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Kanehisa

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(54) **BICYCLE DISC BRAKE HUB**

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(73) Assignee: **Shimano Inc.**, Osaka (JP)

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(51) **Int. Cl.**
B62L 5/00 (2006.01)

(52) **U.S. Cl.** **188/26**

(58) **Field of Classification Search** 192/46, 192/64; 188/24.17, 26; 74/594.1; 301/6.8
See application file for complete search history.

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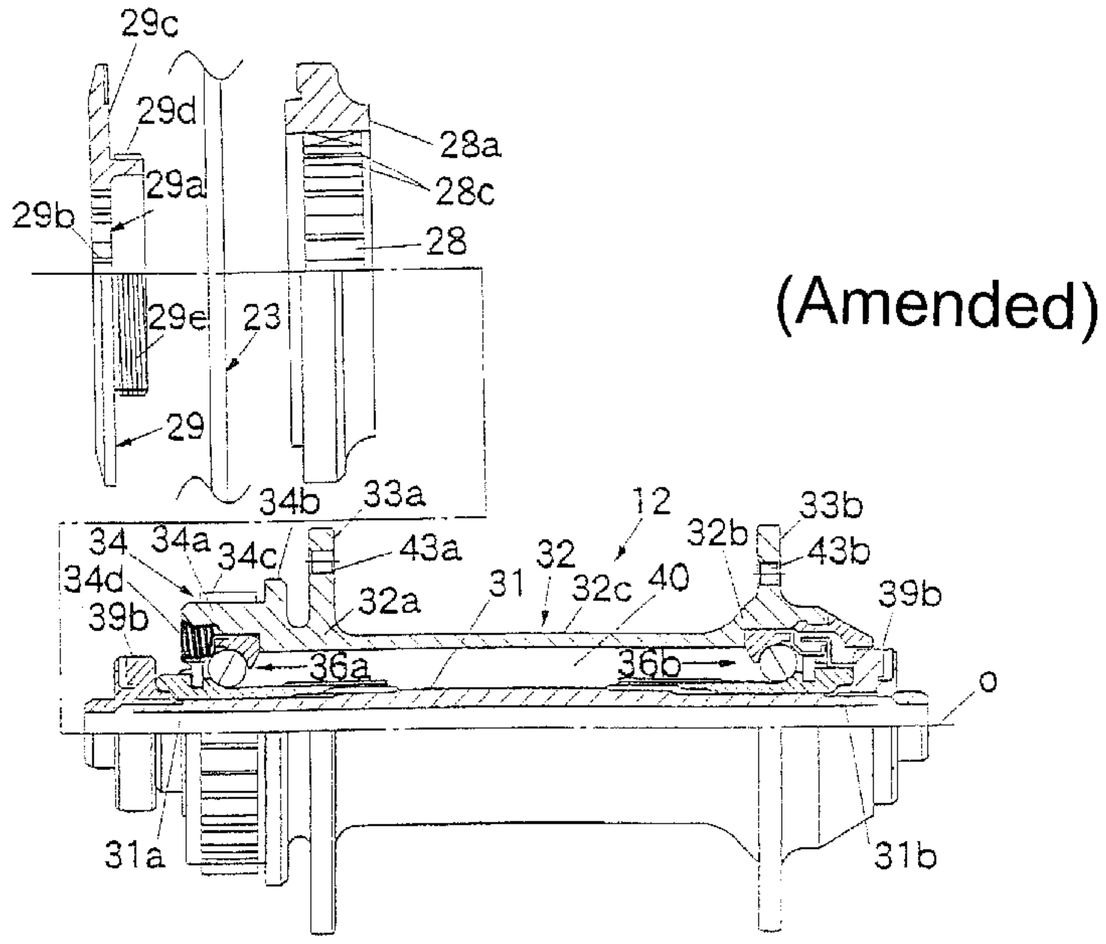
(57) **ABSTRACT**

A bicycle disc brake hub is provided with a brake rotor attachment portion having an external surface with an external spline section and an annular internal surface with internal threads, and a locking ring having a center tubular section with external threads and an abutment flange extending outwardly from the center tubular section to form an axially facing retaining surface. The external threads of the center tubular section mates with the internal threads of the brake rotor attachment portion to secure a rotor mounting boss and a brake rotor thereto. In one embodiment, the brake rotor is held between the locking ring and the rotor mounting boss, while in a another embodiment, the brake rotor is riveted to the rotor mounting boss.

43 Claims, 17 Drawing Sheets



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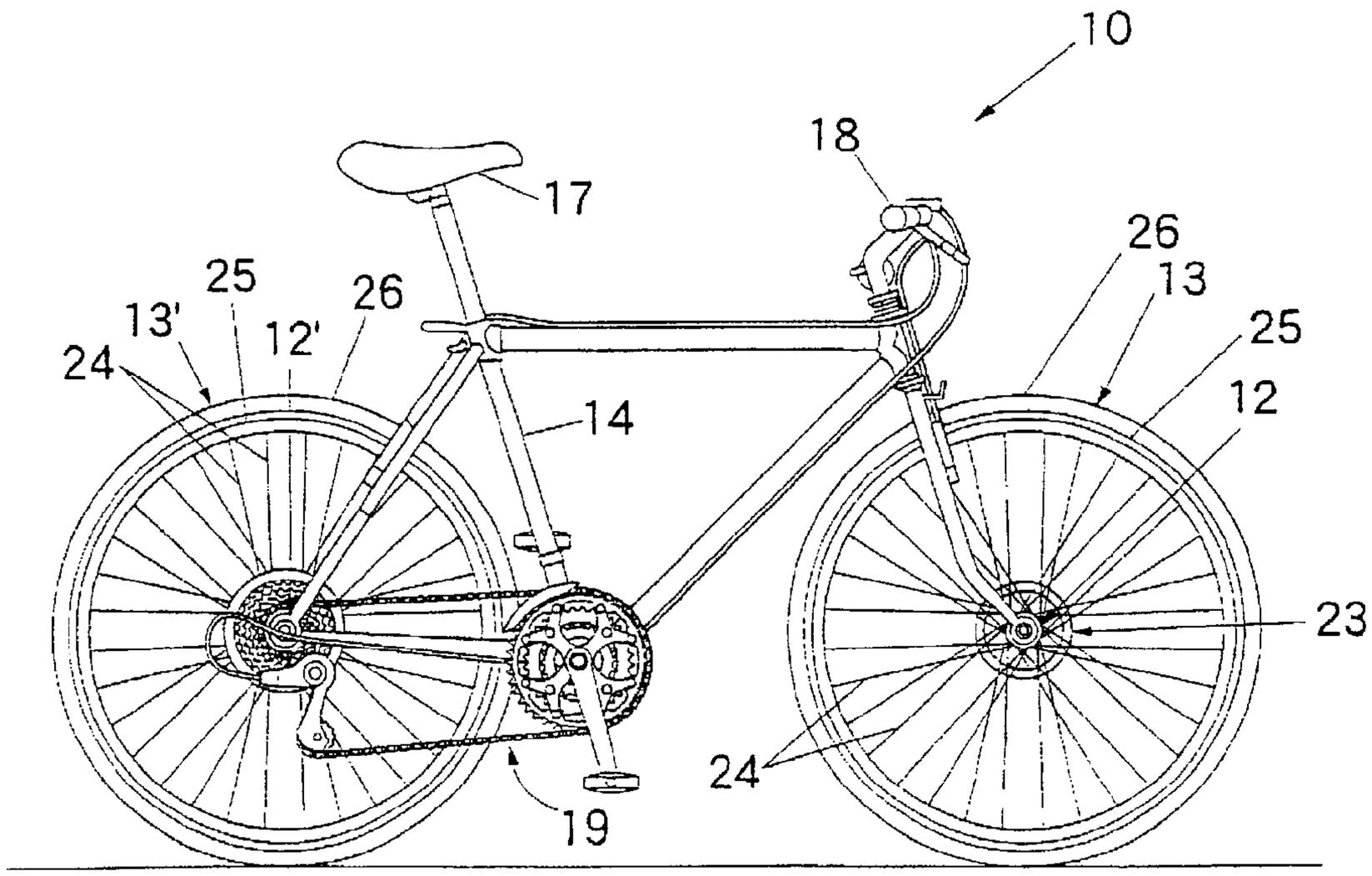

