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Brake Device

Abstract

The invention relates to a brake device attachable on a rotating shaft, which includes a guiding support including at least one transmitting guide, a first casing, a first pusher element movable in the axial direction, a lining disc located between a first brake disc and a second brake disc. The first casing includes a drive system configured to, when activated, move the first pusher element, in the axial direction, towards the lining disc, pushing the first brake disc towards the first lining, wherein the drive system is configured to, when deactivated, retract the first pusher element, moving in an opposite direction to the direction of pushing on the first disc brake, in the axial direction.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application is the United States national phase of International Patent Application No. PCT/ES2022/070674 filed Oct. 20, 2022, and claims priority to Spanish Patent Application No. P202130980 filed Oct. 20, 2021, the disclosures of which are hereby incorporated by reference in their entireties.

BACKGROUND OF THE INVENTION
Field of the Invention
[0002] The invention consists of a brake device that has a system that optimizes the braking capacity of a rotating means such as a shaft, especially based on the retraction capacity of the brake discs. In other words, it is specially designed to reduce the “Time to lock” (TTL) or time needed to brake, by reducing the separation distance of the brake discs with respect to the linings to the minimum to allow the shaft to rotate without any residual friction.
[0003] The invention has application in different industrial fields, mainly in the automotive industry, and in all those industries where braking devices act even though they are not related to automobiles, such as turbines or motors used for the generation of electrical energy, but it is especially suitable for vehicles powered by an electric motor.
Description of Related Art
[0004] In the state of the art, many braking systems with different types of configurations are known, the automotive sector specifically being where greater research and development has been carried out in this field, generating different types of braking systems based on the needs of the vehicle.
[0005] The most well-known braking system in the automotive sector is the brake disc braking system, wherein once the brake pedal is actuated, a hydraulic, pneumatic or electrical system is activated that moves brake pads towards a disc that rotates jointly with the wheels of the vehicle, such that, by means of friction between the brake pads and the disc, the braking of the wheels and consequently of the vehicle takes place.
[0006] In this braking system, the brake disc, as already stated, continuously and rotates jointly with the wheels of the vehicle while the pads are in a fixed position with respect to the wheel. By moving the pads axially towards the brake disc, until they make contact with the disc, and by continuing to exert pressure on it, a friction is generated that causes the braking of the disc and therefore the braking of the wheels of the vehicle, consequently causing overheating between the parts in contact.
[0007] Due to the fact that the brake disc is constantly rotating, the only cooling that is obtained is due to the flow of air it receives from natural convection. Likewise, given the surface, material and configuration of the brake pads, it is extremely complex to have a cooling system therein which evacuates the heat generated.
[0008] In addition to overheating, in the known systems of the state of the art, pads wear unevenly, causing offsets and eccentricities in said pads that affect braking, so the useful life of both the pads and the brake discs is limited.
[0009] Document ES2705358 describes a brake device that defines an axial displacement of the brake discs, while a lining disc rotates jointly with the shaft, as it is mounted on same. With the embodiment described in said document, said brake discs can be cooled by means of a fluid that flows through internal cavities, improving the operation of the device by reducing the heating capacity.
[0010] Document ES2705358 also describes a braking device that is specially adapted to allow

internal cooling, by means of fluid, of the brake discs, which can only move axially, while a lining disc transmits the rotation of the shaft. This document focuses on the methods of axial displacement of the mobile elements of the device, such as brake discs and lining discs.

[0011] Document WO2021156529A1 discloses a brake device to be installed directly on a driving axle, wherein said device comprises a first brake disc joined to the axle sharing rotary motion, a first container disc and a second container disc configured to be moved in the axial direction of said axle.

[0012] Document FR2277705 discloses a double disc brake for a motor vehicle wherein the wheel to be braked is fixed on a flange hub using several wheel studs, wherein there is provided on each wheel stud an extension or end piece directed towards the inside, in that two discs are mounted on the stud ends, at least one of the discs being able to slide axially on said ends.

