

COMMONWEALTH of AUSTRALIA

PATENTS ACT 1952

APPLICATION FOR A STANDARD PATENT

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We

TOCHIGI-FUJI SANGYO KABUSHIKI KAISHA
of 2238 Omiya-cho, Tochigi-shi,
Tochigi-ken, Japan

60 9 2 5 8

hereby apply for the grant of a Standard Patent for an invention entitled:

"HUB CLUTCH"

which is described in the accompanying ~~provisional~~ complete specification.

~~Details of basic application(s):~~

Number

Convention Country

Date

This application is made under the provisions of
Section 51 of the Patents Act 1952 in respect of
Australian Patent Application No. 76763/87 in the
name of TOCHIGI-FUJI SANGYO KABUSHIKI KAISHA.

APPLICATION ACCEPTED AND AMENDMENTS

ALLOWED 1 . 2 . 9 1 .

The address for service is care of DAVIES & COLLISON, Patent Attorneys, of 1 Little
Collins Street, Melbourne, in the State of Victoria, Commonwealth of Australia.

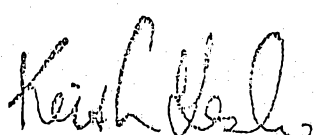
Dated this

24th

day of February,

19 1989

To: THE COMMISSIONER OF PATENTS


.....
(a member of the firm of DAVIES &
COLLISON for and on behalf of the Applicant).

Davies & Collison, Melbourne and Canberra.

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952

DECLARATION IN SUPPORT OF CONVENTION OR
NON-CONVENTION APPLICATION FOR A PATENT

Insert title of invention.

In support of the Application made for a patent for an invention
entitled: "HUB CLUTCH"

Insert full name(s) and address(es)
of declarant(s) being the appli-
cant(s) or person(s) authorized to
sign on behalf of an applicant
company.

~~I~~
~~We~~ Yoshihiko KURIHARA
TOCHIGI-FUJI SANGYO KABUSHIKI KAISHA
2388, Omiya-cho, Tochigi-shi,
Tochigi-ken, JAPAN

Cross out whichever of paragraphs
1(a) or 1(b) does not apply

1(a) relates to application made
by individual(s)
1(b) relates to application made
by company; insert name of
applicant company.

do solemnly and sincerely declare as follows :-

1. (a) ~~I am~~ the applicant..... for the patent
~~We are~~

or (b) I am authorized by

TOCHIGI-FUJI SANGYO KABUSHIKI KAISHA

the applicant..... for the patent to make this declaration on ^{its}
~~their~~ behalf.

2. (a) ~~I am~~ the actual inventor..... of the invention
~~We are~~

or (b)

Sakuo Kurihara
of 2238, Omiya-cho,
Tochigi-shi, Tochigi-ken,
Japan

Cross out whichever of paragraphs
2(a) or 2(b) does not apply

2(a) relates to application made
by inventor(s)

2(b) relates to application made
by company(s) or person(s) who
are not inventor(s); insert full
name(s) and address(es) of inven-
tors.

~~is~~ the actual inventor..... of the invention and the facts upon which the applicant.....
~~are~~
~~is~~
~~are~~ entitled to make the application are as follows :-

State manner in which applicant(s)
derive title from inventor(s)

The applicant would, if a patent were granted upon
an application made by the said actual inventor, be
entitled to have the patent assigned to it.

Cross out paragraphs 3 and 4
for non-convention applications.
For convention applications,
insert basic country(s) followed
by date(s) and basic applicant(s).

~~3. The basic application..... as defined by Section 141 of the Act ^{was} made
~~were~~
in on the
by
in on the
by
in on the
by~~

~~4. The basic application..... referred to in paragraph 3 of this Declaration ^{was}
~~were~~
the first application..... made in a Convention country in respect of the invention the subject
of the application.....~~

Insert place and date of signature.

Declared at Tochigi-ken, this 19th day of June, 1989
Japan

Signature of declarant(s) (no
attestation required)

Yoshihiko Kurihara
Yoshihiko KURIHARA

Note: Initial all alterations.

DAVIES & COLLISON, MELBOURNE and CANBERRA.

(12) PATENT ABRIDGMENT (11) Document No. AU-B-30759/89
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 609258

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HUB CLUTCH

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DAVIES & COLLISON, 1 Little Collins Street, MELBOURNE VIC 3000

(56) Prior Art Documents
US 4538714
US 4327821
US 4287972

(57) Claim

1. A hub clutch for selectively transmitting torque between an axle shaft extending in an axial direction and a wheel hub, said hub clutch comprising:
 - a casing fixed to the wheel hub,
 - said casing having an inner peripheral surface, and a spline extending along said inner peripheral surface;
 - a drive gear secured to the axle shaft at an end thereof, said drive gear having both a gear portion and a spline extending on the outer periphery thereof;
 - a cam member in splined engagement with said spline of said drive gear so as to be movable along said drive gear in the axial direction,
 - said cam member having a cam portion projecting toward an inner side of the hub clutch;
 - an outer brake having a grooved cam portion engageable with said cam

