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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
06 June 2024 (06.06.2024)

WIPO | PCT

(10) International Publication Number
WO 2024/115992 A1

(51) International Patent Classification:
F16D 65/847 (2006.01) *B60T 5/00* (2006.01)

(21) International Application Number:
PCT/IB2023/061266

(22) International Filing Date:
08 November 2023 (08.11.2023)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
102022000024648 30 November 2022 (30.11.2022) IT

(71) Applicant: **C.R.F. SOCIETÀ CONSORTILE PER AZIONI** [IT/IT]; strada Torino 50, I-10043 Orbassano (Torino) (IT).

(72) Inventors: **CORTELLETTI, Eleonora**; c/o C.R.F. Società Consortile per Azioni, strada Torino 50, I-10043 Orbassano (Torino) (IT). **BERGAMASCHI, Riccardo**; c/o Maserati S.p.A., Viale Ciro Menotti 322, I-41121 MODENA (IT). **SANDRI, Silvano**; c/o C.R.F. Società Consortile per Azioni, strada Torino 50, I-10043 Orbassano (Torino) (IT).

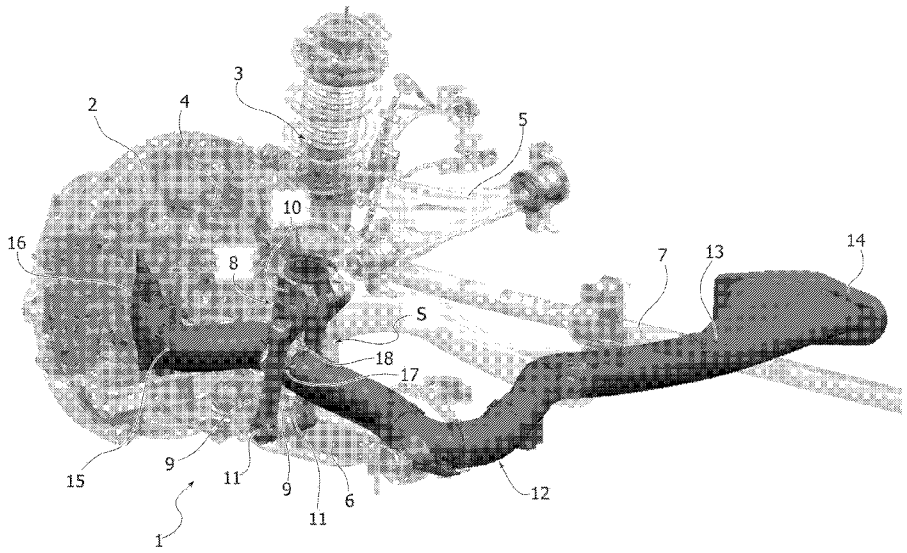
(74) Agent: **NOTARO, Gianluca**; c/o Buzzi, Notaro & Antonielli d'Oulx, corso Vittorio Emanuele II, 6, I-10123 Torino (IT).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH,

WO 2024/115992 A1

(54) Title: AIR CONVEYOR SYSTEM FOR COOLING A SUSPENSION AND BRAKE ASSEMBLY OF A MOTOR-VEHICLE WHEEL

FIG. 1



(57) Abstract: Air conveyor system (S) for cooling a suspension and brake assembly (1) of a motor-vehicle wheel, comprising a suspension fork (8) and an air conveyor duct (12) for conveying a cooling airflow towards one or more components of said suspension and brake assembly (1). The duct (12) comprises an intermediate portion (17) passing through a stiffening and fixing receiving body (18) suitable for supporting and fixing said intermediate portion (17). The fork (8) is made by an additive manufacturing technology, defining a single piece comprising said receiving body (18) or a single piece comprising one or more fastening seats (19) for fixing the receiving body (18) to the arms (9). The duct (12) comprises a proximal portion (15) protruding from the fork (8) towards one or more components to be cooled of said suspension and brake assembly (1).

[Continued on next page]

TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

"Air conveyor system for cooling a suspension and brake assembly of a motor-vehicle wheel"

****

TEXT OF THE DESCRIPTION

Field of the invention

The present invention refers to an air conveying system for cooling a suspension and brake assembly of a motor-vehicle wheel, comprising:

- a suspension fork arranged to be connected respectively at its opposite ends to an oscillating rod and a shock absorber unit,
- an air conveyor duct for conveying a cooling airflow towards one or more components of said suspension and brake assembly.

The present invention finds particular application in the field of sports vehicles with high performance and low production volumes.

Prior art

In general, for high-performance sports vehicles, the braking devices and the wheel assembly must be effectively cooled to dissipate the heat generated, so as to avoid wear and/or failures of the braking system or other components connected to the wheel. In this regard, documents **US11313426** and **EP3753760** illustrate various devices configured for conveying a cooling airflow towards one or more components of a suspension and brake assembly of a motor-vehicle wheel.

