing with a separation cavity and driving means of said cylinder, truncated cone or sphere, in the case of a wedged linear door, consisting of a wedge, a wedged housing and driving means of said wedge.

2. The interactive casing according to claim 1, wherein the instrument-chamber contains sensors of electromagnetic waves included inside a cone with a fixed opening and two laser pointers each of which parallel to one of the two generatrices lying on a section of the cone containing the

axis of the same.

3. The interactive casing according to claim 1, wherein, in the case of separated bodies, means for the injection of gas or compressed air are also present in the door-chamber.

4. A process for detecting electromagnetic and/or acoustic waves and/or physical and/or chemical magnitudes and/or emitting electro-magnetic and/or acoustic signals by the remote use of sensors, television cameras, thermo-cameras, emitters, actuators, and/or instruments specific for elaborating signals, characterized in that it uses the interactive casing as per one of the claims from 1 to 3.

5. The process according to claim 4, wherein the electromagnetic waves are detected by means of the casing according to claim 2, wherein the two laser pointers operate simultaneously so as to create two luminous points on an emitting body, obtaining from the distance of said two points, both the diameter of the cone, or diameter of the zone measured, and the height of the cone corresponding to the distance between the sensor and the emitter.

6. A cylindrical or truncated conical revolving-body-door, consisting of a cylinder or truncated cone, containing a pass-through hole to allow the input and output of signals and terminating at the side surface of the same, a relative housing with a separating air space, driving means of said cylinder or truncated cone and means for injecting

gas or compressed air into the air space.

7. A remote-controlled valve for fluids with a high closing/opening rate, which consists of a body with a cylindrical or truncated-conical revolving-door, consisting of a cylinder or a truncated cone containing a pass-through hole and terminating at the side surface of the same, a relative housing with a separation air space, driving means of said cylinder or truncated cone and gaskets situated in said housing or housed in the cylinder or truncated cone.

