(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
3 January 2003 (03.01.2003)

PCT

(10) International Publication Number
WO 03/001076 A1

(51) International Patent Classification[7]: F16D 65/12

(21) International Application Number: PCT/IT01/00303

(22) International Filing Date: 13 June 2001 (13.06.2001)

(25) Filing Language: Italian

(26) Publication Language: English

(71) Applicant *(for all designated States except US)*: **FRENI BREMBO S.P.A.** [IT/IT]; Via Brembo, 25, I-24035 Curno (IT).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **CAVAGNA, Lorenzo** [IT/IT]; Via Taramelli, 7, I-24040 Bonate Sopra (IT). **OBERTI, Leone** [IT/IT]; Via Scalvino, 27, I-24010 Lenna (IT).

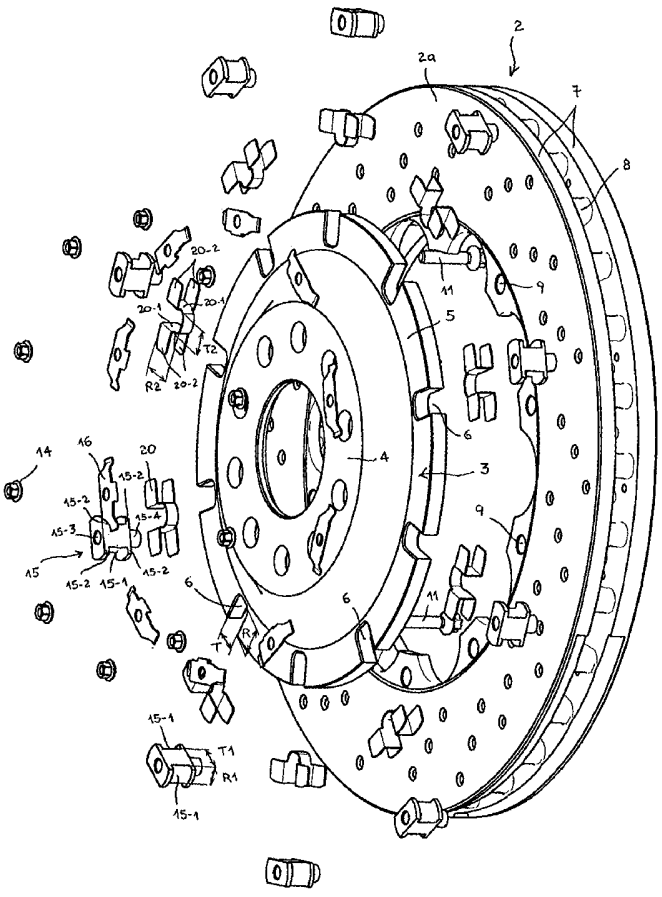
(74) Agents: **CRIPPA, Paolo, Ernesto** et al.; c/o Jacobacci & Partner S.p.A., Via Senato, 8, I-20121 Milano (IT).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: COMPOSITE DISK FOR A DISK BRAKE



(57) Abstract: The disk is formed by an annular braking band (2), by a bell (3), and by connecting means between the band (2) and the bell (3). The bell (2) has a plurality of radial recesses around its periphery. The connecting devices comprise a corresponding plurality of drive elements (15), each fitted in a radial recess (6) of the bell (3) with the ability to move substantially only radially, and a corresponding plurality of flat springs (16) arranged to permit resilient axial play between the band (2) and the bell (3). A plurality of inserts (20) is also provided, the inserts (2) being constituent by shaped element made of wear-resistant sheet-metal and being interposed between the flat springs (16) and the bell (3) so as to provide bearing surfaces for the springs and thus to prevent wear of the face of the bell facing the springs and the consequent reduction of the axial load exerted by the springs.

WO 03/001076 A1

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

DESCRIPTION

"Composite disk for a disk brake"

The present invention relates to a composite disk-brake disk as defined in the preamble to Claim 1.

In order to reduce the thermal stresses to which conventional brake disks are subject, particularly when they are used in high-performance motorcars, so-called composite disks have been proposed. In comparison with disks of previously known type formed integrally by an annular element or braking band and by a hub or bell arranged, respectively, for providing the braking surfaces for the brake calipers and for coupling the brake disk to a wheel, the particular characteristic of composite disks is that the braking band and the bell are produced as separate parts, which may be made of different materials, and which are finally coupled by suitable connection means.

For a better understanding of the state of the art on the subject of the invention, a composite disk of known construction will be described first of all with reference to Figures 4 to 6 of the appended drawings, pointing out, in particular, the connection system between the braking band and the bell.

