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(71) Applicant: **MIKUNI CORPORATION**
Chiyoda-ku, Tokyo (JP)

(72) Inventors:
- **Karasawa, Toshio, c/o Mikuni Corporation**
  Odawara-shi, Kanagawa (JP)
- **Soyama, Hiroaki, c/o Mikuni Corporation**
  Odawara-shi, Kanagawa (JP)
- **Hirakawa, Fumihiro, c/o Mikuni Corporation**
  Odawara-shi, Kanagawa (JP)
- **Osanai, Atsushi, c/o Mikuni Corporation**
  Odawara-shi, Kanagawa (JP)
- **Yoshizaki, Keisuke, c/o Mikuni Corporation**
  Odawara-shi, Kanagawa (JP)

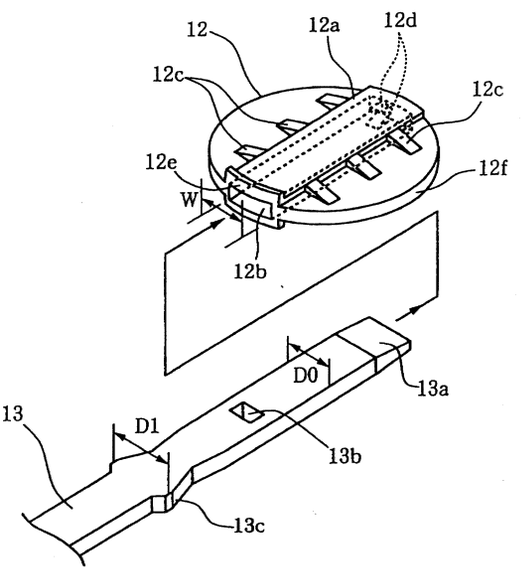
(74) Representative: **Betten & Resch**
Postfach 10 02 51
80076 München (DE)

(54) Structure for coupling shaft and valve in throttle body

(57) A structure for coupling a throttle valve (12) and a throttle shaft (13) in a throttle body reliably receives thrust force applied to the throttle shaft (13), and assures smooth rotation of the throttle shaft (13) and a wide open area of a bore when the throttle valve (12) is fully opened.

In this structure, the throttle valve (12) is in the shape of a disc, and the throttle shaft (13) is in the shape of a plate parallel to the throttle valve (12), and is formed with a recess (13e). The throttle valve has a through-hole (12b), and projections (12d) to be fitted in the recess (13e) of the throttle shaft (13). Further, a thrust surface (12e) is formed at an entrance of the through-hole (12b), and receives thrust force applied to the throttle shaft (13) when brought into contact with an inner surface of a bore.

Fig. 2



EP 1 128 040 A2

Description

[0001] The present invention relates to a throttle body, and more particularly to a structure for coupling a throttle valve and a throttle shaft in a throttle body and reliably receiving thrust force applied to the throttle shaft.

[0002] Up to now, a throttle body of a motor vehicle has been mainly made of a die-cast aluminum alloy. Recently, synthetic resin is being extensively used to form such a throttle body since it is light in weight and can be shaped with a reduced number of machining processes after molding. This is very advantageous in reducing the cost of the throttle body.

[0003] Fig. 6 of the accompanying drawings is a sectional view of an existing throttle body made of synthetic resin, which is sectioned at a throttle valve. A cylindrical bore la is formed substantially at the center of a throttle main body 1, and functions as an intake air path. A disc-shaped throttle valve 2 is fixedly attached to a throttle shaft 3 and is rotatable within the cylindrical bore la.

[0004] The right end of the throttle shaft 3 goes through a boss 1b formed on the throttle main body 1 and projects therefrom. A throttle lever 4 is attached to the right end of the throttle shaft 3 using a nut, etc.

[0005] The left end of the throttle shaft 3 goes through a short boss 1c, to which an E-ring 6 is attached in order to receive thrust force and prevent dislocation of the throttle shaft 3. A disc 7 is attached to the left end of the throttle shaft 3 going through the E-ring 6 and rotates together with the throttle shaft 3.