Fig. 1

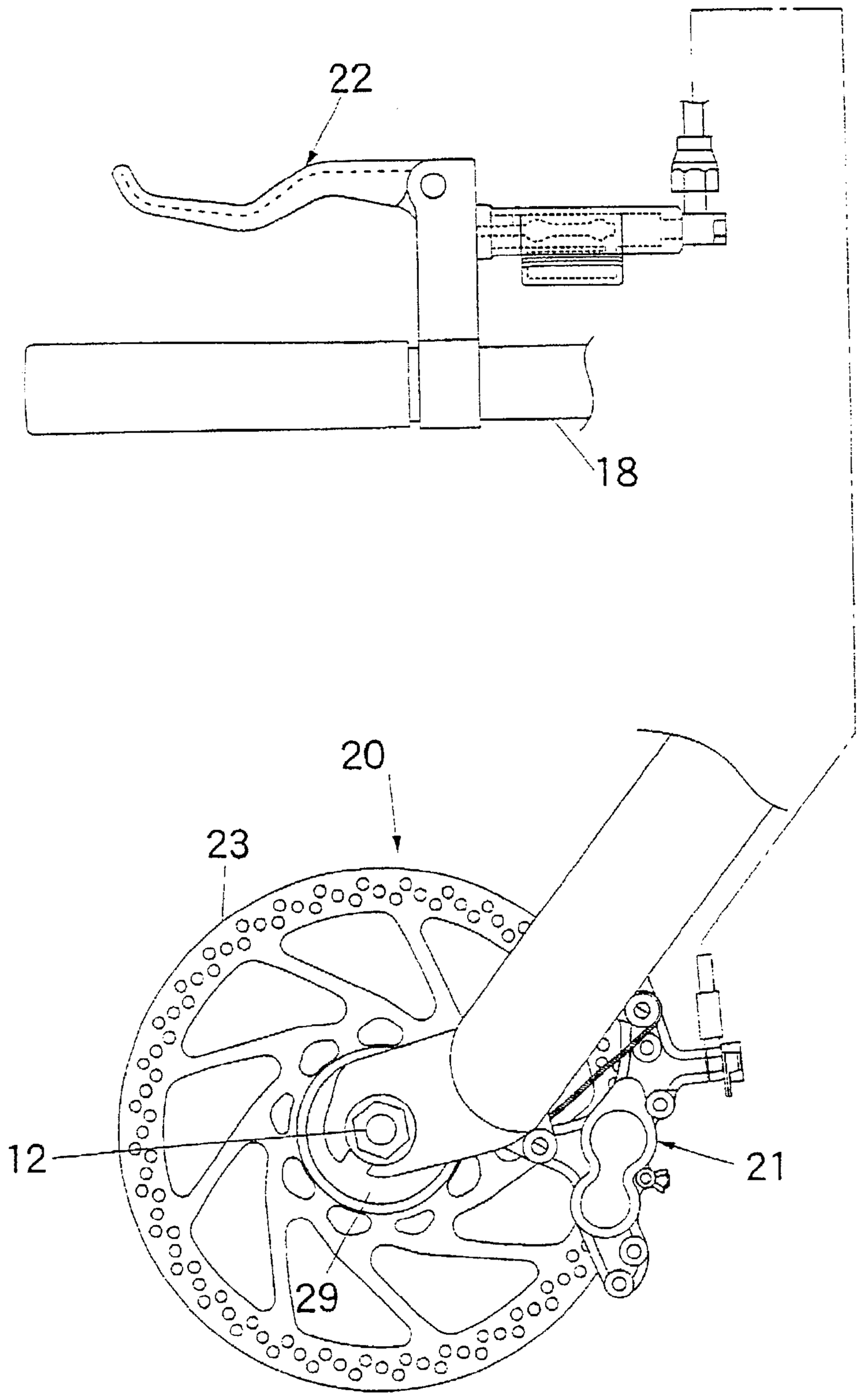

Fig. 2

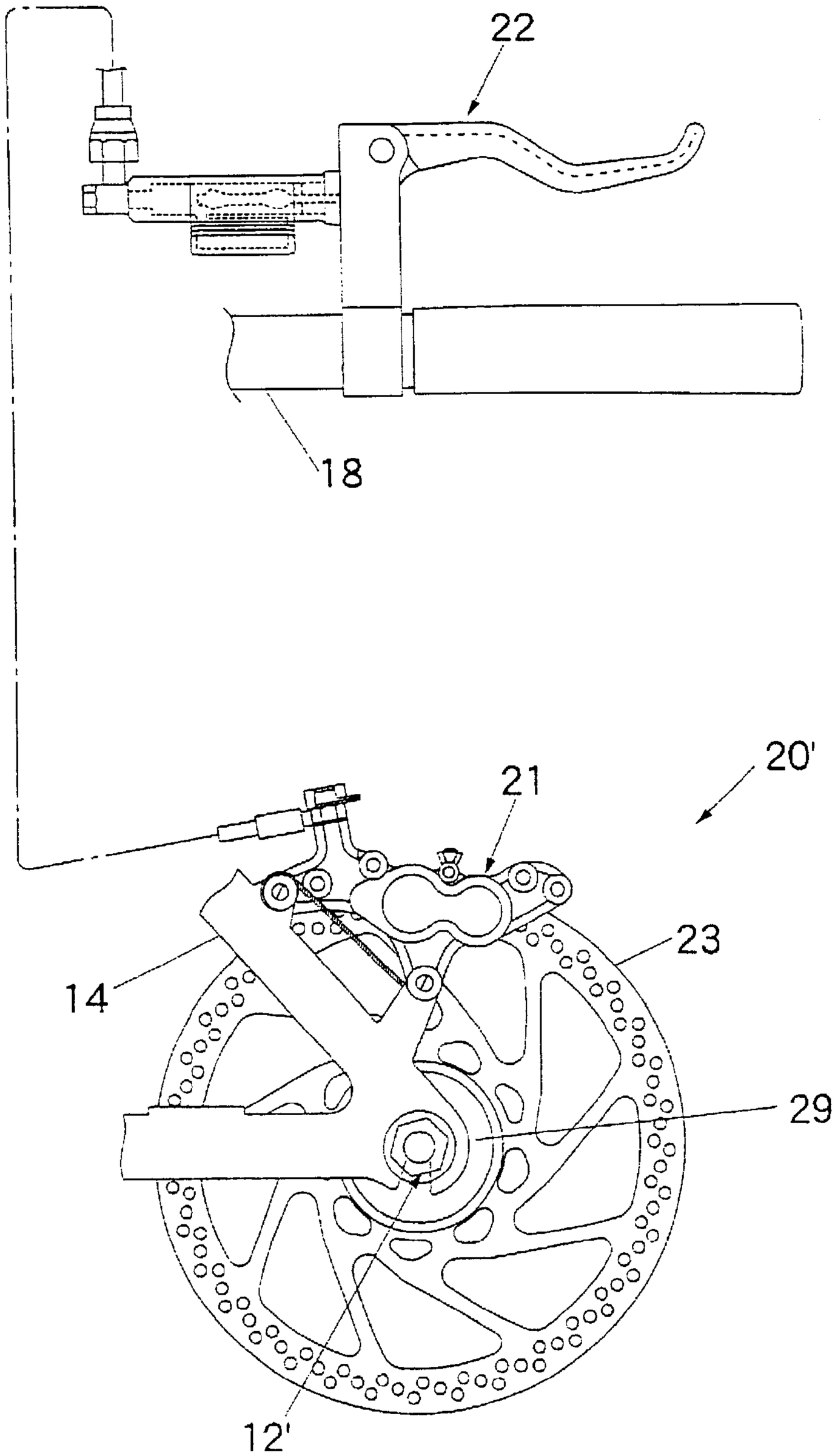

Fig. 3

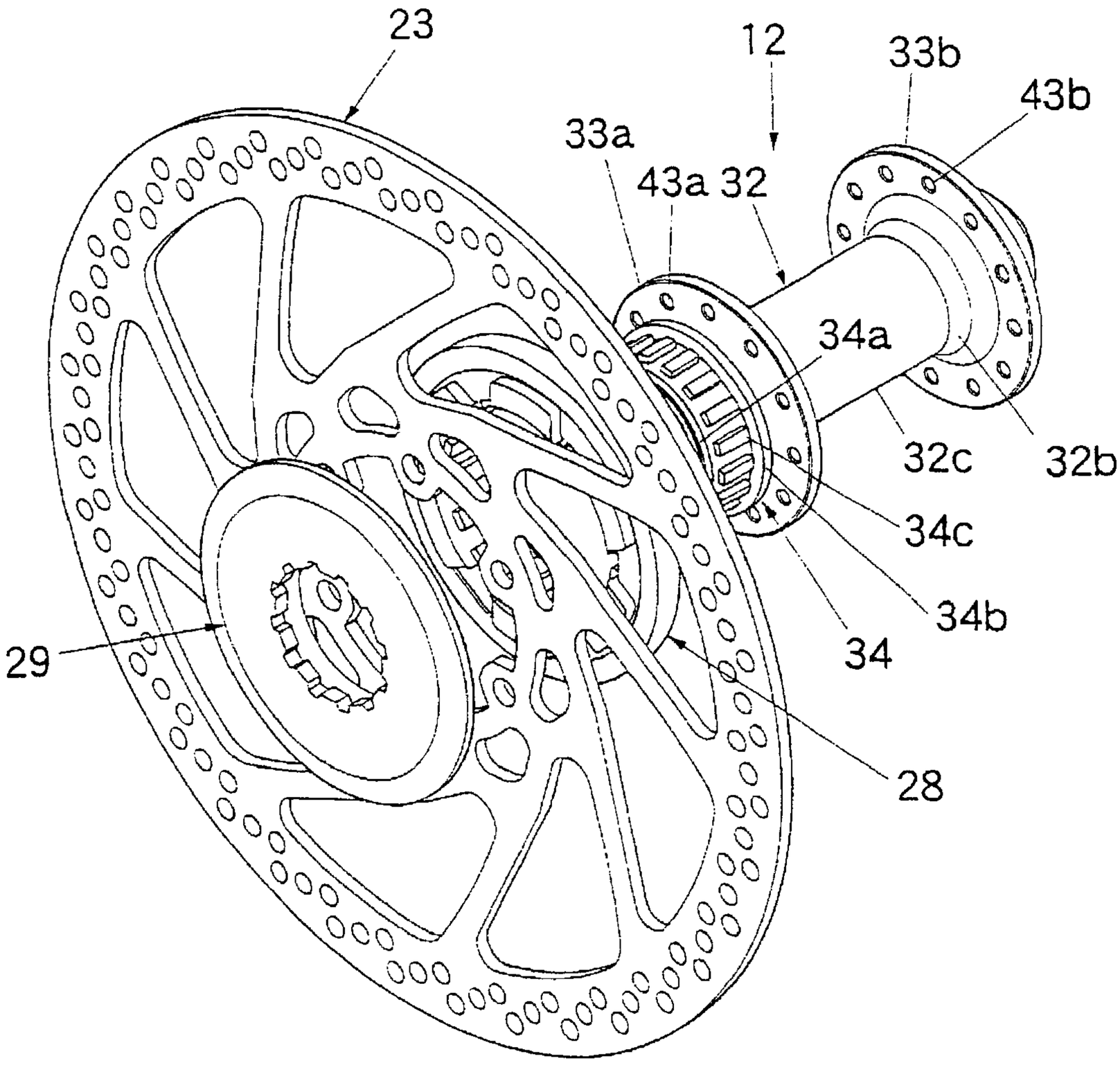

Fig. 4

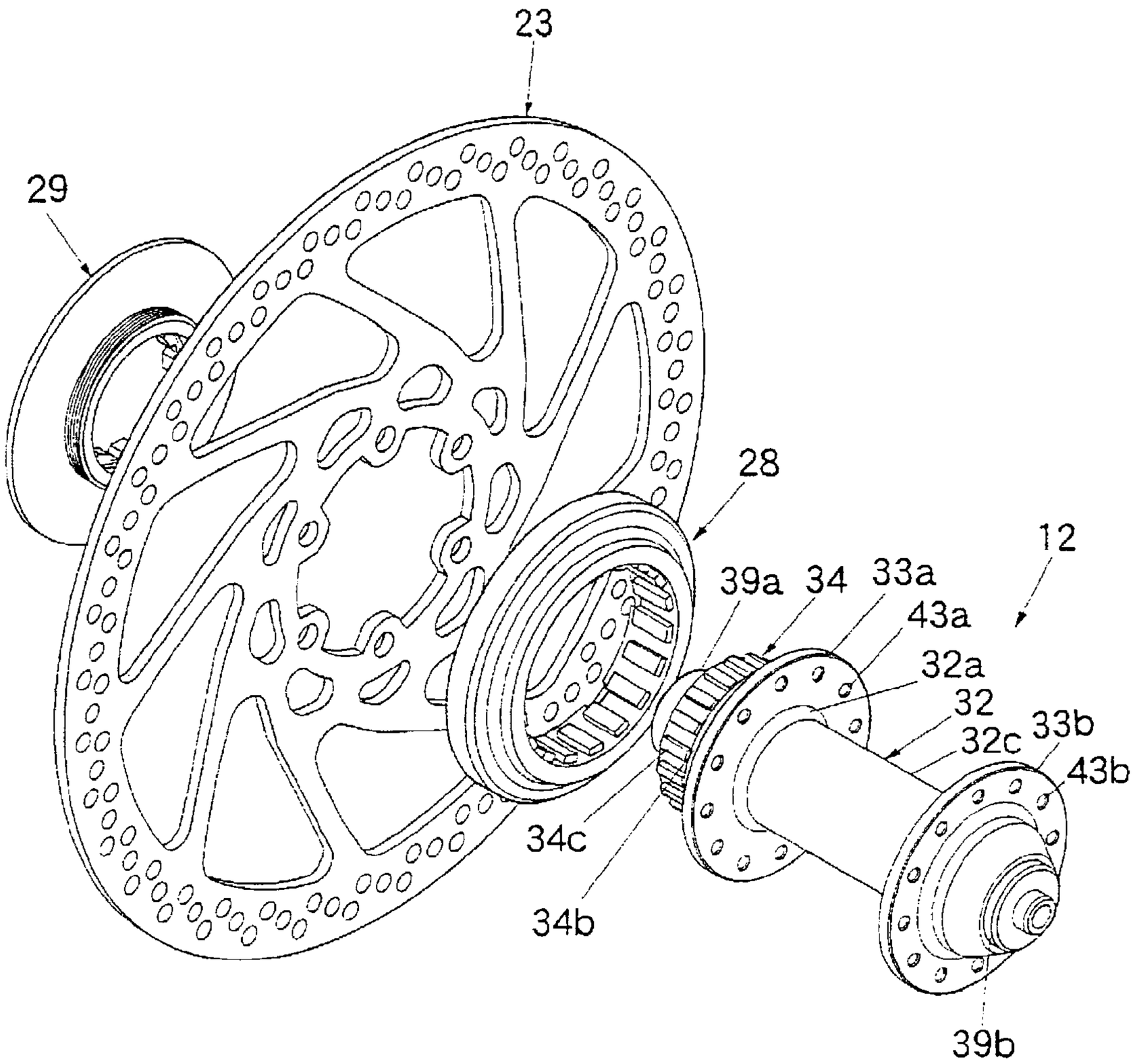

Fig. 5

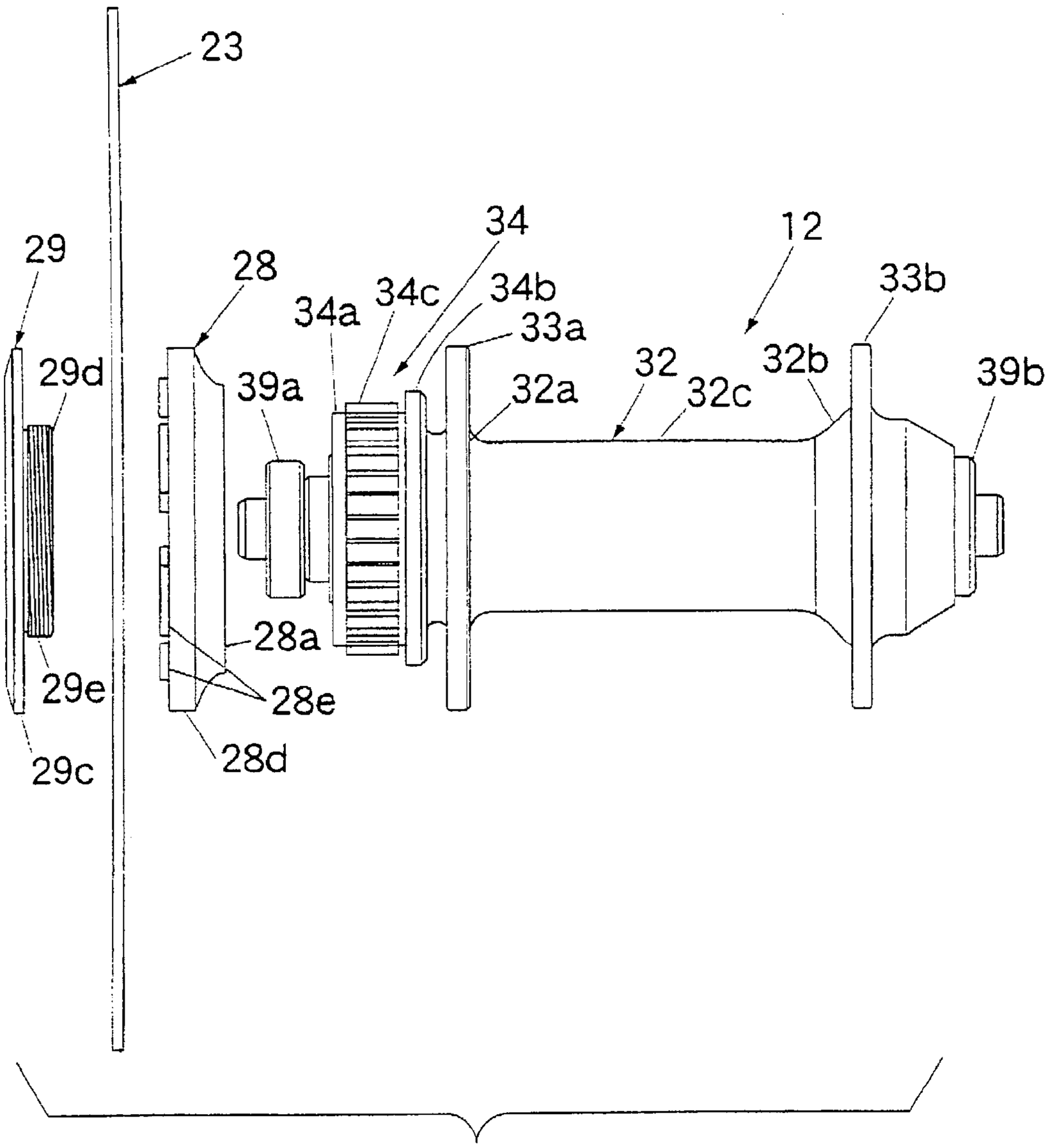
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Fig. 6

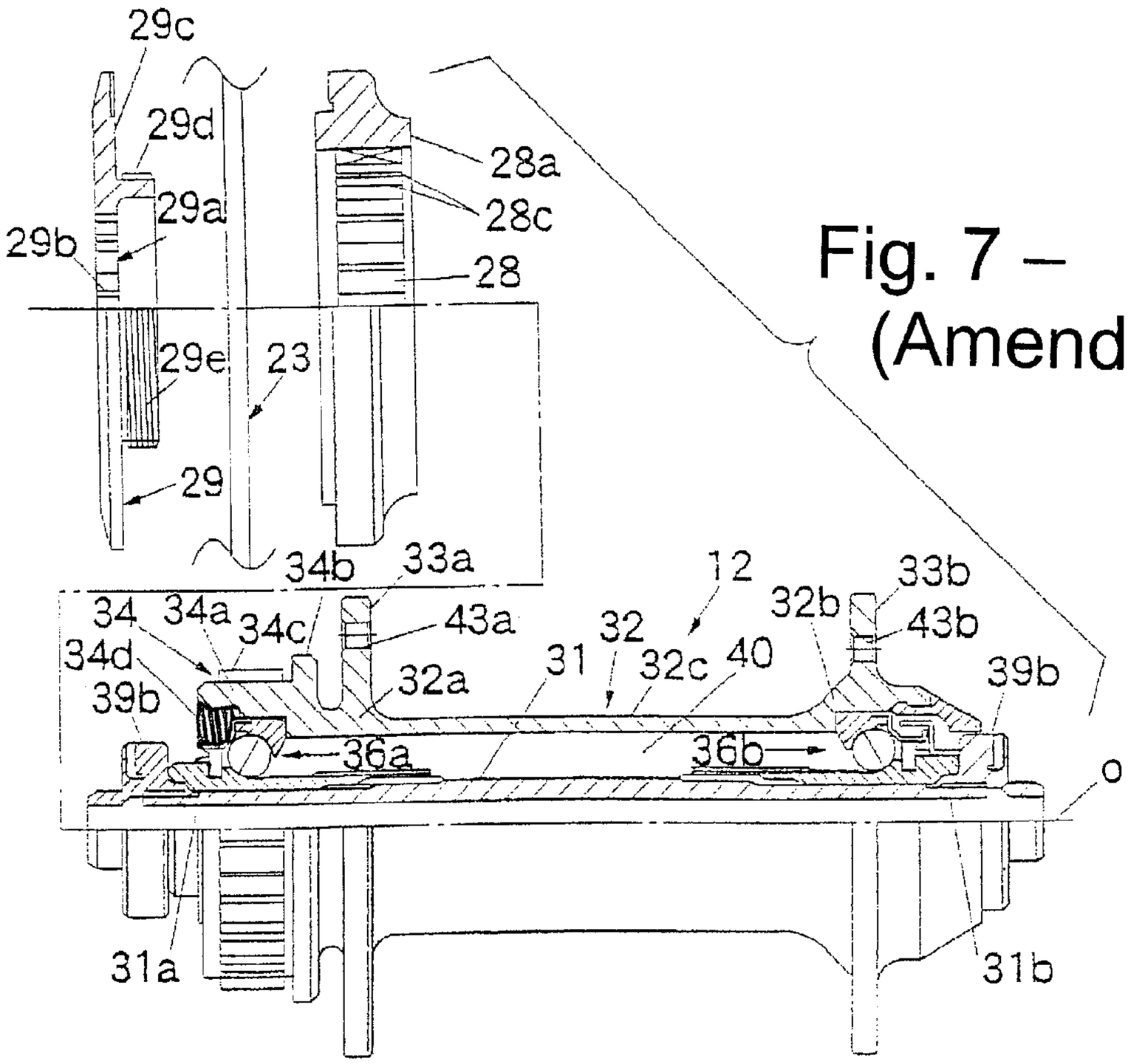
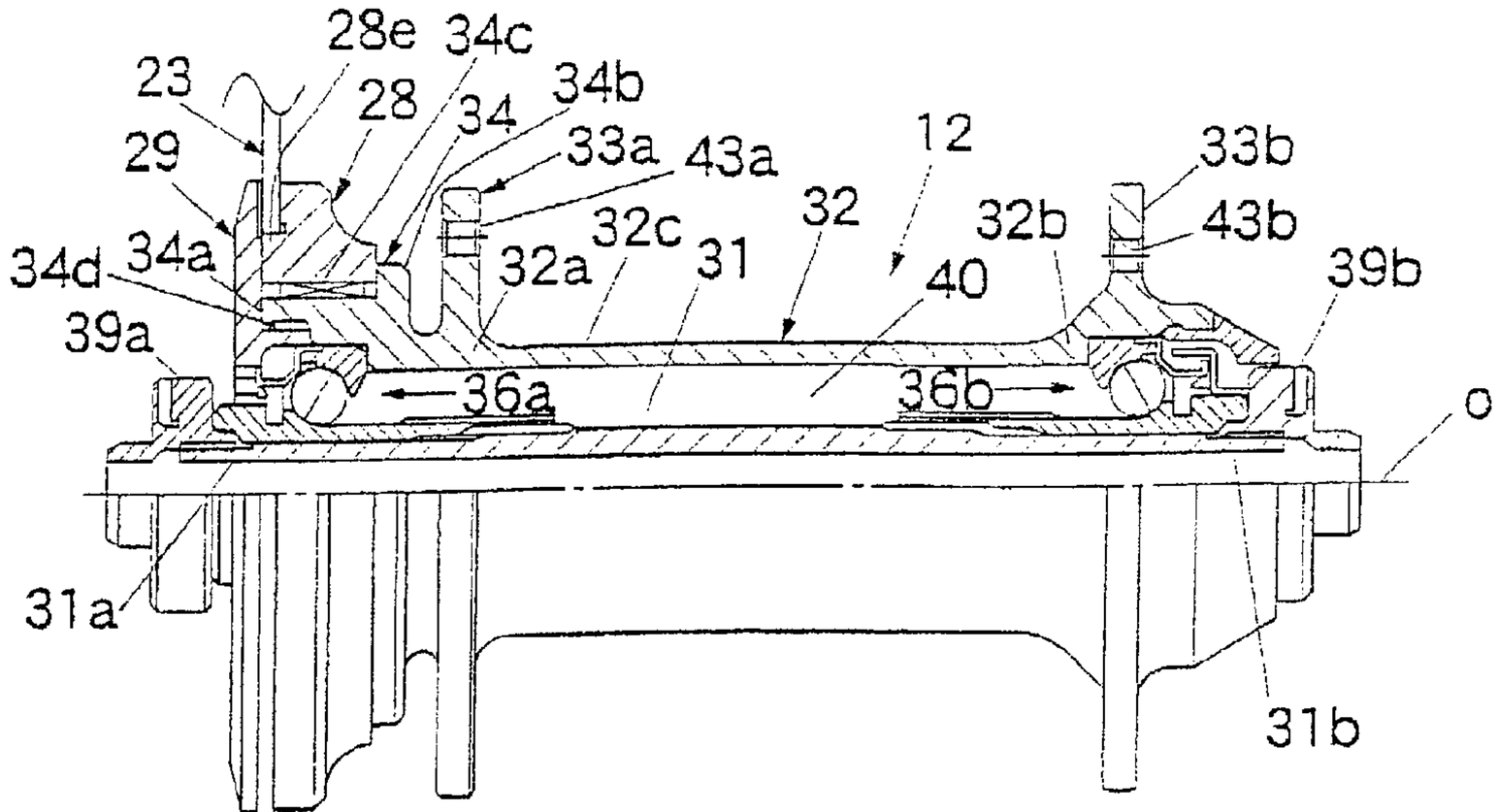