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(10) 609258

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portion of said cam member, an inner peripheral surface, and a V-shaped groove extending in said inner peripheral surface;

a stationary system connected to said outer brake for preventing said outer brake from rotating;

an inner brake having a grooved first cam portion engageable with said cam portion of said cam member, second cam portions each of which is disposed at a respective one of opposite sides of said grooved first cam portion, and a projecting portion;

a wire brake extending in said V-shaped groove,

said wire brake having end portions which extend from said V-shaped groove radially inwardly in said hub clutch,

said end portions being engageable with said projecting portion of said inner brake;

a slide gear in splined engagement with said spline of said casing so as to be movable ^{relative to} ~~along~~ said ~~inner~~ casing in the axial direction,

said slide gear movable to a clutching position at which said slide gear engages said gear portion of said drive gear;

a retainer slidably mounted in said hub clutch and contacting said cam member; and

a release plate mounted to said drive gear and having an arm,
said arm being engageable with said end portions of said wire brake.

C O M M O N W E A L T H O F A U S T R A L I A

PATENTS ACT 1952

COMPLETE SPECIFICATION

(Original)

FOR OFFICE USE

609258

Class

Int. Class

Application Number:

Lodged:

Complete Specification Lodged:

Accepted:

Published:

Priority:

Related Art:

This document contains the
amendments made under
Section 49 and is correct for
printing.

Name of Applicant: TOCHIGI-FUJI SANGYO KABUSHIKI KAISHA.

Address of Applicant: 2238 Omiya-cho, Tochigi-shi,
Tochigi-ken, Japan

Actual Inventor(s): Sakuo KURIHARA

Address for Service: DAVIES & COLLISON, Patent Attorneys,
1 Little Collins Street, Melbourne, 3000.

Complete specification for the invention entitled:

"HUB CLUTCH"

The following statement is a full description of this invention,
including the best method of performing it known to us :-

SPECIFICATION

TITLE OF THE INVENTION

HUB CLUTCH

BACKGROUND OF THE INVENTION

1. Filed of the Invention

This invention related to a hub clutch used at part time four-wheel drive cars, and particularly to a hub clutch which produces sufficient braking force in case of transferring to a locked state to improve the response thereof.

2. Description of the Related Art

There is a conventional automatic free-wheel hub clutch (hereinafter referred to simply as "hub clutch") which has been disclosed in U.S. Patent No. 4,327,821 and which comprises a group of rotational parts assembled successively to the circumference of a drive shaft, and a group of stationary parts assembled on a spindle wherein the group of rotational parts begins the action by the commencement of rotation of a drive shaft while being in liaison with each other, whereby a connecting state is established between the drive shaft and the wheel hub. The groups of the rotational and stationary parts are in liaison with each other by means of a braking member in the stationary system and a braking member (brake shoe) in the rotational system, and these

braking members maintain a connecting state between the drive shaft and the wheel hub in case of travelling in four-wheel driving mode. The brake shoe comes in slidably contact with the circumferential surface of the braking member in the stationary system and is simultaneously pressed against the braking member in the stationary system by means of a ring-shaped spring with a prescribed force at constant.

The above described hub clutch, however, involves such a problem that its responsibility deteriorates or the function thereof becomes poor because of insufficient braking force due to insufficient pressingly contacting force which is given to a sliding part positioned between both the braking members by means of an elasticity applying means such as a spring and the like. In this connection, it is required to obtain high braking force in order to overcome poor function, and it results in a necessity for taking a means for increasing elastic force or number of turns of the elasticity applying means. However, such increase for the elastic force or number of turns of the elasticity applying means provides disadvantages such as deterioration in durability and an increase in cost due to fast wear of the brake shoe as well as an increase of an axial length in the means, and accordingly these disadvantages have been serious problems.

SUMMARY OF THE INVENTION

According to the present invention there is provided a hub clutch for selectively transmitting torque between an axle shaft extending in an axial direction and a wheel hub, said hub clutch comprising:

- 5 a casing fixed to the wheel hub,
said casing having an inner peripheral surface, and a spline extending along said inner peripheral surface;
a drive gear secured to the axle shaft at an end thereof, said drive gear having both a gear portion and a spline extending on the outer periphery
10 thereof;
a cam member in splined engagement with said spline of said drive gear so as to be movable along said drive gear in the axial direction,
said cam member having a cam portion projecting toward an inner side of the hub clutch;
15 an outer brake having a grooved cam portion engageable with said cam portion of said cam member, an inner peripheral surface, and a V-shaped groove extending in said inner peripheral surface;
a stationary system connected to said outer brake for preventing said outer brake from rotating;
20 an inner brake having a grooved first cam portion engageable with said cam portion of said cam member, second cam portions each of which is disposed at a respective one of opposite sides of said grooved first cam portion, and a projecting portion;
a wire brake extending in said V-shaped groove,
25 said wire brake having end portions which extend from said V-shaped groove radially inwardly in said hub clutch,
said end portions being engageable with said projecting portion of said inner brake;
a slide gear in splined engagement with said spline of said casing so as
30 to be movable ^{relative to} ~~along~~ said ~~inner~~ casing in the axial direction,
said slide gear movable to a clutching ^{position} ~~portion~~ at which said slide gear