In the description and in the appended claims, terms such as "axial", "radial", or "tangential" are intended to refer to the condition of mounting on the motor vehicle or to the axis of the disk.

With reference to Figure 4, in which the bell and the braking band of a composite disk-brake disk of the prior art are shown as two axially separated and radially aligned parts, the disk comprises, substantially:

- a radially outer braking band 2, generally made of cast iron and having axially opposed braking surfaces 2a for cooperating, in known manner, with the calipers of the braking device (not shown), and

- a radially inner bell 3, generally made of light aluminium alloy and arranged for connection to the hub of a wheel (not shown) and for supporting the braking band 2.

The bell 3 comprises a perforated flange 4 for fixing the disk to the hub and a peripheral ring 5 formed integrally with the flange 4 and having a plurality of radial recesses 6 with parallel sides, distributed uniformly around its periphery.

The braking band 2 comprises two substantially annular plates 7 arranged parallel to one another and connected by spacer elements 8. The annular plate 7

facing the bell 3 has a plurality of through-holes 9 distributed uniformly in the vicinity of its radially inner edge at the same angular intervals as the radial recesses 6 of the bell, in order to be aligned with these recesses when the two parts 2, 3 of the disk are assembled.

The braking band 2 and the bell 3 are joined together by connecting devices 10 such as those illustrated in Figures 5 and 6, each of which usually comprises a steel drive element arranged to be housed in a respective radial recess 6 in the periphery of the bell 3, in direct contact with the sides of the recess, and to be connected to the braking band 2 by threaded connection means.

According to the known solution shown in the above-mentioned drawings, each connecting device 10 comprises, in particular, a screw 11, a first washer 12, a second washer 13, a self-locking nut 14, a drive element 15 formed by a shaped block with four sides, that is, two pairs of parallel sides, a leaf-spring-like flat spring 16 and, finally, a bush 17 formed by a tubular element with an intermediate collar 18 having opposed flat surfaces.

The assembly of the connecting devices 10 between the braking band 2 and the bell 3 of a composite disk

requires the following steps:

- inserting a bush 17 in each of the holes 9 in the annular plate 7 facing the bell, until the collar 18 is brought into abutment with the surface of the plate,

- bringing the bell 3 up to the plate 7 in a manner such that the recesses 6 in the peripheral ring 5 of the bell are aligned with the bush 17,

- fitting a drive element 15 axially on each bush 17 until it abuts the collar 18,

- inserting the screws 11 in the respective first washers 12 and in the respective bushes 17,

- arranging the flat springs 16 in a manner such that their ends are in contact with the surface of the bell 3,

- fitting the second washers 13, and

- screwing the nuts 14 onto the ends of the screws 11 until they are fully tightened.

Upon completion of the assembly, the bell 3 is spaced axially from the plate 7 of the braking band 2 by virtue of the collars 18 of the bushes 17 and is urged against the collars by the action of the flat springs 16 (Figure 6).

Whereas the tangential play in the coupling is very small, the radial depth of the recesses 6 is quite large so as to permit free radial relative movement between

the band 2 and the bell 3 in order not to oppose the dimensional variations due both to the different coefficients of thermal expansion of the materials of the band and of the bell, and to the different temperatures which are reached in these two elements when the disk is heated during a braking operation.

With regard to expansions and/or movements in an axial direction, however, (for example, due to vibrations of the suspension or caused by accelerations of the vehicle axially relative to the disk), the connecting devices 10 permit sufficient axial play by virtue of the fact that the depth of the drive elements 15 is greater than the thickness of the peripheral ring 5 of the bell 3. The springs 16 serve to prevent vibrations and axial movements which would produce undesired noise.

Composite disks have been found very effective for solving the problems of thermal expansion for which they were designed. However, when a car on which these disks are mounted is travelling along roads with rough and uneven surfaces (for example, cobbles, paving etc.), particularly harmful vibrations and jolts are produced and may give rise to undesired noise or even compromise the integrity of the disks. If the connecting devices between the braking band and the bell provide for the

interposition of a flat spring, the continual hammering effect due to these vibrations may cause the ends of the spring to cut into the surface of the bell against which they bear, resulting in a reduction in the resilient effect exerted by the spring and an increase in the play in the coupling between the braking band and the bell, which leads to unacceptable deterioration of the disk within a short time.

The present invention proposes to provide a composite brake disk which can overcome the above-mentioned disadvantage.