[0006] A resistive film is printed on the disc 7. A brush (not shown) fixedly attached on an inner surface of a cover 8 slides on the resistive film in response to the rotation of the disc 7, thereby producing electrical resistance in accordance with a rotation angle of the throttle shaft 3. This electric resistance is measured as a resistance across connector terminals (not shown) which are integral with the throttle body, so that a throttle angle is detected.

[0007] A coil spring 9 is wound around the boss 1b of the throttle main body 1, has one end thereof engaged with the throttle body 1 and the other end thereof engaged with the throttle lever 4, and urges the throttle shaft 3 to rotate in one direction. Therefore, the throttle valve 2 is urged to remain at the fully closed position. At the same time, the coil spring 9 urges the throttle lever 4 to move in a direction (shown by an arrow) away from the throttle body 1 in order to protect the throttle shaft 3 against vibration in the thrust direction.

[0008] In the foregoing throttle body, a diameter of the throttle shaft 3 made of a round bar is deducted from an open area of the bore when the throttle valve 2 is fully opened, i.e. the open area of the bore becomes small. This problem is very serious in a small throttle body since a ratio of the diameter of the throttle shaft to the bore diameter is large.

[0009] Further, the thrust force of the coil spring 9 applied to the throttle shaft 3 is received by the E-ring 6 which is brought into pressure contact with the end surface of the boss 1c. However, the E-ring is small and therefore has difficulty in reliably withstanding the thrust force from the coil spring 9. In addition, the part of the boss 1c which is in contact with the small E-ring easily wears, which causes the operation of the throttle shaft to be rough, and shortens the life span of the throttle body.

[0010] The present invention has been contemplated in order to overcome the foregoing problems of the related art. A first object of the invention is to provide a throttle body in which a large open area can be secured when a throttle valve is fully opened. A second object of the invention is to provide a throttle body which is substantially free from wearing, has a long life span, and permits smooth rotation of a throttle shaft.

[0011] In order to accomplish the first object of the invention, there is provided a structure for coupling a valve and a shaft in a throttle body, which comprises: a throttle body main having a bore as a gas path; a throttle shaft passing through the bore; a throttle valve fixedly attached to the throttle shaft and being rotatable in the bore; a throttle lever fixedly attached to one end of the throttle shaft; and a return spring provided between the throttle lever and the throttle body and urging the throttle valve to close. In this structure, the throttle valve is in the shape of a disc, the throttle shaft is in the shape of a plate and parallel to the throttle valve and has a recess, and the throttle valve is formed with a through-hole in which the throttle shaft is fitted and has projections for engaging the recess of the throttle shaft.

[0012] In order to accomplish the first and second objects, the return spring applies thrust force to the throttle shaft, and the throttle valve has a thrust surface facing an inner surface of the bore to which the throttle valve is pressed by the thrust force.

[0013] The through-hole of the throttle valve may have flexible arms at its entrance, or the throttle shaft may have a force-fit portion for engagement with the throttle valve.

[0014] The bosses may be provided at opposite ends of the throttle body where the throttle shaft passes through. In such cases, the throttle lever fixedly attached to one end of the throttle shaft has its shaft portion fitted into one of the foregoing bosses, and functions as a plain bearing, and a shaft portion of a rotor serving as a throttle position sensor is fitted into the other boss, thereby functioning as another plain bearing.

[0015] In order to accomplish the second object of the invention, there is provided a structure for coupling a valve and a shaft in a throttle body which comprises: a throttle body main having a bore as a gas path; a throttle shaft going through the bore; a throttle valve fixedly attached to the throttle shaft and being rotatable in the bore; a throttle lever fixedly attached to one end of the throttle shaft; and a return spring provided between the throttle lever and the throttle body and urging the throttle valve to close. In this structure, the return spring urges

the throttle shaft in a thrust direction, and the throttle valve has a thrust surface facing an inner surface of the bore to which the throttle valve is pressed by the thrust force.