engages said gear portion of said drive gear;

a retainer slidably mounted in said hub clutch and contacting said cam member; and

a release plate mounted to said drive gear and having an arm,

5 said arm being engageable with said end portions of said wire brake.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1(a) is an explanatory view showing the whole construction of a first embodiment of the present invention in case of a free condition; Fig. 1(b) is a perspective view showing a wire brake ;Fig. 1(c) is an enlarged view showing an engagement portion of the wire brake and an outer brake; and Fig. 1(d) is a development showing the respective parts; Figs. 2(a), 2(b) and 2(c) are explanatory view each showing an engaged state of respective cams and the like in case of a free condition; Figs. 3(a), 3(b) and 3(c) are explanatory views each showing an engaged state of respective cam and the like in the course of transfer to the automatically locked condition; Figs. 4(a) and 4(b) are explanatory views each showing an engaged state of respective members in case of



the automatically locked condition; Figs. 5(a) and 5(b) are explanatory views each showing an engaged state of respective members in case of the manually locked condition; and Figs. 6(a) and 6(b) are explanatory views each showing a relationship between a contact pressure and a brake force in the sliding portion defined between the wire brake and the outer brake.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The hub clutch according to the present invention will be described in detail hereinbelow.

Figs. 1 through 5 illustrate an example of the present invention wherein the hub clutch comprises a drive gear 2 engaged fixedly with the circumference of the extreme end of an axle shaft 1 by a spline and having a gear portion 2a for clutch engagement and a spline portion 2b on the periphery thereof, a cam member 4 engaged transferably with the spline portion 2b by the spline in the axial direction thereof and provided with a V-shaped convex cam portion 4a formed protrusively on the inside edge along the axial direction, an outer brake 8 the rotation of which is suppressed by a stationary system (composed of a spindle 5, a lock nut and the like) and having a plurality of V-shaped grooved cam portions 8a into which is fitted a thickened portion of the cam portion 4a in the cam member 4 on the outer diameter side at the outer edge in the axial direction, an inner brake 9 provided with a V-shaped grooved first cam portion 9a

into which is fitted a thickened portion of the cam portion 4a on the inner diameter side at the outer edge in the axial direction and second cam portions 9b positioned on the opposite sides of said first cam portion, a release plate 11 secured to the periphery of the drive gear 2 by means of a snap ring 12 and from which is extended an arm engageable with end portions 16a and 16b to be engaged in the undermentioned wire brake, a thrust washer 14 disposed between the axial inside end portion and the axial outside surface of the outer brake 8 through a thrust bearing 13, a substantially C-shaped wire brake 16 disposed between the inner circumferential surface of the outer brake 8 and the inner brake 9, a casing 24 secured to a wheel hub, which is not shown, by means of a bolt 20 and having a spline 22 on the inner circumferential surface, besides the end surface of which is formed in an opening 23, a slide gear 25 containing a spline 25a engaging with the spline portion 22 of the casing 24 on the periphery thereof so as to be transferable in the axial direction as well as a gear portion 25b clutching on or off the gear portion 2a of said drive gear on the inner circumference thereof, a retainer 26 provided with a retainer arm 26a the rotation of which is suppressed by the spline 22 and a bent portion 26b towards the inside diametrical direction on the inside of the retainer arm 26a along the axial direction, a spring holder 32, a return spring 27 stretched between a stepped portion 2c on the periphery of the drive gear 2 and the spring holder 32, and a shift spring 28 stretched between the bent portion 26b of the retainer and the inside wall surface of the

slide gear 25 in the axial direction and energizing outwardly the slide gear 25 along the axial direction. The snap ring 12 is fitted to the peripheral surface of the drive gear 2 to prevent the respective parts (4, 11 and the like) kept on the periphery of the drive gear from slipping off.

The return spring 27 is constructed so as to have a stronger expanding force than that of the shift spring 28. The knob 30 is manually attached to the opening 23 of the casing 24 in a rotatable manner, and the boss portion 31 is protrusively formed on the inside at the central portion of the knob 30. The extreme end of the drive gear 2 projects from the axle shaft 1 and the inner circumference of which is supported by an extreme end member 1a secured to the extreme end of the axle shaft 1, and the extreme end member 1a is fixed to the axle shaft 1 by means of a bolt 1c through the spacer 1b. A bearing 29 is disposed between the peripheral surface of the extreme end member 1a and the inner circumferential surface in the boss portion 31 of the knob. The release plate 11 is placed so as to project over the periphery of the drive gear and has such a positional relationship that the arm 11a is engageable with end portions 16a and 16b of the wire 16 to be engaged.