With reference to the systems of the type indicated at the beginning of this description, the solutions known to date include suspension forks made of aluminum and/or steel using traditional processes such as forging, casting or moulding, and a cooling air conveyor duct which it is supported near the wheel assembly by means of metal brackets cantilever mounted and connected to one or more components of the vehicle suspension or to other components adjacent to it. The terminal end of the air conveyor duct is positioned near the wheel well guard, to direct a cooling airflow generally and in a widespread manner towards various components connected to the front wheel, such as for example a brake disc unit, suspension arms, wheel bearings, axle shafts, etc. This type of configuration directs the air generally towards the center of the wheel, without conveying the airflow directly to the components most subjected to thermal stress, thus incurring unnecessary

dispersions. Furthermore, the known solutions described above are susceptible to incurring structural and reliability problems due to accidental events (such as traveling on road roughnesses and/or impacts with external bodies), which could lead to damage to the support brackets and/or of the fixing means associated with them, and therefore to a detachment of the cooling duct.

Furthermore, from a production point of view, these systems involve the implementation of a specific mold for the fork and various other molds for the interface components, such as for example the duct support brackets. Furthermore, subsequent mechanical and assembly processes are necessary for the overall implementation of the system.

In light of the above, the management cost of the components and the high investment cost of the molds for their implementation have an impact on a high final development cost. In addition to this, any subsequent modification to one or more components implies a modification of the molds with a further increase in overall times and costs. The subsequent mechanical operations for the implementation of the system and the assembly operations also have a negative impact on overall development times and costs, which are therefore not very sustainable for vehicles with low production volumes.

The present invention starts therefore by the desire to implement a system that is improved from various points of view compared to what is currently known, in particular with regard to the effectiveness of the cooling system and the overall investment cost.

Object of the invention

The object of the present invention is to provide a system of the type indicated at the beginning of this description, which is extremely effective for cooling one or more components of the suspension and brake assembly, with relatively simple means and sustainable costs.

A further object of the invention is to implement such a system, so as to optimize the number of components, the system reliability and the assembly ease.

A further object of the invention is to implement this system, in order to optimize overall investment times and costs, making it compatible for high

performance sports vehicles with low production volumes.

Summary of the invention

According to one or more embodiments, the above-mentioned objects are achieved through an air conveyor system having the features specifically set out in claims 1-10.

According to one or more embodiments, the above-mentioned objects are further achieved through a suspension and brake assembly of a motor-vehicle wheel having the features specifically set out in claim 11.

Brief description of the figures

Further features and advantages of the invention will emerge from the following description with reference to the attached drawings, provided purely by way of non-limiting example, in which:

- figures 1, 2 are perspective views illustrating a suspension and brake assembly of a motor-vehicle wheel, associated with an air conveyor system according to the present invention,

- figures 3, 4 illustrate some features of the air conveyor system, according to a first embodiment, and

- figures 5, 6 illustrate further features of the air conveyor system, according to a second embodiment.

Detailed description of embodiments

The following description illustrates various specific details aimed at an in-depth understanding of examples of one or more embodiments. The embodiments may be implemented without one or more specific details, or with other methods, components, materials etc. In other cases, known structures, materials or operations are not shown or described in detail to avoid obscuring various aspects of the embodiments. The reference to "an/one embodiment" within this specification is to indicate that a particular configuration, structure or feature described in connection with the embodiment is included in at least one embodiment. Thus, phrases such as "in an/one embodiment", possibly present in different places in this specification, do not necessarily refer to the same embodiment. Furthermore, particular conformations, structures or features can be

combined appropriately in one or more embodiments and/or associated with the embodiments in a different way from as illustrated here, so for example a feature exemplified here in relation to a figure it may be applied to one or more embodiments exemplified in a different figure.

The references illustrated here are for convenience only and therefore do not delimit the extent of protection or the scope of the embodiments.

Figures 1, 2 are different perspective views illustrating a suspension and brake assembly 1 of a motor-vehicle wheel, associated with an air conveyor system S for cooling one or more components of the assembly 1, according to the present invention.

Purely by way of non-limiting example, the suspension and brake assembly 1 illustrated in figures 1, 2 is an assembly of a front wheel of a motor-vehicle, comprising a brake disc 2 of a disc braking system, a shock absorber unit 3, a wheel strut 4, an upper oscillating arm 5, a lower oscillating rod 6 and a suspension stabilizer bar 7.

According to an illustrated feature, the air conveyor system S for the suspension and brake assembly 1 comprises a suspension fork 8 having a body with two parallel arms 9, connected respectively at its opposite ends to the lower oscillating rod 6 and the shock absorber unit 3. More particularly, the suspension fork 8 comprises an upper portion 10 defining a seat for receiving and fixing the shock absorber unit 3. From the upper portion 10 the parallel and spaced arms 9 extend, along a substantially vertical direction with reference to the configuration mounted on the vehicle. At the lower end of each arm 9 a fastening seat 11 is provided to fix the lower oscillating rod 6, in particular by connecting the seats 11 to an elastic bush carried by the rod 6. Note that the present invention is equally applicable to a suspension group with single-leg fork.