This aim is achieved by virtue of the fact that the connecting devices between the braking band and the bell comprise a plurality of inserts made of wear-resistant material, each interposed between the respective resilient element, such as a flat spring, and the bell so as to provide bearing surfaces for the spring and thus to prevent wear of the surface of the bell facing the spring and the consequent reduction of the axial load exerted by the spring, as defined in Claim 1.

A preferred but non-limiting embodiment of the invention will be described below, with reference to the appended drawings, in which:

Figure 1 is an exploded perspective view of a composite disk-brake disk according to the invention,

Figure 2 is a perspective view of the disk of Figure 1, assembled,

Figure 3 is an axial view which shows, in detail, the fitting of a connecting device between the braking band and the bell of the disk of Figure 1,

Figure 4 is an exploded perspective view of a braking band and of a bell of a composite disk-brake disk of known type,

Figure 5 is an exploded perspective view of a known connecting device usable for the coupling between a braking band and a bell such as those shown in Figure 4, and

Figure 6 is a view of the known connecting device of Figure 5, in section and in the assembled condition.

As can be seen in Figures 1 to 3, in which parts and elements identical or corresponding to those of Figures 4 to 6 (prior art) have been attributed the same reference numerals, the braking band 2 and the bell 3 of a composite disk according to the invention are coupled to one another by connecting means or connecting devices each comprising substantially a screw 11, a nut 14, a drive element 15, a flat spring 16, and an insert 20.

Each drive element 15 is constituted by a single block, preferably made of steel, of a shape and size such that it can be housed in the corresponding radial

recess 6 of the bell 3 with the ability to move substantially only radially, as will be specified further below.

Each drive element 15 has two parallel opposed faces 15-1, spaced apart by a distance T1 and having a radial dimension R1. Four projections 15-2 are also provided, in the form of tabs which define the two opposed faces 15-1 axially and, when the drive element is arranged in the recess 6, engage the two opposed faces of the peripheral ring 5 of the bell 3 in the region of the four corners of the radial edges of the recess. Finally, the drive element 15 has a through-hole 15-3 through which the screw 11 can extend.

Each drive element 15 also has a cylindrical appendage 15-4, through which the hole 15-3 also extends and which can engage in the corresponding hole 9 provided in the plate 7 of the braking band 2. The axial length of the appendage is slightly less than the thickness of the plate 7 in the vicinity of the holes 9.

The insert 20 is a shaped element made of wear-resistant sheet-metal such as, for example, spring steel, and arranged to be housed in a respective recess 6, between the bell 3 and the drive elements 15. The insert comprises a substantially U-shaped central portion with two opposed parallel sides 20-1 spaced

apart by a distance T2 which, in the non-assembled condition, is slightly greater than the width T of the recesses 6 (the distance between their radial sides), to enable the inserts to be held in position as a result of the resilient reaction of the sides 20-1 on the sides of the recesses. The distance T2 is only slightly greater than the distance T1 between the opposed faces 15-1 of each drive element 15, that is, the tangential play of the coupling between the recesses 6 and the drive elements 15 is very small.

The U-shaped central portion of each insert 20 has a radial dimension R2 slightly less than the radial depth R of each recess 6, so as to be housed completely inside the respective recess without projecting radially. The dimension R2, on the other hand, is sufficiently greater than the radial dimension R1 of the drive elements 15 to permit free radial movement of these elements as a result of dimensional variations of a thermal nature of the braking band 2 and of the bell 3.

According to a preferred embodiment of the invention, each insert 20 has two pairs of opposed parallel tabs 20-2 which extend outwardly, relative to the U-shaped central portion, from each of the two sides 20-1 (Figure 1). These pairs of tabs are arranged to

cover the portions of the two axially opposed faces of the bell 3 around the radial edges of a recess 6 in the assembled condition, so as to provide a bearing and reaction surface of wear-resistant material for the projections 15-2 of the drive elements 15 and for the edges of the flat springs 16, thus preventing the above-mentioned phenomenon of cutting of the face of the bell facing the springs, and hence ensuring an adequate life of the disc.

The composite disk according to the invention is assembled by the following steps:

- fitting the inserts 20 on the sides of the recesses 6 of the bell 3, the inserts 20 remaining in position by resilient reaction,

- inserting the drive elements 15 in the U-shaped central portions of the inserts 20, the drive elements 15 remaining in position by form coupling,

- bringing the braking band 2 up to the bell 3 in a manner such that the cylindrical appendages 15-4 of the drive elements 15 enter the corresponding holes 9 in the bell,

- inserting the screws 11 in the holes 9 in the bell 3 and in the holes 15-3 in the drive elements 15,

- arranging the flat springs 16 in a manner such that their edges bear on the tabs 20-2 of the inserts

20, and

- screwing the nuts 14 onto the ends of the screws 11 until they are fully tightened.