The wire brake 16 is obtained by forming a wire having a circular section into a substantially C-shape as shown in Fig. 1(b) and has such a construction that both the ends 16a and 16b of the wire are bent in the inside diameter and the axially outward directions, respectively. A substantially V-shaped groove 18 is defined on the inner circumferential surface of the

outer brake 8 engaging slidably with the wire brake 16 in the circumferential direction thereof (Fig. 1(c)). The bottom portion of the groove 18 may be formed either flat as shown in Fig. 1(c) or sharpened like a V-shape.

The axial outside end portion of the retainer arm 26a of the retainer 26 is bent to the inside diameter side as shown in Fig. 1(a) to form a pawl portion 26c. A cam surface 31a is formed on the peripheral surface of the boss portion 31. This cam surface is a surface inclined continuously from the axial inside to the outside thereof and which is constructed in such that the pawl portion 26c of the retainer 26 is engageable. The axial inside of the cam surface is opened as an opened portion 31b so as to permit entrance and leave of the pawl portion 26c, and a concave 31c is formed as a lock position on the axial outside of the cam surface. An automatic state is attained by such a manner that the pawl portion 26c of the retainer 26 is transferred by means of a rotating operation of the knob 30 to the axial inside along the cam surface so that the pawl portion 26c becomes disengaged condition, and on the other hand, when the pawl portion 26c is transferred to the axial outside along the cam surface, the pawl portion 26c is locked to the lock position 31c, whereby the same comes to be in manually locked condition.

In the above construction, driving force has not been transferred to the axle shaft 1 in case of free travel (two-wheel drive) so that the axle shaft 1 does not rotate, whilst

since the respective gear portions 2a and 25b are in a clutched-off (disengaged) state, the housing 24, the retainer 26, the knob 30, the slide gear 25 and the like do rotate. The engaging projection 9f of the inner brake 9 is in a disengaged state with the end portions 16a and 16b of the wire brake 16.

Next, such an operation in the case where the clutch-off state shown in Fig. 1(a) moves to the clutch-on state shown in Figs. 4(a) and (b) will be described. First of all, when the driving force from the engine is transmitted to the axle shaft 1, the integral rotation of the drive gear 2 and the cam member 4 starts. In this case, the cam portion 4a of the cam member 4 is fitted into the cam groove 8a of the outer brake 8 and the grooved cam portion 9a of the inner brake 9 at the same time, but the cam member 4 tries to transfer outwardly in the axial direction while urging inwardly both the brakes 8 and 9 in the axial direction by means of a thrust force produced in a contacting portion of the grooved cam portion 9a of the outer brake 8, being a stationary system, with the cam member. The cam portion 4a of the cam member 4 transfers outwardly in the axial direction along the grooved cam portion 8a of the outer brake 8 and goes up completely the groove 8a, thereafter said cam portion abuts upon the second cam portion 9b of the inner brake 9 (Figs. 3(b) and (c)). At that time, the inner brake 9 has already been rotated by the cam member 4, and the engaging projection 9f of the inner brake engages with either end portion 16b (or 16a) of the wire brake 16 to be engaged thereby contemplating to rotate the same. However, the wire brake 16 is

expanded to be pressingly contact with an inclined inner wall surface of the groove 18 of the outer brake 8, so that a remarkable rotating resistance produces between both of them. As a result of suppressing the rotation of the wire brake 16, the rotation of the inner brake 9 is also suppressed, and the cam portion 4a goes up further the second cam portion 9b of the inner brake outwardly in the axial direction. At the time when the cam portion 4a went up the second cam portion 9b of the inner brake as shown in Fig. 4(a), the arm 11a of the release plate 11 engages with the other end portion 16a of the wire brake 16 to be engaged to rotate the same. Thus, the wire brake 16 contracts, and the rotating resistance between the wire brake and the outer brake 8 decreases remarkably. Then, the wire brake 16 is integrally rotated with the inner brake 9 by means of the release plate 11. At this time, the slide gear 25 displaces outwardly in the axial direction by means of resilient force of the shift spring 28, the gear portion 25b of the slide gear meshes completely with the gear portion 2a of the drive gear thereby realizing a locked state. As a result, when a perfect clutch-on condition is obtained, the arm 11a of the release plate engages with the projection 9f on the inner circumference of the inner brake 9 through the end portion 16a of the wire brake to be engaged to rotate directly the same while contracting the wire brake 16 thereby transmitting the rotational torque. For this reason, a braking force for which sliding resistance is used becomes small, and the resistance due to a relative rotation between both the brakes disappears

sufficiently, so that there is no fear of causing inconveniences such as decrease in durability and the like. The thrust bearing 13 and the thrust washer 14 contribute also to prevent both the brake members 8 and 9 from decrease in durability due to the sliding between them.

