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(54) Yarn-unwinding sensor for storage yarn feeders with rotary drum

(57) A yarn feeder is provided with a motorized, yarn-winding rotary drum (12) which is rotatable with respect to a motor-housing (16) and is adapted to have a plurality of yarn loops (Y) wound on itself, which are adapted to be unwound upon request from a downstream machine. A sensor comprises light-emitting means (42) and light-receving means (44), at least one of which is to be fixed to the rotary drum (12), which operatively define a light connection passing through a detection area (30c) of the rotary drum (12) which is adapted to be repeatedly engaged by the yarn during its rotational unwinding movement. The unwinding of yarn from the rotary drum is determined on the basis of the variation of light resulting from the yarn (Y) transiting on the detection area (30c).

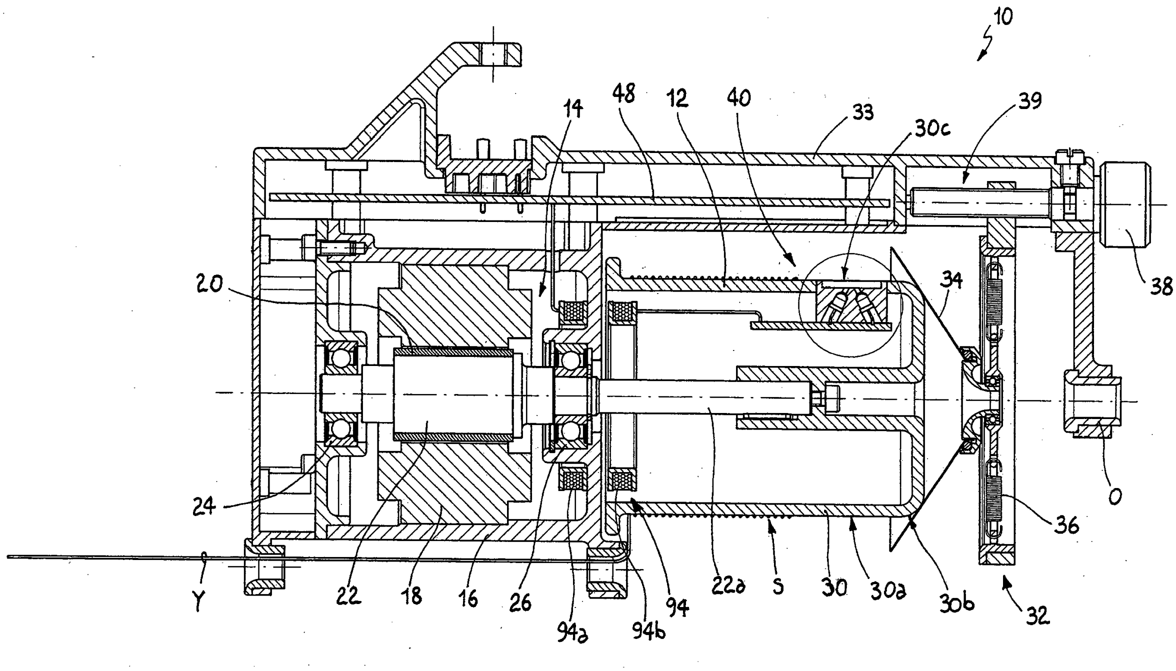

Fig. 1

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Description

[0001] The present invention relates to a yarn-unwinding sensor for storage yarn feeders with rotary drum.

[0002] As known, in a textile process the yarn may be fed to a textile machine, e.g., a circular knitting machine, by a plurality of so-called "storage" yarn feeders. A storage yarn feeder is generally provided with a drum which has a plurality of yarn loops wound thereon which are adapted to be unwound upon request from a dowstream machine. As the yarn is unwound from the drum, it may be re-loaded either by a motorized swivel arm which rotates about an axis coaxial with the axis of the drum, or, in the case of feeders considered herein, by driving the drum to rotate, which drum, in this case, must be motorized.

[0003] As well known to the person skilled in the art, it is very important to maintain the amount of yarn stored on the drum substantially constant on an optimal level, in order to stabilize the tension of the yarn delivered by the feeder. In fact, a reduction of the stock below the optimal level would cause the yarn tension to rise eccessively, resulting in defects in the finished product. On the contrary, a growth of the stock above the optimal level would cause the yarn to accumulate at the delivery end of the drum, with the yarn loops overlapping unevenly and consequent anomalies in the feeding process.

[0004] In EP 2 592 032, the rotation of the motor is controlled in such a way as to maintain the amount of yarn substantially constant with respect to a predetermined amount which is wound on the drum during an initial loading procedure. The feeder is provided with a sensor which is arranged at the delivery end of the drum and is provided with three, or even more, stationary photoelectric cells which are spaced at equal angles about the axis of the drum for detecting the unwinding yarn. Based on the sequence of activation of the photoelectric cells, the control unit determinates wether the yarn is wound or unwound and controls the motor in such a way that, in a steady-state, the amount of yarn wound is equal to the amount of yarn unwound, so that the sensor does not detect any yarn unwinding. Therefore, in a steady-state, an outer observer will see the yarn substantially rotationally motionless, because the winding speed in one direction is equal to the unwinding speed in the opposite direction.