Fig. 7 – (Amended)



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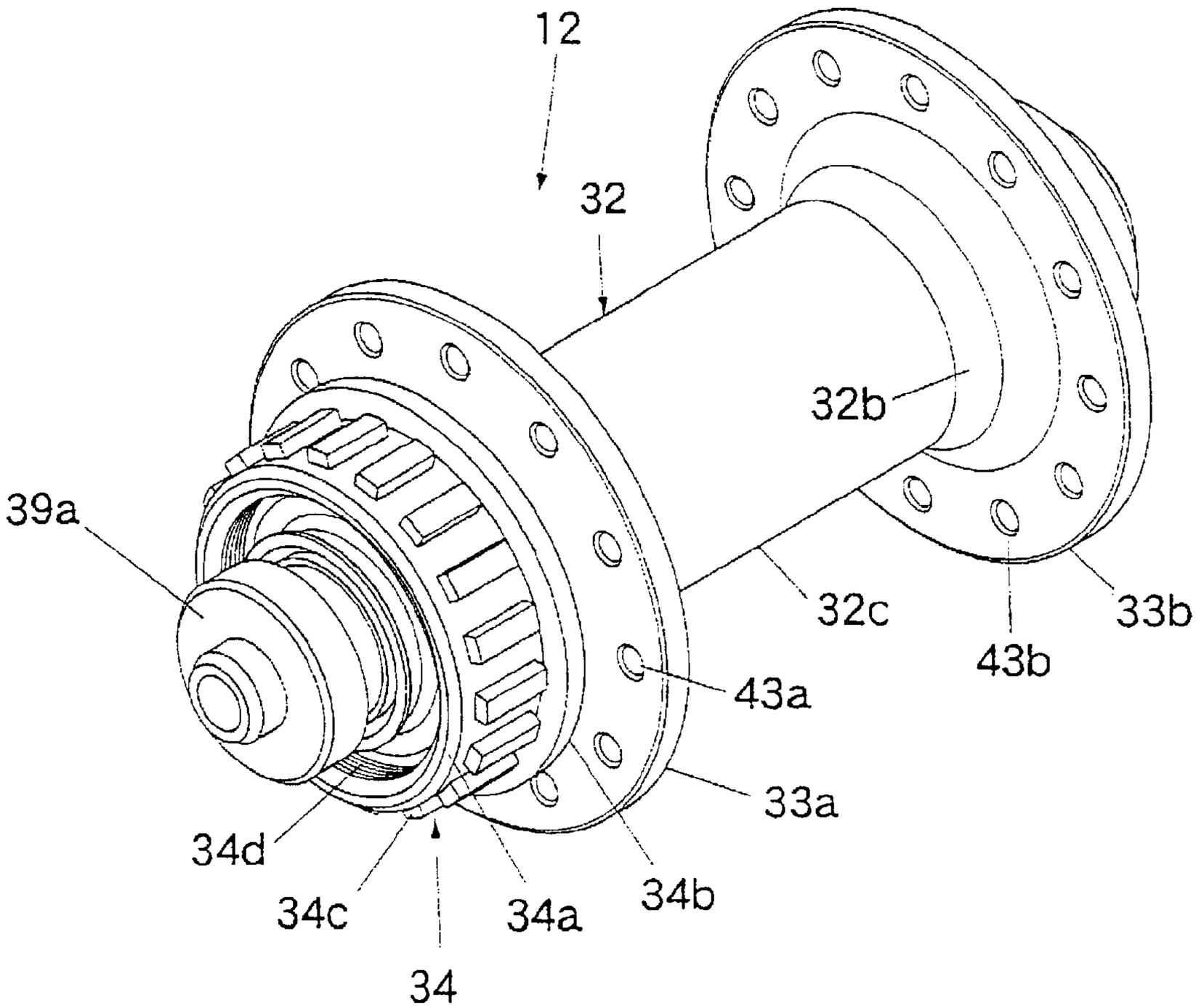