In the case where a four-wheel drive mode is turned to a two-wheel drive mode, the vehicle is allowed to slightly move in the direction opposite to that along which the vehicle had just before advanced after cutting off the transmission of driving force to the axle shaft 1. As a result, the arm 11a of the release plate 11 is away from the end portion 16a or 16b of the wire brake to be engaged so that the wire brake 16 is urged again in the rotating direction by means of the engaging projection 9f of the inner brake and is pressingly contact with the inner circumferential surface of the outer brake. The rotation of the inner brake 9 is suppressed by the wire brake 16 as in the case of transferring a free condition to a locked condition. Accordingly, the cam portion 4a of the cam member 4 transfers inwardly in the axial direction along the second cam portion 9b. In this case, since the cam member 4 is urged to the axial inside due to an expanding force of the return spring 27, the cam portion 4a is easily displaced to the axial inside along the cam portion 9b, and finally it drops into the cam portion 7a of the outer brake 8 and the cam portion 9a of the inner brake 9. As a result, a clutch-off condition is realized (Fig. 1(a) and Figs. 2(a) - (c)). The mesh of the gear portion 25b of the slide gear 25 is released from the gear portion 2a by

means of the expanding force of the return spring 27 in the course of the displacement of the cam member 4 along the inward axial direction.

Figs. 6(a) and 6(b) show a condition of the engagement of the wire brake 16 with the groove 18 in the outer brake as well as an engagement condition wherein no groove 18 is defined on the outer brake in accordance with the present invention respectively. As in the case of Fig. 6(b) wherein no groove 18 is defined, if a contact force (contact pressure) applied to the surface of the outer brake is represented by P and coefficient of friction is represented by μ , the braking force becomes μP . On the other hand, each contact pressure in two contact points is represented by $P_1 = P/2 \cos \theta$ ($0 < \theta < \pi/2$), and the total of the respective braking forces μP_1 becomes $2\mu P_1 = \mu P / \cos \theta$ as in the case of Fig. 6(a) wherein the groove 18 is defined on the outer brake. In this case, since $\mu P / \cos \theta > \mu P$, the contact pressure does not increase in spite of remarkable increase of the braking force in the two contact points. Accordingly, the present example has such an advantage that a high braking force can be attained, whilst the durability in the sliding portion does not remarkably decrease.

Moreover, the present example can significantly increase braking force by means of such a simple modification of definition of a groove without any remarkable change in design such as increase in spring force of the wire brake, increase in number of turns or the like.

In addition, since a lubricating oil such as grease and the like is easily maintained in gaps each defined between the bottom surface of the substantially V-shaped groove 18 and the wire brake 16, such durability in the sliding surface of the groove 18 can be improved.

The automatic condition illustrated in Fig. 1(a) - Figs. 4(a) and (b) is attained in the case where the pawl portion 26c of the retained 26 is transferred by means of a rotating operation of the knob 30 to the axial inside along the cam surface and the pawl portion 26c becomes disengaged with the cam surface, whilst manually locked condition illustrated in Figs. 5(a) and (b) is obtained in the case where the pawl portion 26c is transferred to the axial outside along the cam surface and the pawl portion is locked at the lock position.

As described above, according to the hub clutch of the present invention, braking force of rotating system braking members by means of stationary system braking members in the course of transfer to a locked state can be increased, thereby improving the responsibility thereof without accompanying such a complicated means of increasing spring force of the wire brake itself, besides decrease in durability can be prevented.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. A hub clutch for selectively transmitting torque between an axle shaft extending in an axial direction and a wheel hub, said hub clutch comprising:

5 a casing fixed to the wheel hub,

said casing having an inner peripheral surface, and a spline extending along said inner peripheral surface;

a drive gear secured to the axle shaft at an end thereof, said drive gear having both a gear portion and a spline extending on the outer periphery thereof;

10 a cam member in splined engagement with said spline of said drive gear so as to be movable along said drive gear in the axial direction,

said cam member having a cam portion projecting toward an inner side of the hub clutch;

15 an outer brake having a grooved cam portion engageable with said cam portion of said cam member, an inner peripheral surface, and a V-shaped groove extending in said inner peripheral surface;

a stationary system connected to said outer brake for preventing said outer brake from rotating;

20 an inner brake having a grooved first cam portion engageable with said cam portion of said cam member, second cam portions each of which is disposed at a respective one of opposite sides of said grooved first cam portion, and a projecting portion;

a wire brake extending in said V-shaped groove,

25 said wire brake having end portions which extend from said V-shaped groove radially inwardly in said hub clutch,

said end portions being engageable with said projecting portion of said inner brake;

30 a slide gear in splined engagement with said spline of said casing so as to be movable ^{relative to} ~~along~~ said ~~inner~~ casing in the axial direction,

said slide gear movable to a clutching ^{position} ~~portion~~ at which said slide gear



engages said gear portion of said drive gear;

a retainer slidably mounted in said hub clutch and contacting said cam member; and

a release plate mounted to said drive gear and having an arm,

5 said arm being engageable with said end portions of said wire brake.