According to the present invention, the system S comprises an air conveyor duct 12 configured for conveying a cooling airflow towards one or more components of the suspension and brake assembly 1. In the assembled configuration, the duct 12 comprises a distal portion 13 having an inlet opening 14 adapted to operate as an air intake for the entry of an airflow into the duct 12 to be directed towards the suspension and brake assembly 1. In one or more embodiments, the distal portion 13 extends

inside the bumper of the motor-vehicle (not shown), so that the inlet opening 14 faces the bumper from the front so as to receive an inlet airflow during the motion of the motor-vehicle. The duct 12 further comprises a proximal portion 15 having an outlet opening 16 configured to direct the airflow towards one or more components of the suspension and brake assembly 1.

In one or more embodiments, the duct 12 comprises an intermediate portion 17 passing between the parallel arms 9 of the fork 8, in particular through a stiffening and fixing receiving body 18 associated with the arms 9. Preferably, the duct 12 is of circular section and the stiffening and fixing body 18 has a section with the same shape and diameter suitable for receiving the intermediate portion 17 of the duct 12 along its inner wall. The receiving body 18 therefore defines an annular body with a main axis perpendicular to the plane of the fork defined by the parallel arms placed side by side. In other embodiments, the axis of the annular body is not perpendicular to the plane of the fork and has an angle with respect to it, depending on the layout of the duct 12.

In one or more embodiments, the outer circumferential wall of the intermediate portion 17 is blocked by interference with the inner circumferential wall of the receiving body 18. In other embodiments, the duct 12 can be glued to the receiving body 18 or joined by means of fixing means such as clamping band and/or bayonet-type fixture. Further characteristics of the receiving body 18 are illustrated later in the description.

According to a further aspect of the invention, the suspension fork 8 is made by an additive manufacturing technology. The expression “additive manufacturing” generally refers to a process known in the art in which use is made of an energy source, such as for example a laser or plasma beam, to selectively fuse powder layers or metallic or plastic material sheets, of various sizes, so as to form, layer after layer, a component of metallic material or plastic material. A device for producing components through additive manufacturing is known for example from document **EP 3148784 A1**, while the European patent application **EP 3470248 A1** in the name of the same Applicant illustrates an example of application of the construction technique described above in the field of motor-vehicle suspensions.

In one or more embodiments, the suspension fork 8 is made by means of an additive manufacturing technology based on the deposition of

material on layers (for example according to the “Fused Deposition Modelling”, FDM).

By making the fork 8 in additive manufacturing it is possible to produce the fork 8 without moulds, allowing the formation of geometric undercuts that would otherwise not be achievable with a single piece component.

As indicated previously, the duct 12 comprises an intermediate portion 17 passing between the parallel arms 9 of the fork 8, in particular through a stiffening and fixing receiving body 18 associated with the arms 9. The fixing of the conveyor duct 12 directly on the fork 8 allows to optimize the orientation of the proximal portion 15 with the outlet opening 16, so that the cooling airflow is directly directed to one or more components involved in cooling (such as for example brake caliper, wheel bearing, axle shaft) thus avoiding unnecessary dispersion of the airflow. In other words, the outlet opening 16 directly faces one or more specific components of the suspension and brake assembly 1. Furthermore, the fact of providing a rigid body connected to the arms 9 and placed between them allows the stiffness of the fork 8 to be increased, to the advantage of the stability of the suspension system.

Therefore, the air conveyor system S according to the invention provides a conveyor duct 12 integrated with the fork 8, ensuring properties of strength and stability of the duct 12, without having to provide brackets or other means of support and fixing in proximity to the fork 8.

With reference to the embodiment illustrated in figures 3, 4, the fork 8 is made in additive manufacturing by defining a single piece comprising the fork body with two parallel arms 9 and the aforementioned stiffening and fixing receiving body 18 suitable for receiving and fixing the intermediate portion 17 of the duct 12. In this embodiment, the specific geometry of the fork 8 consists of a two-legged archetype which has a central stiffening body suitable for receiving and locking the cooling duct 12 in position. The outer circumferential wall of the receiving body 18 has opposite lateral portions joined to a respective inner face 9’ of the arms 9.

Figures 5, 6 illustrate a further embodiment of the invention. In this embodiment, the fork 8 is made by an additive manufacturing technology so as to form a single piece comprising the parallel arms 9 and one or more

fastening seats 19. The fastening seats 19 are integrated in a single piece with the arms 9 and are designed to rigidly connect the receiving body 18 to the arms 9 of the fork 8. As illustrated in figures 5, 6, the fastening seats 19 are protruding pins suitable for cooperating with respective fixing means - for example a threaded nut 20 - to fix lateral portions 21 of the receiving body 18 to the arms 9. The arms comprise a pair of pins positioned substantially at the center line of the arms 9, protruding perpendicularly with respect to a longitudinal direction of the arms 9. The circular-shaped receiving body 18 comprises two lateral portions 21 defining respective connection flanges to be joined to the pins with the threaded nuts 20. This embodiment in which the receiving body 18 is not integrated in a single piece in additive manufacturing with the fork 8, allows the dimensions and/or the general shape of the receiving body 18 to be varied, depending on the shape of the duct 12. In fact, the shape and more generally the layout of the duct 12 could vary depending on the type of vehicle on which the system S is to be installed. For example, the duct 12 could have a diameter of different dimensions depending on the need to direct an airflow with a greater or lesser flow rate. Furthermore, the duct 12 could be provided with other shapes than illustrated, for example with an oval section.