[0016] The invention is described in detail below with reference to drawings which illustrate two specific embodiments, in which:

Fig. 1 is a sectional view of an assembled throttle body according to a first embodiment of the invention;
Fig. 2 is an exploded perspective view showing essential parts of a throttle valve and a throttle shaft;
Fig. 3(a) shows an open area of the bore in the related art with the throttle valve fully opened;
Fig. 3(b) shows an open area of a bore of the present invention with the throttle valve fully opened;
Fig. 4 is an exploded perspective view showing essential parts of a throttle valve and a throttle shaft in a second embodiment of the invention;
Fig. 5 is a sectional view showing the throttle shaft fitted into the throttle body of Fig. 4; and
Fig. 6 is a sectional view of the throttle body of the related art.

[0017] Referring to Fig. 1, a throttle main body 11 has a cylindrical bore 11a at the center thereof, and bosses 11b and 11c at the opposite sides thereof. A throttle valve 12 is housed in the center of the bore 11a.

[0018] A throttle shaft 13 is made of a metal plate curved in the shape of letter J, and goes through the throttle valve 12. The curved portion of the throttle shaft 13 is injection-molded together with a resin throttle lever 14. The end of the J-shaped portion projects through the throttle lever 14, and functions as an operation part 14a of the throttle lever 14.

[0019] A shaft portion 14b of the throttle lever 14 fitted into the boss 11b is cylindrical, and functions as a plain bearing at one end of the throttle shaft 13.

[0020] The throttle shaft 13 goes through the throttle valve 12, is force-fitted into a hole of a shaft 15a of a resin rotor 15, and rotates integrally with the rotor 15. The shaft 15a of the rotor 15 is rotatably fitted in a hole of the boss 11c, functioning as a plain bearing at the other end of the throttle shaft 13.

[0021] The throttle lever 14 includes a coil return spring 16 which is wound around the throttle main body 11. The return spring 16 urges the throttle lever 14 in such a direction that the throttle valve 12 closes the bore 11a. Further, the return spring 16 also functions as a compression spring for urging the throttle lever 14 to move away from the throttle main body 11.

[0022] The rotor 15 has a resistive film printed thereon, with which a pair of brushes 19 attached to a cover 18 are in contact. As the throttle shaft 13 rotates, the brushes 19 slide on the resistive film of the rotating rotor 15, and produce an electric resistance in accordance with an open extent of the throttle valve 12. This electric resistance is measured as a resistance across terminals 21 of a connector 20 which extends from the boss 1c of the throttle main body 11 as an integral member. The rotor 15 functions as a throttle position sensor for detecting the open extent of the throttle valve 12.

[0023] Referring to Fig. 2, the throttle valve 12 is substantially in the shape of a disc, and has a thick portion 12a at the center thereof, in which a through-hole 12b is formed. The throttle shaft 13 is fitted into the through-hole 12b. The thick portion 12a includes a plurality of triangular reinforcing ribs 12c arranged along opposite side edges thereof in order to protect the plate-shaped throttle valve 12 against warping. Upper and lower projections 12d are formed on an inner surface of an exit of the through-hole 12b.

[0024] The thick portion 12a is enlarged in the shape of a brim at the entrance of the through-hole 12b, and this part functions as a thrust surface 12e. The thrust surface 12e and a peripheral edge 12f of the throttle valve 12 form a part of a sphere whose diameter is substantially equal to the diameter of the bore 11a.

[0025] The throttle shaft 13 is made of a metal plate, and has a rectangular cross section, a tapered end 13a to enable straightforward entry into the through-hole 12b, and a recess 13b in which the projections 12d of the through-hole 12b are engaged.

[0026] A pair of force-fit projections 13c extend from the side edges of the throttle shaft 13 near its base. It is assumed that the throttle shaft 13 has a width D0, the force-fit projections 13c have a width D1, and the through-hole 12b has a width W. In this case, D0 is slightly smaller than W, and D1 is slightly larger than W. As a result, when the throttle shaft 13 is inserted into the throttle valve 12 and the projections 12d are engaged in the recess 13b, the force-fit projections 13c are force-fitted in the through-hole 12b. In this state, the throttle shaft 13 and throttle valve 12 are reliably and closely engaged with each other.