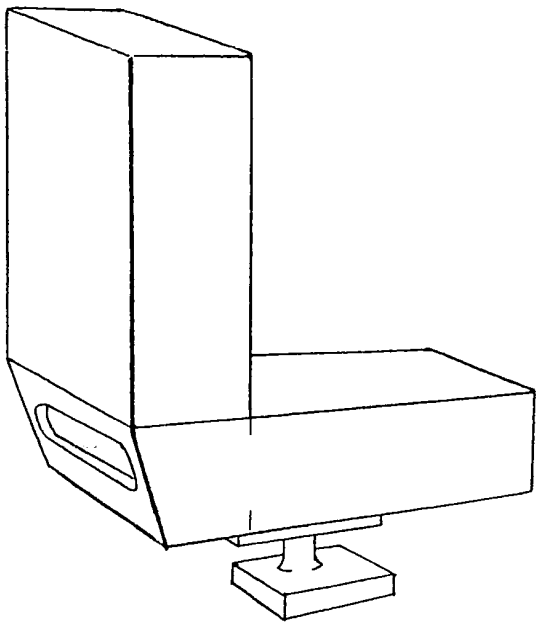


Fig. 1a

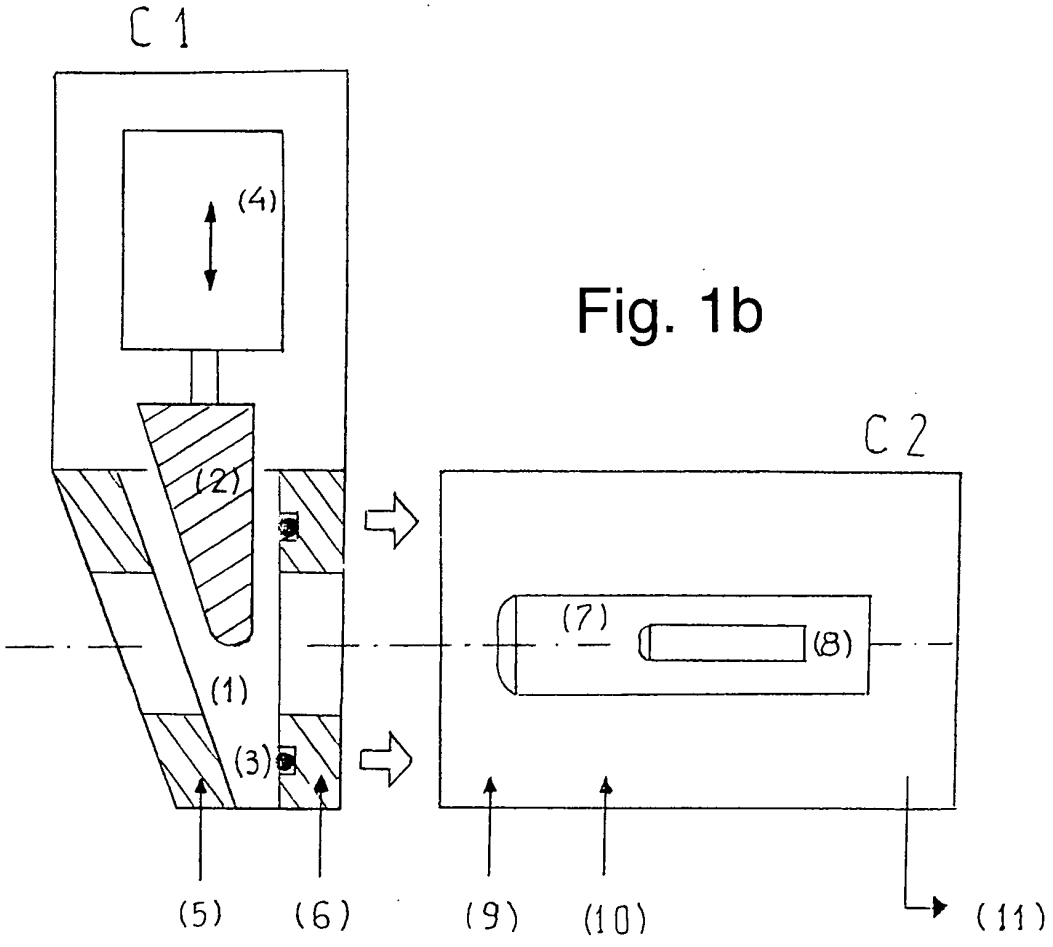


Fig. 1b

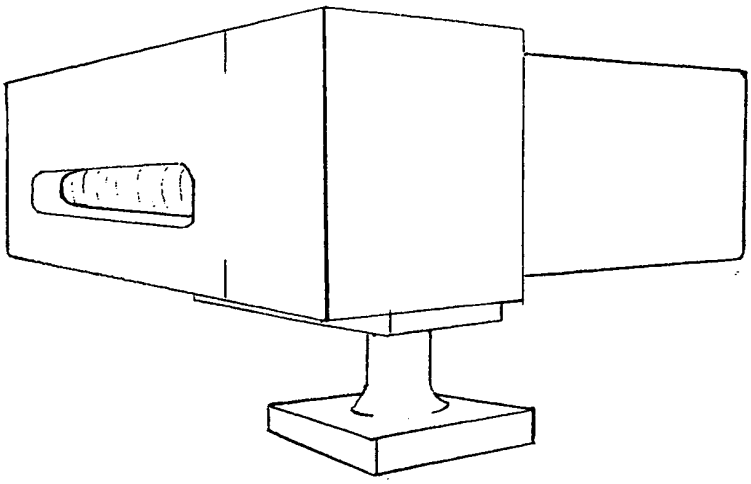


Fig. 2a