[0005] Consequently, with the system described in EP 2 592 032, the sensor is not capable, per se, of providing an absolute binary information about the amount of yarn which is unwound from the drum, but only a relative information based on the amount of yarn which is wound on it.

[0006] It is a main object of the present invention to provide a yarn-unwinding sensor for storage yarn feeders with rotary drum, which is capable, per se, of providing an accurate, reliable absolute information about the amount of yarn which is unwound from the drum in any steady/transient state.

[0007] The above object and other advantages, which will better appear from the following description, are achieved by a sensor having the features recited in claim 1, while the dependent claims state other advantageous, though secondary, features of the invention.

[0008] The invention will be now described in more detail, with reference to a few preferred, non-exclusive embodiments shown by way of non-limiting example in the attached drawings, wherein:

Fig. 1 is a view in longitudinal cross-section of a storage yarn feeder with rotary drum having a yarn-unwinding sensor according to the invention installed thereon;

Fig. 2 shows a first detail of Fig. 1 to an enlarged scale;

Fig. 3 shows a second detail of Fig. 1 to an enlarged scale;

Fig. 4 is a view in axial cross-section of a portion of a storage yarn feeder having a yarn-unwinding sensor installed thereon according to a first alternative embodiment of the invention;

Fig. 5 shows a detail of Fig. 4 to an enlarged scale;

Fig. 6 is a view in axial cross-section of a portion of a storage yarn feeder having a yarn-unwinding sensor installed thereon according to a second alternative embodiment of the invention;

Fig. 7 shows a detail of Fig. 6 to an enlarged scale;

Fig. 8 is a view in axial cross-section of a portion of a storage yarn feeder having a yarn-unwinding sensor installed thereon according to a third alternative embodiment of the invention;

Fig. 9 shows a detail of Fig. 8 to an enlarged scale;

Fig. 10 is a perspective view showing a component of the yarn-unwinding sensor of Fig. 8.

[0009] With reference to the above Figures, a storage yarn feeder 10 comprises a yarn-winding drum 12 having a plurality of loops of yarn Y wound thereon, which form a stock S and are adapted to be unwound upon request from a general downstream machine (not shown). As the yarn is unwound from drum 12, the latter is driven to rotate by a motor 14 to draw fresh yarn from a reel (not shown) and wind it upon itself in the form of new loops.

[0010] As shown in Fig. 1, motor 14 is received in a motor-housing 16 of feeder 10, and comprises an annular stator 18 fixed within motor-housing 16, and a rotor 20 which is inserted into annular stator 18 and is fitted to a driving shaft 22. Driving shaft 22 is supported within motor-housing 16 by a pair of rolling bearings 24, 26 and projects outside of motor-housing 16 with a projection 22a, which has drum 12 keyed thereto.

[0011] Drum 12 could incorporate a loop-separing device, which is known per se and does not fall within the scopes of the present invention; therefore, it is neither discussed nor shown herein for the sake of simplicity.

[0012] A delivery end portion 30 of drum 12 has a cylindrical surface 30a engaged by the unwinding yarn, and terminates with a rounded delivery edge 30b.

[0013] Feeder 10 is also provided with a braking device 32 known per se, which is supported by an arm 33 projecting from motor-housing 16 parallel to the axis of drum 12.

[0014] Braking device 32 comprises a hollow, frustoconical braking member 34 which is biased by elastic means 36 to coaxially abut with its inner surface against rounded delivery edge 30b of the drum, in order to apply a static braking action by friction upon the unwinding yarn. The braking action is manually adjustable by a knob 38 which controls adjusting means 39 incorporated in arm 33, which are also known per se and therefore are not discussed in detail herein.

[0015] Yarn Y coming out from the feeder is guided by a yarn-guide eyelet O which is also supported by arm 33.

[0016] A control unit is programmed to drive motor 14 in such a way as to stabilize the stock on drum 12 on a predetermined optimal level. In particular, the stock of yarn is determined on the basis of the number of loops which are unwound from drum 12 and the number of loops which are wound on it.

[0017] The number of loops which are wound on drum 12 can be calculated on the basis of either the speed of rotation or the position of motor 14, in a way known per se.

[0018] For the detection of the unwinding loops, yarn feeer 10 is provided with a sensor 40 which comprises light-emitting means and light-receiving means, at least one of which is adapted to be attached to the drum, which operatively define a light connection passing through a detection area 30c of cylindrical surface 30a which is adapted to be repeteadly engaged by the yarn during its rotary, unwinding motion; accordingly, the unwinding of yarn is determined based on the variation of light resulting from the yarn transiting above detection area 30c.

[0019] In a first embodiment of the invention, as shown in Figs. 1-3, the light-emitting means and the light-receiving means are both integral with the drum, and the light connection is closed by means of a reflecting surface arranged between the light source and the light receiver.

