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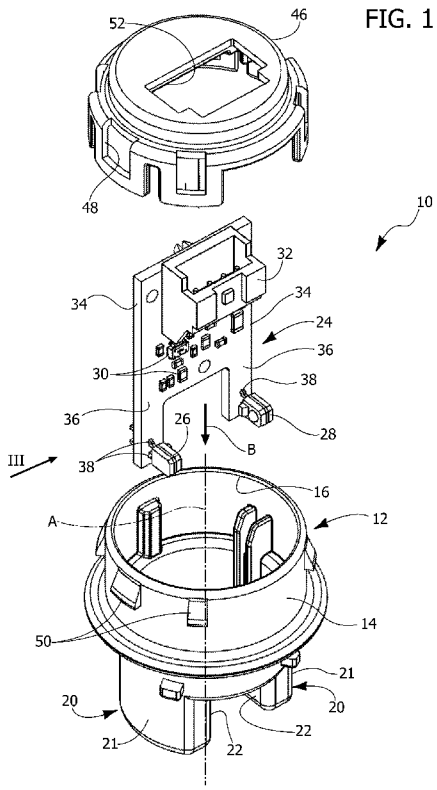
(54) **Title**: TURBIDITY SENSOR WITH INTEGRAL GUIDE FORMATIONS FOR EMITTER AND RECEIVER ALIGNMENT

FIG. 1



(57) **Abstract**: Turbidity sensor for washing machines or dishwashers, comprising: - a hollow casing (12) having two hollow arms (20) parallel to a longitudinal axis (A), and - a printed circuit board (24) with two branches (36) spaced apart from each other which carry, respectively, an optical transmitter (26) and an optical receiver (28) connected to the printed circuit board (24) by means of respective terminals (38), in which the printed circuit board (24) can be inserted into said casing (12) by a movement along said longitudinal axis (A) in the course of which said branches (36) of the printed circuit board (24) are inserted into said hollow arms (20) of the hollow casing (12), and in which said hollow casing (12) is provided with integral guide formations (40, 42) formed on the inner surfaces of said hollow arms (20), in which said guide formations (40, 42) receive and orient the receiver and transmitter (26, 28) in the course of the insertion of the printed circuit board (24) into the hollow casing (12) in said longitudinal direction (A).

DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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TURBIDITY SENSOR WITH INTEGRAL GUIDE FORMATIONS FOR EMITTER AND RECEIVER ALIGNMENT

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DESCRIPTION

Technical field

The present invention relates to a turbidity sensor for washing machines or dishwashers, adapted to detect the level of turbidity of a liquid during a wash cycle.

Background of the invention

Optical sensors adapted to detect the turbidity of a liquid in a washing machine or dishwasher are well known. These sensors typically comprise an optical transmitter which transmits light radiation through the washing liquid and an optical receiver which receives the optical radiation transmitted by the transmitter after the passage of the radiation through the washing liquid. By comparing the measurement of the optical radiation transmitted by the transmitter with the measurement of the optical radiation received by the receiver, the level of turbidity of the washing liquid can be determined.

The precision of turbidity sensors depends on a number of factors, including the dispersion of the optical radiation transmitted by the transmitter. In order to reduce the effects of dispersion, there is a known way of using transmitters which generate a beam having a small cross section in the direction of propagation. For this purpose, use is made, for example, of laser transmitters. However, transmitters of this type are costly. Furthermore, transmitters generating a beam with a small cross section must be aligned very precisely with the receiver.

US-A-2007/0188763 describes a turbidity sensor comprising a diaphragm system placed between the

transmitter and the receiver, enabling the precise alignment of the transmitter and receiver to be avoided. By using the diaphragm it is possible to establish a purely approximate alignment between the transmitter and the receiver, the actual alignment being produced by the diaphragm which generates a measuring beam aligned between the transmitter and the receiver.

The drawback of the solution described in US-A-2007/0188763 is the need to provide the sensor with an additional component (the diaphragm) in order to align the measuring beam between the transmitter and the receiver.