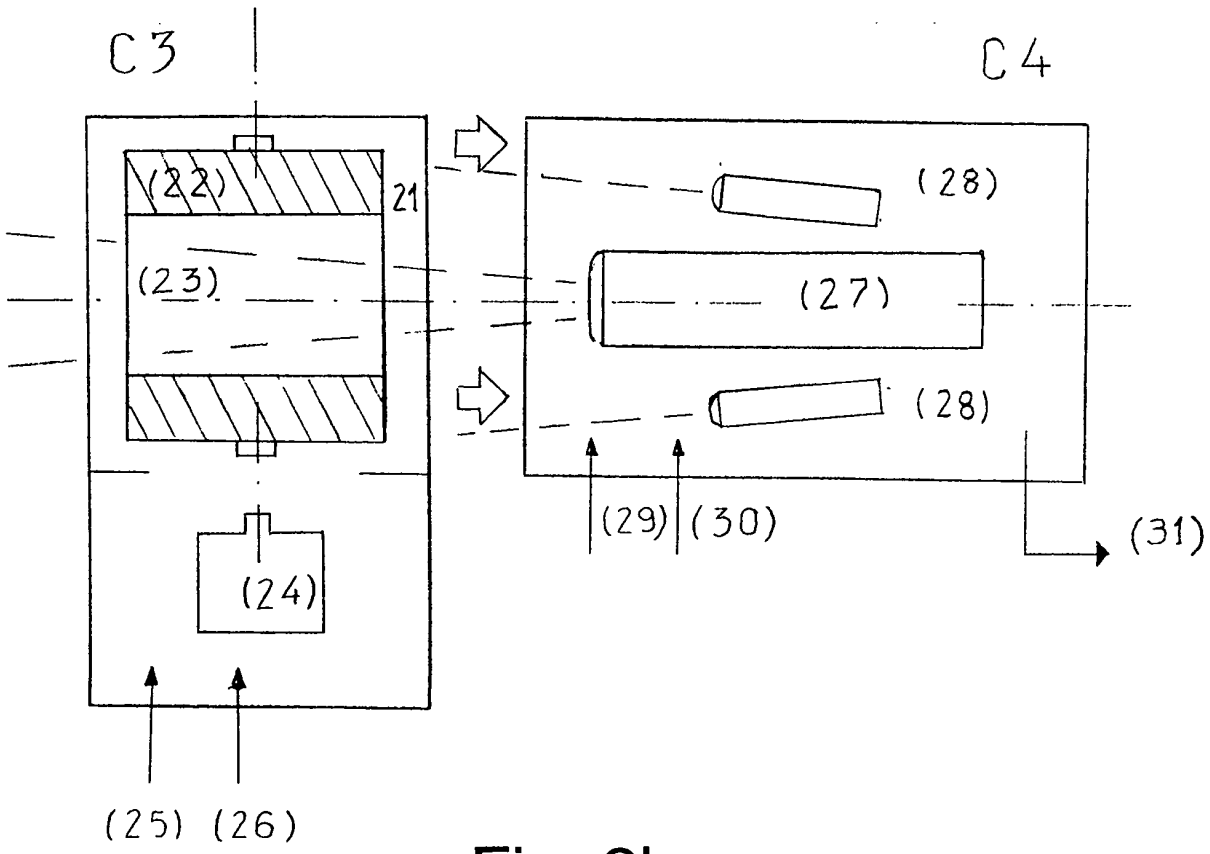


Fig. 2b

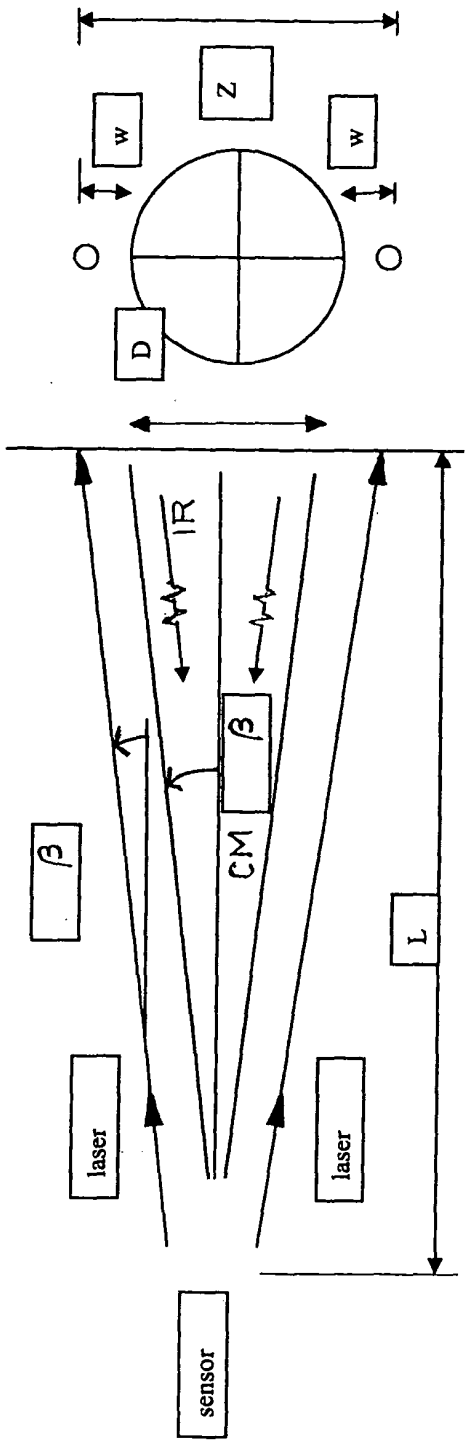


Fig. 2c

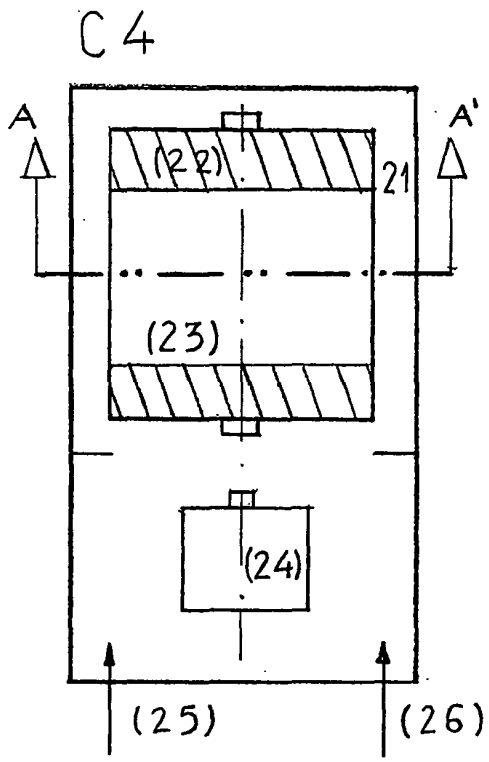


Fig. 3a