Fig. 9

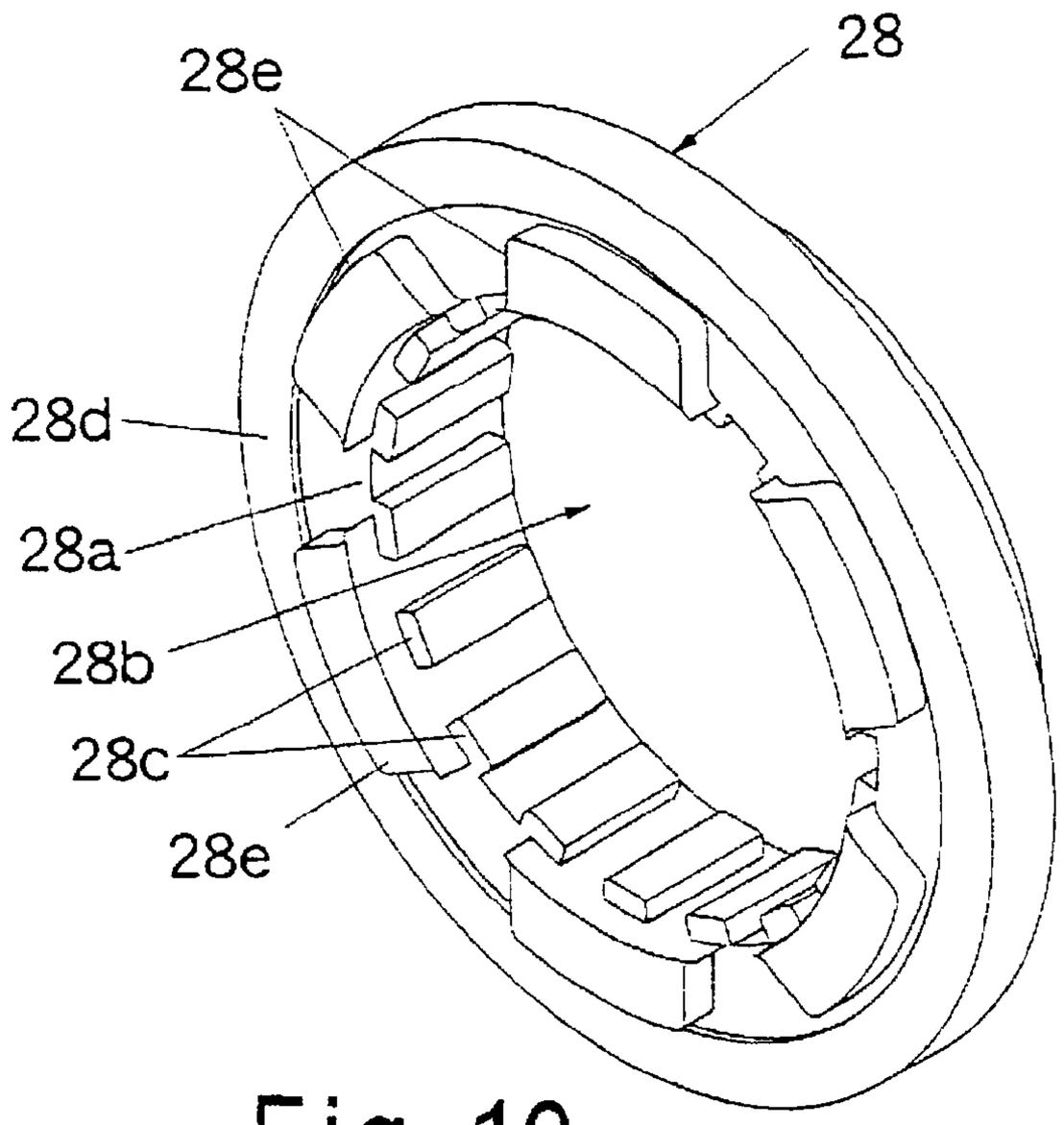

Fig. 10

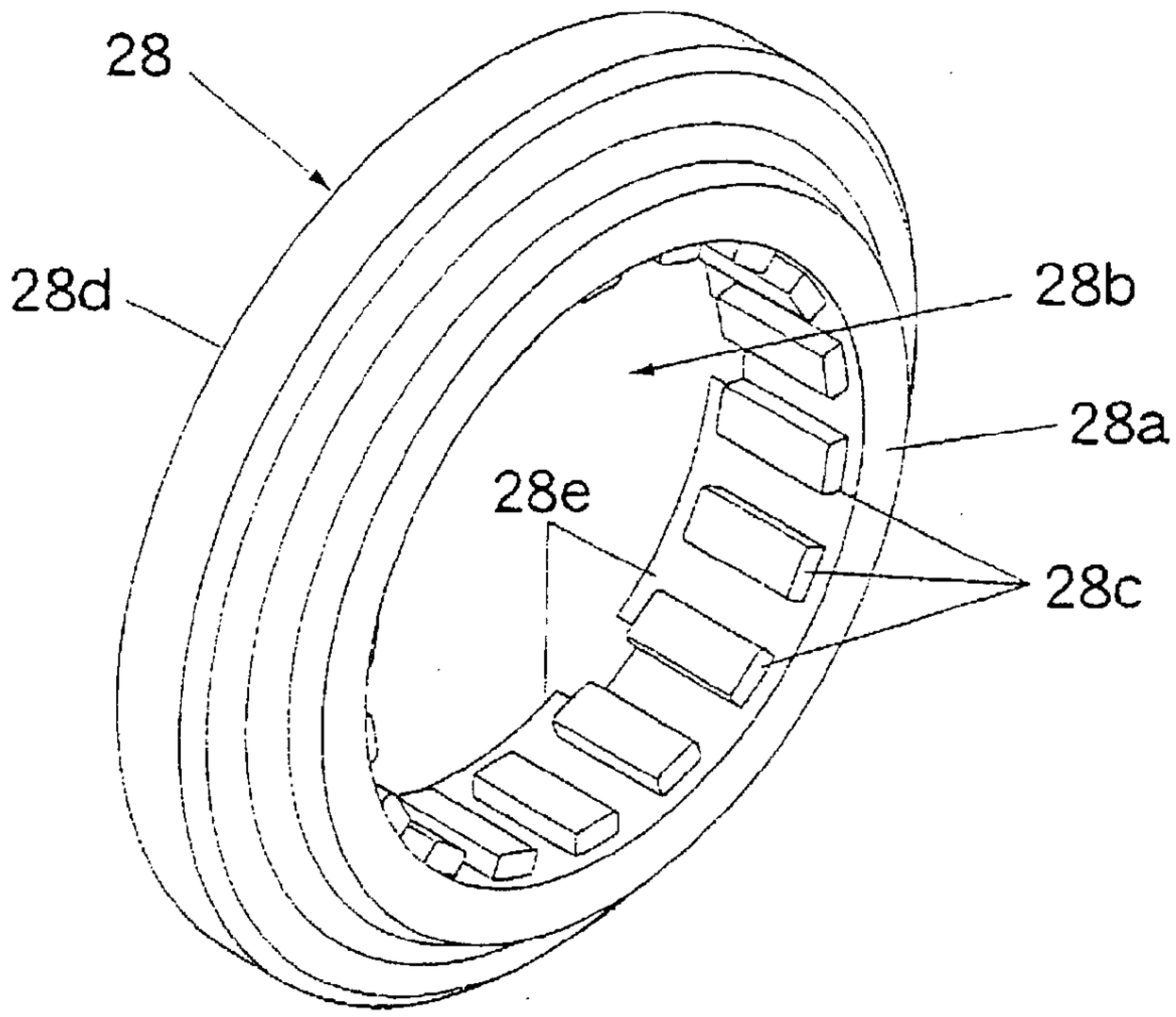

Fig. 11

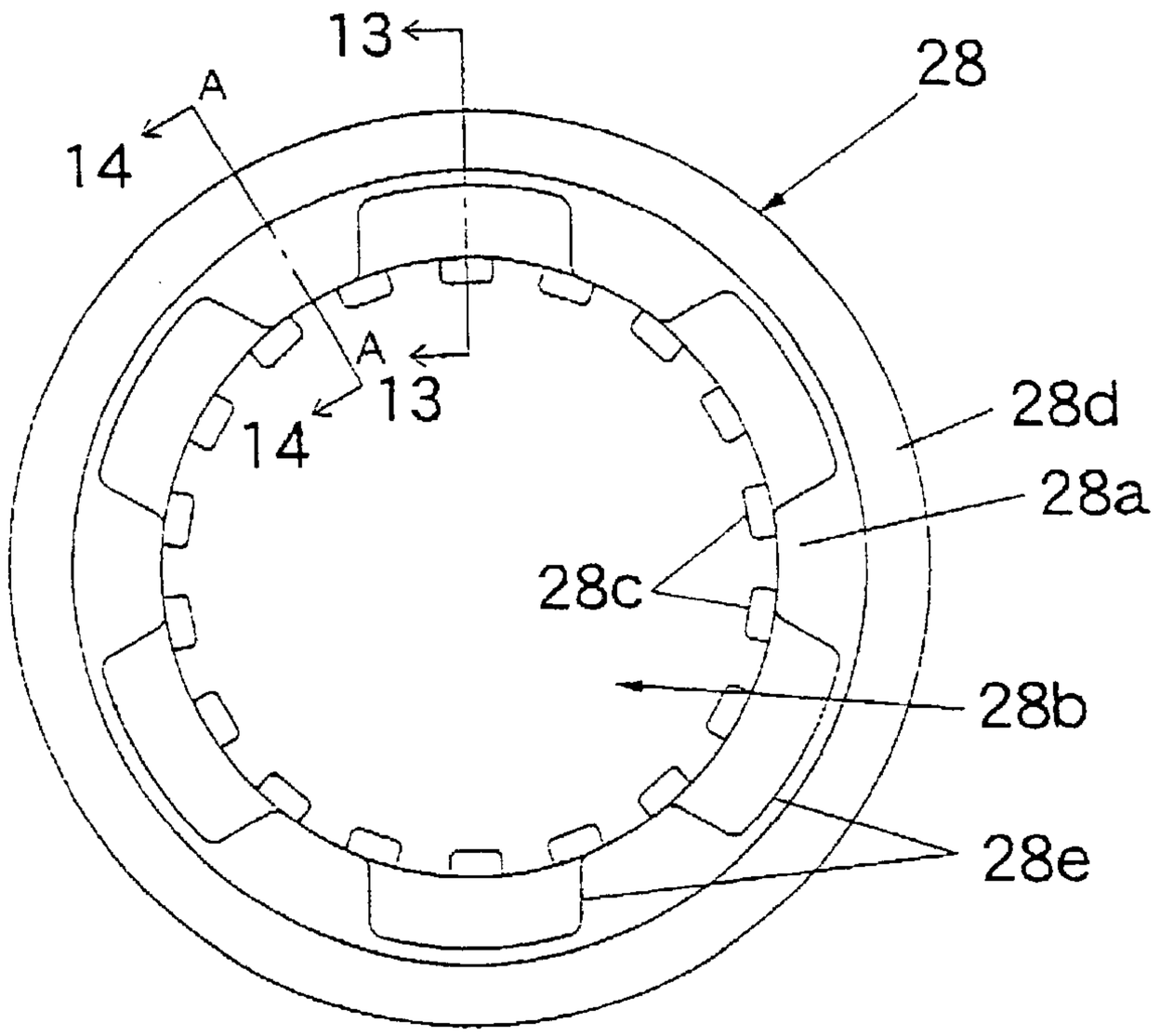

Fig. 12

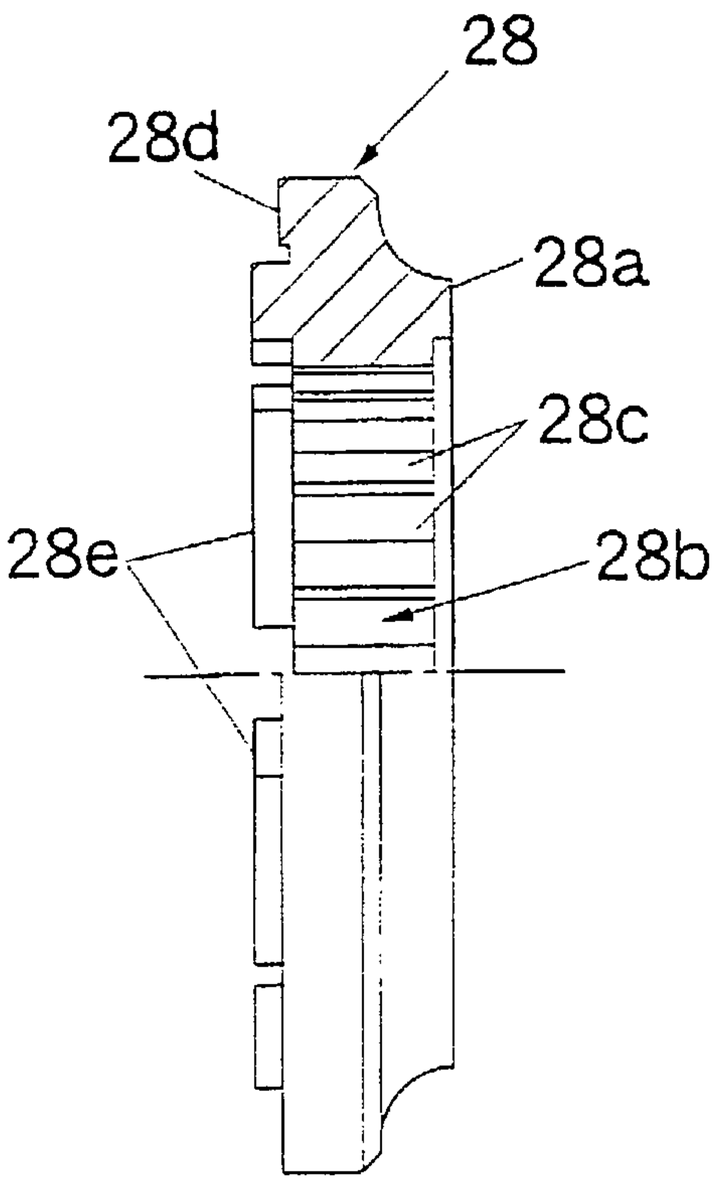

Fig. 13

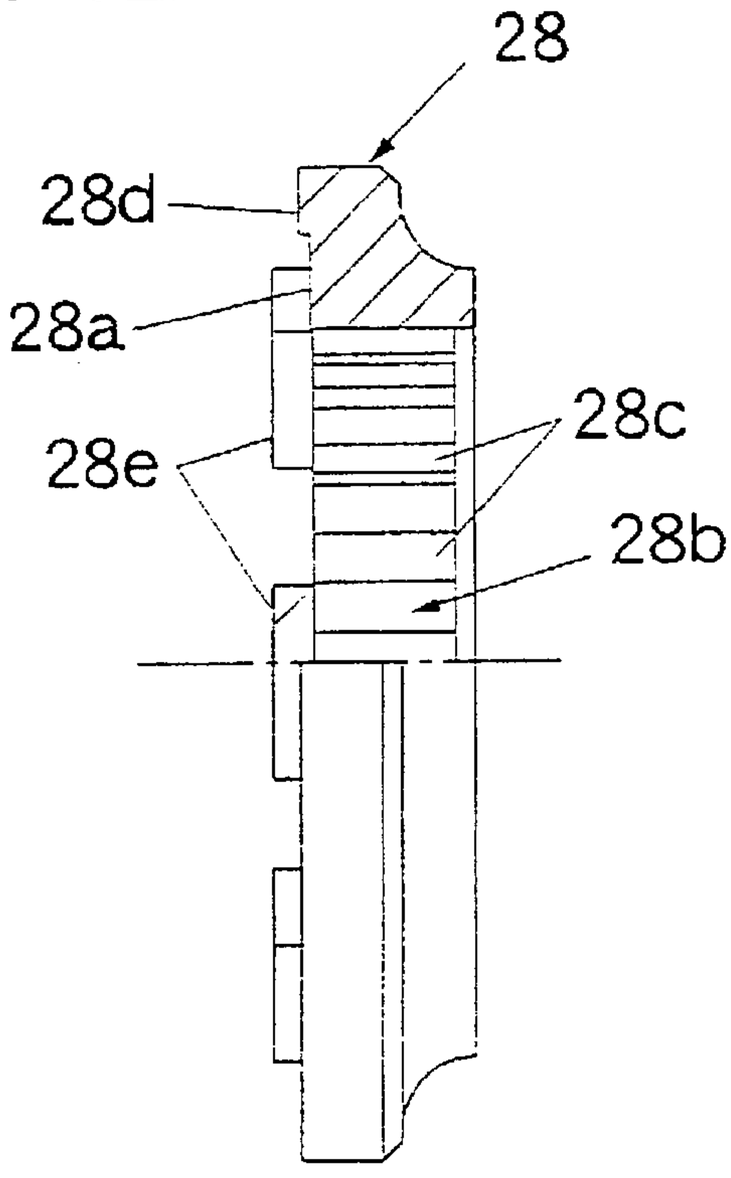

Fig. 14

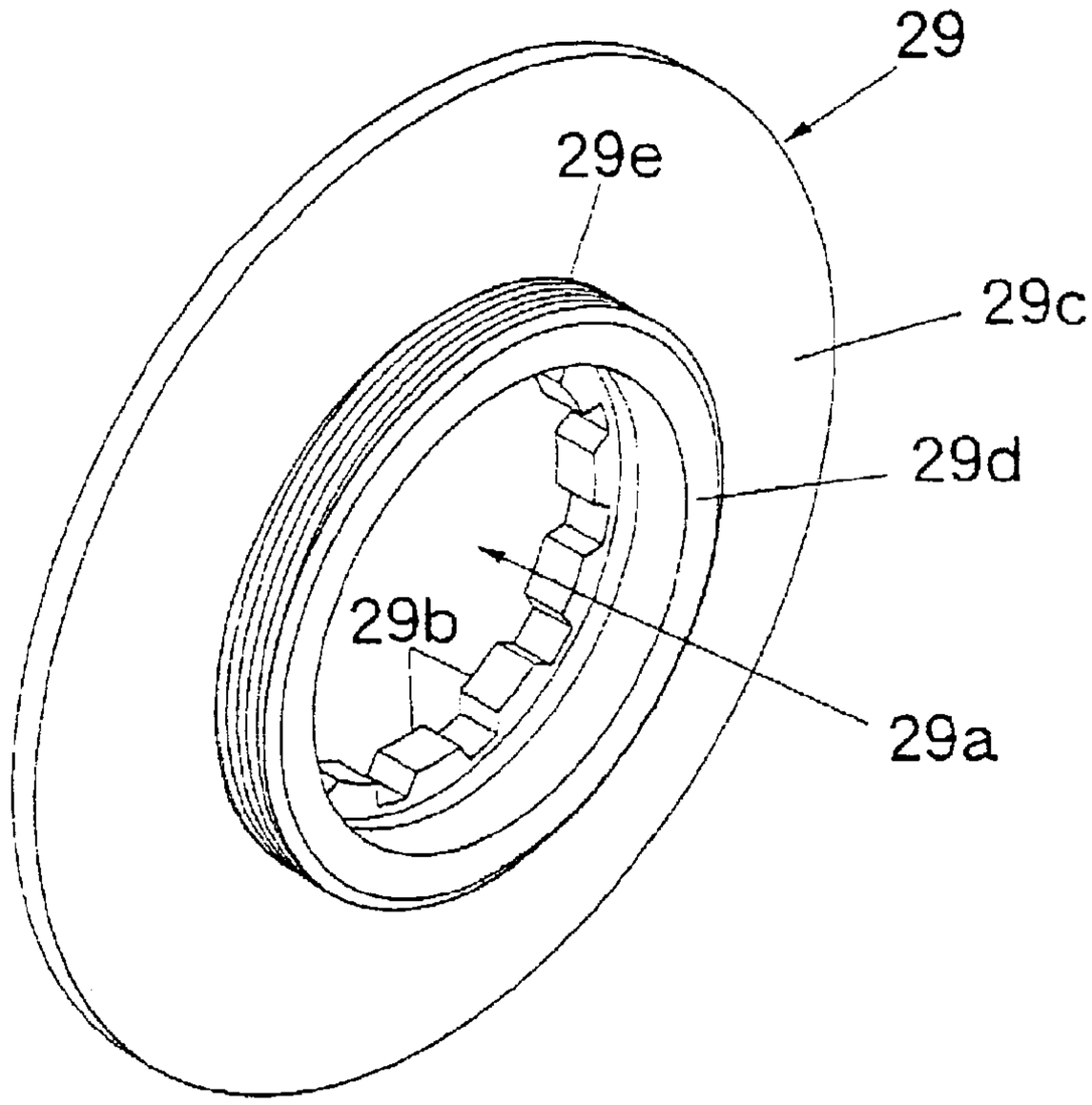