[0013] U.S. Pat. No. 5,307,730A discloses a piston return spring system with self-adjusting clearance feature for use in fluid operated friction torque transmission devices including relatively rotatable members carrying a plurality of torque plates one of the members providing a fluid chamber in which the piston means is reciprocable.

[0014] None of the documents mentioned, nor those found, mention or define a retraction system, which consists of a displacement of the brake discs with respect to the lining discs that is sufficient for said lining disc to be able rotate without friction of any kind, and therefore, allowing to reduce to a minimum the necessary distance to axially move said brake discs in the braking direction until achieving the necessary contact to brake.

[0015] In other words, none of the devices described in the documents includes any technical feature that allows there to be provided an approximation system, which positions the brake discs at a minimum distance from the lining disc, without residual friction between them, allowing the braking propagation speed to increase and the braking time to be as short as possible, throughout the entire brake pad wear stroke.

[0016] In the same way, the devices described in the aforementioned documents require compression springs located between the lining discs and the brake discs, to separate the contact areas of said discs, thus including an element susceptible to damage and/or corrosion, due to the continuous stress to which it is subjected.

SUMMARY OF THE INVENTION

[0017] The present invention relates to a brake device attachable (or that can be assembled) on a rotating shaft, that is, a torque transmitting shaft, in such a way that it can be assembled on the brake device directly or through intermediate elements such as a bushing.

[0018] This brake device is specially adapted to be installed in vehicles that have an electric drive motor or a hybrid drive system, since, in vehicles of this type, the energy efficiency of all the systems incorporated in its architecture becomes much more relevant in order to maximize the electrical energy offered by current batteries, so that they weigh less and offer greater vehicle autonomy.

[0019] On the other hand, electric and hybrid vehicles have energy recovery systems that are capable of generating braking torques of up to [0.2 g-0.3 g], cooperating with the mechanical brake system to reach 1 g of emergency deceleration braking, so that the mechanical system is actuated by EHB (Electronic Hydraulic Brake) or 100% electric systems. This brake device substantially improves braking, achieving less wear thanks to its optimization with this approximation system, as in its free rotation, without energy loss due to residual friction, also requiring less energy for its application as it is closer together, and all of this increases vehicle autonomy.

[0020] On the other hand, in current vehicles, one of their priorities is the constant improvement in active safety systems. Many of these electronic systems are associated with the braking system, such as ABS, ESP, “torque vectoring”, “Antiroll”, Traction Control (TC), etc., so that this brake device substantially improves the TTL obtaining more immediate responses on vehicle dynamics, which increases the active safety of the vehicle. Thanks to the design of this mechanical device, it is obtained weighing less and being much more robust when a large axial force is applied to generate high braking torques.

[0021] The device comprises: [0022] a guiding support rigidly attachable on the shaft, wherein said guiding support comprises at least one longitudinal transmitting guide, although it preferably comprises three guide shafts evenly distributed on the guiding support, and wherein said transmitting guide is oriented in the same axial direction of the shaft, located in an eccentric position with respect to the shaft, when the guiding support is assembled on the shaft; [0023] a first fixed support casing, that is, it does not move or rotate with respect to the shaft and allows the rigid fixing of the brake device to an external frame, such as a vehicle; [0024] a first pusher element movable in the axial direction with respect to the first casing; [0025] a lining disc comprising: [0026] a support disc coupled to the at least one transmitting guide of the guiding support in a floating manner; [0027] a first lining assembled on a first surface of the support disc; and [0028] a second lining assembled on a second surface of the support disc; [0029] a first brake disc movable in the axial direction with respect to the first casing; and [0030] a second brake disc; [0031] wherein the lining disc is located between the first brake disc and the second brake disc; [0032] wherein the guiding support is configured to transmit a rotation of the shaft to the lining disc, which is configured to rotate jointly with the shaft, as it is coupled by the at least one transmitting guide of the guiding support.

[0033] The fact that the support disc is coupled to the transmitting guide or guides in a floating manner means that, although said disc rotates with the shaft if it is mounted on or coupled to same, the support disc can move in the axial direction of the shaft even if the shaft does not move, since, for example, it can have a loose coupling.