The assembled unit appears as shown in Figure 2. Naturally, the principle of the invention remaining the same, the forms of embodiment and details of construction may be varied widely with respect to those described and illustrated purely by way of non-limiting example, without thereby departing from the scope of the invention as defined in the appended claims.

CLAIMS

1. A composite disk-brake disk of the type comprising:

- an annular braking band (2),

- a bell (3) with a plurality of radial recesses (6) around its periphery, and

- connecting devices between the braking band (2) and the bell (3), comprising a plurality of drive elements (15), each fitted in a radial recess (6) of the bell (3) with the ability to move substantially only radially, and a corresponding plurality of resilient elements (16) such as flat springs, arranged to permit resilient axial play between the braking band (2) and the bell (3),

characterized in that it further comprises a plurality of inserts (20) made of wear-resistant material, interposed between the plurality of flat springs (16) and the bell (3) so as to provide bearing surfaces for the springs and thus to prevent wear of the face of the bell facing the springs and the consequent reduction of the axial load exerted by the springs.

2. A disk according to Claim 1 in which each insert (20) is partially housed in a corresponding radial recess (6) of the bell (3) so as to be interposed

between the bell (3) and the drive element (15) fitted in the recess (6).

3. A disk according to Claim 2 in which each insert (20) is a shaped sheet-metal element with at least two tabs (20-2) each interposed between a respective end of the flat spring (16) and the face of the bell (3) which faces the spring.

4. A disk according to Claim 3 in which each insert (20) has two pairs of parallel tabs (20-2) for covering portions of the opposed faces of the bell (3) around the radial edges of the recesses (6).

5. A disk according to any one of the preceding claims in which each insert (20) has a substantially U-shaped central portion arranged for housing a respective drive element (15) and having two opposed parallel sides (20-1) for engaging the sides of a respective radial recess (6).

6. A disk according to Claim 5 in which the U-shaped central portion of each insert (20) has a radial dimension (R2) greater than that (R1) of the drive elements (15) to permit free radial movement of the elements (15) as a result of the dimensional variations of a thermal nature of the braking band (2) and of the bell (3).

7. A disk according to any one of the preceding

claims in which the inserts (20) are made of spring steel.