Alternatively, the force-fit projections 13c may be dispensed from the throttle shaft 13. In such cases, the throttle shaft 13 has to be closely fitted in the through-hole 12b at the portion having the width D0. For this purpose, D0 and W should be substantially equal in order to closely fit the throttle shaft 13 in the throttle valve 12. However, the throttle shaft 13 should be substantially force-fitted into the throttle valve 12, which is very difficult if the throttle shaft 13 is long. In order to overcome such a problem, the throttle shaft 13 has the force-fit projections 13c as shown in Fig. 2 so that the portions except for the projections 13c and having the width DO can be easily inserted into the through-hole 12b. Thereafter, when the throttle shaft 13 is inserted to a certain extent, the force-fit projections 13c are force-fitted into the through-hole 12b, which enables the throttle shaft 13 to be tightly engaged in the throttle valve 13.

[0027] The throttle body is assembled in the following manner. The return spring 16 is attached around the

main body 11 with its one end engaged therewith. The throttle lever 14 and throttle shaft 13 which are combined are inserted into the main body 11 via the boss 11b. In this case, the throttle valve 12 is placed in the bore 11a beforehand with the tip of the throttle shaft 13 fitted into the through-hole 12b.

[0028] When the throttle shaft 13 is inserted into the through-hole 12b to a predetermined extent, the upper and lower projections 12d are engaged in the recess 13b, and the force-fit projections 13c are force-fitted into the through-hole 12b. In this state, the tapered tip 13a of the throttle shaft 13 is loosely fitted in the boss 11c at the side opposite to the boss 11b.

[0029] Thereafter, the rotor 15 is positioned in order that the tapered tip 13a of the throttle shaft 13 fits into the bore in the rotor shaft 15a. Then, the rotor shaft 15a is inserted into the boss 11c. In this state, the throttle valve 12 is 360° rotatable in the bore 11a, and has its thrust surface 12e being in light contact with the inner wall of the bore 11a.

[0030] A cover 18 is then attached to the throttle body in such a manner that a projecting end 15b of the rotor 15 is received in a center recess 18a of the cover 18. The other end of the return spring 16 is engaged with the throttle lever 14 at a predetermined position. The throttle lever 14 is adjusted using an adjusting screw or stop (not shown) with respect to a fully opened position and a fully closed position.

[0031] In the assembled throttle body, the throttle shaft 13 is pushed toward the throttle lever 14 by the return spring 16. The thrust surface 12e of the throttle valve 12 is brought into pressure contact with the inner surface of the bore 11a and receives the thrust force. Formed on the throttle valve 12, the thrust surface 12e is much larger than an E-ring, and can receive a sufficient amount of the thrust force. The thrust surface 12e is substantially free from wearing, and the throttle shaft 13 can smoothly operate for a long period of time.

[0032] Referring to Fig. 3(a), the throttle shaft 3 of the related art has a circular cross section. The throttle shaft 3 having a diameter d1 blocks up air flow in the bore 1a having a diameter D. If the diameter d1 is reduced, an open area may be increased in the bore 1a. In such a case, the throttle shaft 3 may suffer from a reduced strength. Therefore, the diameter D1 is made large enough to secure sufficient strength of the throttle shaft 3, which means a small open area. This problem is serious in the case of a throttle body in which the bore 1a has the small diameter D.

[0033] In accordance with the present invention, the throttle shaft 13 is plate-shaped as shown in Fig. 3(b), and is in parallel to the throttle valve 12 in the shape of a plate. The thickness dO of the thick portion 12a can be made smaller than the diameter of the throttle shaft of the related art, which means that the open area of the bore 11a can be increased.

[0034] The through-hole 12b may crack when the throttle shaft 13 is inserted therein with a large force if they have substantially the same size.

[0035] Fig. 4 is an exploded perspective view of a throttle valve 12' which is devised in order to overcome this problem. In the throttle valve 12', slits are formed at the entrance of the through-hole 12b of the throttle valve 12, and flexible arms 12g are provided at the upper and lower parts of the entrance. The flexible arms 12g have projections 12h.

[0036] On the other hand, a throttle shaft 13' has toothed force-fit portions 13d in order to engage with the throttle valve 12'.

[0037] The throttle valve 12' is engaged with the throttle shaft 13' as shown in Fig. 5. In this embodiment, the upper and lower flexible arms 12g flex to open the through-hole 12b, which enables easy insertion of the tapered tip of the throttle shaft 13, and is effective in preventing the cracking of the through-hole 12b.