The invention as described above allows the following advantages to be obtained:

- directing the cooling air directly to the components most affected by wear and/or failures due to high temperatures, while avoiding structural and reliability problems that could lead to damage to the cooling duct.
- overall investment costs compatible for the production of sports vehicles with high performance and low production volumes,
- assembling the system intuitively and with a particularly small number of components,
- making changes to the fork or duct quickly and economically, for implementation on different vehicle models.

Of course, notwithstanding the principle of the invention, the construction details and the embodiments may vary widely with respect to what is described and illustrated purely by way of example, without thereby departing from the scope of the present invention as defined in the attached claims.

CLAIMS

1. Air conveyor system (S) for cooling a suspension and brake assembly (1) of a motor-vehicle wheel, comprising:

- a suspension fork (8) arranged to be connected respectively at its opposite ends to an oscillating rod (6) and a shock absorber unit (3),
- an air conveyor duct (12) for conveying a cooling airflow towards one or more components of said suspension and brake assembly (1),
- wherein said duct (12) comprises an intermediate portion (17) integrated with the fork (8) and passing through a stiffening and fixing receiving body (18) suitable for supporting and fixing said intermediate portion (17),
- wherein said fork (8) is made by an additive manufacturing technology, defining a single piece comprising said receiving body (18) or a single piece comprising one or more fastening seats (19) for connecting the receiving body (18) to the arms (9),
- wherein said duct (12) comprises a proximal portion (15) protruding from the fork (8) towards one or more components to be cooled of said suspension and brake assembly (1), said proximal portion (15) comprising an outlet opening (16) directly facing one or more components of the suspension and brake assembly (1).

2. System (S) according to claim 1, wherein the duct (12) comprises a distal portion (13) having an inlet opening (14) adapted to operate as an air intake for the entry of an airflow inside the duct (12).

3. System (S) according to claim 1 or 2, wherein the receiving body (18) has an annular-shaped body with a diameter suitable for receiving the intermediate portion (17) of the duct (12) along its inner wall.

4. System (S) according to claim 3, wherein the outer circumferential wall of the intermediate portion (17) is blocked by interference with the inner circumferential wall of the receiving body (18).

5. System (S) according to any of the preceding claims, wherein the duct (12) is rigidly connected to the receiving body (18) by means of fixing means such as clamping band and/or bayonet-type fixture.

6. System (S) according to any of the preceding claims, wherein the receiving body (18) is a rigid body forming a single piece with the

suspension fork (8).

7. System (S) according to any of the preceding claims, wherein said suspension fork (8) has a body with two parallel arms (9), wherein said intermediate portion (17) passes between said parallel arms (9) and through said stiffening and fixing receiving body (18).

8. System (S) according to claim 7, wherein the receiving body (18) is a rigid body connected to the arms (9) and interposed between them, forming a single piece with the suspension fork (8), wherein the outer circumferential wall of the receiving body (18) has opposite lateral portions joined to a respective inner face (9') of the arms (9).

9. System (S) according to claim 7, wherein said one or more fastening seats (19) are protruding pins adapted to cooperate with respective fixing means to connect lateral portions (21) of the receiving body (18) to the arms (9).