Object and summary of the invention

The object of the present invention is to provide a simple and economical turbidity sensor, enabling a precise alignment to be established between the transmitter and receiver while using a smaller number of components than in the known solutions.

According to the present invention, this object is achieved with a turbidity sensor having the characteristics described in claim 1.

The claims form an integral part of the teachings provided in relation to the invention.

Brief description of the drawings

The present invention will now be described in detail with reference to the attached drawings, provided purely by way of non-limiting example, wherein:

- Figure 1 is an exploded perspective view of a turbidity sensor according to the present invention,

- Figure 2 is an exploded view in elevation in the direction of the arrow II in Figure 1,

- Figure 3 is an exploded cross section taken along the line III-III of Figure 2,

- Figure 4 is an axial section through the sensor of Figure 1, and

- Figure 5 is a cross section taken along the line V-V of Figure 4.

Detailed description of embodiments of the invention

With reference to the drawings, the number 10 indicates a turbidity sensor for washing machines or dishwashers. The sensor 10 comprises a hollow casing 12 of plastic material, having a longitudinal axis A. The casing 12 has a cylindrical lateral wall 14 having a circular aperture 16 at one of its ends. The hollow casing 12 has a bottom wall 18 and two hollow arms 20 extending beyond the bottom wall 18 in a direction parallel to the longitudinal axis A. The hollow arms 20 are made in one piece with the lateral wall 14, and have respective outer walls 21 and inner walls 22. The inner walls 22 face each other and are parallel to the longitudinal axis A.

The sensor 10 comprises a printed circuit board 24 which carries an optical transmitter 26 and an optical receiver 28. The printed circuit board 24 also carries the components 30 of an electronic control circuit associated with the transmitter 26 and the receiver 28. The printed circuit board 24 also carries an electrical connector 32 for the electrical connection of the sensor 10 to an external circuit.

The printed circuit board 24 has two opposing longitudinal edges 34 which are parallel to each other and are placed parallel to the longitudinal axis A. The printed circuit board 24 has two branches 36 spaced apart from each other in such a way that one end of the board 24 is substantially U-shaped. The transmitter 26 and the receiver 28 are fixed to the ends of the respective arms 36. The

transmitter 26 can be, for example, an LED, while the receiver 28 can be, for example, a phototransistor, a photodiode or a solar cell. The hollow casing 12 is permeable to the optical radiation generated by the transmitter 26, at least on the inner walls 22. Preferably, the whole casing 12 is made from a single transparent plastic material. With particular reference to Figure 2, the transmitter 26 and the receiver 28 are fixed to the printed circuit board 24 by means of respective metal terminals 38 which are inserted and fixed into respective holes in the printed circuit board 24.

As shown in Figures 1 and 2, the transmitter 26 and the receiver 28 are spaced at a certain distance from the surface of the front of the printed circuit board 24.

The transmitter 26 and the receiver 28 are connected to, and project from, the front surface of the printed circuit board 24, by means of respective portions of the metal terminals 38. The metal terminals 38 have a degree of flexibility such that the transmitter 26 and the receiver 28 can be displaced to a small extent relative to the printed circuit board 24 by the elastic deformation of the portions of the terminals 38 which extend between the body of the transmitter 26 or of the receiver 28 and the front surface of the printed circuit board 24.

The printed circuit board 24 is inserted into the hollow casing 12 by a movement in a direction parallel to the longitudinal axis A, as indicated by the arrow B in Figures 1, 2 and 3.

With particular reference to Figure 5, the hollow arms 20 of the casing 12 have, on the inner surfaces of their walls 21, 22, respective guide formations 40, 42 which receive and guide the transmitter 26 and the receiver 28 in