[0020] In particular, the light-emitting means and the light-receiving means respectively comprise an infrared light emitting diode 46 and an infrared light receiving diode 72 which are mounted within drum 12. The two diodes are arranged with their axes which are slanting specularly with respect to a plane perpendicular to the axis of the drum, and are incident at an incidence point P which lies on detection area 30c of drum 12. The diodes are mounted on a support 31 fixed to drum 12, and are operatively connected to a first circuit board 75 of the control unit, which is incorporated in drum 12 and is also fixed to support 31. The two diodes are shielded by a window 86 made of a transparent material, e.g., glass, which is mounted on support 31 at the same level of cylindrical surface 30a.

[0021] For powering the diodes and transmitting the signal generated by them, the feeder is provided with an electromagnetic power supply unit 94 which comprises:

- a primary toroidal coil 94a integral with, and housed within, motor-housing 16 coaxially to drum 12, which coil is operatively connected to a second circuit board 48 of the control unit which is incorporated in arm 33, and

- a secondary toroidal coil 94b integral with, and coaxially housed within, drum 12, which coil is in relation of magnetical induction with primary toroidal coil 94a and is operatively connected to a first circuit board 75 incorporated in drum 12.

[0022] In a way known per se, the power is transmitted from primary toroidal coil 94a to secondary toroidal coil 94b (which rotates) by magnetical induction. If there is no yarn at detection area 30c, the light beam generated by emitting diode 46 does not reach receiving diode 72 (Fig. 2). When the yarn transits on detection area 30c at point P (Fig. 3), the light beam I generated by emitting diode 46 is reflected by the yarn towards receiving diode 72. The electronics on board of first circuit board 75 incorporated in drum 12 is programmed to process the variation of signal determined by the passage of the loop, and to generate a variation of the electrical load on secondary toroidal coil 94b. Such variation generates a variation in the current across primary toroidal coil 94a, which is measured and processed by the electronics on board of second circuit board 48 incorporated in arm 33.

[0023] It is easily understood that the sensor according to the invention allows the number of unwinding yarns to be counted in absolute terms, regardless of the speed of rotation of the drum, rather that in relative terms with respect to the number of loops which are wound on the drum, as it occurs with the prior art discussed at the beginning of the present disclosure.

[0024] Figs. 4 and 5 show a further embodiment, which differs from the previous one in that the axes of emitting diode 146 and receiving diode 172 are incident at a point P' which is radially spaced from the surface of drum 112. Moreover, drum 112 is coaxially surrounded by an annular mirror 196 which is attached to arm 133 and has an inner, cylindrical reflecting surface 196a which cointains incidence point P' and faces outer cylindrical surface 130a of the drum.

[0025] If there is no yarn at the detection area 130c, the light beam generated by emitting diode 146 passes through window 186, hits annular mirror 196, and is reflected towards receiving diode 172 through window 186.

The yarn transiting on detection area 130c cuts off the light beam connection, thereby causing a variation of the signal. This variation of the signal is processed by the control unit in a manner similar to the previous embodiment, but in this case the passage of yarn causes a signal cutoff rather than a signal activation.

[0026] Figs. 6 and 7 describe a further embodiment of the invention, in which the same electromagnetic power supply unit 294 of the two previous embodiments is used for powering the diodes and transmitting their signals.

[0027] Also with this embodiment, an infrared light emitting diode 246 and an infrared light receiving diode 272 are mounted on a support 231 fixed within drum 212, and are both connected to a circuit board 275 which is incorporated in the drum and is also fixed to support 231. However, in this case, emitting diode 246 is arranged in such a way as to emit an infrared light beam outwardly, in a radial direction at right angles to the axis of drum 212, via a radial through channel 278 of support 231 which leads to detection area 230c. The axis of receiving diode 272 is parallel to the axis of the drum and intersects the axis of emitting diode 246 at an incidence point P". Receiving diode 272 is received within a seat of support 231 which communicates with radial through channel 278 via a longitudinal channel 279. At the incidence point of the axis of emitting diode 246 with the axis of receiving diode 272, support 231 houses a semi-reflecting mirror 266 inclined by 45°, in order to reflect a radial light beam coming from the outside towards receiving diode 272. Also in this case, radial through channel 278 is externally closed by a window 286 made of glass, which is mounted to support 231 at the same level of cylindrical surface 230a.

[0028] Drum 212 is coaxially surrounded by a reflector 296 which is attached to arm 233 and has an inner, cylindrical reflective surface 296a facing cylindrical surface 230a of the drum.

[0029] If there is no yarn at the detection area 230c, the light beam generated by emitting diode 246 passes through mirror 266 - on the side facing away from the reflecting side - as well as window 286, hits reflector 296, and then is reflected in the same radial direction towards the reflecting side of mirror 266, through window 286. Mirror 266 reflects the light beam towards receiving diode 272. The yarn transiting above detection area 230c cuts off the light connection, thereby causing a variation of the signal which is processed by the control unit in a manner similar to the previous embodiment.

[0030] Figs. 8-10 show a further embodiment of the sensor according to the invention, in which, unlike the previous embodiments, only the light-emitting means are integral with drum 312, while the light receiving means are stationary, i.e., they are integral with the motor-housing and, in particular, are attached to arm 333.