[0034] The second brake disc can be mounted in the same way as the first brake disc, that is, it can move axially with respect to the shaft, but it can also remain motionless for the device to work, without requiring the loose coupling.

[0035] The first pusher element and the first brake disc are fixed, forming an axial displacement unit, that is, whenever they move, they do so together as a single element. For this purpose, the brake device may comprise compression springs located between the brake discs, so that, regardless of the displacement of the first pusher element, said first brake disc is always in contact with the first pusher element. In other embodiments, said elements can be fixed in another way, such as by means of mechanical elements such as pins, even forming a single casting.

[0036] The first casing comprises a drive system configured to, when activated, move the first pusher element, in the axial direction, towards the brake disc, pushing the first brake disc towards the first brake lining of said brake disc, generating a first friction, in such a way that in said displacement, the first brake disc is configured to exert a pushing pressure on the first lining of the lining disc, in the axial direction, and to move it towards the second brake disc, when it is pushed by the first pusher element.

[0037] In this way, the second brake disc can remain immobile, acting as a stop for the axial displacement of the first pusher element, thus allowing the lining disc to contact each brake disc on both sides, compressing the linings, generating a braking torque, which is transmitted from the brake discs to the shaft. In this way, the second brake disc does not need to move axially to brake the lining disc and can be rigidly attached to the first casing, although it is also preferably fixed in a floating manner.

[0038] In the same way that the drive system, when activated, can move the brake disc in the pushing direction, towards the second brake disc, it is also configured to, when deactivated, retract the first pusher element, moving said first pusher element, in an opposite direction to the direction of pushing on the first brake disc, in the axial direction.

[0039] In this way, the first brake disc is also configured to move in an opposite direction to the direction of pushing on the lining disc, in the axial direction, jointly with the retraction, in said opposite direction, of the first pusher element.

[0040] The retraction consists of a minimum displacement of the first pusher element in the opposite direction to the pushing displacement, so that said displacement is also carried out by the first brake disc, by forming an axial displacement unit. With this small displacement, a small axial clearance space is generated between the two brake discs, where the lining disc is located.
[0041] The floating coupling of the lining disc on the transmitting guide together with the rotation of said lining disc, as it is coupled to the rotating shaft, are configured to place said lining disc between the two brake discs, within the axial clearance generated, being self-positioned, when the first brake disc moves in the opposite direction. In other words, it does not require springs between the support disc and the brake discs for them to separate, with the attachment of the lining disc to the transmitting guide being sufficient.
[0042] In this way, the retraction only moves the first brake disc enough so that the lining disc can rotate without any type of residual friction with the brake discs. Therefore, the block time for a new braking is reduced to a minimum, since the travel of the first brake disc in a new braking would also be minimal.
[0043] In the same way, this configuration also allows to always adjust the separation distance of the brake discs to the lining disc when the linings are worn. In other words, regardless of the wear of the linings, with this configuration, the brake discs are always located at a minimum distance from the linings, and this distance is determined according to the elements that make up the drive system, solving the problems present in the devices described in the background.
[0044] In other words, thanks to the free rotation of the lining disc (without being subjected to axial force by the brake discs through springs) and its floating position with respect to the guiding support, the lining disc produces a very small lateral eccentricity, sufficient to move apart, and be moved apart, on each side of the brake discs until inertia self-positions it in the center. It is clear that the minuscule space generated by retraction of the pusher is sufficient for the “self-fitting” to occur and to free the lining from any friction and to free the rotating shaft from any residual brake.
[0045] In one embodiment, the brake device comprises: [0046] a second fixed support casing, arranged at an opposite end part of the first support casing; [0047] a second pusher element movable in the axial direction with respect to the second support casing; [0048] wherein the second pusher element and the second brake disc are fixed, forming an axial displacement unit and wherein the second casing comprises a drive system configured to, when activated, move the second pusher element, in the axial direction, towards the lining disc, pushing the second brake disc towards the second lining of said lining disc.
[0049] In other words, the operation of the device having a second casing would be the same as with the first casing, only that in this case, the second brake disc can move in the axial direction, towards the lining disc. In this way, faster braking could be produced by moving both brake discs towards the linings at the same time.
[0050] In this embodiment, the second brake disc is configured to exert a pushing pressure on the second lining in the axial direction, and to move said brake disc towards the first brake disc, when it is pushed by the second pusher element.
[0051] In the same way as with the first pusher element, the drive system of the second casing is configured to, when deactivated, retract the second pusher element, said second pusher element moving in a direction opposite to the direction of pushing on the second disc brake, in the axial direction.
[0052] For this reason, the second brake disc is configured to move in a direction opposite to the direction of pushing on the lining disc, in the axial direction, jointly with the retraction of the second pusher element, and the lining disc is configured to be self-positioned between the two brake discs, that is, to be separated from both, without generating residual friction, when the first and second pusher elements are retracted.
[0053] These embodiments, both with a first or with a first and a second casing, allow there to be two or more brake discs as well as one or more lining discs, intercalated between said brake discs,