8. An insert (20) of wear-resistant material for a composite disk according to any one of the preceding claims.

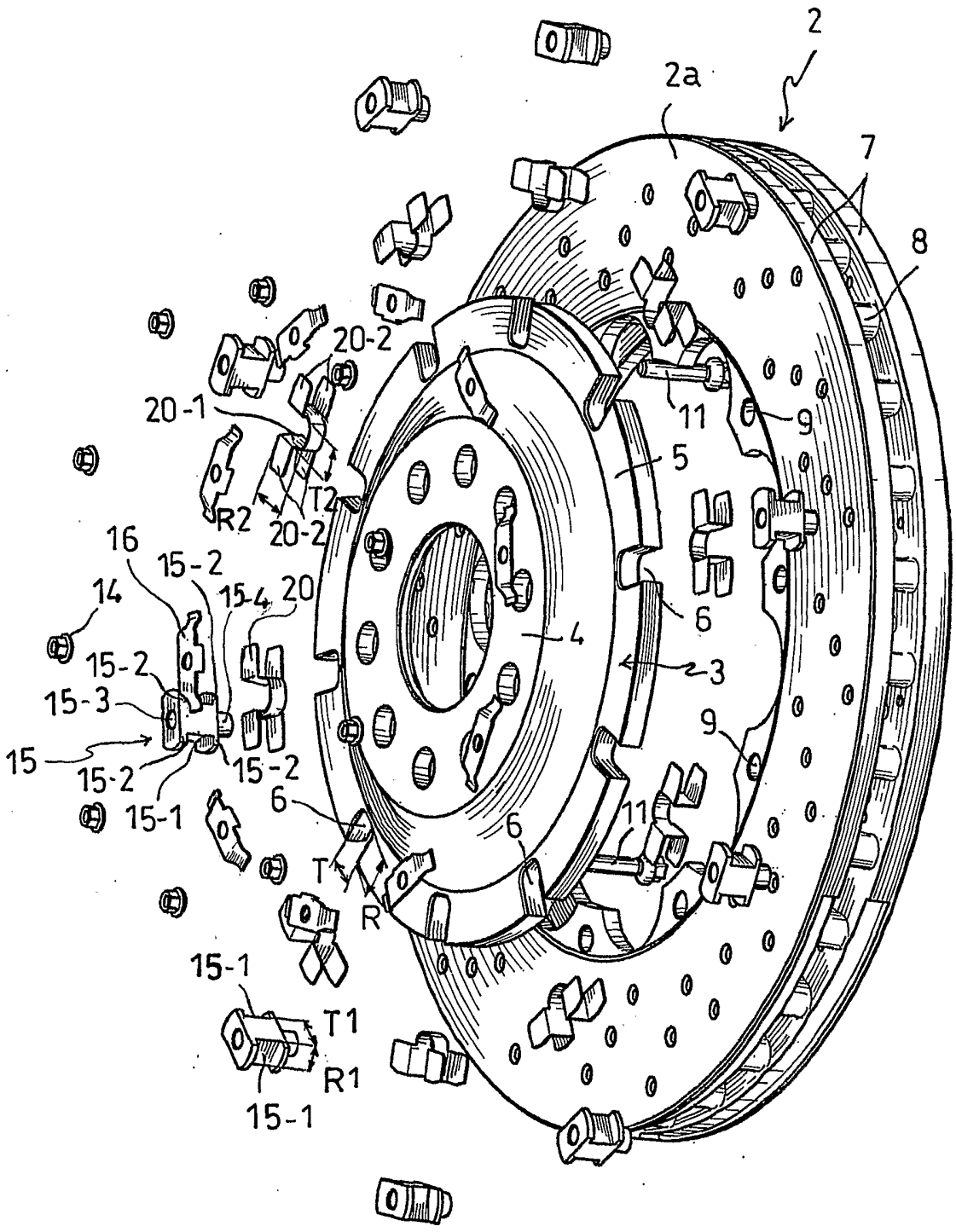

2
2a