[0031] In particular, with this embodiment, the light-emitting means comprise an infrared light emitting diode 346, which is attached to the inner end of a tubular support 331 which extends radially within drum 312. Tubular support 331 is closed at its inner end by a disc-shaped window 386 made of a transparent material, e.g., glass, which is arranged at the same level of outer cylindrical surface 330a at detection area 330c. Emitting diode 346 is connected to a circuit board 375, which is incorporated within the drum and is also attached to support 331. Emitting diode 346 is arranged in such a way as to generate an infrared light beam outwardly in the radial direction (i.e., at right angles to the axis of drum 312), through a spherical lens 382 which is housed within the tubular support for collimating the light generated by emitting diode 346.

[0032] The light-receiving means comprise a series of receiving diodes 372 which are mounted at equally-spaced radial positions on an annular circuit board 373 (Fig. 10), so that they operatively face cylindrical surface 330a of drum 312. Annular circuit board 373 surrounds drum 312 and is operatively connected to circuit board 348 incorporated in arm 333.

[0033] The sensor could also have an inverse configuration with respect to the last described embodiment, e.g., with a sole receiving diode integral with the drum and a plurality of emitting diodes mounted at equally-spaced angular positions on the annular circuit board. Such embodiment will be obvious to the person skilled in the art in view of the other, above-described embodiments and, therefore, is not illustrated herein.

[0034] A few preferred embodiments of the invention have been described herein, but of course many changes may be made by a person skilled in the art within the scope of the claims. For instance, the yarn-unwinding sensor according to the invention could be located at an intermediate longitudinal position of the drum to be simply used as a stock sensor adapted to provide a binary information about the presence/absence of stock at a predetermined area of the drum. Moreover, in the described embodiments, the light-emitting means and the light-receiving means intercept the yarn upstream of the rounded delivery edge. However, it would be possible to arrange the light-emitting means and the light-receiving means in such a way as they intercept the yarn downstream of the rounded delivery edge.

Claims

1. A yarn-unwinding sensor for a storage yarn feeder (10), said yarn feeder being provided with a motorized, yarn-winding rotary drum (12) which is rotatable with respect to a motor-housing (16) and is adapted to have a plurality of yarn loops (Y) wound on itself, said loops being adapted to be unwound upon request from a downstream machine,

   characterized in that it comprises light-emitting means (42) and light-receving means (44), at least one of which is to be fixed to the rotary drum (12), which operatively define a light connection passing through a detection area (30c) of the rotary drum

(12) which is adapted to be repeatedly engaged by the yarn during its rotational unwinding movement, whereby the unwinding of yarn from the rotary drum is determined on the basis of the variation of light resulting from the yarn (Y) transiting on said detection area (30c).

2. The yarn-unwinding sensor of claim 1, **characterized in that** said light-emitting means (46, 146, 246) and said light-receving means (72, 172, 272) are both adapted to be fixed to the rotary drum (12), said light connection being adapted to be closed in the presence of a reflecting surface operatively arranged between said light-emitting means and said light-receving means.

3. The yarn-unwinding sensor of claim 2, **characterized in that** said light-emitting means (46) and said light-receiving means (72) have their axes specularly slanted with respect to a plane perpendicular to the axis of the rotary drum (12) and incident at a incidence point (P) which substantially lies on said detection area (30c), said reflecting surface being the surface of the yarn when it engages said detection area (30c) at the incidence point (P) and reflects the light beam (I) from said light-emitting means (46) to said light-receiving means (72).

4. The yarn-unwinding sensor of claim 2, **characterized in that** said light-emitting means (146) and said light-receiving means (172) have their axes specularly slanted with respect to a plane perpendicular to the axis of the rotary drum (12) and incident at a incidence point (P') which is radially spaced from the surface of the rotary drum (112), said reflecting surface comprising a cylindrical reflecting surface (196a) which coaxially surrounds the rotary drum (112) and contains said incidence point (P'), in such a way as to reflect the light beam (I) from said light-emitting means (146) to said light-receiving means (172).

5. The yarn-unwinding sensor of claim 2, **characterized in that** said light-emitting means (246) are arranged to generate a light beam which radially projects outwards at right angles to the axis of the rotary drum (212), and said light-receiving means comprise
a light-receiver (272) having its axis parallel to the axis of the rotary drum and incident with the axis of the light-emitting means (246) at an incidence point (P''), and
a semi-reflecting mirror (266) having a reflecting side which contains said incidence point (P'') and is slanted at 45° for reflecting a light beam radially coming from the outside towards said light receiver (272),
said reflecting surface comprising a cylindrical reflecting surface (296a) which coaxially surrounds the rotary drum (212) for radially reflecting the light beam (I) from said light-emitting means (246) to said reflecting side of the semi-reflecting mirror (266).

6. The yarn-unwinding sensor of claim 1, **characterized in that** one of said light-emitting means and said light-receving means is adapted to be fixed to said motor-housing and has an annular configuration (373) operatively facing an annular surface (330a) of the rotary drum (312) which contains said detection area (330c).

7. The yarn-unwinding sensor of claim 6, **characterized in that** said light-emitting means (346) are arranged to emit a light beam projecting outwards from said detection area (330c), and said light receiving means (344) comprise a plurality of light receivers (372) surrounding the rotary drum (312) for receiving said light beam.