and not being limited to having two brake discs and only one lining disc.
[0054] In one embodiment, the support disc of the lining disc comprises: [0055] an outer perimeter area on the first and second surfaces of the support disc in which the linings are fixed; and [0056] at least one sliding connection housing, which comprises the axial direction; [0057] wherein said sliding connection housing is preferably located in a perimeter part of a central through hole of the support disc, and is coupled to the at least one longitudinal transmitting guide in a loosely adjusted attachment.
[0058] In one embodiment, the brake device comprises an elastic damping gasket located between each fitted coupling of each transmitting guide and the sliding connection housing of the lining disc. Said gasket allows the coupling between said parts to be more damped, avoiding vibrations and resonances that can damage the components of the device, canceling, in the same way, vibrations that can produce frequencies in the human hearing spectrum. Preferably, said gasket is made of fluoropolymer rubber, which has a high chemical resistance, is highly resistant to abrasion and corrosion, and is able to withstand a continuous temperature of 200°-280°, with peaks of 340°, making it suitable for the described use.
[0059] In one embodiment, the lining disc comprises a plurality of fins, which allow the heat accumulated in the disc to be dissipated, arranged on a perimeter of a central through hole of the support disc, wherein: [0060] said plurality of fins are rigidly attached to the support disc by means of a rigid connection means; or [0061] wherein said plurality of fins and the support disc comprise a single casting.
[0062] In other words, they can be made in one piece or in several attached together by mechanical means such as welding or screws.
[0063] When the lining disc rotates, due to its coupling to the rotating shaft, these fins rotate with the same angular velocity. In their rotation, the fins generate a drive of fluid, creating a current from the inside to the outside. Depending on the angle of inclination and surface of these fins, higher speed and fluid flow rate may be provided at the same rpm.
[0064] In one embodiment, the lining disc comprises a plurality of first linings and second linings, fixed, respectively, in an outer area of the first and second surfaces of the support disc, said linings being separated by radial channeled gaps; wherein the linings comprise a blade shape.
[0065] These channeled gaps favor the expulsion of particles out of the support disc, wherein a filter can be placed that allows them to be retained to prevent them from affecting the operation of the device, as well as to reduce environmental pollution.
[0066] In one embodiment, the brake device comprises a particle filtering structure arranged concentrically covering the lining disc, configured to retain particles detached from the linings. In one embodiment, this structure is arranged between the first and second brake discs.
[0067] In another embodiment, the filtering structure is a cylindrical-shaped framework, arranged covering the first and second brake discs, that is, the area where friction is generated and particles are released from the linings to the outside. This framework can be fixed to the casing, as well as to any element that is not subject to displacement with respect to the shaft.
[0068] In one embodiment, at least one brake disc comprises an annulus shape, with a central disc through hole, concentric to the shaft, comprising the axial direction, and a solid outer friction section against linings. In other words, the area in which the friction of said brake disc is generated is solid so that it has a greater capacity to resist the stresses to which it is subjected.
[0069] In one embodiment, at least one brake disc comprises an annulus shape, with a central disc through hole, concentric to the shaft, that is, comprising the axial direction, and an outer friction section against linings comprising at least one internal channel configured for the passage of a fluid. Preferably, said brake disc comprises a plurality of radially open internal channels through which a fluid, such as air, can pass in order to cool the brake disc, which is susceptible to heating up.
[0070] In one embodiment, at least one brake disc comprises a plurality of heat dissipation brake