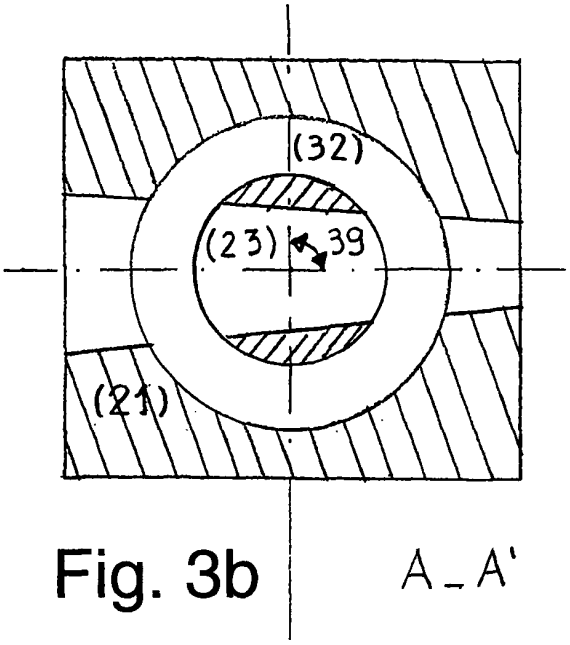


Fig. 3b A_A'

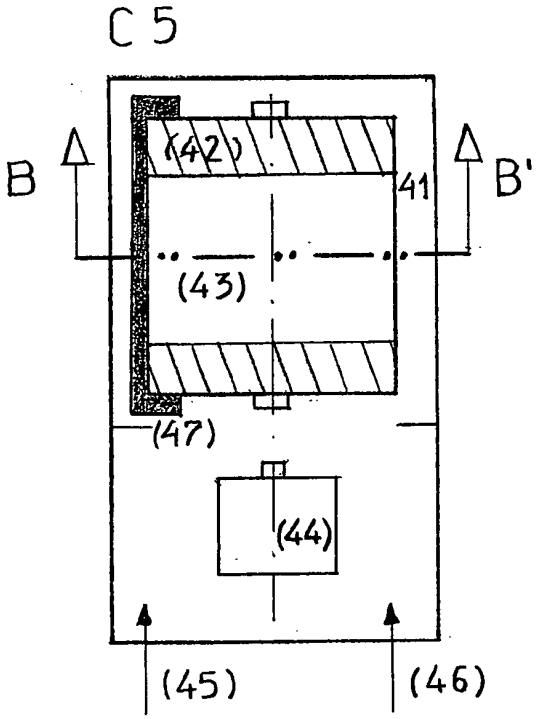


Fig. 4a

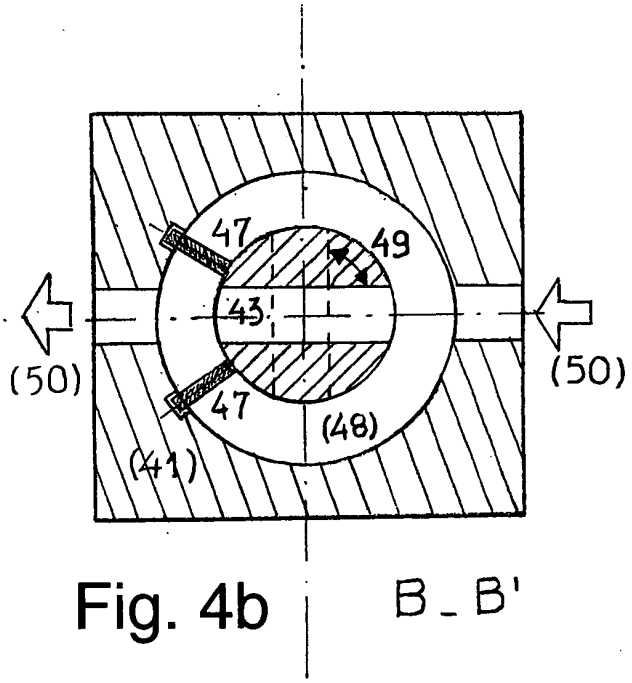


Fig. 4b