8. The yarn-unwinding sensor of any of claims 1 to 7, **characterized in that** at least one of said light-emitting means (46, 146, 246, 346) and said light-receving means (72, 172, 272, 372) is powered by, and transmits signals via, an electromagnetic power supply unit (94) comprising:

- a primary toroidal coil (94a) integral with, and housed within, the motor-housing (16) coaxially to the rotary drum (12), and
- a secondary toroidal coil (94b) integral with, and housed within, the rotary drum (12) in relation of magnetical induction with the primary toroidal coil (94a).

9. The yarn-unwinding sensor of any of claims 1 to 8, **characterized in that** said light emitting means and said light receiving means respectively comprise infrared light emitting diodes (46, 146, 246, 346) and infrared light receiving diodes (72, 172, 272, 372).

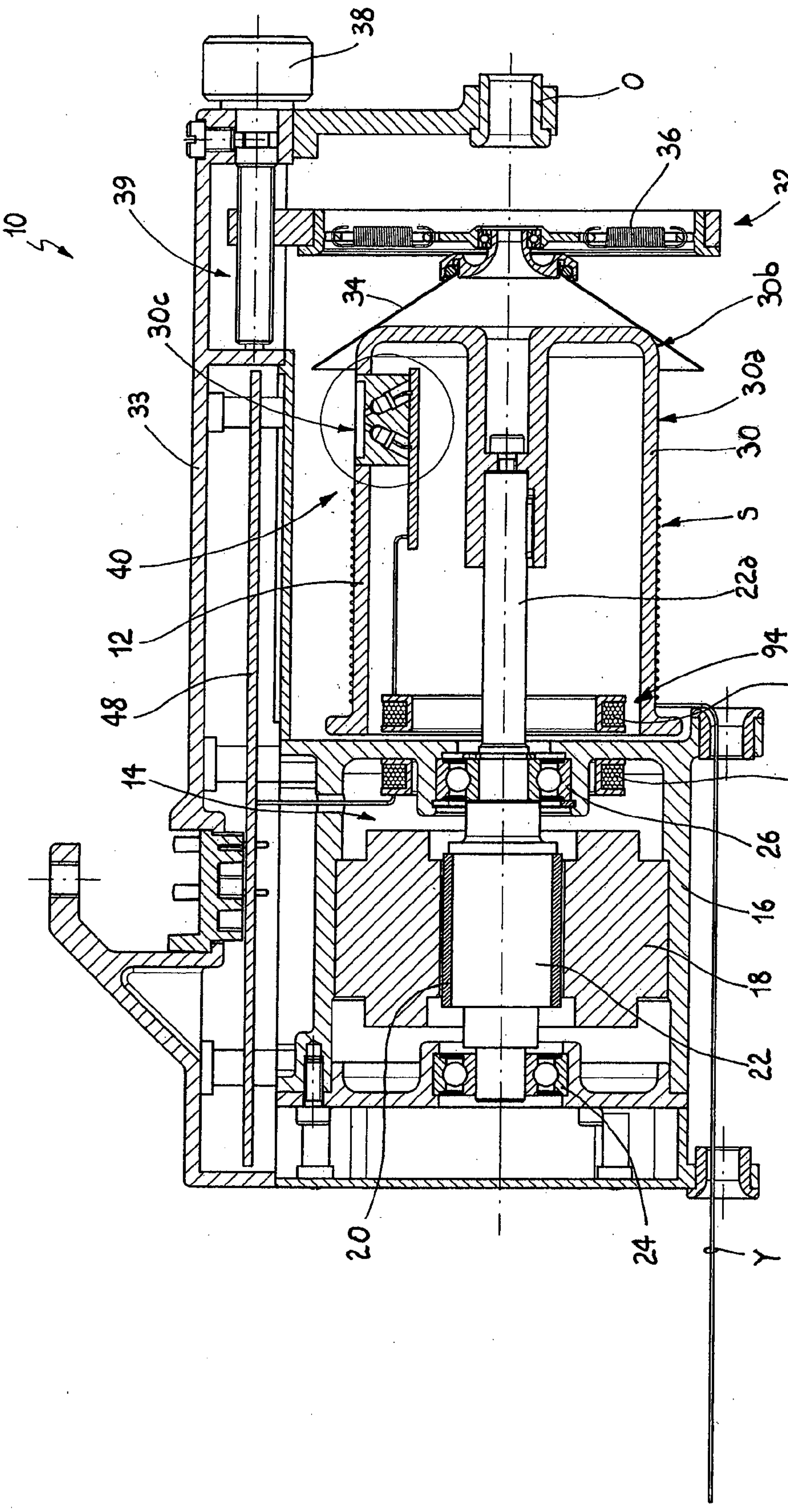
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Fig. 1