2. A hub clutch substantially as hereinbefore described with reference to the drawings.

10 Dated this 4th day of January, 1991

TOCHIGI-FUJI SANGYO KABUSHIKI KAISHA

by their Patent Attorneys

DAVIES & COLLISON



Fig. 1 (a)

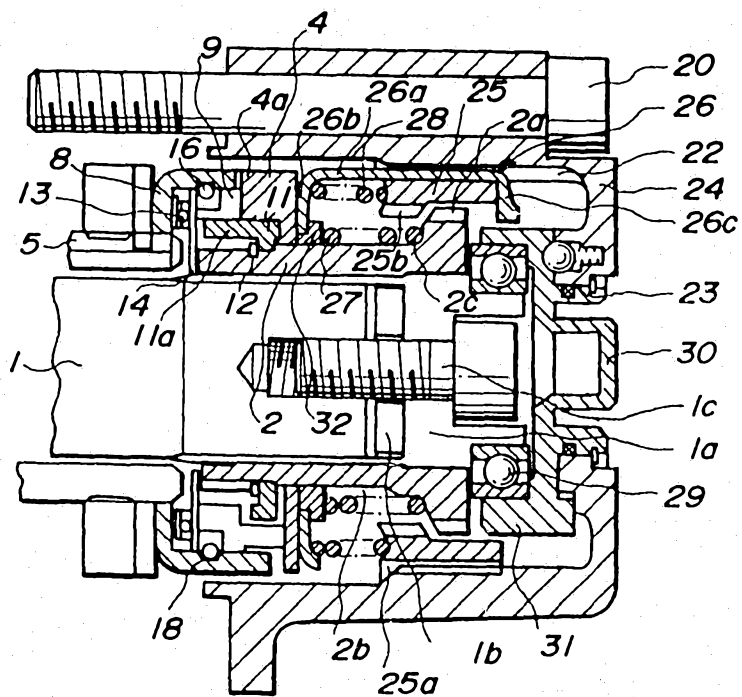


Fig. 1 (b)

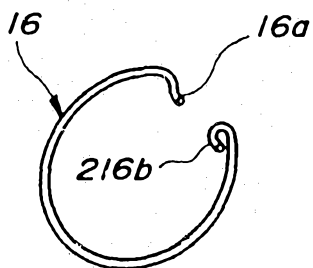


Fig. 1 (c)

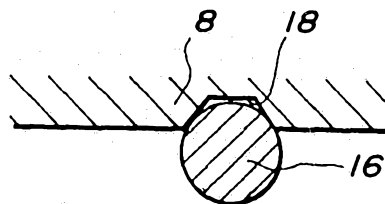


Fig. 1 (d)