7
8
20-2
20-1
11
9
5
T2
R2
20-2
16
15-2
14
15-4
20
6
4
15-2
3
15-3
9
15
15-2
15-2
6
11
15-1
6
T
R
15-1
T1
R1
15-1

FIG. 1

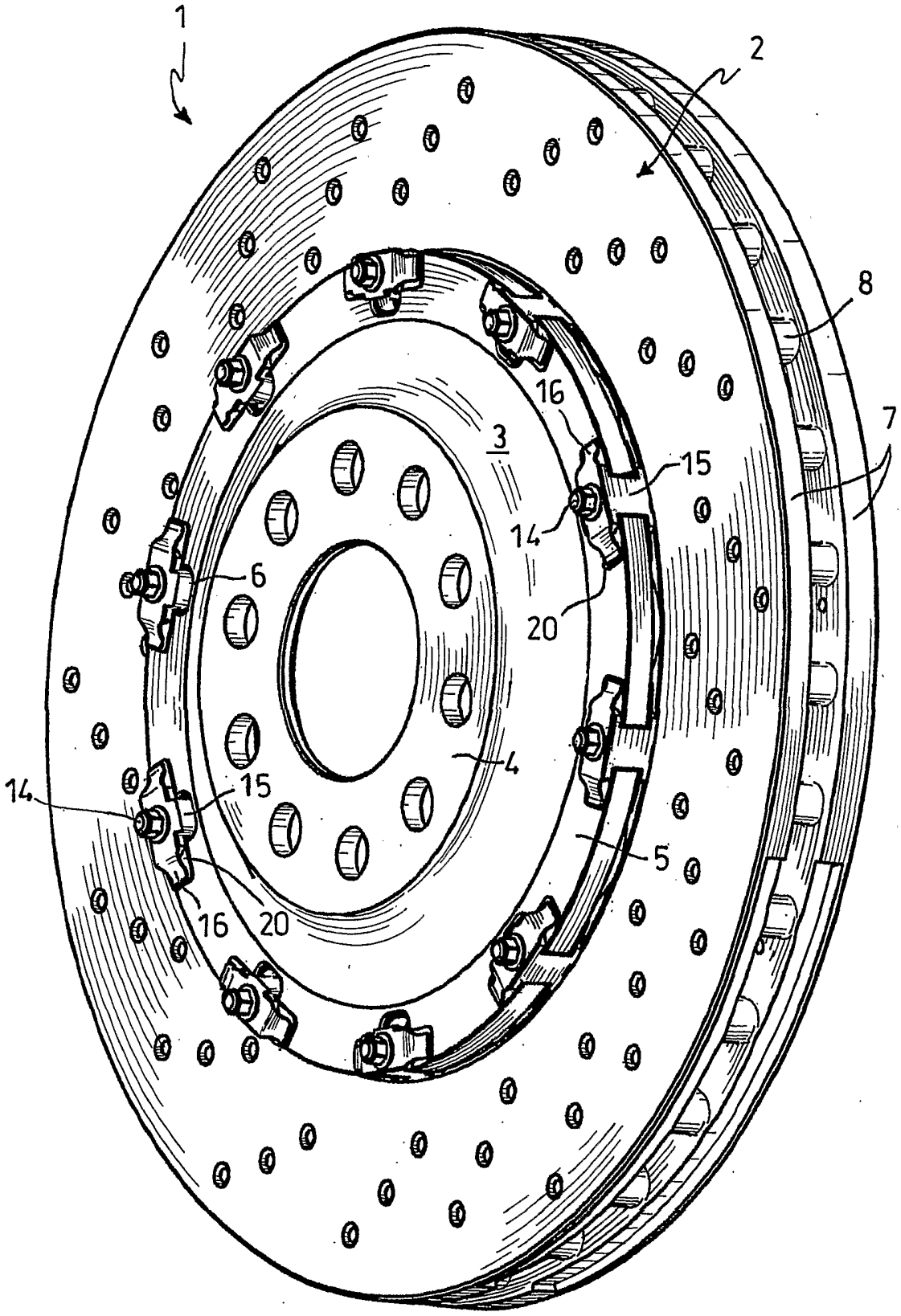