fins, wherein preferably, said brake fins are located on an outer perimeter of said brake disc, arranged in a radial direction.
[0071] In the same way as with the brake discs, these heat dissipation fins can be part of the same casting body or of two or more rigidly attached independent bodies. In this way, if they are two bodies manufactured independently, the advantage is that the fins can be made of a material that has a better thermal conductivity so that it improves temperature dispersion (for example aluminum).
[0072] In one embodiment, the brake device comprises a bearing, preferably a roller bearing, which can be assembled on the shaft. This bearing allows the brake discs or the casing, which do not rotate on the shaft, to be supported, transmitting the transverse stresses of said components to the shaft.
[0073] In one embodiment, the brake device comprises at least one compression spring located between the brake discs, configured to exert a separation pressure between said brake discs. Said spring allows said brake discs to always be kept separated by a distance determined by the pusher element of the drive system.
[0074] In one embodiment, the brake device comprises at least one guide element, fixed to the first housing, oriented in the axial direction of the shaft; wherein the first brake disc comprises a through hole loosely fitted to said guide element; wherein the second brake disc comprises a through hole fitted to the guide element, which can also be loosely fitted, especially if the brake device comprises a second casing and a second pusher element.
[0075] In one embodiment, the brake device comprises an elastic damping gasket located between each fitting of each guide element and each through hole of the brake discs. This elastic gasket can be the same as the one located between the sliding connection housing of the lining disc and the transmitting guide.
[0076] In one embodiment, the brake device comprises a plurality of guide elements each comprising a guide screw inserted into a through hole, of the same plurality of through holes, of each of the brake discs, wherein said guide screws are configured to guide the displacement of the first brake disc in the axial direction of the shaft. Said guide screws are preferably inserted into the through holes located in lugs of each of the brake discs.
[0077] In one embodiment, the brake device comprises a plurality of compression springs, each one mounted concentrically on each guide screw, said compression springs being located between the first and second brake discs, said compression springs being configured to exert a separation pressure between said brake discs.
[0078] The guide screws allow the distance between the first casing and the second brake disc, or between the two casings, to be limited, depending on the embodiment, as they can be threaded onto nuts that fix the components of the brake device.
[0079] In one embodiment, the pusher element of the axial drive system comprises: [0080] a piston configured to generate a pushing load on a lateral surface of the first brake disc, said surface being opposite to the surface that generates friction with the first lining;
wherein said piston is configured to be housed and moved longitudinally, that is, in the axial direction, in a cavity of the first casing in one pushing direction and in a retraction direction, opposite to the pushing direction.
[0081] In one embodiment, the axial drive system of the first pusher element comprises: [0082] at least one fluid access, such as for a liquid or a gas, located in the casing, said access being configured to introduce and extract fluid in the cavity of said casing; wherein the introduction and extraction of said fluid is configured to move the piston in the axial direction; [0083] a high pressure gasket located in the cavity of the first casing, configured to exert transverse pressure on a lateral surface of the piston; [0084] also being able to comprise an O-ring, parallel to the high pressure gasket, also located in the cavity of the casing, to avoid pressure losses;
wherein said high pressure gasket is configured to retract the piston into the cavity of the first

casing when the axial drive system is deactivated.

[0085] The high pressure gasket is configured so that it deforms upon transverse contact with the surface of the piston when the piston moves in the pushing direction, undergoing an elastic deformation that allows storage of deformation energy, which performs the retraction displacement when the actuation system is deactivated. In other words, retraction depends directly on the properties and shape of the high pressure gasket, as well as on its deformation.

[0086] Preferably, the high pressure gasket is made of ethylene propylene diene rubber or EPDM, which consists of an elastomeric thermopolymer with high abrasion and wear resistance.

[0087] Preferably, the high pressure gasket is formed by two concentric gaskets facing each other in the cavity of the casing, each of which gaskets even more preferably has a U-shaped section.