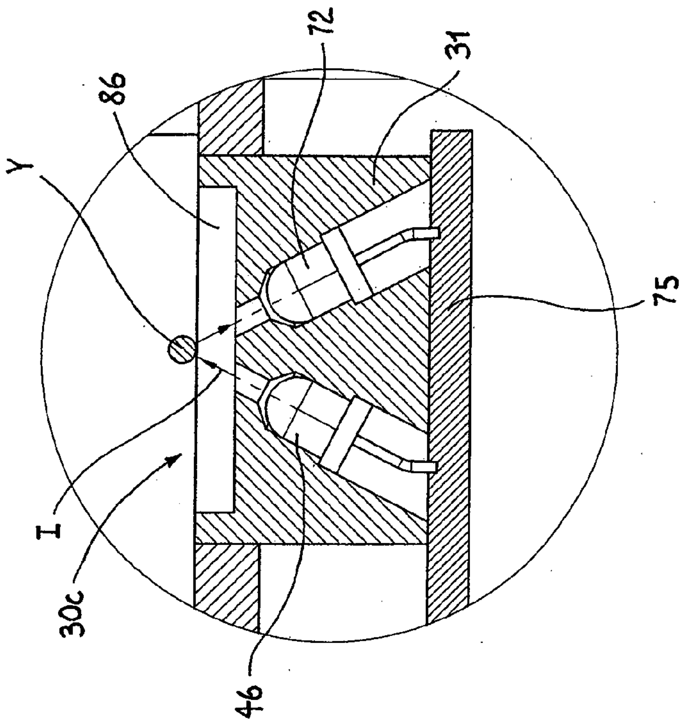

Fig. 3

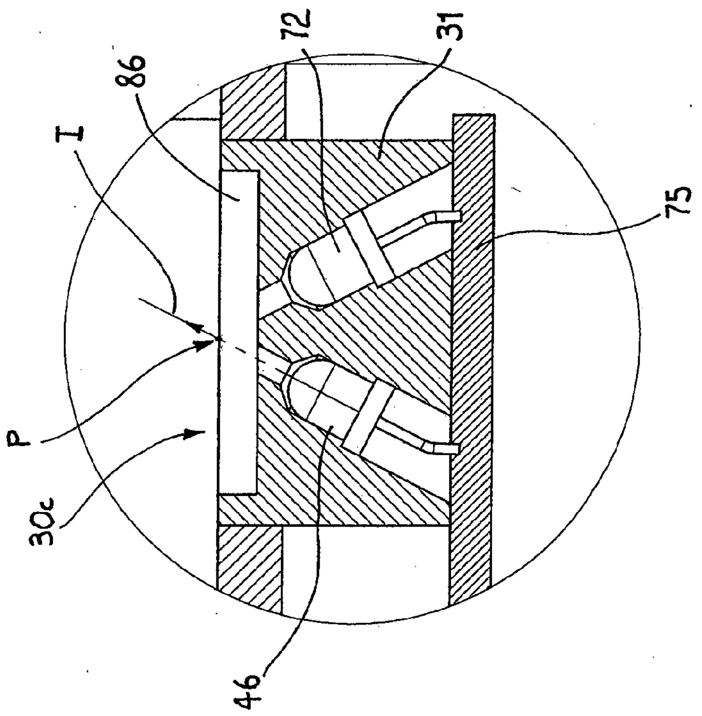

Fig. 2

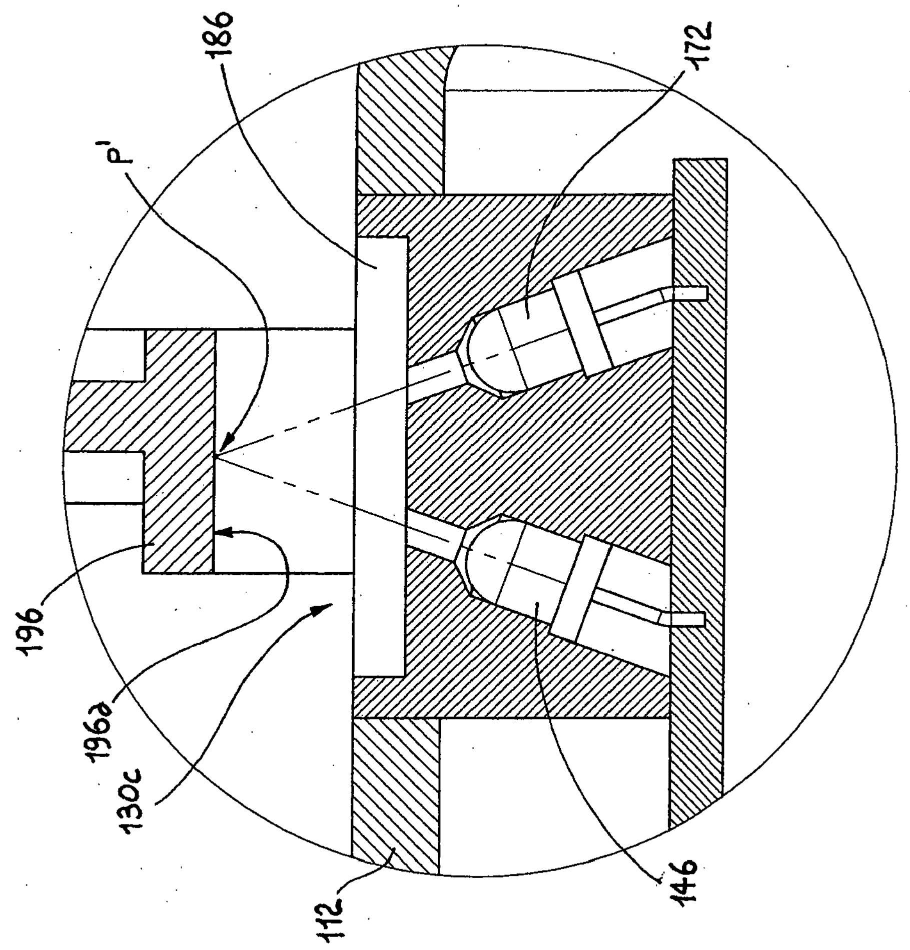

Fig. 5