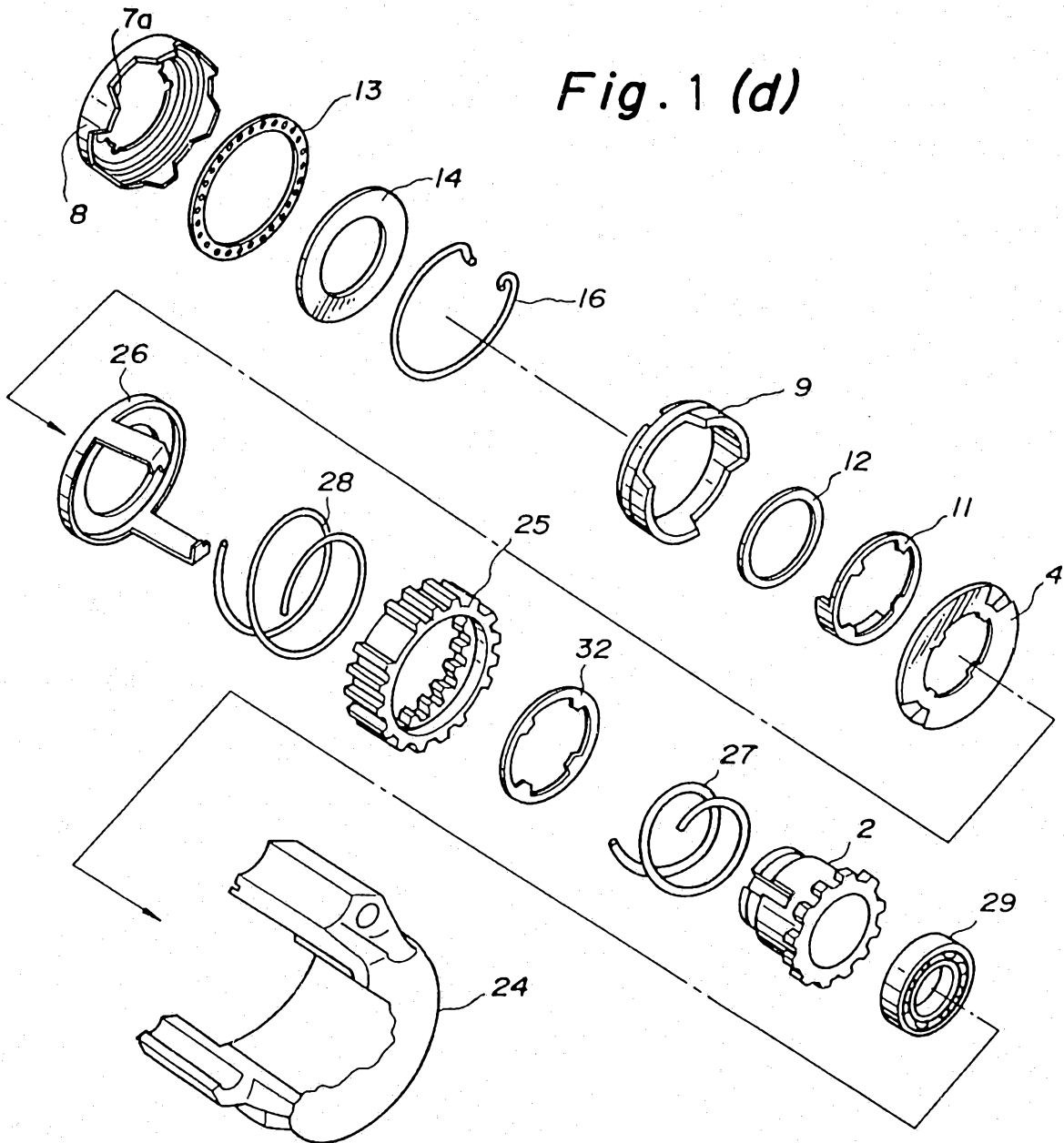


Fig. 2 (a)

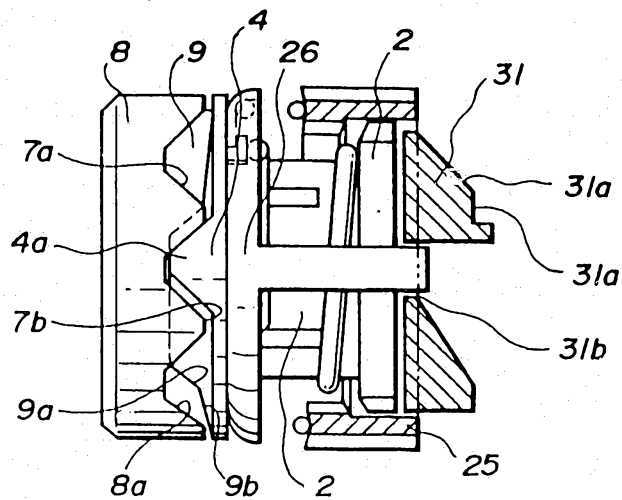


Fig. 2 (b)

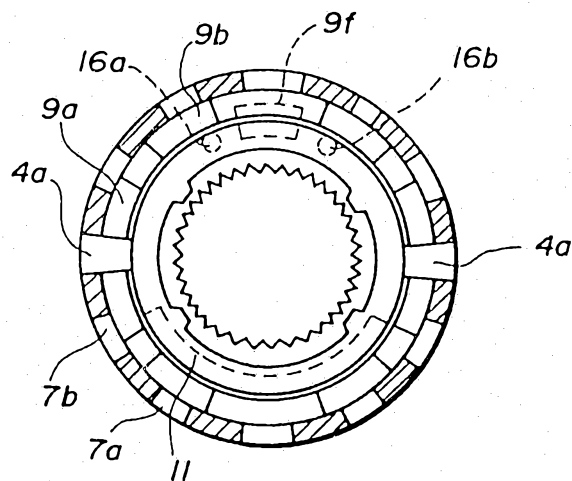


Fig. 2 (c)

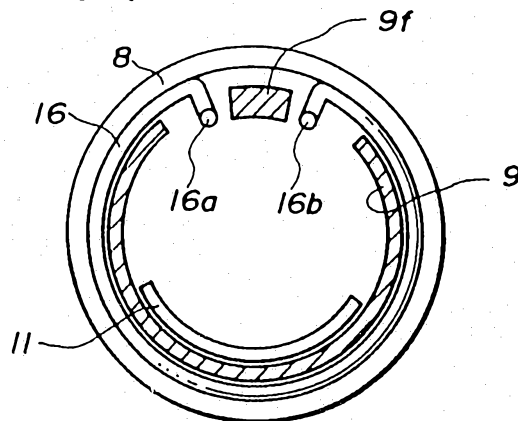


Fig. 3 (a)