Fig. 15

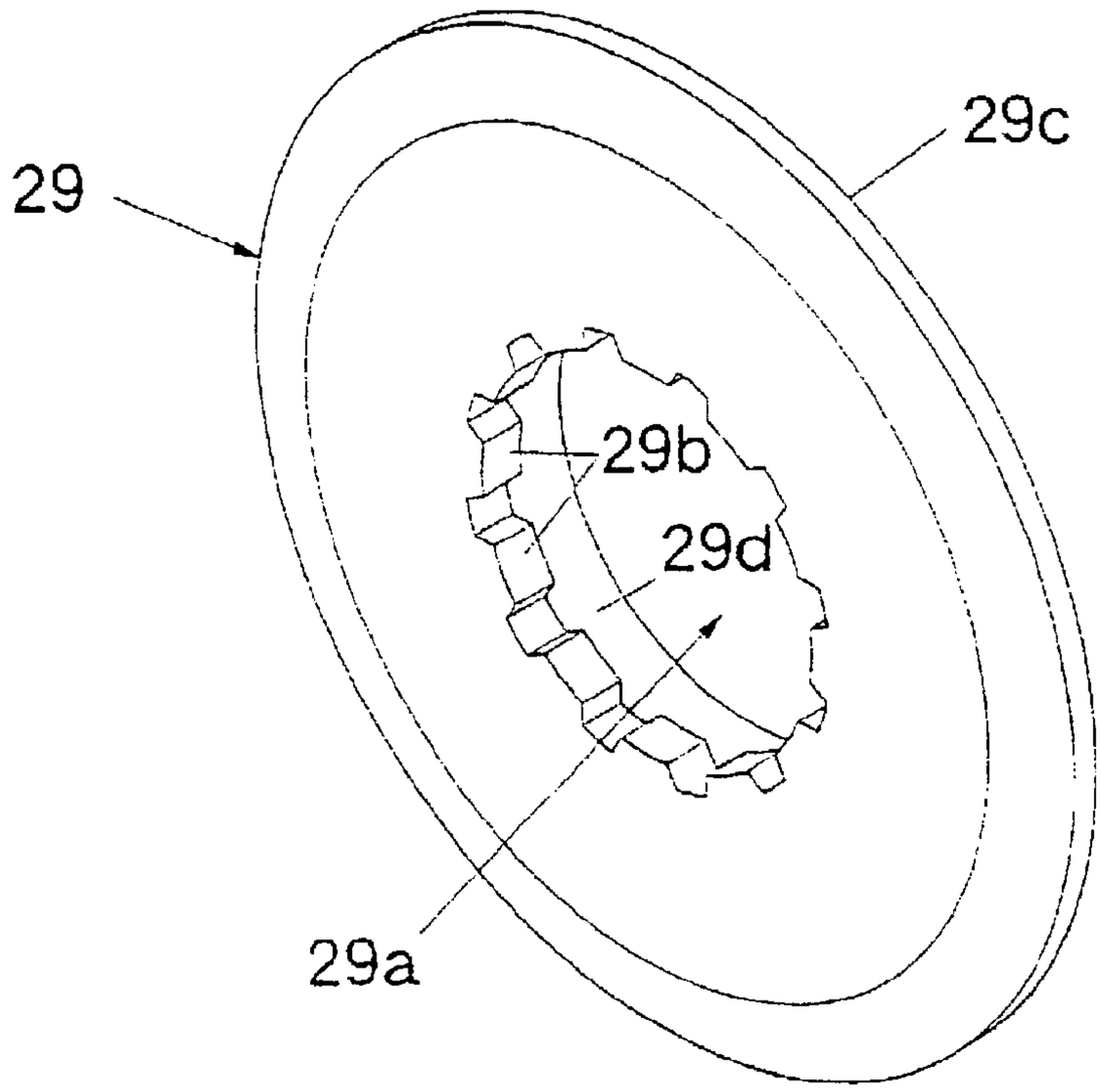

Fig. 16

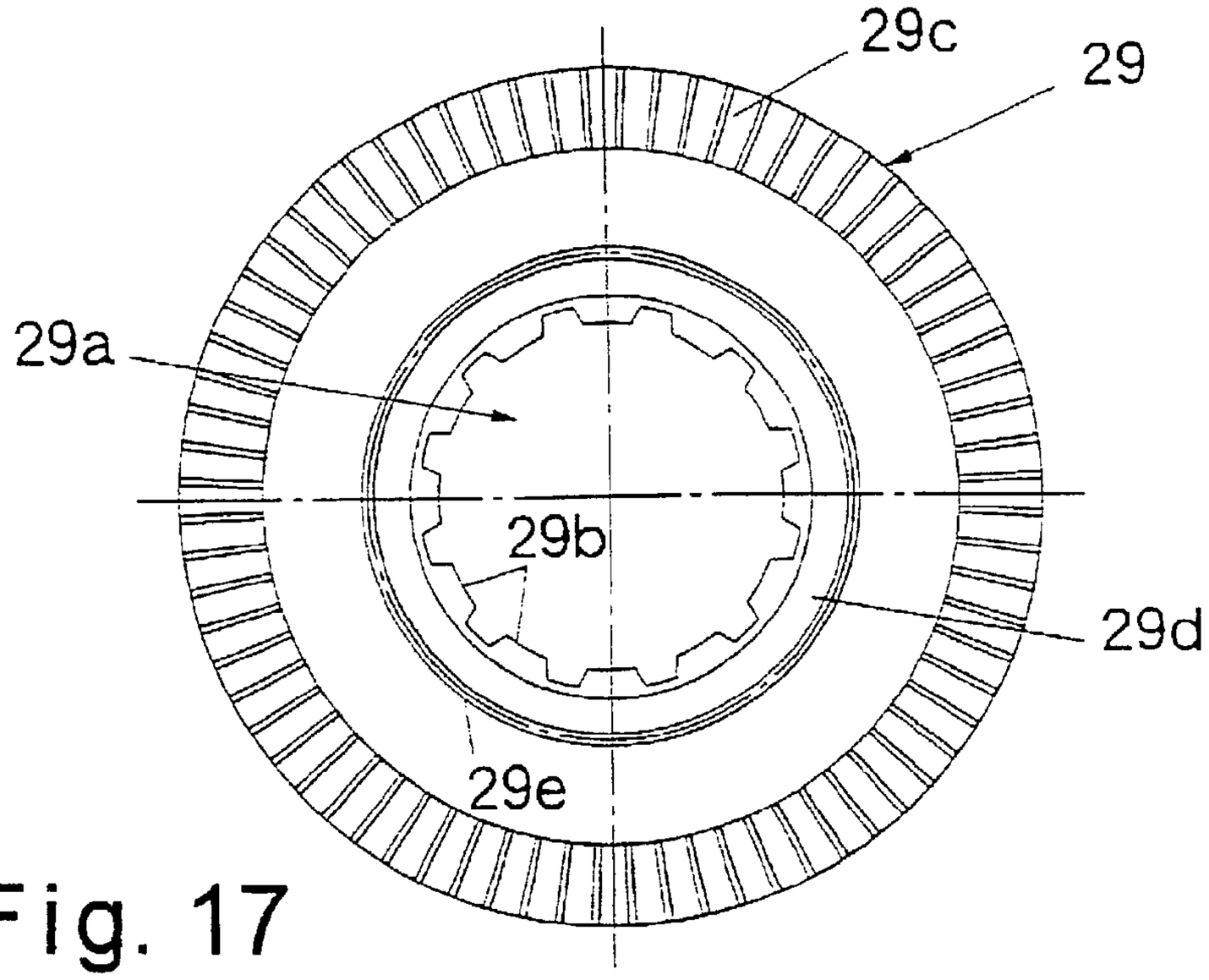

Fig. 17

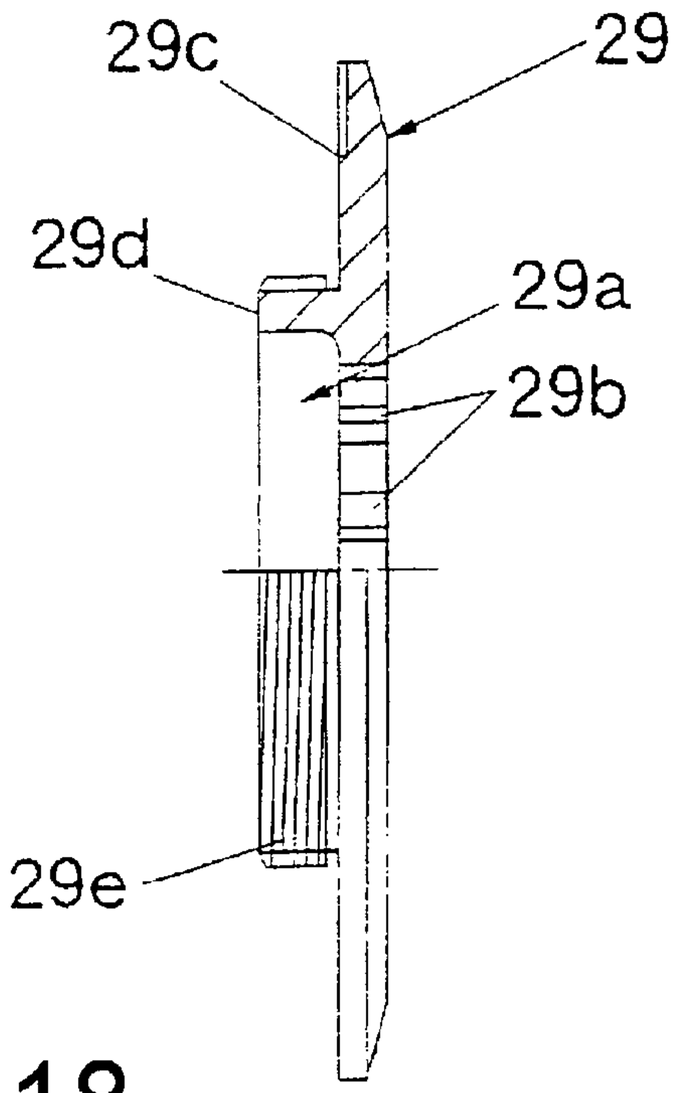

Fig. 18

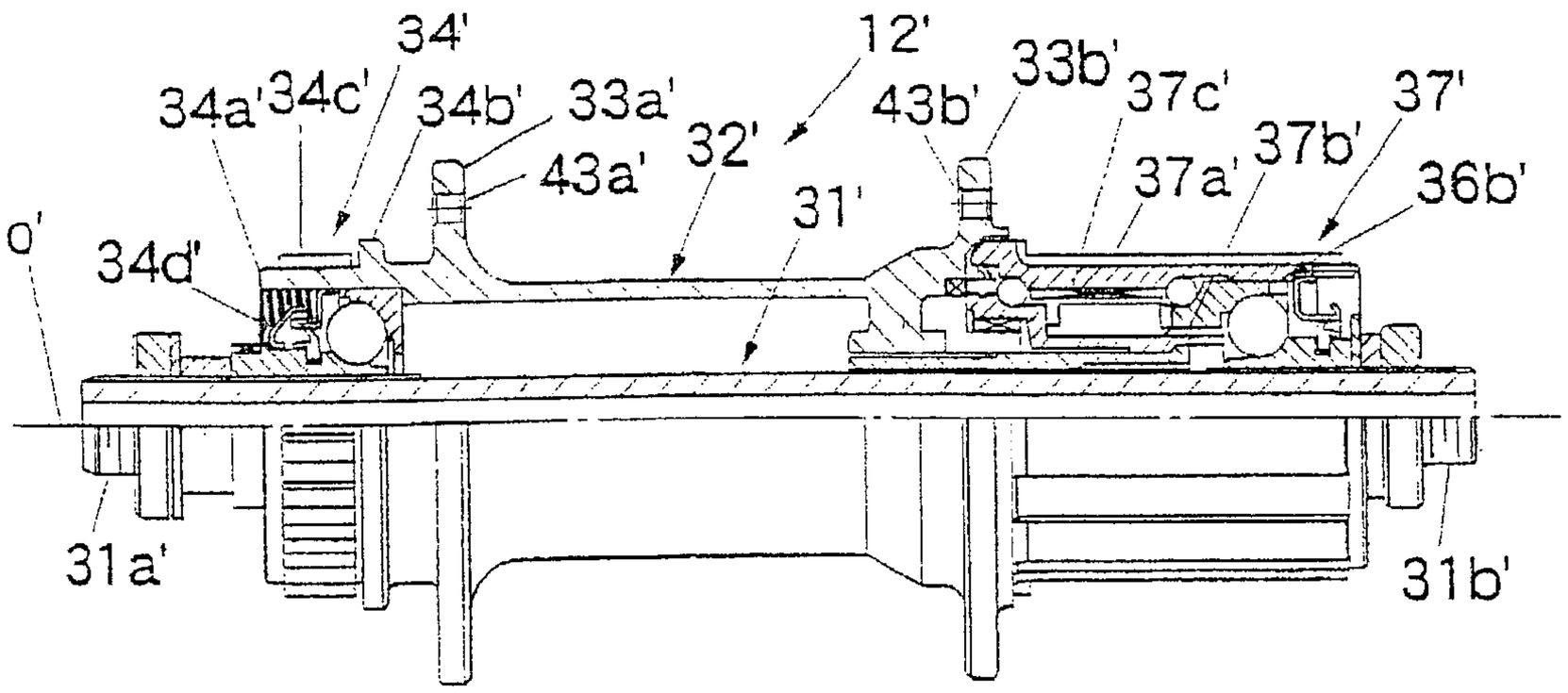

Fig. 19 – (Amended)

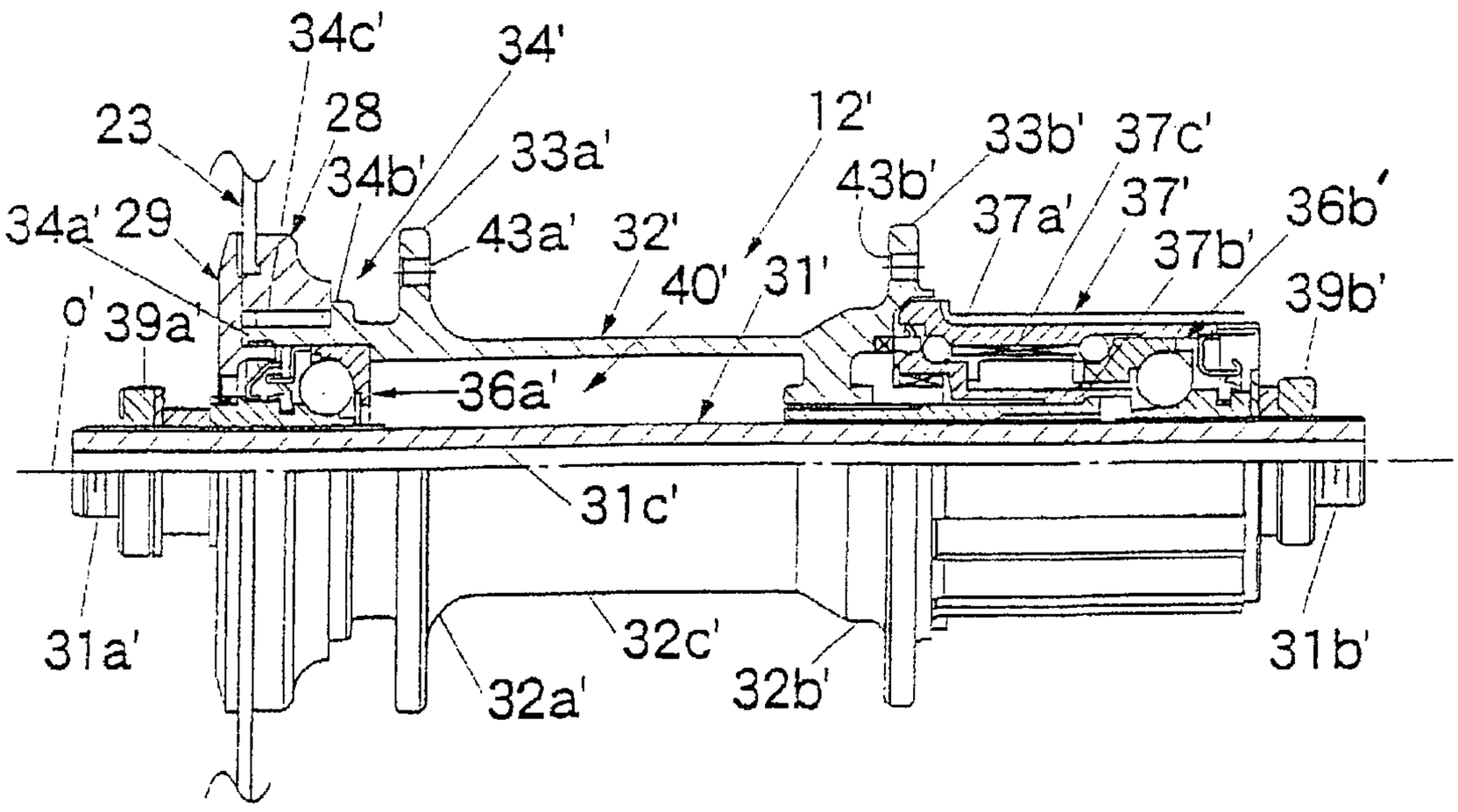

Fig. 20 – (Amended)