FIG.2

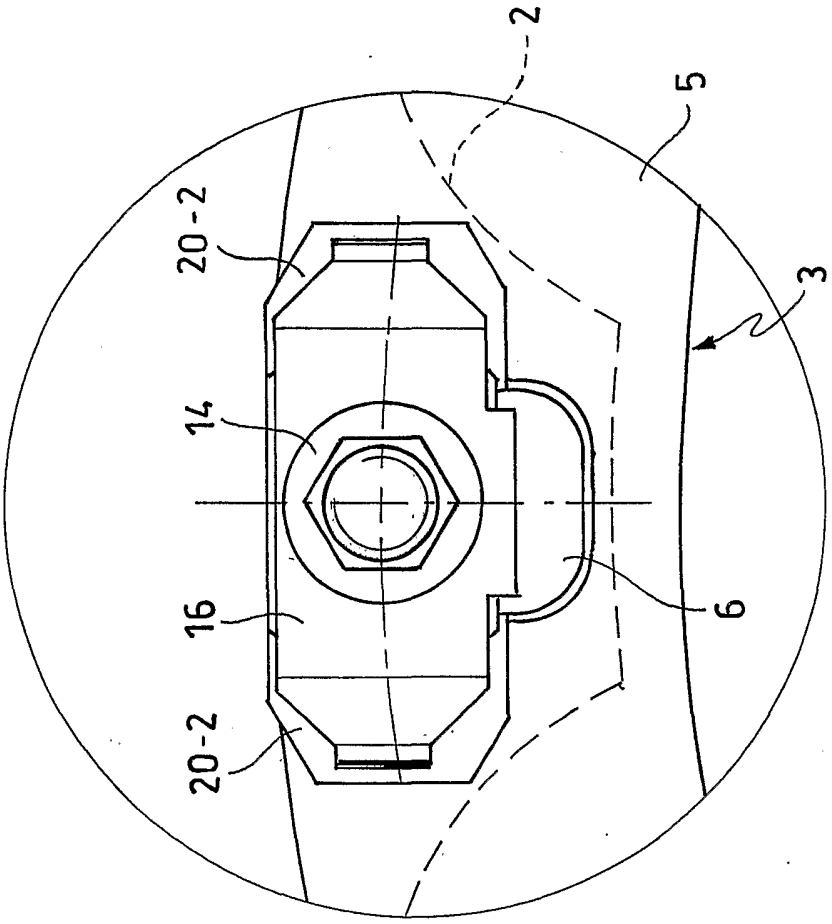


FIG. 3

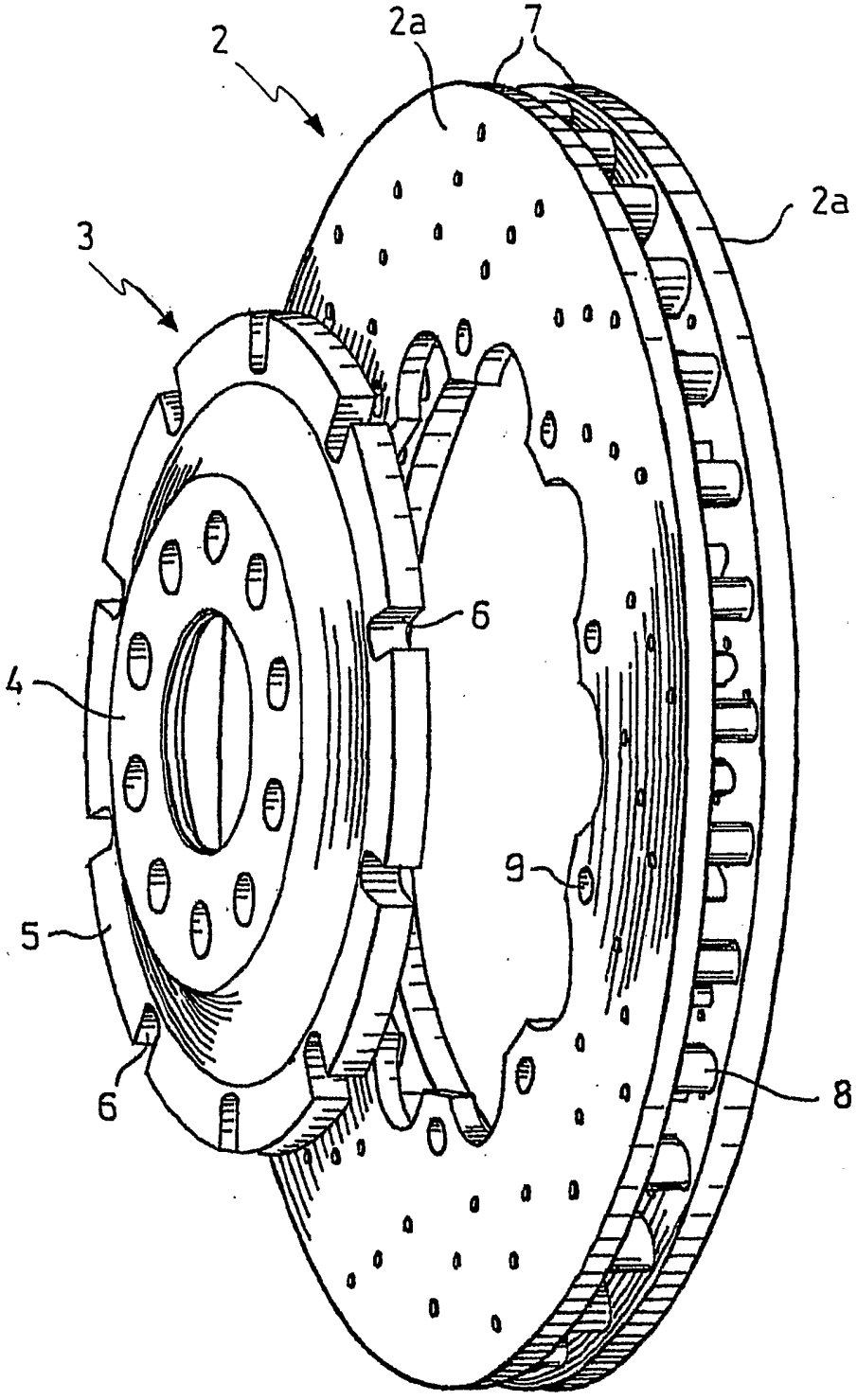


FIG.4
(State of the Art)

FIG. 5
(State of the Art)