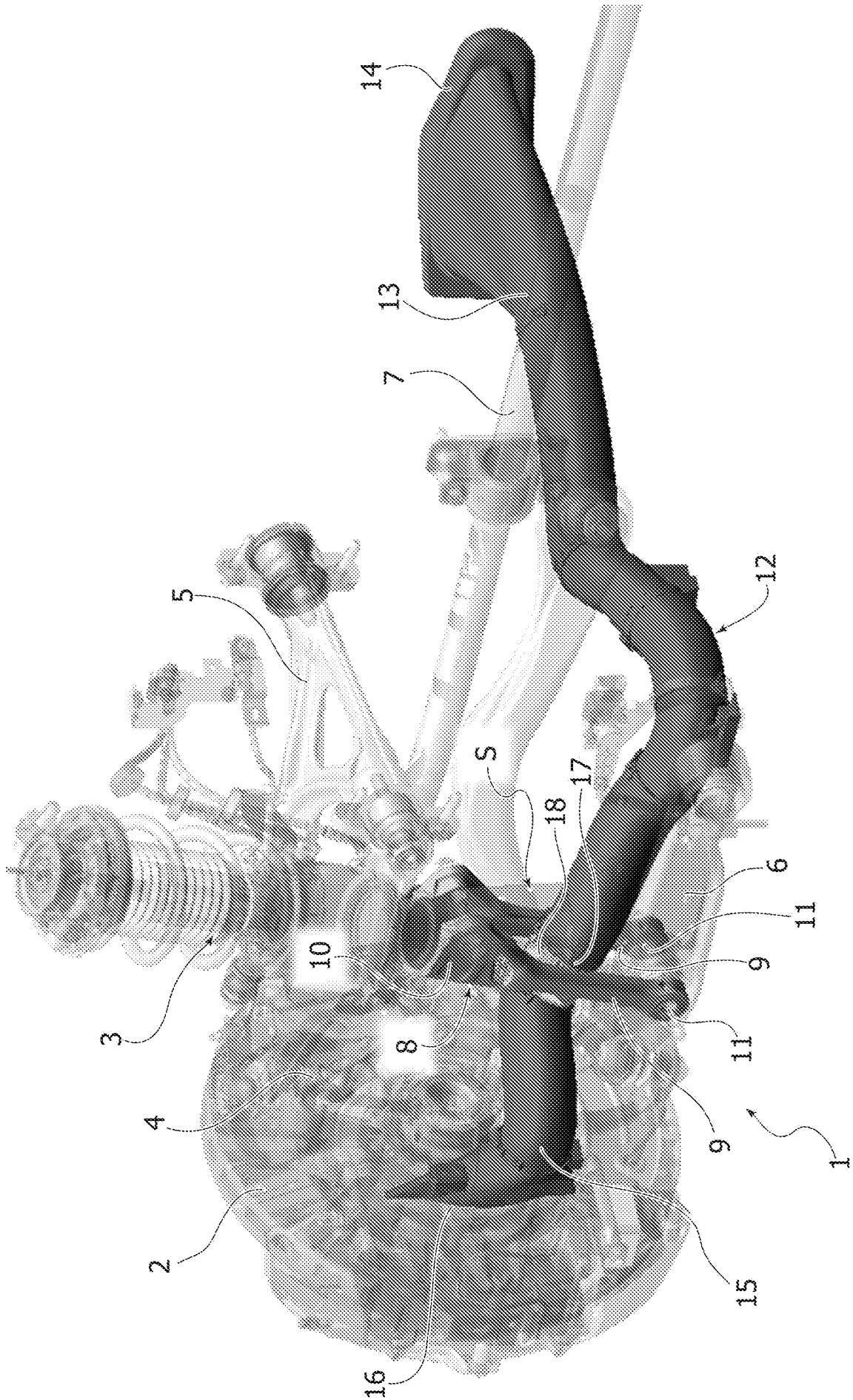
10. System (S) according to claim 9, wherein the arms (9) comprise a pair of pins positioned substantially at the center line of the arms (9), protruding perpendicularly with respect to a longitudinal direction of the arms (9), wherein the receiving body (18) comprises two lateral connection flanges (21) joined to the pins with respective fixing means.

11. Suspension and brake assembly (1) of a motor-vehicle wheel comprising an air conveyor system (S) for cooling one or more components of said suspension and brake assembly (1), including:

- a suspension fork (8) connected respectively at its opposite ends to an oscillating rod (6) and a shock absorber unit (3),
- an air conveyor duct (12) for conveying a cooling airflow towards one or more components of said suspension and brake assembly (1),
- wherein said duct (12) comprises an intermediate portion (17) integrated with the fork (8) and passing through a stiffening and fixing receiving body (18),
- wherein said fork (8) is made by an additive manufacturing technology, defining a single piece comprising said receiving body (18) or a single piece comprising one or more fastening seats (19) for fixing the receiving body (18) to the arms (9),
- wherein said duct (12) comprises a proximal portion (15) protruding from the fork (8) towards one or more components to be cooled of said

suspension and brake assembly (1), said proximal portion (15) comprising an outlet opening (16) directly facing one or more components of the suspension and brake assembly (1).