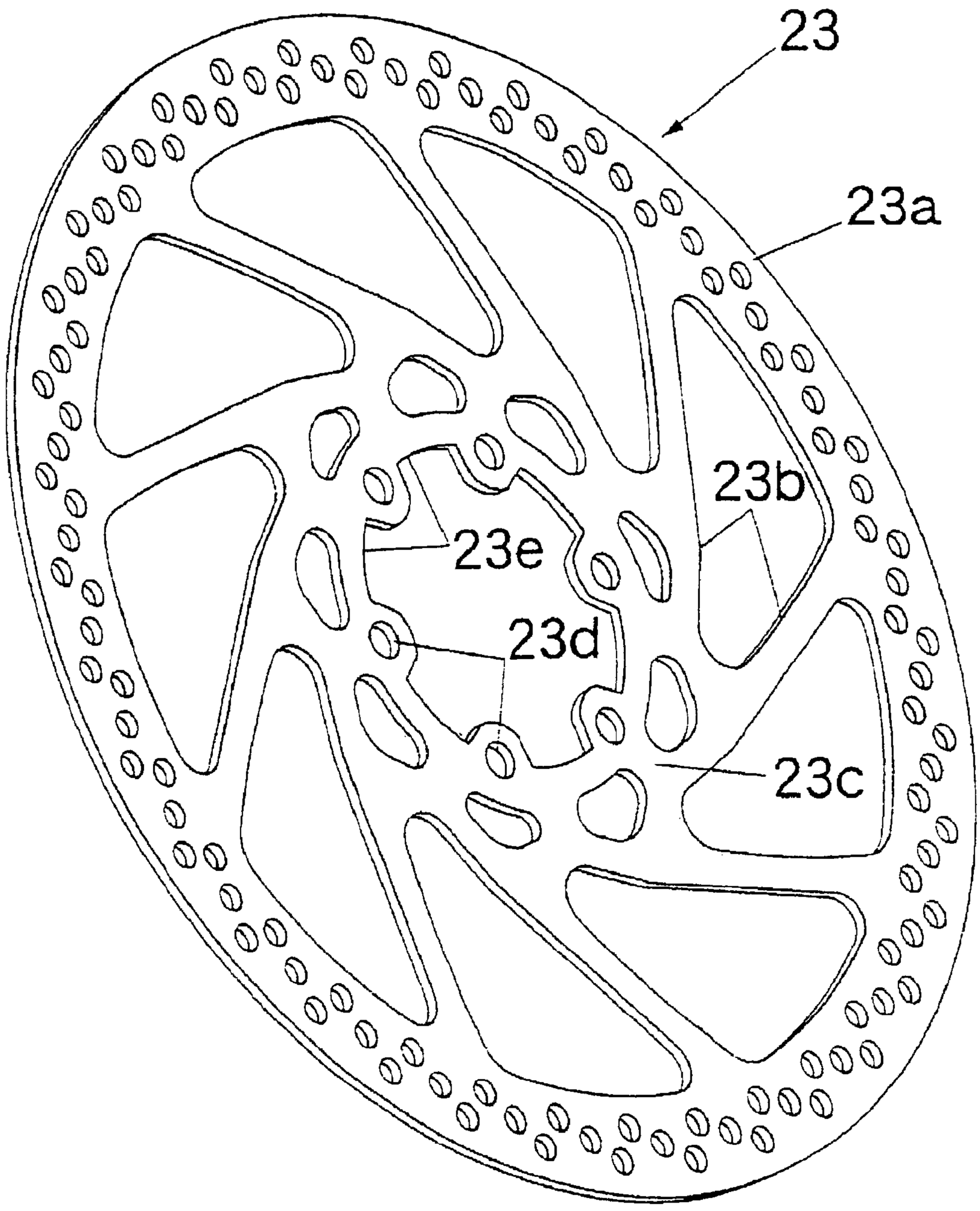

Fig. 21

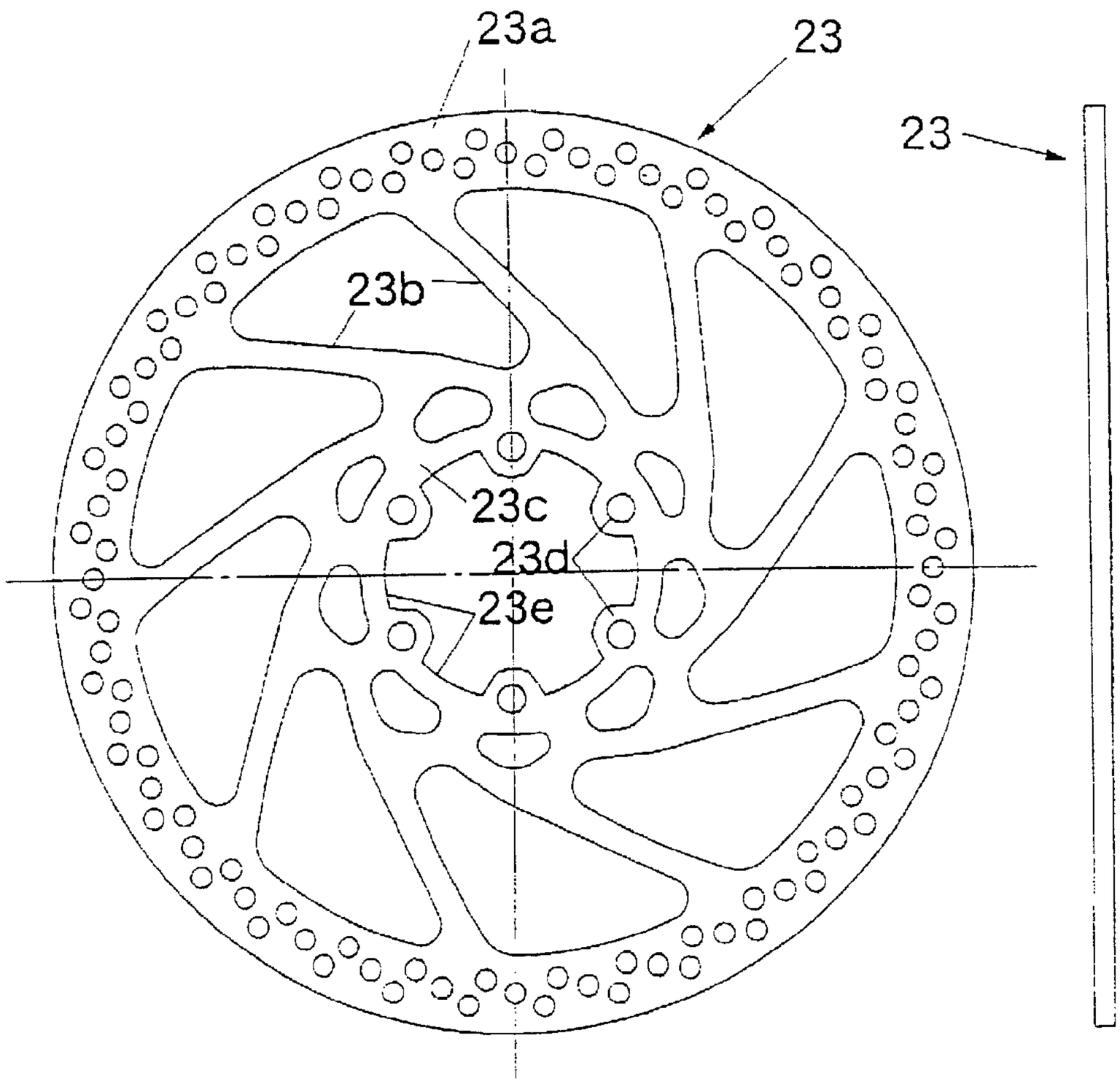

Fig. 22

Fig. 23

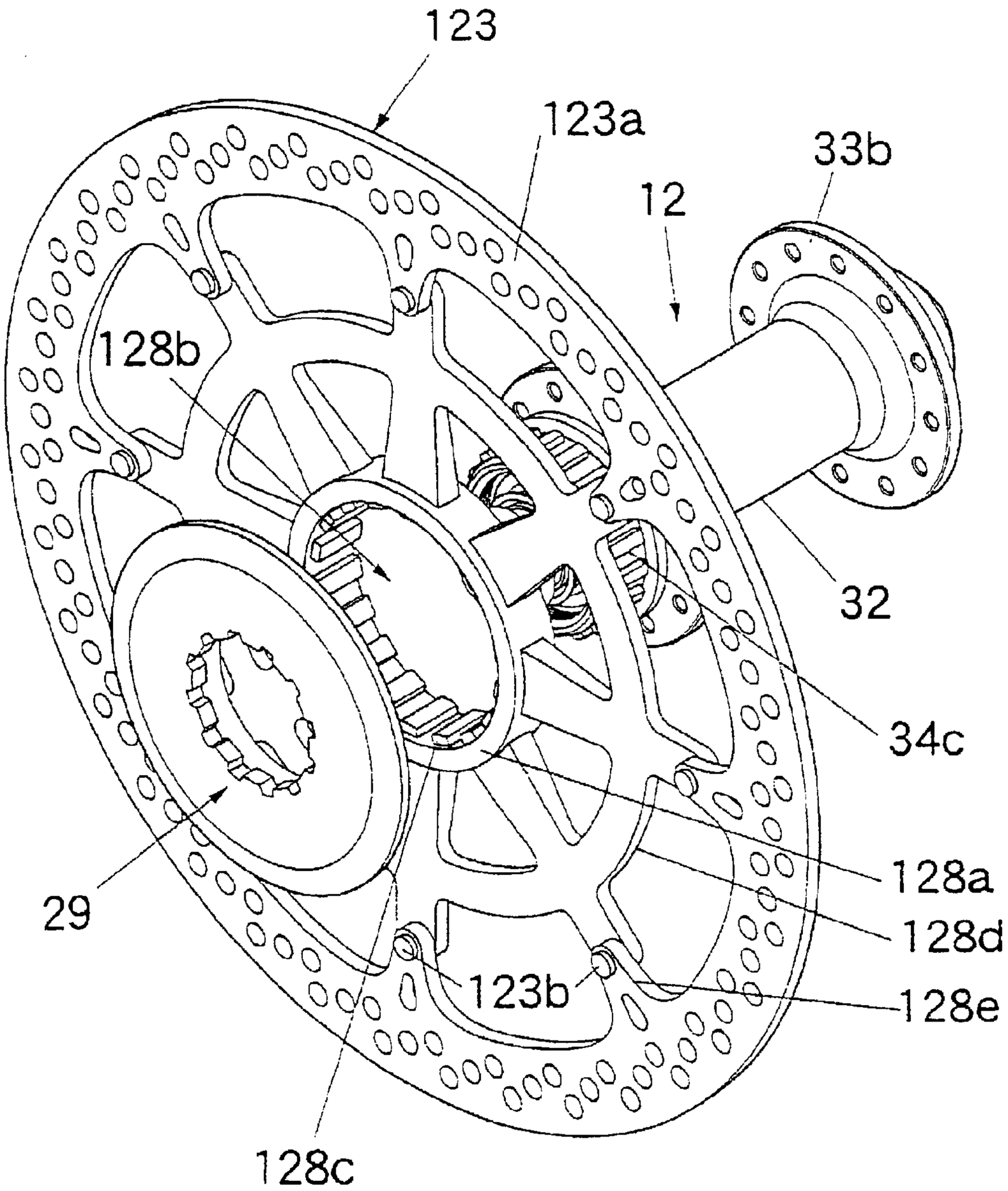

Fig. 24

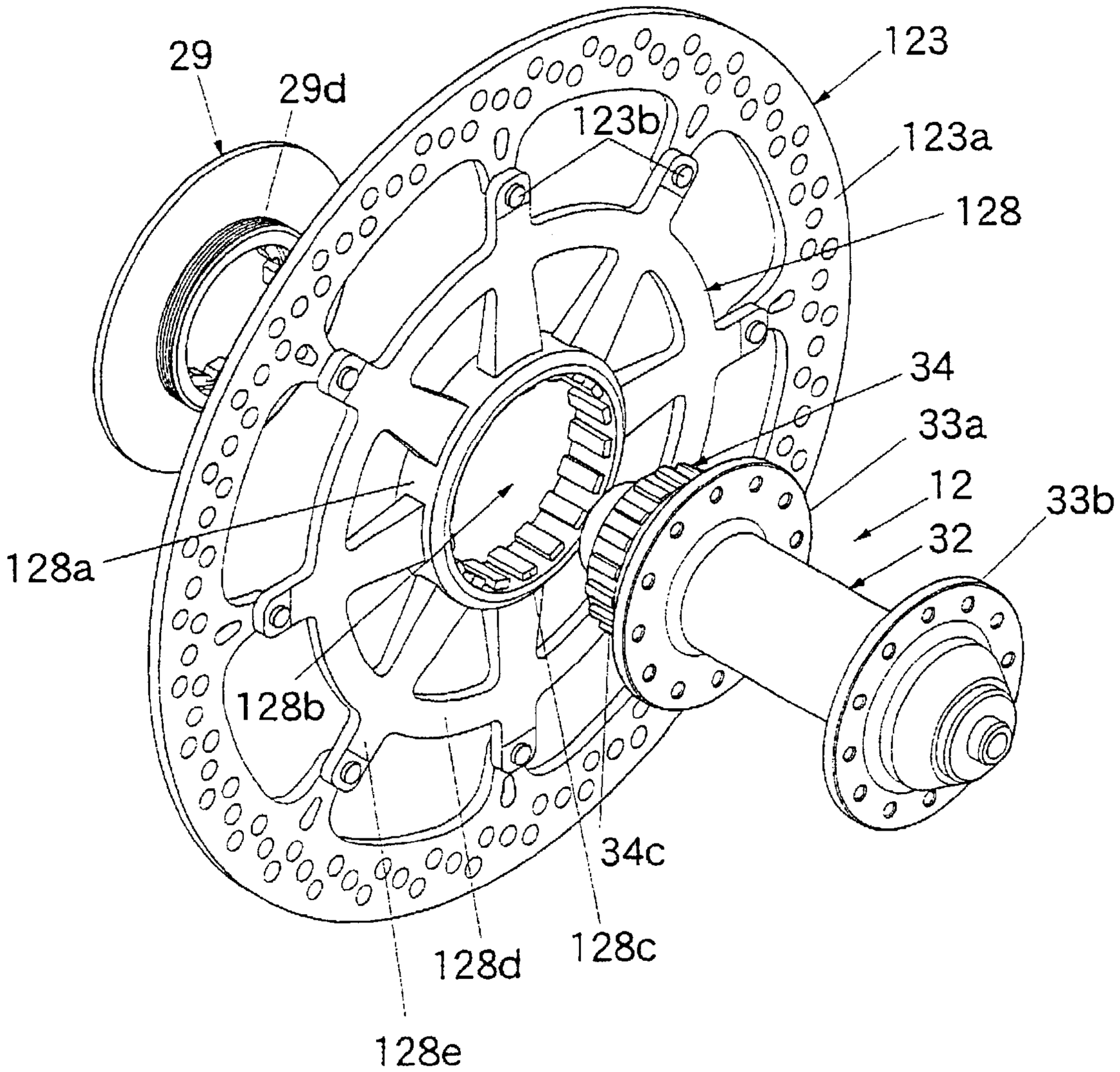
29
29d
123
123b
123a
128
34
33a
12
33b
32
128a
128b
34c
128c
128d
128e

Fig. 25

BICYCLE DISC BRAKE HUB

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention generally relates to a bicycle disc brake hub. More specifically, the present invention relates a bicycle disc brake hub in which the brake rotor mounted on a splined section of the hub shell.

2. Background Information

Bicycling is becoming an increasingly popular form of recreation as well as a means of transportation. Moreover, bicycling has become a very popular competitive sport. Whether the bicycle is used for recreation, transportation or competition, the bicycle industry is constantly improving their components. One particular component of the bicycle which has been extensively redesigned over the past years is the bicycle braking system.

There are several types of bicycle brake devices, which are currently available on the market. Examples of some types of common bicycle brake devices include rim brakes, caliper brakes and disc brakes. If a rider wants a very high performance brake system, then the rider typically wants a disc brake system. Disc brake systems provide a substantial braking power in relationship to the amount of braking force applied to the brake lever. Moreover, disc brake systems typically provide a high level of consistency in all types of weather and riding conditions.

Typically, a brake disc assembly for a bicycle includes a caliper mounted on the bicycle frame and operatively coupled to a brake lever, and a disc brake rotor fixedly coupled to the hub of the wheel of the bicycle. The disc brake rotor has been coupled to the hub of the wheel in several different ways. For example, a brake rotor attachment flange is often provided for bolting the disc brake rotor to the hub. Alternatively, as shown in U.S. Pat. No. 6,206,144 to Di Bella, the hub has splines at one end that a boss part is non-rotatably mounted thereon and secured by a locking ring. One problem with the latter method of attaching the disc brake rotor to the hub is that the external seat may become damaged such that the locking ring cannot be installed thereon. One problem with this type of mounting method is that the brake rotor attachment portion can often be difficult to manufacture and/or install the brake rotor thereon.

In view of the above, there exists a need for an improved bicycle disc brake hub which overcomes the above mentioned problems in the prior art. This invention addresses this need in the prior art as well as other needs, which will become apparent to those skilled in the art from this disclosure.

SUMMARY OF THE INVENTION

One object of the present invention is to provide a bicycle disc brake hub that is relatively is reliable and durable so that the disc brake rotor can be easily installed on the hub even after extensive use.

Another object of the present invention is to provide a bicycle disc brake hub that is relatively lightweight.

Still another object of the present invention is to provide bicycle disc brake hub that is relatively compact in overall construction.

Yet another object of the present invention is to provide a bicycle hub that is relatively inexpensive to manufacture.

The foregoing objects can basically be attained by providing a bicycle disc brake hub comprising a hub axle, a hub shell, a brake rotor attachment portion and a locking ring. The hub axle has a center axis extending in an axial direction between a first axle end and a second axle end. The hub shell has first and second hub shell ends with the hub axle rotatably coupled to the hub shell. The brake rotor attachment portion is disposed at the first hub shell end. The brake rotor attachment portion has an external surface with an external splined section and an annular internal surface with internal threads. The locking ring has a center tubular section with external threads and an abutment flange extending outwardly from the center tubular section to form an axially facing retaining surface. The external threads of the center tubular section mate with the internal threads of the brake rotor attachment portion.

In one embodiment of the present invention, the brake rotor is held between the locking ring and the rotor mounting boss, while in another embodiment of the present invention, the brake rotor is riveted to the rotor mounting boss.

These and other objects, features, aspects and advantages of the present invention will become apparent to those skilled in the art from the following detailed description, which, taken in conjunction with the annexed drawings, discloses a preferred embodiment of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring now to the attached drawings which form a part of this original disclosure:

FIG. **1** is a side elevational view of a conventional bicycle with front and rear disc brake hubs in accordance with a first embodiment of the present invention;

FIG. **2** is a schematic elevational view of the from disc brake assembly coupled to a front fork and a front disc brake operating mechanism of the bicycle illustrated in FIG. **1**;

FIG. **3** is a schematic elevational view of the rear disc brake assembly coupled to a rear fork and a rear disc brake operating mechanism of the bicycle illustrated in FIG. **1**;

FIG. **4** is an exploded outer side perspective view of the front disc brake hub in accordance with the first embodiment of the present invention;

FIG. **5** is an exploded inner side perspective view of the front disc brake hub illustrated in FIG. **4** in accordance with the first embodiment of the present invention;

FIG. **6** is an exploded elevational view of the front disc brake hub illustrated in FIGS. **4** and **5** in accordance with the first embodiment of the present invention;

FIG. **7** is an exploded elevational view of the front disc brake hub illustrated in FIGS. **4-6**, with the upper portion of the front disc brake shown in cross-section;

FIG. **8** is an assembled elevational view of the front disc brake hub illustrated in FIGS. **4-7**, with the upper portion of the front disc brake shown in cross-section;

FIG. **9** is an enlarged perspective view of the front disc brake hub illustrated in FIGS. **4-8**, with the **[**rear**]** *front* disc brake rotor, the rotor mounting boss and the rotor locking ring removed;

FIG. **10** is an outer side perspective view of the rotor mounting boss for the front disc brake hub illustrated in FIGS. **4-9** in accordance with the first embodiment of the present invention;

FIG. **11** is an inner side perspective view of the rotor mounting boss illustrated in FIG. **10** for the front disc brake hub illustrated in FIGS. **4-9**;

FIG. **12** is an inside elevational view of the rotor mounting boss illustrated in FIGS. **10** and **11** for the front disc brake hub illustrated in FIGS. **4-9**;

FIG. **13** is a partial cross-sectional view of the rotor mounting boss illustrated in FIGS. **10-12** as seen along section line **13-13** of FIG. **12**;

FIG. **14** is a partial cross-sectional view of the rotor mounting boss illustrated in FIGS. **10-13** as seen along section line **14-14** of FIG. **12**;

FIG. **15** is an inner side perspective view of the rotor locking ring for the front disc brake hub illustrated in FIGS. **4-9** in accordance with the first embodiment of the present invention;

FIG. **16** is an outer side perspective view of the rotor locking ring illustrated in FIG. **15** for the front disc brake hub illustrated in FIGS. **4-9**;

FIG. **17** is an inner side elevational view of the rotor locking ring illustrated in FIGS. **15** and **16** for the front disc brake hub illustrated in FIGS. **4-9**;

FIG. **18** is a partial cross-sectional view of the rotor locking ring illustrated in FIGS. **15-17** as seen along section line **18-18** of FIG. **17**;

FIG. **19** is a side elevational view of the rear disc brake hub in accordance with present invention, with the upper half of the rear disc brake hub illustrated in cross-section;

FIG. **20** is an elevational view of the rear disc brake hub illustrated in FIG. **18** with the upper half of the rear disc brake hub illustrated in cross-section and with the rear disc brake rotor, the rotor mounting boss and the rotor locking ring removed;

FIG. **21** is a perspective view of one of the disc brake rotors utilized with the front and rear disc brake hubs;

FIG. **22** is a side elevational view of the disc brake rotor illustrated in FIG. **21**;

FIG. **23** is an edge elevational view of the disc brake rotor illustrated in FIGS. **20** and **21**;

FIG. **24** is an outer side perspective view of a front disc brake hub in accordance with a second embodiment of the present invention; and

FIG. **25** is an inner side elevational view of a front disc brake hub illustrated in FIG. **23** in accordance with a second embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring initially to FIGS. **1-3**, a bicycle **10** is illustrated with front and rear disc brake hubs **12** and **12'** in accordance with a first embodiment of the present invention as discussed below. The front disc brake hub **12** rotatably couples a front wheel **13** to a front fork of a frame **14**, while the rear disc brake hub **12'** rotatably couples a rear wheel **13'** to a rear portion of a frame **14** of the bicycle **10**. The frame **14** also includes a seat **17** adjustably coupled to the frame **14**, a handlebar **18** coupled to the front fork for turning the front wheel **13** and a drive train **19** for propelling the bicycle **10**.

Since **[**these**]** most of the parts of the bicycle **10** are well known in the art, the parts of the bicycle **10** will not be discussed or illustrated in detail herein, except for the parts relating to the front and rear disc brake hubs **12** and **12'** of the present invention. Moreover, various conventional bicycle parts such as brakes, derailleurs, additional sprocket, etc., which are not illustrated and/or discussed in detail herein, can be used in conjunction with the present invention.

As best seen in FIGS. **1-3**, the bicycle **10** is also provided with front and rear disc brake assemblies **20** and **20'**. The front disc brake assembly **20** and the rear disc brake assembly **20'**

are basically identical, except for the front and rear disc brake hubs **12** and **12'**. In other words, the front disc brake assembly **20** and the rear disc brake assembly **20'** uses many of the same parts. The front disc brake assembly **20** and the rear disc brake assembly **20'** each includes a caliper **21** operatively coupled to a brake lever **22** and a disc brake rotor **23**. In the case of the front disc brake assembly **20**, the disc brake rotor **23** is fixedly coupled to the front disc brake hub **12** of the front wheel **13**. Similarly, in the case of the rear disc brake assembly **20'**, the disc brake rotor **23** is fixedly coupled to the rear disc brake hub **12'** of the rear wheel **13'**.

As seen in FIG. **1**, the front and rear disc brake hubs **12** and **12'** of the front and rear wheels **13** and **13'** have a plurality of spokes **24** extending outwardly therefrom. The outer ends of the spokes **24** are fixedly coupled to the rim **25** by spoke nipples (not shown). A tire **26** is located on the outer surface of each of the rims **25** in a conventional manner.

The disc brake rotors **23** are removably attached to the front and rear disc brake hubs **12** and **12'** by rotor mounting bosses **28** and locking rings **29**, respectively, as explained below. The rotor mounting bosses **28** cooperate with the front and rear disc brake hubs **12** and **12'** to secure disc brake rotors **23** without rivets or bolts.

Front Hub **12**

Turning now to FIGS. **4-9**, the front disc brake hub **12** is illustrated in accordance with the present invention. The front disc brake hub **12** is basically a conventional hub, except for the structure that secures the disc brake rotor **23** thereto. Thus, conventional parts of the bicycle disc brake hub **12'** will not illustrated and/or discussed in detail herein. The front hub **12** is substantially identical to the rear hub **12'**, except that the front hub **12** does not have a freewheel.

The bicycle disc brake hub **12** basically comprising a hub axle **31**, a hub shell **32**, a first spoke attachment portion **33**a, a second spoke attachment portion **33**b, and a brake rotor attachment portion **34**. The bicycle disc brake hub **12** is basically a conventional hub, except for the configuration of the brake rotor attachment portion **34**. Thus, conventional parts of the bicycle disc brake hub **12** will not illustrated and/or discussed in detail herein.

The hub axle **31** has a center axis O extending in an axial direction between a first axle end **31**a and a second axle end **31**b. The hub axle **31** has a center bore **31**c such that a quick release mechanism (not shown) is coupled to the hub axle **31** in a conventional manner. The hub axle **31** rotatably supports the hub shell **32** by first and second bearing assemblies **36**a and **36**b. The first and second ends **31**a and **31**b of the hub axle **31** are threaded for receiving a pair of nuts **39**a and **39**b that applies an axial force on the hub shell **32** and the bearing assemblies **36**a and **36**b.