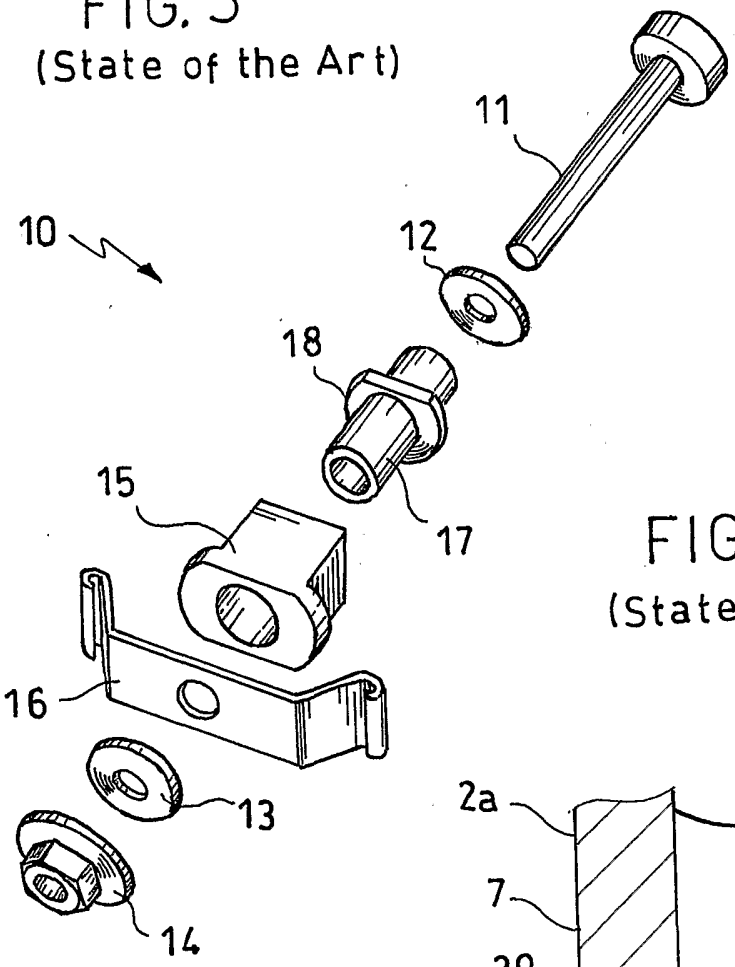
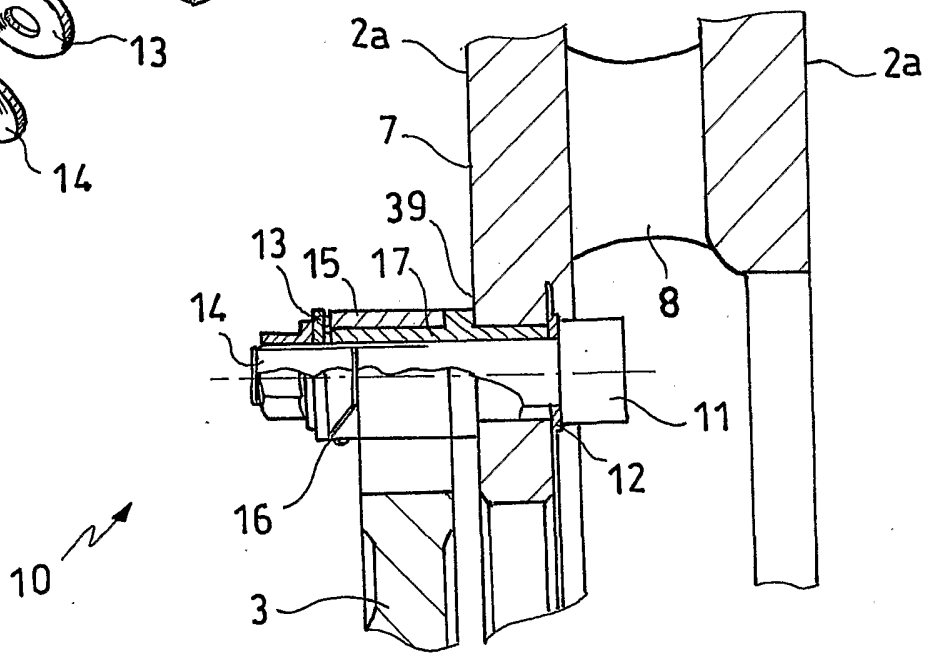


FIG.6
(State of the Art)



INTERNATIONAL SEARCH REPORT

Int Application No
PCT/IB 01/00303

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F16D65/12

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F16D

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 610 797 A (YUTAKA GIKEN CO LTD) 17 August 1994 (1994-08-17)	1,8
A	abstract; figures 5,9,10 column 6, line 11 - line 21	3,7
Y	DE 299 06 138 U (SPIEGLER BREMSTECHNIK GMBH) 1 July 1999 (1999-07-01) claim 1; figures	1,8
A	US 4 662 482 A (BASS RICHARD A) 5 May 1987 (1987-05-05) the whole document	1-3,7

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" *document of particular relevance; the claimed invention* cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 February 2002	20/02/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Gertig, I

INTERNATIONAL SEARCH REPORT

Information on patent family members

Ir [redacted] l Application No
PCT/IT 01/00303

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0610797 A	17-08-1994	DE 69409988 D1	10-06-1998
		DE 69409988 T2	17-12-1998
		EP 0610797 A1	17-08-1994
		US 5520269 A	28-05-1996
DE 29906138 U	01-07-1999	DE 29906138 U1	01-07-1999
US 4662482 A	05-05-1987	EP 0170438 A1	05-02-1986
		GB 2161898 A ,B	22-01-1986