the course of the insertion of the printed circuit board 24 into the hollow casing 12 in the longitudinal direction A. Each of these guide formations is, for example, formed by two parallel ribs 40, 42 which extend parallel to the longitudinal axis A. The ribs 40, 42 are formed, respectively, on the inner surfaces of the walls 21, 22 of the arms 20. The ribs 40, 42 are located on opposite sides of a plane which lies parallel to the longitudinal axis A and which passes through the terminals 38 of the transmitter 26 and the receiver 28. The ribs 40, 42 are preferably spaced apart from each other in a direction perpendicular to the printed circuit board 24. The ribs 40, 42 come into contact with opposite sides of the transmitter 26 and the receiver 28, and form guides for the orientation of the transmitter 26 and the receiver 28 in such a way that the respective transmitting and receiving surfaces are correctly aligned with each other. The alignment of the transmitter 26 with the receiver 28 is made possible by the elastic yielding properties of the portions of the terminals 38 which connect the transmitter 26 and the receiver 28 to the printed circuit board 24. The alignment takes place automatically as a result of the insertion of the printed circuit board 24 into the hollow casing 12.

Preferably, the hollow casing 12 is provided with a further guide which receives the printed circuit board 24. This further guide is preferably formed by opposing grooves 44 which receive the opposing longitudinal edges 34 of the printed circuit board 24.

With reference to Figures 1-3, the sensor 10 is provided with a cover 46 which is fixed to the hollow casing 12 after the insertion of the printed circuit board 24. The cover 46 is preferably snap-fitted to the casing 12

by means of apertures 48 which engage with teeth 50 formed on the outer surface of the cylindrical wall 14 of the hollow casing 12. The cover 46 is also provided with a front aperture 52 facing the connector 32 of the printed circuit board 24.

The solution according to the present invention enables the transmitter 26 and the receiver 28 to be aligned with each other by means of integral guides 40, 42 formed in the hollow casing 12. The alignment between the transmitter 26 and the receiver 28 is established in the course of the insertion of the printed circuit board 24 into the casing 12, without the need to perform any preliminary operation for aligning the transmitter 26 with the receiver 28.

The present invention does not require diaphragms or other additional components for the optical alignment of the radiation transmitted by the transmitter 26.

Clearly, provided that the principle of the invention is retained, the details of construction and the forms of embodiment can be varied widely from what has been described and illustrated, without departure from the scope of the invention as defined by the following claims.

CLAIMS

1. A turbidity sensor for washing machines or dishwashers, comprising:

- a hollow casing (12) having two hollow arms (20) parallel to a longitudinal axis (A), and

- a printed circuit board (24) with two branches (36) spaced apart from each other which carry, respectively, an optical transmitter (26) and an optical receiver (28) connected to the printed circuit board (24) by means of respective terminals (38),

in which the printed circuit board (24) can be inserted into said casing (12) by a movement along said longitudinal axis (A) in the course of which said branches (36) of the printed circuit board (24) are inserted into said hollow arms (20) of the hollow casing (12),

characterized in that said hollow casing (12) is provided with integral guide formations (40, 42) formed on the inner surfaces of said hollow arms (20), in which said guide formations (40, 42) receive and orient the receiver and transmitter (26, 28) in the course of the insertion of the printed circuit board (24) into the hollow casing (12) in said longitudinal direction (A).

2. The turbidity sensor as claimed in claim 1, characterized in that each of said guide formations comprises two longitudinal ribs (40, 42) located on opposite sides of a plane which lies parallel to said longitudinal axis (A) and which passes through said terminals (38) of the transmitter and receiver (26, 28).

3. The turbidity sensor as claimed in claim 2, characterized in that said ribs (40, 42) are spaced apart from each other in a direction perpendicular to said printed circuit board (24).

4. The turbidity sensor as claimed in claim 1, characterized in that the transmitter (26) and the receiver (28) are spaced apart from the printed circuit board (24) and are connected to, and project from, the printed circuit board (24) by means of respective portions of said terminals (38).