[0088] With the gaskets (high pressure gasket and O-ring) the tightness of the chamber that is generated between the casing and the piston is guaranteed.

[0089] In this embodiment, the brake device may comprise a thermal insulation part located between the piston and the first brake disc, or installed in the part of the brake disc wherein it is in contact with the piston. In this way, in the event of an increase in temperature in the first brake disc, said insulating part allows thermal insulation of the piston, which is in contact with the fluid in the casing chamber, thus avoiding possible problems of said fluid boiling, which could cause a failure at the time of braking, known as the “Fading Effect”.

[0090] In one embodiment, the piston comprises a cylindrical ring shape and the compression springs comprise a conical shape; or the piston comprises a conical ring shape and the compression springs comprise a cylindrical shape.

[0091] In order to achieve an adequate force balancing system so that throughout the entire stroke the brake system is at the maximum approximation between the friction elements, two equivalent solutions are estimated. The first solution is the combination of a cylindrical ring-shaped piston together with conical-shaped compression springs. These elements have a constant resistance force throughout the entire axial displacement stroke, so a balanced system is achieved. The second solution is the combination of a conical piston and some springs that comprise a cylindrical shape, these two elements having a linearly increasing resistance force along the length their stroke, so the system is balanced by equalizing the slope of the resistance force of each element. Both solutions guarantee permanent contact throughout the entire stroke of the pusher element and the first brake disc.

[0092] In one embodiment, the axial drive system comprises: [0093] an electric motor fixed to the casing, configured to rotate a toothed pinion comprised in the pusher element, connected to a shaft of said motor; [0094] wherein the piston comprises a ring shape comprising a thread on an outer cylindrical surface and a toothing on an inner cylindrical surface, meshed with the pinion; wherein the casing comprises an internal thread in the cavity, said internal thread being threaded with the thread of the piston; wherein the electric motor is configured to rotate the pinion, transmitting the rotation to the piston which, upon rotation, is configured to be screwed into or unscrewed from the casing, moving axially, moving the brake disc.

[0095] Depending on the torque applied by the electric motor, there will be a higher or lower axial force, increasing or decreasing the resulting braking torque.

[0096] This configuration allows precise adjustment of the retraction based on the distance traveled by the first pusher element, turning the motor in the direction opposite to the pushing displacement, only as much as is needed to leave enough clearance between the two brake discs so that the linings on the lining disc do not rub against any of them.

[0097] Similarly, this configuration also allows for a built-in auxiliary (hand) brake. This is because by rotating the piston with a desired torque, an axial force can be generated which, thanks to the resistance force of the thread of the piston with the cavity of the casing, it allows the mechanical load torque to be maintained constant, even though it does not have torque from the electric motor.

[0098] In one embodiment dependent on this previous embodiment, the brake device may