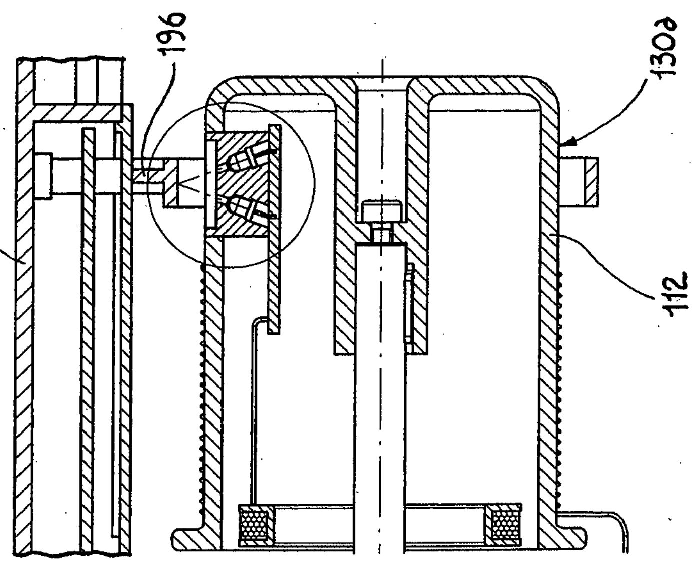

Fig. 4

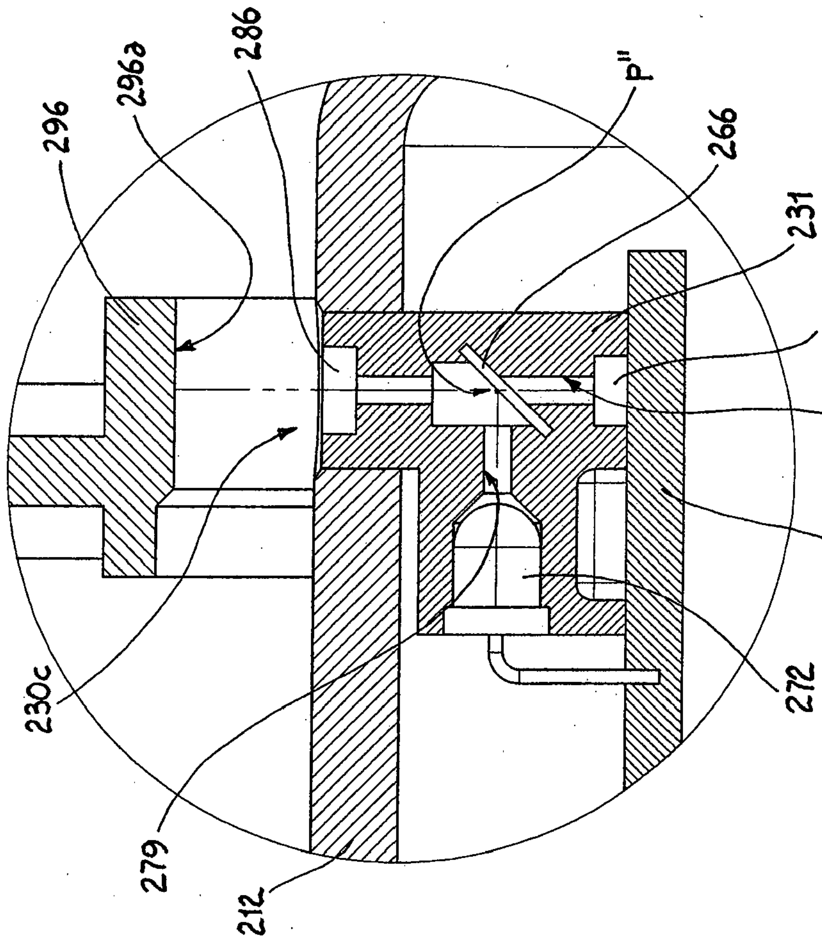
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Fig. 7