[0038] A distance D2 between the toothed force-fit portions 13d is slightly larger than the width D2 of the through-hole 12b. The leading sides (in an inserting direction) of the toothed force-fit portions 13d are sloped, which enables the throttle shaft 13 to be easily force-fitted into the through-hole 12b and difficult to come out therefrom.

[0039] Although not shown in the drawings related to the second embodiment, a thrust surface 12e and flexible arms 12g may be formed near the entrance of the through-hole 12b, similarly to those shown in Fig. 2. In the present invention, the throttle shaft 13 is not limited to the shape of the plate in order to receive the applied thrust force via the thrust surface 12e. For instance, the thrust surface 12a may be formed on the throttle valve 2 in the throttle body of the related art shown in Fig. 6. In such a case, an E-ring may be dispensable.

[0040] In the foregoing combining structure, the throttle valve is disc-shaped while the throttle shaft is plate-shaped and is parallel to the throttle valve. The throttle shaft has the recess, and the throttle valve is formed with the through-hole into which the throttle shaft is fitted. The throttle valve is provided with the projections to be engaged in the recess of the throttle shaft. This structure can make the throttle valve thinner, and increase the open area of the bore when the throttle valve is fully opened.

[0041] The return spring urges the throttle shaft in the thrust direction, and the throttle valve includes the thrust surface facing the inner surface of the bore pressed by the return spring. Therefore, the thrust force applied to the throttle shaft is received by the thrust surface of the throttle valve. The thrust surface can be enlarged to sufficiently withstand the thrust force and be slow to wear. This structure assures smooth rotation of the throttle shaft and extends the life span of the throttle body.

[0042] The through-hole of the throttle valve may have the flexible arms at the entrance thereof, so that the throttle shaft can be easily and smoothly fitted into the through-hole without causing any cracks at the entrance of the through-hole.

Claims

1. A structure for coupling a valve and a shaft in a throttle body, comprising: a throttle body main having a bore as a gas passage; a throttle shaft passing through the bore; a throttle valve fixedly attached to the throttle shaft and being rotatable in the bore; a throttle lever fixedly attached to one end of the throttle shaft; and a return spring provided between the throttle lever and the throttle body and urging the throttle valve to close, wherein: the throttle valve is in the shape of a disc; the throttle shaft is in the shape of a plate and parallel to the throttle valve and has a recess; and the throttle valve is formed with a through-hole fitted with the throttle shaft and has projections for engagement in the recess of the throttle shaft.

2. The structure as claimed in claim 1, wherein the return spring urges the throttle shaft in a thrust direction, and the throttle valve has a thrust surface facing an inner surface of the bore, with the throttle valve being pressed towards the thrust surface by the thrust force.