FIG. 1

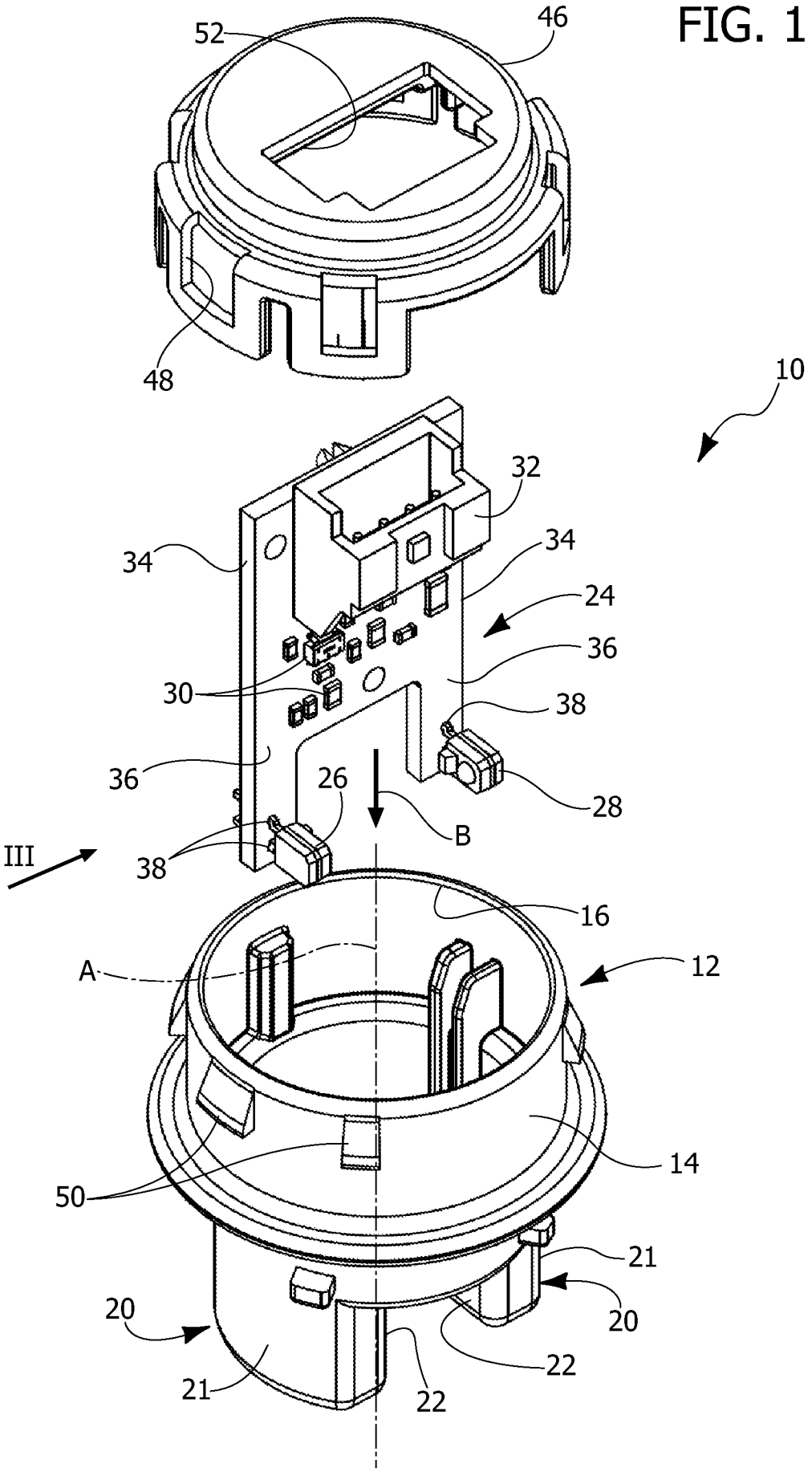
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FIG. 2