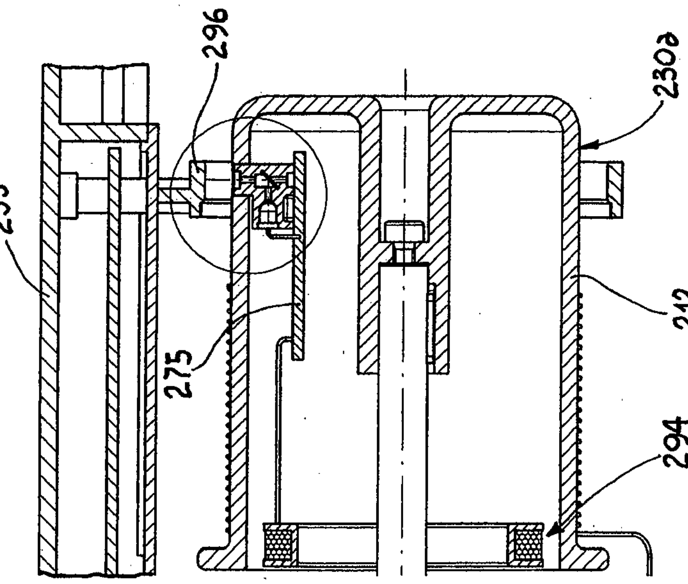
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Fig. 6

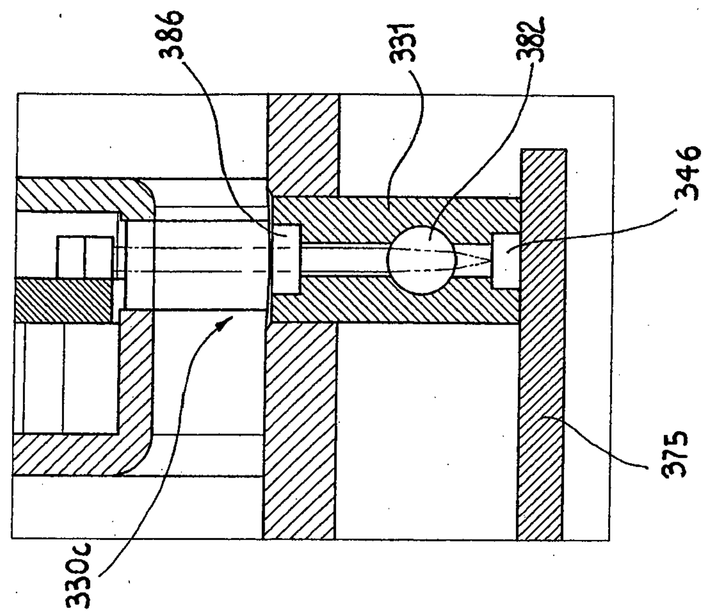

Fig. 9

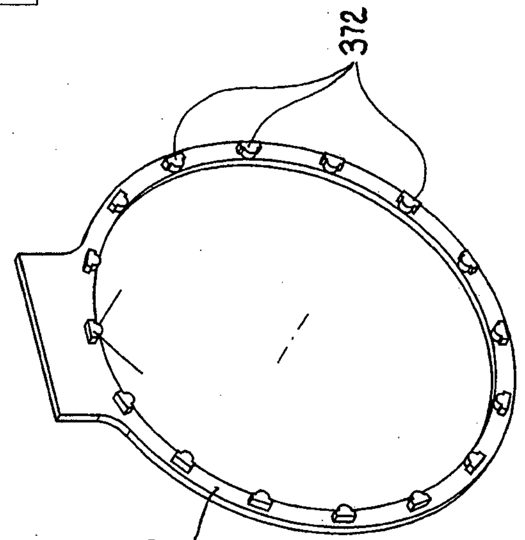

Fig. 10

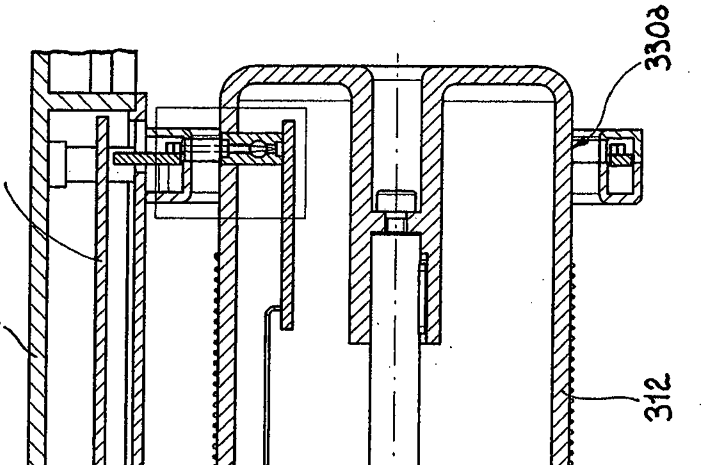

Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 14 00 3877

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A,D	EP 2 592 032 A1 (BTSR INT SPA [IT]) 15 May 2013 (2013-05-15) * paragraph [0021] - paragraph [0023]; figure 4 * -----	1-9	INV. D04B15/48 B65H51/20 B65H51/22
A	WO 96/35834 A1 (FABSCHITZ HEINRICH [DE]) 14 November 1996 (1996-11-14) * abstract; figures 1, 5 * -----	1-9	
A	US 6 125 663 A (WEBER FRIEDRICH [DE]) 3 October 2000 (2000-10-03) * column 5, line 28 - line 42; figure 1 * -----	1-9	

TECHNICAL FIELDS SEARCHED (IPC)
D04B
B65H

1

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	26 January 2015	Braun, Stefanie

CATEGORY OF CITED DOCUMENTS

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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