The hub shell **32** is a tubular member that has an interior passageway **40** extending between first and second hub shell ends **32**a and **32**b with the hub axle **31** being rotatably supported in the interior passageway **40**. In particular, the first and second bearing assemblies **36**a and **36**b rotatably mount the hub shell **32** on the hub axle **31** for freely rotating the hub shell **32** in both directions about the hub axle **31**. The hub shell **32** also has a center tubular portion **32**c located between the first and second hub shell ends **32**a and **32**b, which are integral formed with the center tubular portion **32**c as a one-piece, unitary member. The first and second spoke attachment portions **33**a and **33**b and the brake rotor attachment portion **34** are integrally formed with the hub shell **32** as a one-piece, unitary member. In particular, the first hub shell end **32**a has the first spoke attachment portion **33**a and the brake rotor

attachment portion **34** integrally mounted thereon, while the second hub shell end **32**b has the second spoke attachment portion **33**b integrally mounted thereon.

The bearing assemblies **36**a and **36**b rotatably support the hub shell **32** on the hub axle **31**. Since the bearing assemblies **36**a and **36**b are well known in the bicycle art, they will not be discussed or illustrated in detail herein. The bearing assembly **36**a basically includes a plurality of balls located between an inner race member and an outer race member in a conventional manner. Similarly, the bearing assembly **36**b basically includes a plurality of balls located between an inner race member and an outer race member in a conventional manner.

The first spoke attachment portion **33**a is preferably an annular spoke flange that is located at the first hub shell end **32**a of the hub shell **32**. The first spoke attachment portion **33**a has a plurality of first spoke holes **43**a. In this embodiment, the first spoke holes **43**a are equally spaced apart about the imaginary circle. The first spoke holes **43**a are arranged to **[**receiving**]** *receive* the bent ends of the spokes **24**. Similarly, the second hub shell end **32**b of the hub shell **32** is provided with a plurality of second spoke holes **43**b for receiving the bent ends of the spokes **24**. In the illustrated embodiment, the second spoke holes **43**b are equally spaced apart about the imaginary circle that is centered on the center axis O of the hub axle **31**. Each of the spoke holes **43**b is also designed to receive one of the bent ends of the spokes **24**. Accordingly, the front hub **12** is designed to have spokes extending outwardly therefrom in a generally tangential direction.

The brake rotor attachment portion **34** is integrally formed with the first hub end **32**a of the hub shell **32** as a one-piece, unitary member. The brake rotor attachment portion **34** is disposed at the first hub shell end **32**a adjacent the first spoke attachment portion **33**a. The brake rotor attachment portion **34** is a tubular member, which has a tubular section **34**a and an annular abutment flange **34**b extending outwardly from the tubular section **34**a in a radial direction. The annular abutment flange **34**b is spaced from the free end of tubular section **34**a. The tubular section **34**a has an external surface with an external splined section **34**c and an annular internal surface with internal threads **34**d. The external splined section **34**c has a plurality of axially extending external splines to non-rotatably engage the rotor mounting boss **28**. The internal threads **34**d threadedly engage the locking ring **29**. Thus, the disc brake rotor **23** is non-rotatably secured to the brake rotor attachment portion **34** between the rotor mounting boss **28** and locking ring **29**.

As best seen in FIGS. **10-14**, the rotor mounting boss **28** is a ring-shaped member, which has a base section **28**a with a center opening **28**b with a plurality of internal splines **28**c that mate with the external splined section **34**c of the brake rotor attachment portion **34**. Thus, relative rotation between the rotor mounting boss **28** and the brake rotor attachment portion **34** of the front hub **12** is prevented. The rotor mounting boss **28** also has an outer rotor attachment section **28**d extending from the base section **28**a. The base section **28**a has at least one axially extending protrusion **28**e (preferably six axially extending protrusions **28**e). The axially extending protrusions **28**e engage the disc brake rotor **23** to prevent relative **[**axial**]** rotation between the rotor mounting boss **28** and the disc brake rotor **23**. The rotor mounting boss **28** is preferably constructed of a first material, while the disc brake rotor **23** is constructed of a second material having a higher specific gravity than the first material of the rotor mounting boss **28**. The first material of the rotor mounting boss **28** is preferably aluminum or any other suitable material, while the second material of the disc brake rotor **23** is preferably stainless steel or any other suitable material.

As best seen in FIGS. **15-18**, the locking ring **29** is a disk-shaped member, which has a center opening **29**a with a plurality of internal splines **29**b. More specifically, the locking ring **29** an abutment flange **29**c and a center tubular section **29**d extending axially from the inner side of the abutment flange **29**c. The center tubular section **29**d is concentrically arranged relative to the center opening **29**a. The center tubular section **29**d has external threads **29**e that mate with the internal threads **34**d of the brake rotor attachment portion **34**. The abutment flange **29**c extending outwardly from the center tubular section **29**d to form an axially facing retaining surface that opposes a corresponding axially facing retaining surface of the annular abutment flange **34**b of the brake rotor attachment portion **34**. Thus, the locking ring **29** retains the disc brake rotor **23** and the rotor mounting boss **28** on the external splined section of the brake rotor attachment portion **34**, when the external threads **29**c of the center tubular section **29**d are engaged with the internal threads **34**d of the brake rotor attachment portion **34**.

Rear Hub **12'**

As best seen in FIGS. **19** and **20**, the bicycle disc brake hub **12'** basically comprising a hub axle **31'**, a hub shell **32'**, a first spoke attachment portion **33**a**[40]'**, a second spoke attachment portion **33**b**[40]'**, and a brake rotor attachment portion **34'**. The bicycle disc brake hub **12'** is basically a conventional hub, except for the structure that secures the disc brake rotor **23** thereto. Thus, conventional parts of the bicycle disc brake hub **12'** will not illustrated and/or discussed in detail herein. Moreover, the rear hub **12'** is substantially identical to the front hub **12**, discussed above, except that the rear hub **12** has a freewheel **37'**. In other words, the disc brake rotor **23** is secured to brake rotor attachment portion **34'** using the rotor mounting boss **28** and the locking ring **29**. In view of the similarity between the rear hub **12'** and the front hub **12**, the description and illustrations of the bicycle disc brake hub **12'** will be omitted for the sake of brevity.

The hub axle **31'** has a center axis O' extending in an axial direction between a first axle end **31**a**[40]'** and a second axle end **31**b'. The hub axle **31'** has a center bore **31**c' such that a quick release mechanism (not shown) is coupled to the hub axle **31'** in a conventional manner. The hub axle **31'** rotatably supports the hub shell **32'** by first and second bearing assemblies **36**a**[40]'** and **36**b'. The second axle end **31**b' has the freewheel **37'** operatively coupled between the hub axle **31'** and the hub shell **32'** in a conventional manner. The hub shell **32'** is fixed with respect to the hub axle **31'** in one rotational direction by the freewheel **37'**, while the freewheel **37'** allows the hub shell **32'** to freely rotate with respect to the hub axle **31'** in the opposite rotational direction. The first and second ends **31**a' and **31**b' of the hub axle **31'** are threaded for receiving a pair of nuts **39**a' and **39**b' that applies an axial force on the hub shell **32'**, the bearing assemblies **36**a**[40]'** and **36**b' and the freewheel **37'**.

The hub shell **32'** is a tubular member that has an interior passageway **40'** extending between first and second hub shell ends **32**a' and **32**b' with the hub axle **31'** being rotatably supported in the interior passageway **40'**. In particular, the first and second bearing assemblies **36**a**[40]'** and **36**b' rotatably mount the hub shell **32'** within the interior passageway **40'**. The hub shell **32'** also has a center tubular portion **32**c' located between the first and second hub shell ends **32**a' and **32**b', which are integral formed with the center tubular portion **32**c' as a one-piece, unitary member. The first and second spoke attachment portions **33**a' and **33**b' and the brake rotor attachment portion **34'** are integrally formed with the hub

shell **32'** as a one-piece, unitary member. In particular, the first hub shell end **32**a' has the first spoke attachment portion **33**a' and the brake rotor attachment portion **34'** integrally mounted thereon, while the second hub shell end **32**b' has the second spoke attachment portion **33**b' integrally mounted thereon.

The second hub shell end **32**b' has the freewheel **37'** fixedly coupled thereto. The freewheel **37'** is attached between the second hub shell end **32**b' and the second axle end **31**b' to allow the hub axle **31'** to rotate freely relative to the hub shell **32'** in one direction, but fixedly couples the hub axle **31'** relative to the hub shell **32'** in the opposite rotational direction.

The bearing assemblies **36**a**[40]'**and **36**b' rotatably support the hub shell **32'** on the hub axle **31'**. Since the bearing assemblies **36**a**[40]'** and **36**b' are well known in the bicycle art, they will not be discussed or illustrated in detail herein. The bearing assembly **36**a**[40]'** basically includes a plurality of balls located between an inner race member and an outer race member in a conventional manner. Similarly, the bearing assembly **36**b' basically includes a plurality of balls located between an inner race member and an outer race member in a conventional manner.

Bicycle freewheels, such as the freewheel **37'**, are well known in the bicycle art, and thus, the freewheel **37'** will not be illustrated or discussed in detail herein. The freewheel **37'** is used to transmit a driving force from the chain to the rear bicycle wheel in one rotation direction only. The freewheel **37'** allows the bicycle **10** to advance freely without any rotation of the pedals. The freewheel **37'** is fastened to the rear hub **12'** as integral part of the rear hub **12'** in a conventional manner. The freewheel **37'** basically includes an outer tubular part **37**a', an inner tubular part **37**b' and a one-way clutch **37**c'. The inner tubular part **37**b', is installed radially inwardly of the outer tubular part **37**a' so that the inner tubular part **37**b' is free to rotate relative to the outer tubular part **37**a'. The one-way clutch **37**c' is installed between the outer tubular part **37**a' and inner tubular part **37**b' for transmitting the driving force from the outer tubular part **37**a' to the inner tubular part **37**b' in one rotational direction only. The outer tubular part **37**a' has a plurality of gears or sprockets (not shown) mounted thereon, while the inner tubular part **37**b' is fixedly mounted on the hub axle **31'**.

The first spoke attachment portion **33**a' is preferably an annular spoke flange located at the first hub shell end **32**a' of the hub shell **32'**. The first spoke attachment portion **33**a' has a plurality of first spoke holes **43**a' equally spaced apart about an imaginary circle that is centered about the center axis O'. The first spoke holes **43**a' are arranged to **[**receiving**]** *receive* the bent ends of the spokes **24**. Similarly, the second hub shell end **32**b' of the hub shell **32'** is provided with a plurality of second spoke holes **43**b' equally spaced apart about the imaginary circle that is centered on the center axis O' of the hub axle **31'**. Each of the spoke holes **43**b' is also designed to receive one of the bent ends of the spokes **24**.

The brake rotor attachment portion **34'** is integrally formed with the first hub end **32**a' of the hub shell **32'** as a one-piece, unitary member. The brake rotor attachment portion **34'** is disposed at the first hub shell end **38**a' adjacent the first spoke attachment portion **33**a'. The brake rotor attachment portion **34'** is a tubular member, which has a tubular section **34**a' and an annular abutment flange **34**b' extending outwardly from the tubular section **34**a' in a radial direction. The annular abutment flange **34**b' is spaced from the free end of tubular section **34**a'. The tubular section **34**a' has an external surface with an external splined-section **34**c' and an annular internal surface with internal threads **34**d'. The external splined section **34**c' has a plurality of axially extending external splines to non-rotatably engage the internal splines **28**c of the rotor mounting boss **28**. The internal threads **34**d' threadedly engage the external threads **29**c of the locking ring **29**. Thus, the disc brake rotor **23** is non-rotatably secured to the brake rotor attachment portion **34'** between the rotor mounting boss **28** and the locking ring **29**.

Bicycle Disc Brake Rotor

Referring now to FIGS. **21-23**, the disc brake rotor **23** basically includes an annular braking ring **23**a, a plurality (nine) of outwardly extending connecting arms **23**b integrally formed with annular braking ring **23**a, and an inner mounting portion **23**c integrally formed with the connecting arms **23**b. Accordingly, the bicycle brake rotor **23** is a one-piece, unitary member. Preferably, the bicycle brake rotor **23** is constructed of any suitable rigid material.

The annular braking ring **23**a is preferably vented with a plurality of holes. The annular braking ring **23**a forms an outer braking portion of the disc brake rotor **23**. The outer ends of the connecting arms **23**b are equally spaced about the inner edge of the annular braking ring **23**a.

The connecting arms **23**b form an intermediate connecting portion of the bicycle brake rotor **23** extending between the annular braking ring **23**a and the inner mounting portion **23**c. These connecting arms **23**b extend tangentially from the inner mounting portion **23**c. The connecting arms **23**b have triangular openings located therebetween.

The inner mounting portion **23**c has a plurality (six) of axially extending attachment holes **23**d and a plurality (six) of attachment notches **23**e. The attachment holes **23**d and the attachment notches **23**e are equally spaced about the circumference of the inner mounting portion **23**c. The attachment notches **23**e are arranged to mate with the axially extending protrusions **28**e to prevent relative axial rotation between the rotor mounting boss **28** and the disc brake rotor **23**. The attachment holes **23**d are normally used when the disc brake rotor **23** is fastened to a hub by bolts. Of course, the axially extending protrusions **28**e of the rotor mounting boss **28** can be configured to engage the attachment holes **23**d instead of the attachment notches **23**e. Preferably, the axially extending protrusions **28**e have an axial length that is no greater than an axially thickness of the inner mounting portion **23**c of the disc brake rotor **23**.

Second Embodiment

Referring now to FIGS. **24** and **25**, an alternate disc brake rotor **123** is illustrated in accordance with second embodiment of the present invention. While the disc brake rotor **123** is illustrated with the front hub **12**, the alternate disc brake rotor **123** is designed to be used with either the front hub **12** or the rear hub **12'**.

The alternate disc brake rotor **123** is basically the rotor mounting boss **28** of the first embodiment being formed as part of the disc brake rotor **23**. In other words, the disc brake rotor **123** basically includes an annular braking ring **123**a and a rotor mounting boss **128** coupled to the annular braking ring **123**a via eight rivets **123**b. The annular braking ring **123**a is preferably vented with a plurality of holes. The annular braking ring **123**a forms an outer braking portion of the disc brake rotor **123**.

The rotor mounting boss **128** has a base section **128**a with central opening **128**b with a plurality of internal splines **128**c that mate with the external splined section **34**c of the brake rotor attachment portion **34**. Thus, relative rotation between the rotor mounting boss **128** and the brake rotor attachment

portion **34** of the front hub **12** is prevented. The rotor mounting boss **128** also has an outer rotor attachment section **128**d extending from the base section with eight attachment points **128**e. The rotor mounting boss **128** is preferably constructed of a first material while the annular braking ring **128** is constructed of a second material having a higher specific gravity than the first material of the rotor mounting boss **128**. The first material of the rotor mounting boss **128** is preferably aluminum or any other suitable material, while the second material of the annular braking ring **123**a is preferably stainless steel or any other suitable material.

Similar to the first embodiment, the rotor mounting boss **128** with the annular braking ring **128**a riveted thereto is removably secured to the brake rotor attachment portion **34** of the front hub **12** by the locking ring **29**. More specifically, the external threads **29**c of the locking ring **29** threadedly engage the internal threads **34**d of the front hub **12** such that the rotor mounting boss **128** is sandwiched between the abutment flanges **29**c and **34**b. Thus, the locking ring **29** retains the disc brake rotor **123** on the external spline section of the brake rotor attachment portion **34**.

As mentioned above, the disc brake rotor **123** can also be mounted on the rear hub **12'** utilizing the locking ring **29** in the same manner as the disc brake rotor **23** is mounted on the front hub **12**.

As used herein, the. following directional terms "forward, rearward, above, downward, vertical, horizontal, below and transverse" as well as any other similar directional terms refer to those directions relative to a bicycle equipped with the present invention. Accordingly, these terms, as utilized to describe the present invention should be interpreted relative to a bicycle equipped with the present invention.

The terms of degree such as "substantially", "about" and "approximately" as used herein mean a reasonable amount of deviation of the modified term such that the end result is not significantly changed. These terms should be construed as including a deviation of at least ±5% of the modified term if this deviation would not negate the meaning of the word it modifies.

While only selected embodiments have been chosen to illustrate the present invention, it will be apparent to those skilled in the art from this disclosure that various changes and modifications can be made herein without departing from the scope of the invention as defined in the appended claims. Furthermore, the foregoing description of the embodiments according to the present invention are provided for illustration only, and not for the purpose of limiting the invention as defined by the appended claims and their equivalents.