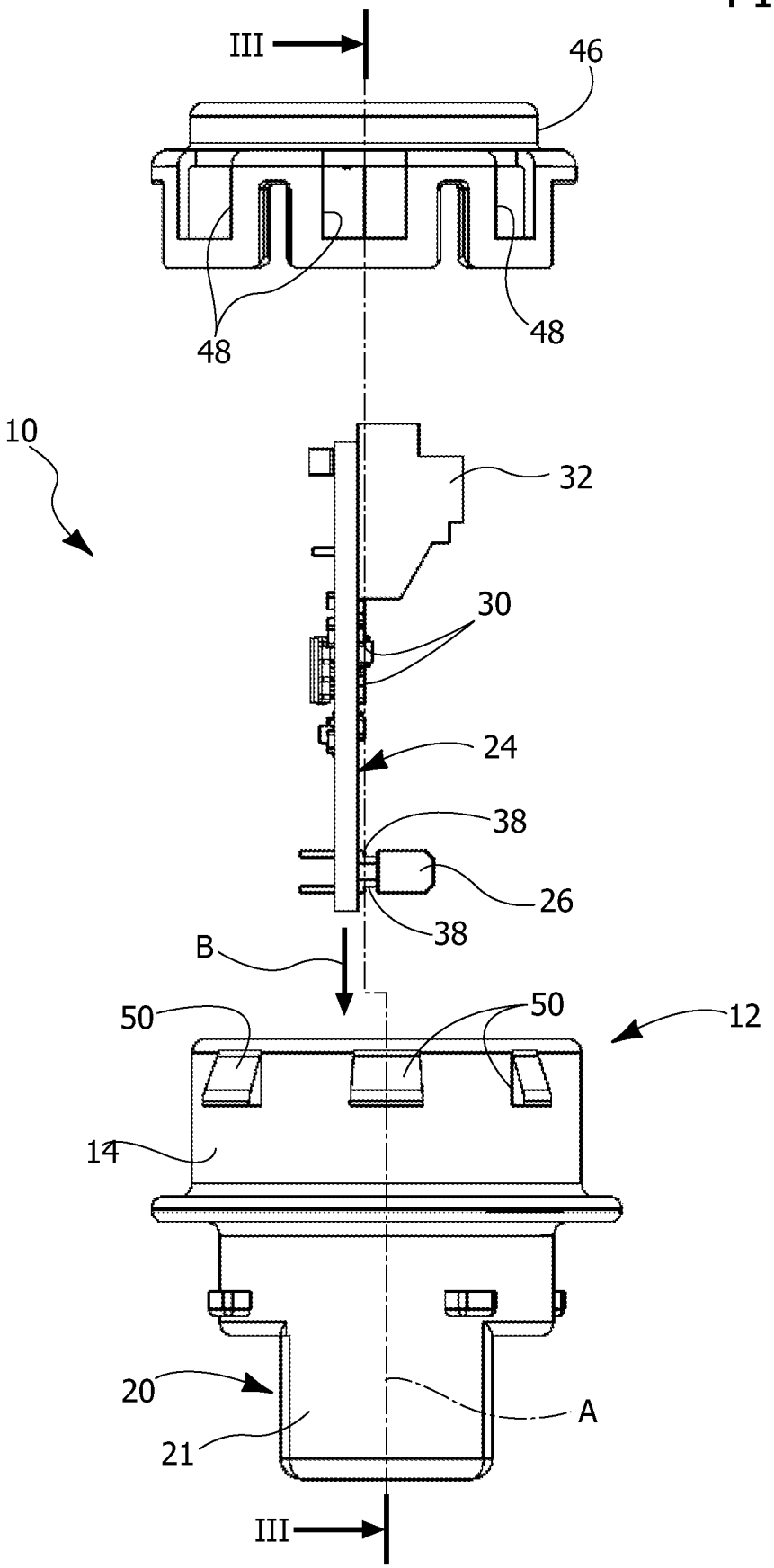


FIG. 3

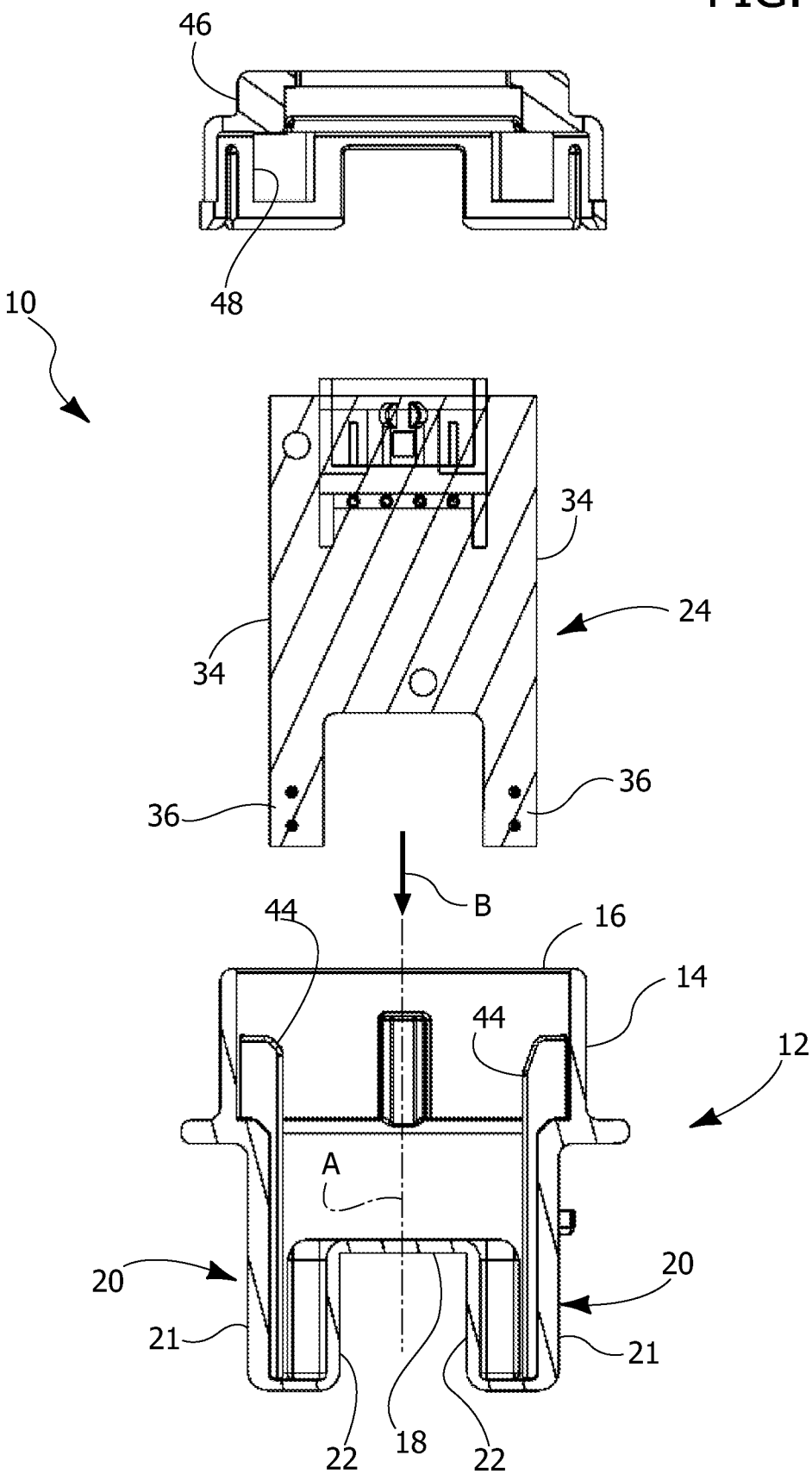


FIG. 4

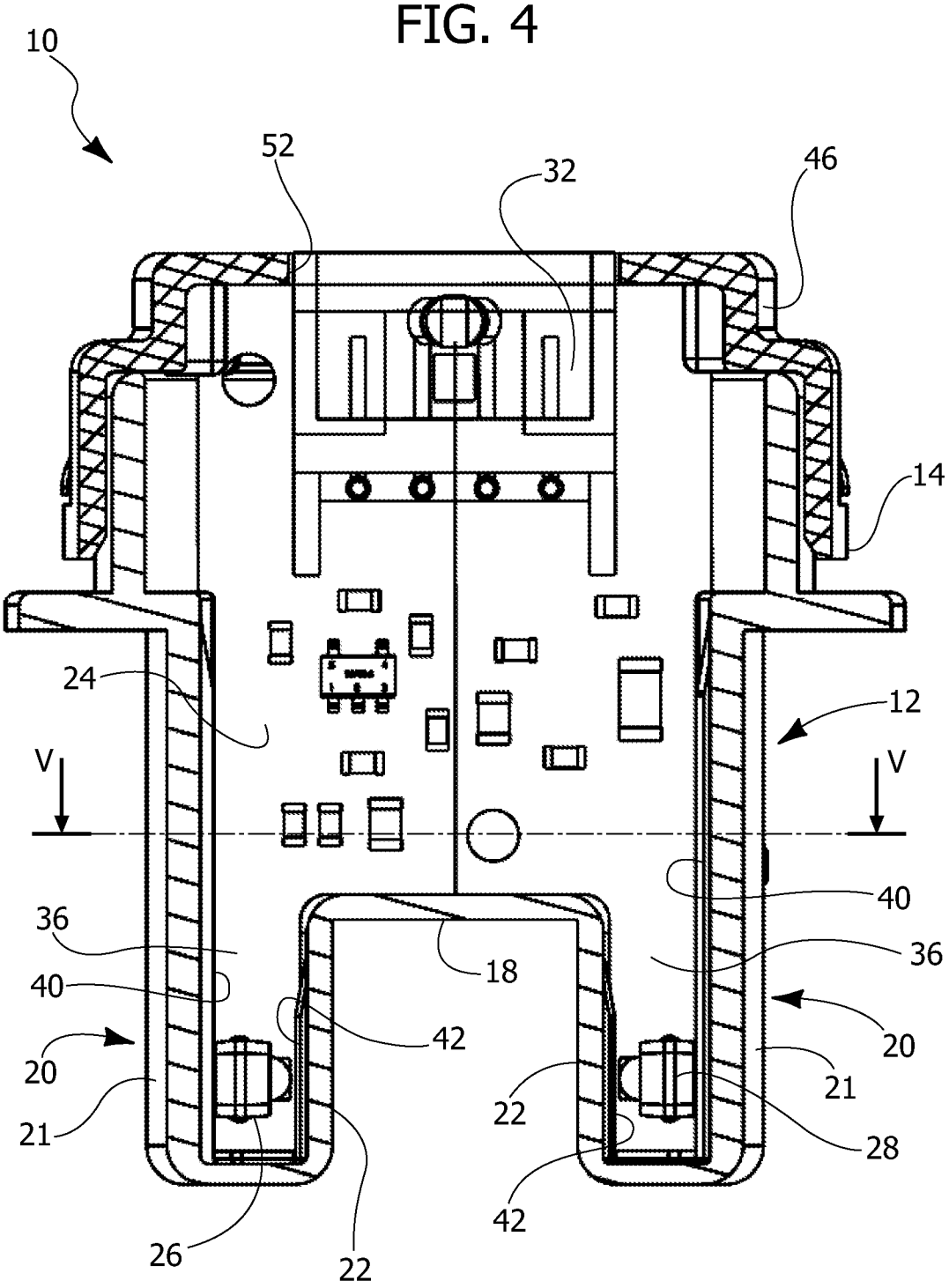
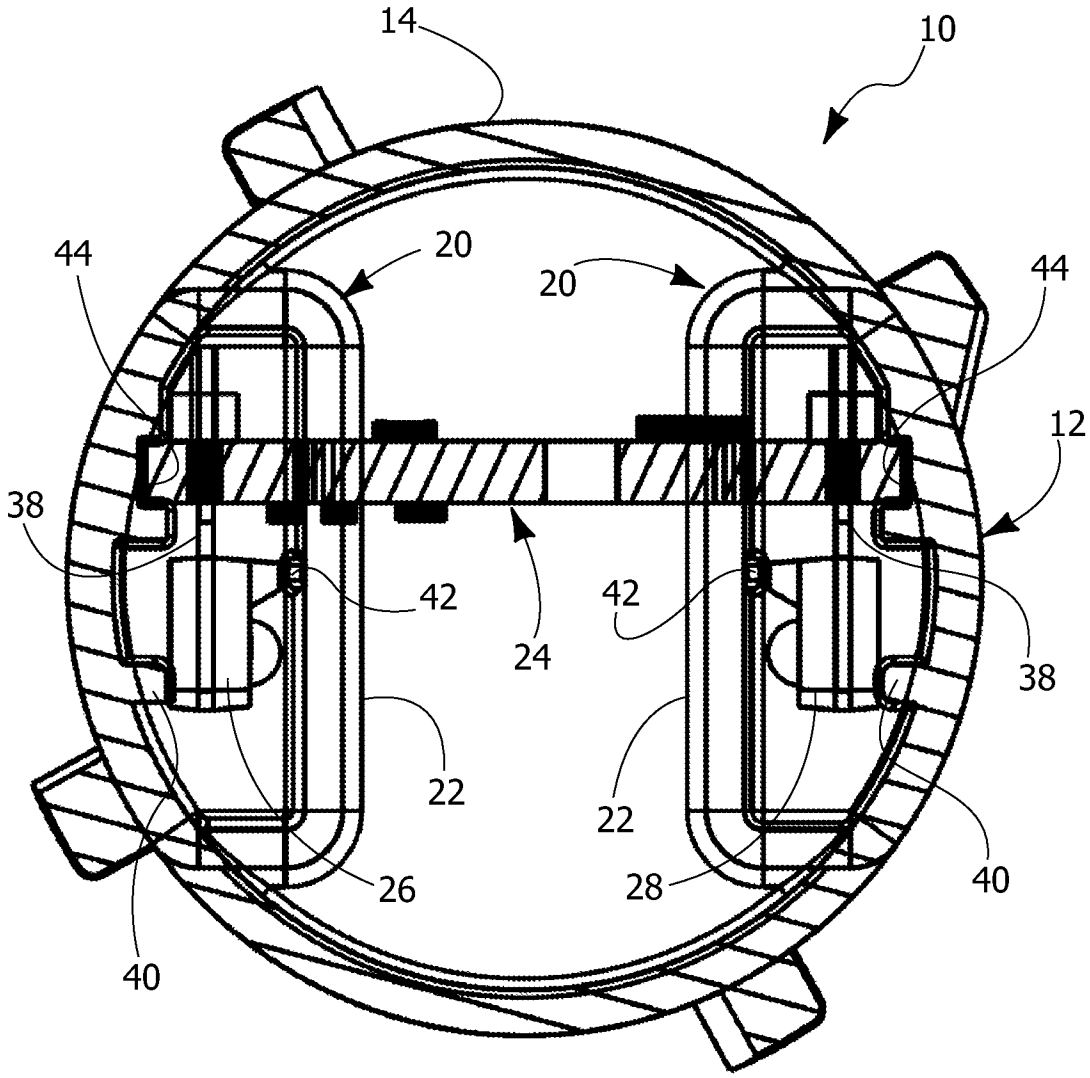


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/031149

A. CLASSIFICATION OF SUBJECT MATTER
INV. A47L15/42 D06F39/00 G01N21/53
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A47L D06F G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2007/115557 A1 (MARQUARDT GMBH [DE]; KAMPF FLORIAN [DE]) 18 October 2007 (2007-10-18)	1
Y	page 2, paragraph 2	4
A	page 3, paragraph 2	2,3
	page 3, last paragraph - page 4, paragraph 1	
	page 6, paragraph 2	
	page 7, paragraph 2	
	figures 1,2	

Y	EP 1 111 119 A2 (TOSHIBA KK [JP]) 27 June 2001 (2001-06-27)	4
A	paragraph [0021]; figure 4	1

A	US 5 828 458 A (TAYLOR ROBERT E [US] ET AL) 27 October 1998 (1998-10-27)	1,3
	column 9, line 4 - line 27; figures 6,7	

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
2 May 2012	10/05/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Verdoodt, Erik

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/031149

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2010/112632 A1 (ZERTAN S A [ES]; DIEZ GARCIA SERGIO [ES]; GARCIA IZAGUIRRE JAVIER [ES]) 7 October 2010 (2010-10-07) figure 4 -----	1

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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