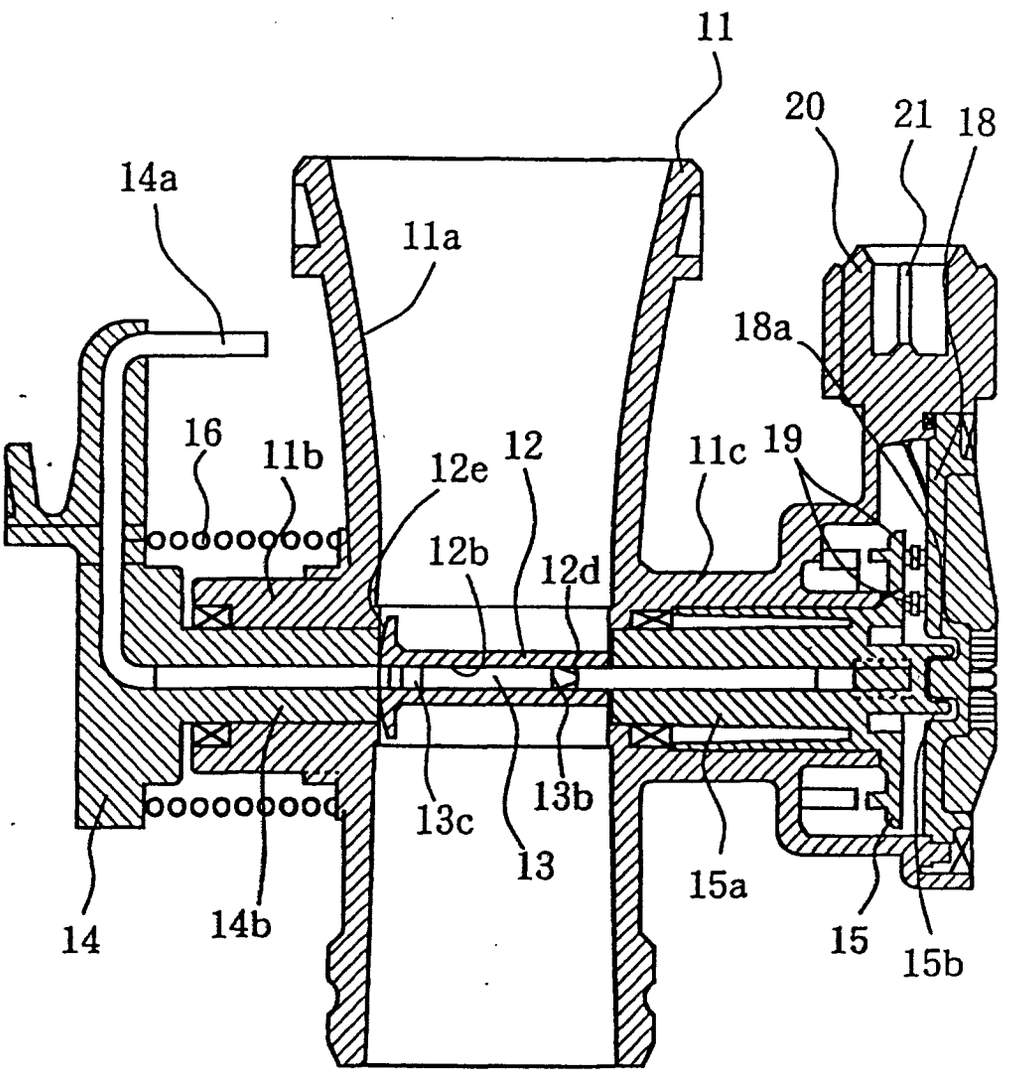
3. The structure as claimed in claim 1 or 2, wherein the through-hole of the throttle valve is provided with flexible arms at an entrance thereof.

4. The structure as claimed in any of claims 1 to 3, wherein the throttle shaft is provided with force-fit portions for engagement with the throttle valve.

5. The structure as claimed in any of claims 1 to 4, wherein: the throttle body is provided with bosses at opposite sides thereof where the throttle shaft project; a shaft of the throttle lever fixedly attached to one end of the throttle shaft is fitted in one of the bosses and functions as a plain bearing; and a shaft of a rotor constituting a throttle position sensor is fitted in the other boss and functions as a plain bearing.

6. A structure for coupling a valve and a shaft in a throttle body, comprising: a throttle body main having a bore as a gas passage; a throttle shaft passing through the bore; a throttle valve fixedly attached to the throttle shaft and being rotatable in the bore; a throttle lever fixedly attached to one end of the throttle shaft; and a return spring provided between the throttle lever and the throttle body and urging the throttle valve to close, wherein the return spring urges the throttle shaft in a thrust direction, and the throttle valve has a thrust surface facing an inner surface of the bore, with the throttle valve being pressed towards the thrust surface by the thrust force.