What is claimed is:

[1. A bicycle disc brake hub comprising:
a hub axle having a center axis extending in an axial direction between a first axle end and a second axle end;
a hub shell having first and second hub shell ends with said hub axle rotatably coupled to said hub shell;
a brake rotor attachment portion disposed at said first hub shell end, said brake rotor attachment portion having an external surface with an external splined section and an annular internal surface with internal threads; and
a locking ring having a center tubular section with external threads and an abutment flange extending outwardly from said center tubular section to form an axially facing retaining surface, said external threads of said center tubular section mating with said internal threads of said brake rotor attachment portion.**]**

2. **[**The**]** *A* bicycle disc brake hub **[**according to claim **1**, further**]** comprising:
a hub axle having a center axis extending in an axial direction between a first axle end and a second axle end;
a hub shell having first and second hub shell ends with said hub axle rotatably coupled to said hub shell;
a brake rotor attachment portion disposed at said first hub shell end, said brake rotor attachment portion having an external surface and an annular internal surface with internal threads;
a locking ring having an opening therein to form an inner peripheral surface, a center tubular section with external threads and an abutment flange extending outwardly from said center tubular section to form an axially facing retaining surface, said inner peripheral surface having a plurality of splines extending radially inwardly therefrom, said external threads of said center tubular section mating with said internal threads of said brake rotor attachment portion; and
a rotor mounting boss *configured to be non-rotatably mounted to said brake rotor attachment portion, said rotor mounting boss* having **[**internal splines that mate with said external splined section of said brake rotor attachment portion**]** *a brake disc fixing structure to non-rotatably engage a brake disc without bolts*, said locking ring retaining said rotor mounting boss on said **[**external splined section of said brake rotor attachment portion,**]** *hub* when said external threads of said center tubular section are engaged with said internal threads of said brake rotor attachment portion.

3. **[**The**]** *A* bicycle disc brake hub **[**according to claim **2**, wherein**]** *comprising:*
a hub axle having a center axis extending in an axial direction between a first axle end and a second axle end;
a hub shell having first and second hub shell ends with said hub axle rotatably coupled to said hub shell;
a brake rotor attachment portion disposed at said first hub shell end, said brake rotor attachment portion having an external surface with an external splined section and an annular internal surface with internal threads;
a locking ring having a center tubular section with external threads and an abutment flange extending outwardly from said center tubular section to form an axially facing retaining surface, said external threads of said center tubular section mating with said internal threads of said brake rotor attachment portion; and
[said**]** *a* rotor mounting boss **[**has**]** *having* at least one axially extending protrusion *non-movably fixed thereto and internal splines that mate with said external splined section of said brake rotor attachment portion,*
said locking ring retaining said rotor mounting boss on said external splined section of said brake rotor attachment portion when said external threads of said center tubular section are engaged with said internal threads of said brake rotor attachment portion.

4. The bicycle disc brake hub according to claim **3**, further comprising
a brake rotor having an inner mounting portion with at least one notch that mates with said at least one axially extending protrusion to prevent relative **[**axial**]** rotation between said rotor mounting boss and said brake rotor.

5. The bicycle disc brake hub according to claim **4**, wherein said at least one notch extends axially through said brake rotor and said at least one axially extending protrusion has an axial length that is no greater than an **[**axially**]** *axial* thickness of said inner mounting portion of said brake rotor.

6. The bicycle disc brake hub according to claim **4**, wherein said at least one axially extending protrusion includes a plurality of axially extending protrusions, and said at least one notch includes a plurality of notches **[**that**]** that mate with said protrusions to prevent relative **[**axial**]** rotation between said rotor mounting boss and said brake rotor.

7. The bicycle disc brake hub according to claim **6**, wherein

said notches extend axially through said brake rotor and said protrusions have axial lengths that are no greater than an **[**axially**]** *axial* thickness of said inner mounting portion of said brake rotor.

8. The bicycle disc brake hub according to claim **4**, wherein

said rotor mounting boss is constructed of a first material and said brake rotor is constructed of a second material having a higher specific gravity than said first material.

9. The bicycle disc brake hub according to claim **[4]** *8*, wherein

said first material of said rotor mounting boss is aluminum and said second material of said brake rotor is stainless steel.

10. The bicycle disc brake hub according to claim **9**, wherein

said first axle end and said first hub shell end are rotatably coupled together by a bearing assembly, and

said second axle end and said second hub shell end are coupled together by a freewheel.

11. The bicycle disc brake hub according to claim **4**, wherein

said first axle end and said first hub shell end are rotatably coupled together by a first bearing assembly to rotate freely in both directions about said center axis of said hub axle, and

said second axle end and said second hub shell end are rotatably coupled together by a second bearing assembly to rotate freely in both directions about said center axis of said hub axle.

12. The bicycle disc brake hub according to claim **4**, wherein

said first hub shell end has a first annular spoke flange with first spoke holes formed therein, and

said second hub shell end has a second annular spoke flange with second spoke holes formed therein.

13. The bicycle disc brake hub according to claim **12**, wherein

said first and second spoke flanges are integrally formed with said hub shell as a one-piece, unitary member.

14. The bicycle disc brake hub according to claim **4**, wherein

said brake rotor further includes a plurality of intermediate connecting portions integrally formed with said inner mounting portion, and an outer braking portion integrally formed with said intermediate connecting portions.

15. **[**The**]** *A* bicycle disc brake hub **[**according to claim **2**, wherein**]** *comprising:*

a hub axle having a center axis extending in an axial direction between a first axle end and a second axle end;

a hub shell having first and second hub shell ends with said hub axle rotatably coupled to said hub shell;

a brake rotor attachment portion disposed at said first hub shell end, said brake rotor attachment portion having an external surface with an external splined section and an annular internal surface with internal threads;

a locking ring having an opening therein to form an inner peripheral surface, a center tubular section with external threads and an abutment flange extending outwardly from said center tubular section to form an axially facing retaining surface, said inner peripheral surface having a plurality of splines extending radially inwardly therefrom, said external threads of said center tubular section mating with said internal threads of said brake rotor attachment portion; and

a rotor mounting boss having internal splines that mate with said external splined section of said brake rotor attachment portion, said locking ring retaining said rotor mounting boss on said external splined section of said brake rotor attachment portion when said external threads of said center tubular section are engaged with said internal threads of said brake rotor attachment portion,

said rotor mounting boss **[**has**]** *having* a base section with said internal splines formed thereon and an outer rotor attachment section extending from said base section.

16. The bicycle disc brake hub according to claim **15**, further comprising

a brake rotor fixedly coupled to said outer rotor attachment section of said rotor mounting boss.

17. The bicycle disc brake hub according to claim **16**, wherein

said outer rotor attachment section of said rotor mounting boss is fixedly coupled to said brake rotor by a plurality of fasteners.

18. The bicycle disc brake hub according to claim **17**, wherein

said fasteners are axially extending rivets.

19. The bicycle disc brake hub according to claim **15**, wherein

said rotor mounting boss is constructed of a first material and said brake rotor is constructed of a second material having a higher specific gravity than said first material.

20. The bicycle disc brake hub according to claim **19**, wherein

said first material of said rotor mounting boss is aluminum and said second material of said brake rotor is stainless steel.

21. The bicycle disc brake hub according to claim **15**, wherein

said first axle end and said first hub shell end are rotatably coupled together by a bearing assembly, and

said second axle end and said second hub shell end are coupled together by a freewheel.

22. The bicycle disc brake hub according to claim **15**, wherein

said first axle end and said first hub shell end are rotatably coupled together by a first bearing assembly to rotate freely in both directions about said center axis of said hub axle, and

said second axle end and said second hub shell end are rotatably coupled together by a second bearing assembly to rotate freely in both directions about said center axis of said hub axle.

23. The bicycle disc brake hub according to claim **15**, wherein

said first hub shell end has a first annular spoke flange with first spoke holes formed therein, and

said second hub shell end has a second annular spoke flange with second spoke holes formed therein.

24. The bicycle disc brake hub according to claim **23**, wherein

said first and second spoke flanges are integrally formed with said hub shell as a one-piece, unitary member.

25. The bicycle disc brake hub according to claim 2, wherein

said first axle end and said first hub shell end are rotatably coupled together by a bearing assembly, and

said second axle end and said second hub shell end are coupled together by a freewheel.

26. The bicycle disc brake hub according to claim 2, wherein

said first axle end and said first hub shell end are rotatably coupled together by a first bearing assembly to rotate freely in both directions about said center axis of said hub axle, and

said second axle end and said second hub shell end are rotatably coupled together by a second bearing assembly to rotate freely in both directions about said center axis of said hub axle.

27. The bicycle disc brake hub according to claim 2, wherein

said first hub shell end has a first annular spoke flange with first spoke holes formed therein, and

said second hub shell end has a second annular spoke flange with second spoke holes formed therein.

28. The bicycle disc brake hub according to claim 2, further comprising

a nut disposed at said first axle end of said a hub axle, said nut having a maximum outer width and said inner peripheral surface of said locking ring having a minimum inner width that is greater than said maximum outer width of said nut.

29. The bicycle disc brake hub according to claim 2, wherein

said brake disc fixing structure of said rotor mounting boss has at least one axially extending protrusion.

30. The bicycle disc brake hub according to claim 29, further comprising

a brake rotor having an inner mounting portion with at least one notch that mates with said at least one axially extending protrusion to prevent relative rotation between said rotor mounting boss and said brake rotor.

31. A bicycle disc brake hub comprising:

a hub axle having a center axis extending in an axial direction between a first axle end and a second axle end;

a nut disposed at said first axle end of said hub axle;

a hub shell having first and second hub shell ends with said hub axle rotatably coupled to said hub shell;

a brake rotor attachment portion disposed at said first hub shell end, said brake rotor attachment portion having an external surface and an annular internal surface with internal threads; and

a locking ring having a center opening with a non-circular inner peripheral surface, a center tubular section with external threads and an abutment flange extending outwardly from said center tubular section to form an axially facing retaining surface; and

a rotor mounting boss configured to be non-rotatably mounted to said brake rotor attachment portion, said rotor mounting boss having a brake disc fixing structure to non-rotatably engage a brake disc without bolts, said locking ring retaining said rotor mounting boss on said hub when said external threads of said center tubular section are engaged with said internal threads of said brake rotor attachment portion,

said external threads of said center tubular section mating with said internal threads of said brake rotor attachment portion, said opening of said locking ring being arranged and configured such that said locking ring can be installed in said axial direction onto said brake rotor attachment portion when said nut is attached to said hub axle.

32. A bicycle disc brake hub comprising:

a hub axle having a center axis extending in an axial direction between a first axle end and a second axle end;

a hub shell having first and second hub shell ends with said hub axle rotatably coupled to said hub shell, said first hub shell end having a brake rotor attachment portion including an annular surface with first threads that surrounds said first axle end of said hub axle;

a rotor mounting member being configured to be non-rotatably mounted on said first hub shell end, said rotor mounting member having at least one axially extending protrusion non-movably fixed thereto that is configured to engage a disc brake rotor, said at least one axially extending protrusion extending axially from an axially facing surface of said rotor mounting member, and

a locking ring having an opening with an inner peripheral surface, a center tubular section with second threads and an abutment flange extending outwardly from said center tubular section to form an axially facing retaining surface,

said annular surface being an inner annular surface, said first threads being internal threads and said second threads being external threads.

33. The bicycle disc brake hub according to claim 32, wherein

said at least one axially extending protrusion of said rotor mounting member includes six axially extending protrusions configured to engage the disc brake rotor.

34. The bicycle disc brake hub according to claim 33, wherein

said inner peripheral surface of said locking ring has a plurality of projections extending radially inwardly therefrom.

35. The bicycle disc brake hub according to claim 34, wherein

said first hub shell end has a first annular spoke flange with first spoke holes formed therein, and

said second hub shell end has a second annular spoke flange with second spoke holes formed therein.

36. The bicycle disc brake hub according to claim 35, wherein

said first axle end and said first hub shell end are rotatably coupled together by a bearing assembly, and

said second axle end and said second hub shell end are coupled together by a freewheel.

37. The bicycle disc brake hub according to claim 35, wherein

said first axle end and said first hub shell end are rotatably coupled together by a first bearing assembly to rotate freely in both directions about said center axis of said hub axle, and

said second axle end and said second hub shell end are rotatably coupled together by a second bearing assembly to rotate freely in both directions about said center axis of said hub axle.

38. The bicycle disc brake hub according to claim 32, wherein

said first axle end and said first hub shell end are rotatably coupled together by a bearing assembly, and

said second axle end and said second hub shell end are coupled together by a freewheel.

39. A bicycle disc brake hub comprising:

a hub axle having a center axis extending in an axial direction between a first axle end and a second axle end;

a hub shell having first and second hub shell ends with said hub axle rotatably coupled to said hub shell, said first hub shell end having a brake rotor attachment portion including an annular surface with first threads that surrounds said first axle end of said hub axle;

a rotor mounting member being configured to be non-rotatably mounted on said first hub shell end, said rotor mounting member having at least one axially extending protrusion non-movably fixed thereto that is configured to engage a disc brake rotor, said at least one axially extending protrusion extending axially from an axially facing surface of said rotor mounting member, and

a locking ring having an opening with an inner peripheral surface, a center tubular section with second threads and an abutment flange extending outwardly from said center tubular section to form an axially facing retaining surface,

said at least one axially extending protrusion of said rotor mounting member including six axially extending protrusions configured to engage the disc brake rotor.

40. A bicycle disc brake hub comprising:

a hub axle having a center axis extending in an axial direction between a first axle end and a second axle end;

a hub shell having first and second hub shell ends with said hub axle rotatably coupled to said hub shell, said first hub shell end having a brake rotor attachment portion including an annular surface with first threads that surrounds said first axle end of said hub axle;

a rotor mounting member being configured to be non-rotatably mounted on said first hub shell end, said rotor mounting member having at least one axially extending protrusion non-movably fixed thereto that is configured to engage a disc brake rotor, said at least one axially extending protrusion extending axially from an axially facing surface of said rotor mounting member, and

a locking ring having an opening with an inner peripheral surface, a center tubular section with second threads and an abutment flange extending outwardly from said center tubular section to form an axially facing retaining surface,

said inner peripheral surface of said locking ring being non-circular.

41. A bicycle disc brake hub comprising:

a hub axle having a center axis extending in an axial direction between a first axle end and a second axle end;

a hub shell having first and second hub shell ends with said hub axle rotatably coupled to said hub shell, said first hub shell end having a brake rotor attachment portion including an annular surface with first threads that surrounds said first axle end of said hub axle;

a rotor mounting member being configured to be non-rotatably mounted on said first hub shell end, said rotor mounting member having at least one axially extending protrusion non-movably fixed thereto that is configured to engage a disc brake rotor, said at least one axially extending protrusion extending axially from an axially facing surface of said rotor mounting member, and

a locking ring having an opening with an inner peripheral surface, a center tubular section with second threads and an abutment flange extending outwardly from said center tubular section to foul! an axially facing retaining surface,

said inner peripheral surface of said locking ring having a plurality of projections extending radially inwardly therefrom.

42. A bicycle disc brake hub comprising:

a hub axle having a center axis extending in an axial direction between a first axle end and a second axle end;

a hub shell having first and second hub shell ends with said hub axle rotatably coupled to said hub shell, said first hub shell end having a brake rotor attachment portion including an annular surface with first threads that surrounds said first axle end of said hub axle;

a rotor mounting member being configured to be non-rotatably mounted on said first hub shell end, said rotor mounting member having at least one axially extending protrusion non-movably fixed thereto that is configured to engage a disc brake rotor, said at least one axially extending protrusion extending axially from an axially facing surface of said rotor mounting member, and

a locking ring having an opening with an inner peripheral surface, a center tubular section with second threads and an abutment flange extending outwardly from said center tubular section to form an axially facing retaining surface,

said first axle end and said first hub shell end being rotatably coupled together by a first bearing assembly to rotate freely in both directions about said center axis of said hub axle, and

said second axle end and said second hub shell end being rotatably coupled together by a second bearing assembly to rotate freely in both directions about said center axis of said hub axle.

43. A bicycle disc brake hub comprising:

a hub axle having a center axis extending in an axial direction between a first axle end and a second axle end;

a hub shell having first and second hub shell ends with said hub axle rotatably coupled to said hub shell, said first hub shell end having a brake rotor attachment portion including an annular surface with first threads that surrounds said first axle end of said hub axle;

a rotor mounting member being configured to be non-rotatably mounted on said first hub shell end, said rotor mounting member having at least one axially extending protrusion non-movably fixed thereto that is configured to engage a disc brake rotor, said at least one axially extending protrusion extending axially from an axially facing surface of said rotor mounting member, and

a locking ring having an opening with an inner peripheral surface, a center tubular section with second threads and an abutment flange extending outwardly from said center tubular section to form an axially facing retaining surface,

said first hub shell end having a first annular spoke flange with first spoke holes formed therein, and

said second hub shell end has a second annular spoke flange with second spoke holes formed therein.

44. A bicycle disc brake hub comprising:

a hub axle having a center axis extending in an axial direction between a first axle end and a second axle end;

a hub shell having first and second hub shell ends with said hub axle rotatably coupled to said hub shell, said first hub shell end having a brake rotor attachment portion including an annular surface with first threads that surrounds said first axle end of said hub axle;

a rotor mounting member being configured to be non-rotatably mounted on said first hub shell end, said rotor mounting member having at least one axially extending protrusion non-movably fixed thereto that is configured to engage a disc brake rotor, said at least one axially extending protrusion extending axially from an axially facing surface of said rotor mounting member;

a locking ring having an opening with an inner peripheral surface, a center tubular section with second threads and an abutment flange extending outwardly from said center tubular section to form an axially facing retaining surface; and

a nut disposed at said first axle end of said a hub axle, said nut having a maximum outer width and said inner peripheral surface of said locking ring having a minimum inner width that is greater than said maximum outer width of said nut.

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