FIG. 1



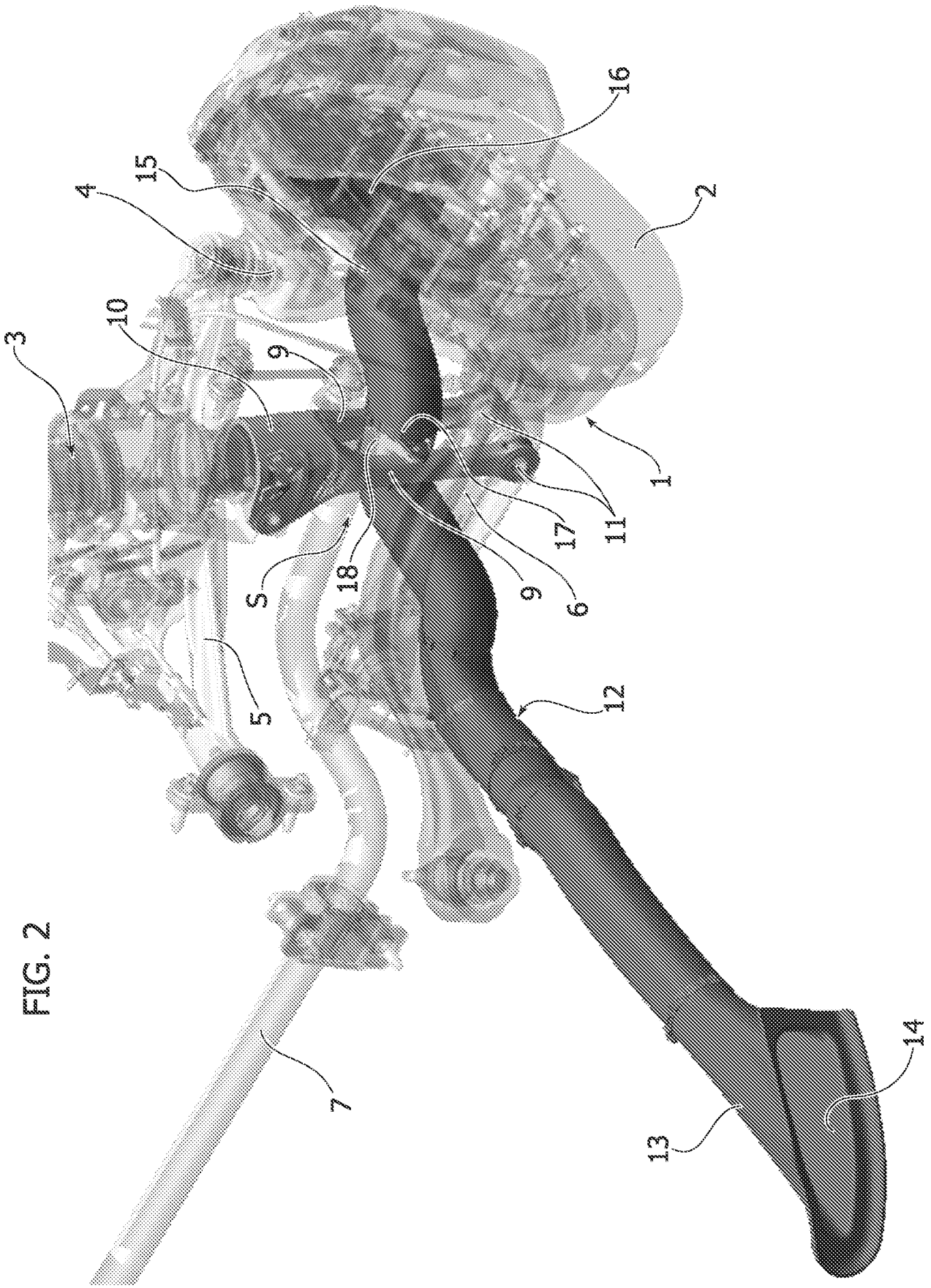


FIG. 2

FIG. 4

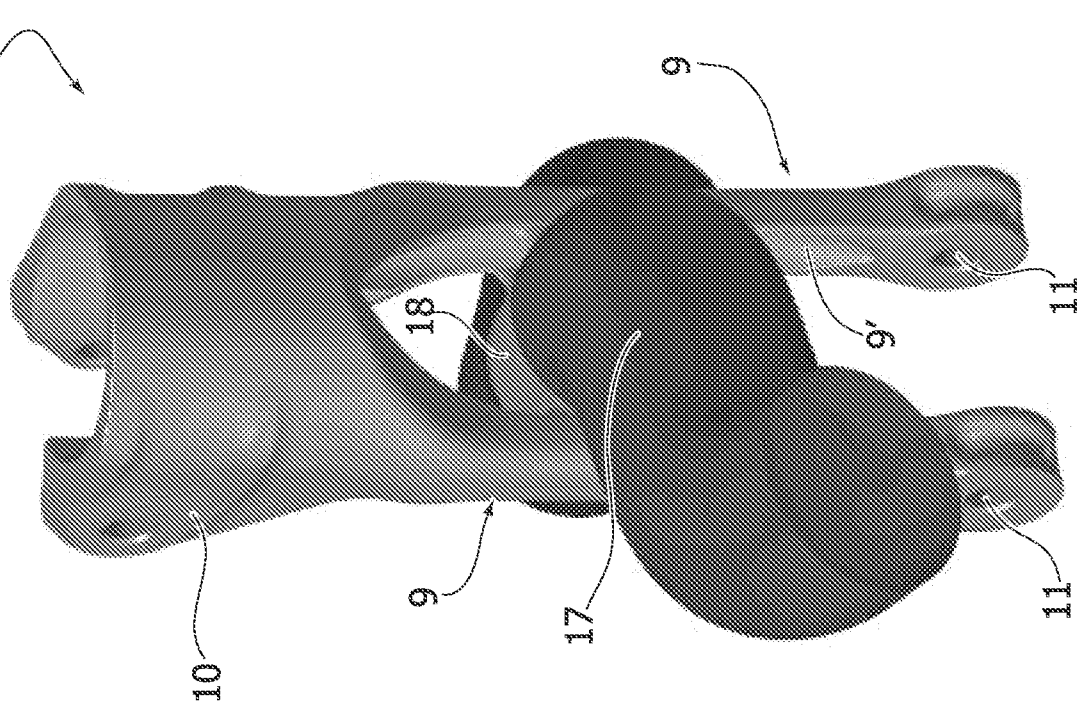


FIG. 3

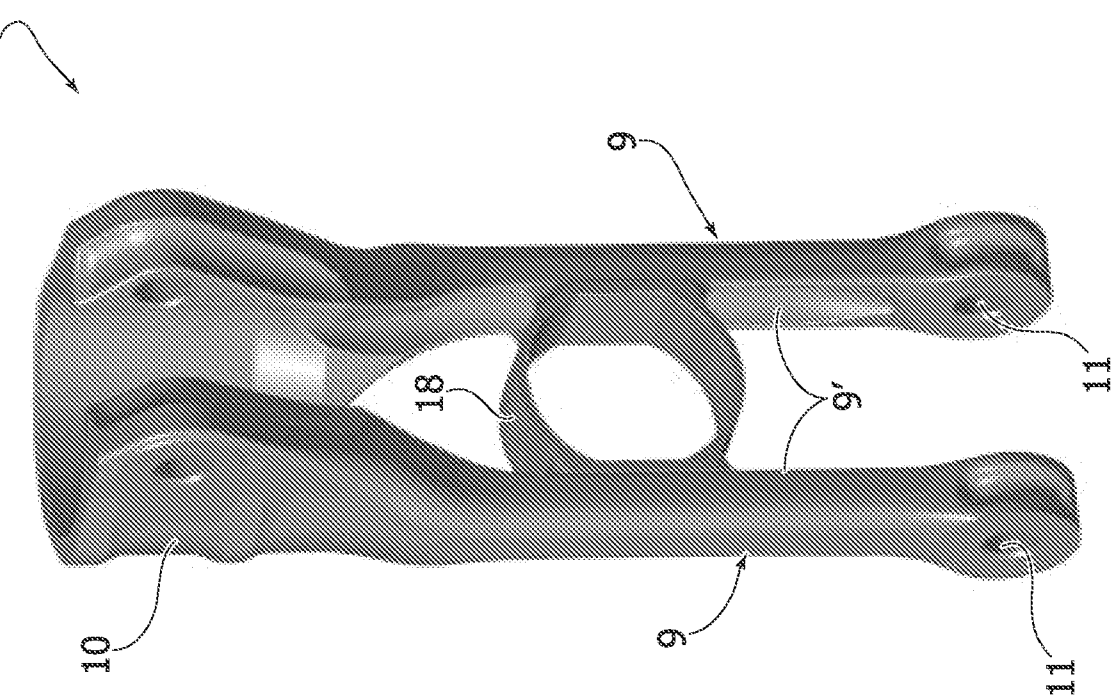


FIG. 6

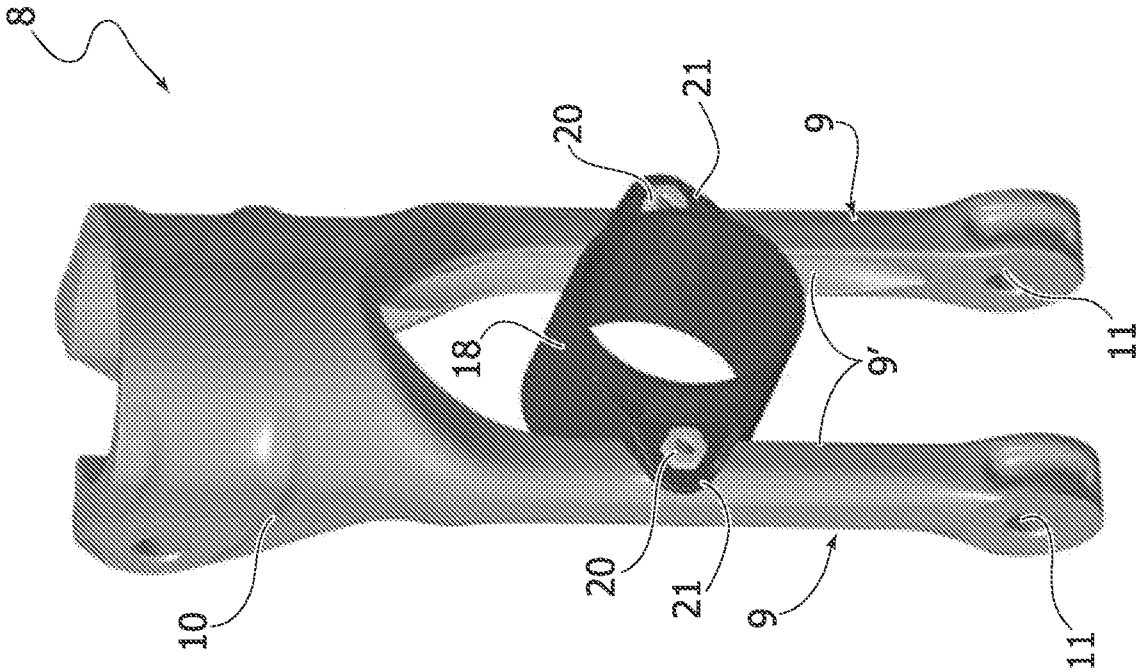
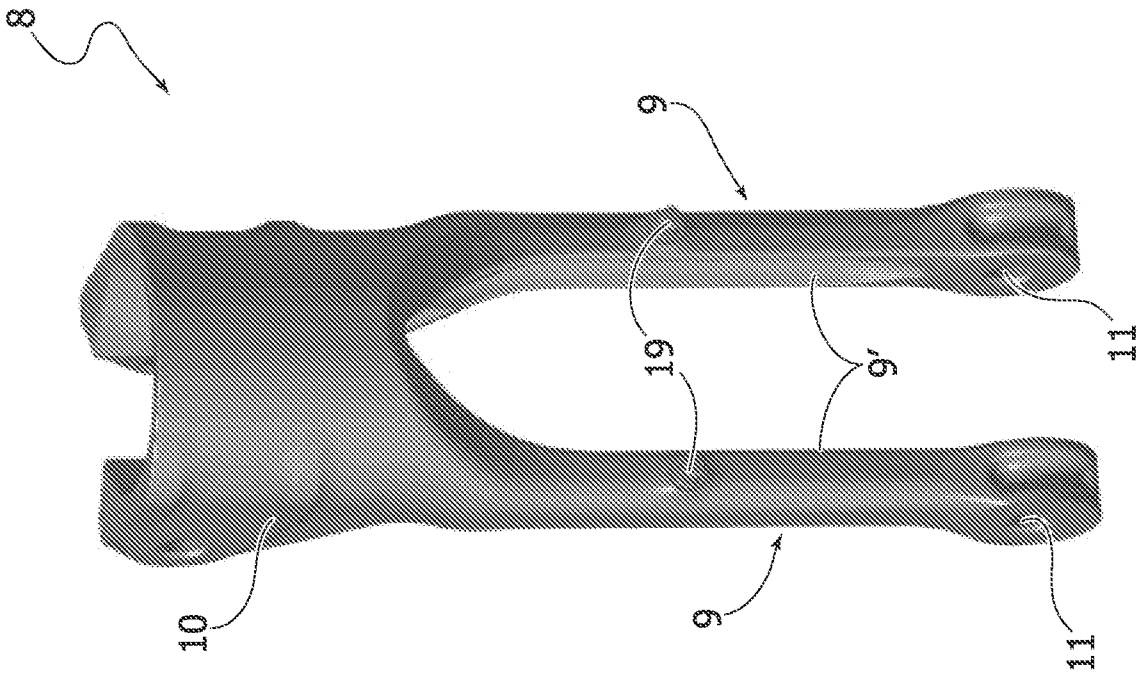


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2023/061266

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16D65/847 B60T5/00
ADD.

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)
F16D B60T

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 practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 9 623 848 B2 (HONDA MOTOR CO LTD [JP]) 18 April 2017 (2017-04-18) figures -----	1-6,11
Y	EP 1 688 343 A1 (YAMAHA MOTOR CO LTD [JP]) 9 August 2006 (2006-08-09) figures 1,5,7 -----	1-6,11