Fig. 1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20
21
18
14a
11a
18a
16
11b
12e
12
11c
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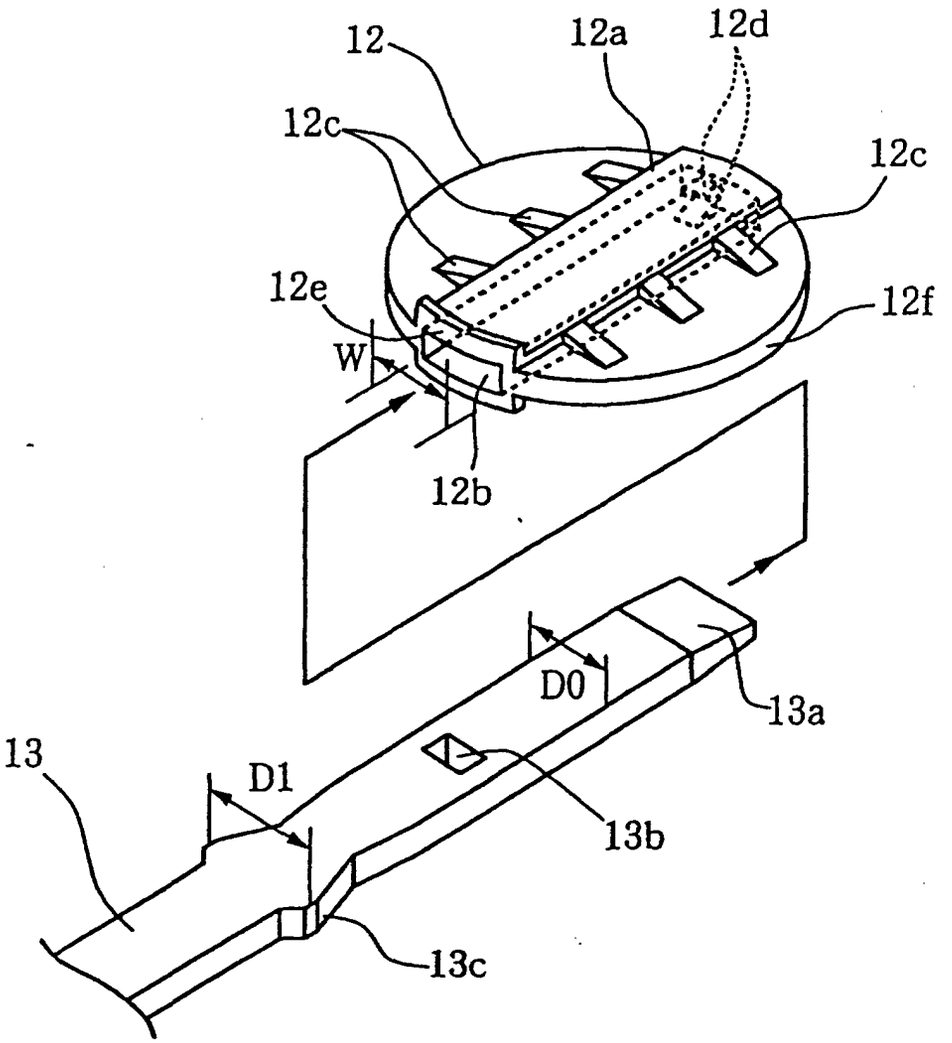
12d
13c
13b
13
15a
14
14b
15
15b

Fig. 2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12d
12c
12c
12e
12f
W
12b
D0
13a
13
D1
13b
13c