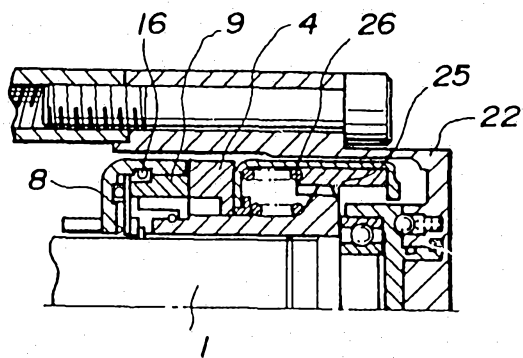


Fig. 3 (b)

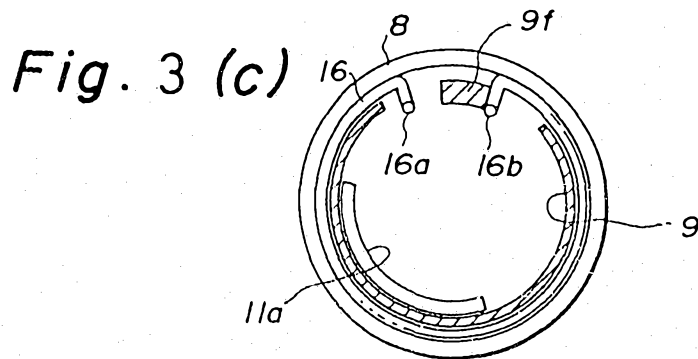
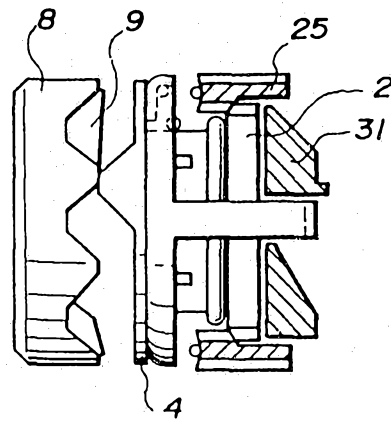


Fig. 4 (a)

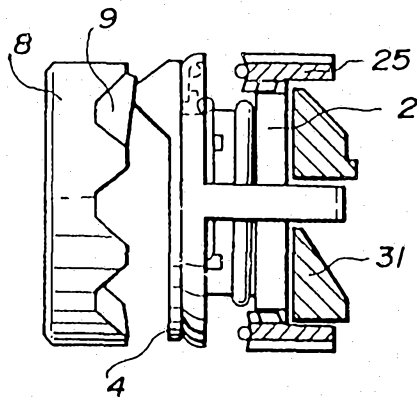


Fig. 4 (b)

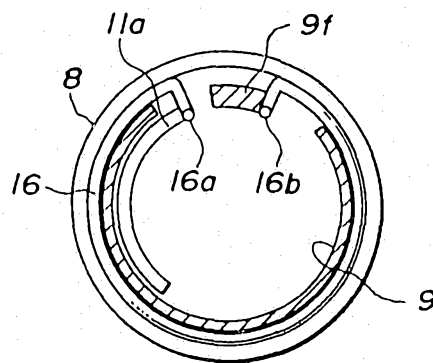


Fig. 5 (a)

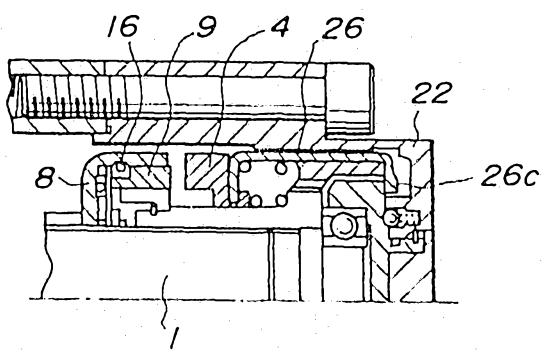


Fig. 5 (b)

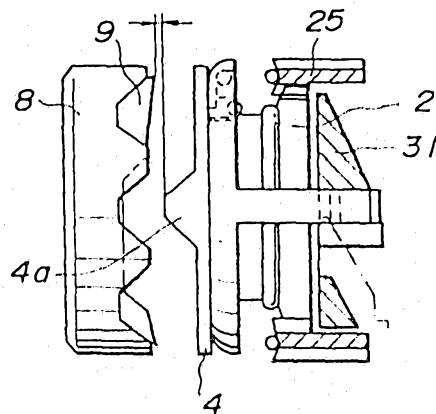


Fig. 6 (a)

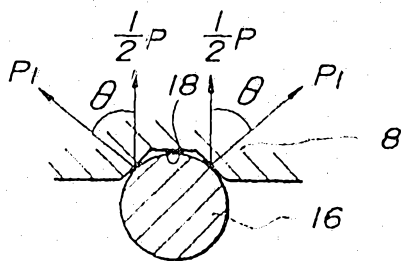


Fig. 6 (b)