Y	DE 10 2005 044062 A1 (GM GLOBAL TECH OPERATIONS INC [US]) 31 May 2007 (2007-05-31) figures -----	1-6,11
	-/--	

[x] Further documents are listed in the continuation of Box C.

[x] See patent family 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 application or patent 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
8 January 2024	29/01/2024

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, Fax: (+31-70) 340-3016	Landriscina, V

1

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2023/061266

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Audrey Nugue: "POLY-SHAPE, leader de la fabrication additive", , 30 June 2017 (2017-06-30), XP055464866, Retrieved from the Internet: URL:http://www.poly-shape.com/parutions/juin/Romain_Dumas.pdf [retrieved on 2018-04-05] the whole document -----	1-6,11
A	US 8 678 426 B1 (BROWNE ALAN L [US] ET AL) 25 March 2014 (2014-03-25) figures -----	1-11

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2023/061266

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 9623848 B2	18-04-2017	NONE	
EP 1688343 A1	09-08-2006	AT E362869 T1	15-06-2007
		CN 1814495 A	09-08-2006
		DE 602006000005 T2	13-09-2007
		EP 1688343 A1	09-08-2006
		ES 2286808 T3	01-12-2007
		JP 2006213107 A	17-08-2006
		TW I290892 B	11-12-2007
		US 2006169513 A1	03-08-2006
DE 102005044062 A1	31-05-2007	NONE	
US 8678426 B1	25-03-2014	CN 103967983 A	06-08-2014
		DE 102013114997 A1	07-08-2014
		US 8678426 B1	25-03-2014