Fig. 3

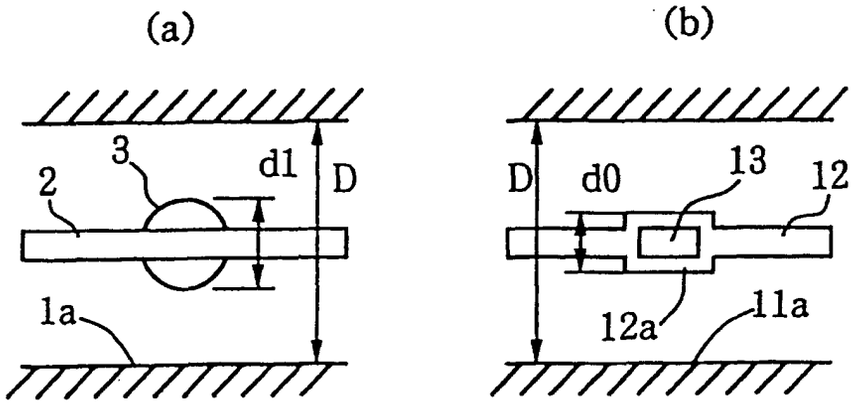
(a)
(b)
3
d1
D
2
1a
D
d0
13
12
12a
11a

Fig. 4

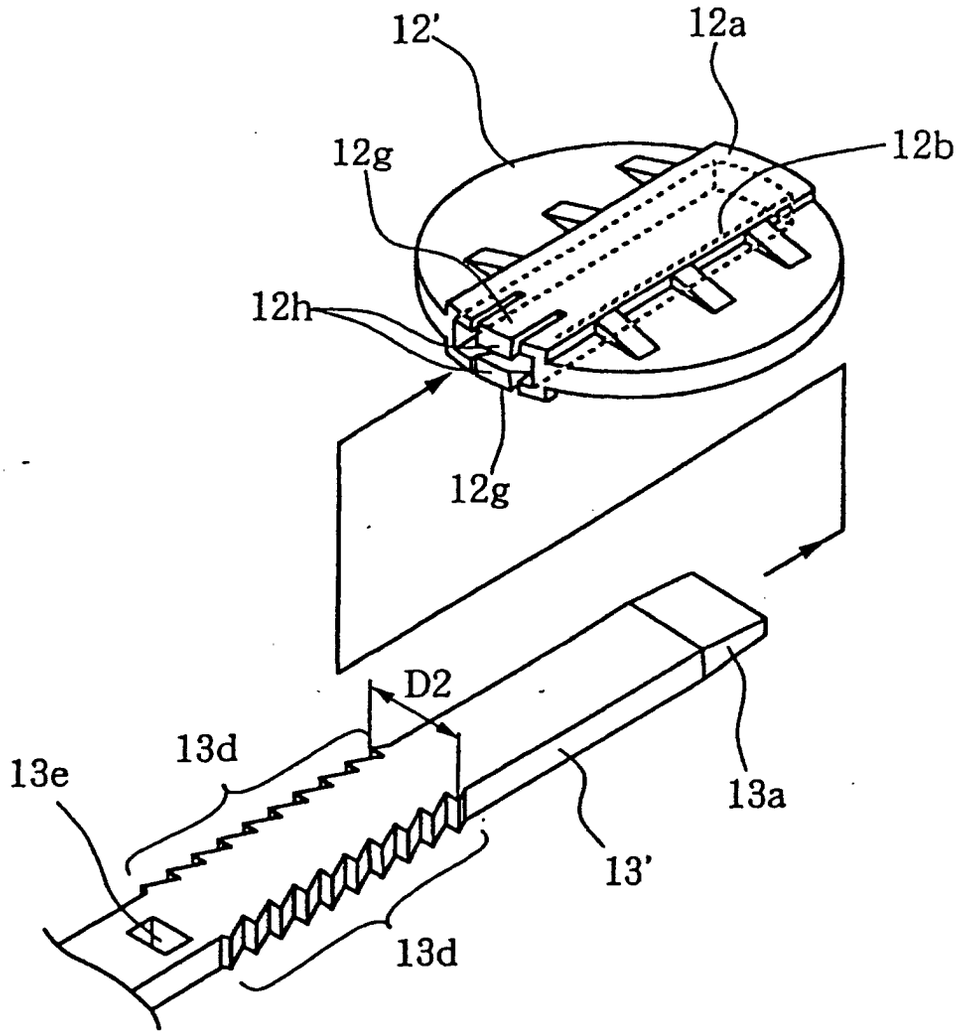

Fig. 5

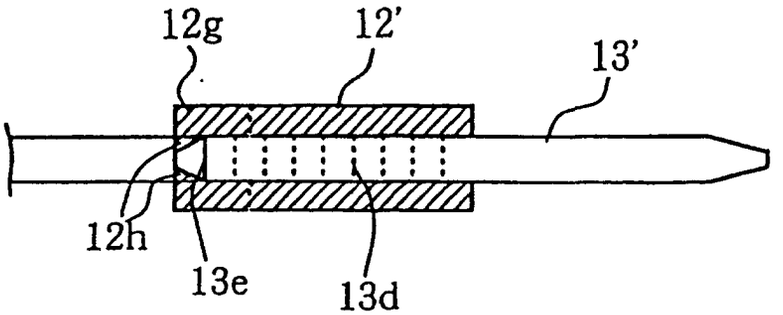

Fig. 6