comprise: [0099] an outer cover rigidly fixed to an outside of the casing, configured to seal the outside part of the casing; [0100] an inner cap rigidly fixed to an inside of the casing, configured to seal the inside part of the piston; and [0101] an elastic dust cover that prevents the entry of particles into the geared system of the piston with respect to the pinion.
[0102] In one embodiment, the axial drive system of the pusher element comprises: [0103] two electric motors fixed to the casing; [0104] wherein the pusher element comprises two pressing members, each of which is connected by a threaded attachment to a shaft of the electric motor, said pressing members being configured to push the brake disc, in the pushing direction, in the axial direction, directly or through a piston located between both; [0105] wherein upon actuation of the electric motors, the threaded attachment of the pressing members transforms the rotation of the motor into an axial displacement of the pressing members, moving them in said axial direction.
[0106] In the same way as with the embodiment with one motor, with this embodiment with two motors it is possible to adjust the retraction to the minimum and sufficient distance so that the lining disc can rotate without residual friction.
[0107] In one embodiment, the brake device comprises a turbofan skeleton comprising a hollow cylindrical shape and a plurality of blades, separated by cavities, said blades arranged on a lateral surface of the turbofan, wherein said turbofan is arranged concentrically surrounding the brake discs and the lining disc, it is connected to the rotating shaft, and it is configured to rotate about itself, with respect to the first housing, generating forced ventilation in the brake device.
[0108] This turbofan skeleton could also be suitable for use in other brake devices that do not have to comprise all the essential features of the device described above, since it can provide ventilation that cools the components that are likely to heat up due to friction.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0109] The terms Fig., Figs., Figure, and Figures are used interchangeably in the specification to refer to the corresponding figures in the drawings.
[0110] To complete the description, and for the purpose of helping to make the features of the invention more readily understandable, this specification is accompanied by a set of drawings constituting an integral part of the same, which by way of illustration and not limitation represent the following:
[0111] FIG. **1**A shows a perspective view of a brake disc, which can be the first or the second brake disc since both can be the same, comprising an annulus shape, with a central disc through hole comprising the axial direction and a solid outer friction section.
[0112] FIG. **1**B shows a perspective view of a brake disc comprising an annulus shape, with a central disc through hole comprising the axial direction and an outer friction section comprising a plurality of radially open internal channels configured for the passage of a fluid inside the brake disc in order to cool same.
[0113] FIG. **1**C shows a perspective view of a brake disc like the one shown in FIG. **1**A, comprising a plurality of heat dissipation brake fins located on an outer perimeter of said brake disc, arranged in a radial direction.
[0114] FIG. **1**D shows a perspective view of a brake disc like the one shown in FIG. **1**B, with a plurality of fins like those of the disc shown in FIG. **1**C.
[0115] FIG. **2** shows a perspective view of a brake disc, which has four linings on each side of the support disc, together with a brake disc that is connected to four guide screws that are each assembled on a compression spring.
[0116] FIGS. **3**A and **3**B show two opposite perspective views of a brake device comprising a filtering structure arranged concentrically covering the lining disc, wherein the axial drive system

comprises a fluid access in the casing.

[0117] FIG. **4** shows an exploded perspective of a brake device shown in FIGS. **3**A-**3**B, wherein the components of said device except for the piston and the high pressure gasket, which are located in the cavity of the casing, can be seen.

[0118] FIGS. **5**A and **5**B show two opposite perspective views of a brake device comprising a filtering structure consisting of a cylindrical-shaped framework, arranged covering the first and second brake discs, wherein the axial drive system comprises two electric motors fixed to the first casing, each connected to a pressing member.

[0119] FIG. **6** shows an exploded perspective view of a brake device shown in FIGS. **5**A-**5**B, wherein the components of said device can be seen.

[0120] FIGS. **7**A and **7**B show two opposite perspective views of a brake device comprising a filtering structure covering the lining disc and a turbofan comprising a hollow cylindrical shape and covering the brake and lining discs, wherein the axial drive system comprises an electric motor fixed to the first casing.

[0121] FIG. **8** shows an exploded perspective view of a brake device shown in FIGS. **7**A-**7**B, wherein the components of said device, such as the piston and casing, can be seen threaded together.

[0122] FIG. **9** shows an interrupted view of a casing with a fluid drive system, and the access for a fluid as well as the high pressure gasket surrounding the piston can be seen.

[0123] FIGS. **10**A-**10**C show a schematic view of the displacement of a piston in the cavity of a casing by means of a drive system comprising an access for a fluid.

[0124] A list of the numerical references used in the depicted figures is provided below: [0125] (**1**) Guiding support [0126] (**2**) Transmitting guide [0127] (**3**) First casing [0128] (**4**)O-ring [0129] (**13**, **17**, **18**) First pusher element [0130] (**5**) Lining disc [0131] (**51**) Support disc [0132] (**52**) First lining [0133] (**53**) Second lining [0134] (**54**) Sliding connection housing [0135] (**55**) Lining fins [0136] (**56**) Channeled gaps [0137] (**6**) First brake disc [0138] (**61**) First brake disc outer friction section [0139] (**62**) First brake disc internal channel [0140] (**63**) First brake disc brake fins [0141] (**64**) First brake disc through hole [0142] (**7**) Second brake disc [0143] (**71**) Second brake disc outer friction section [0144] (**72**) Second brake disc internal channel [0145] (**73**) Second brake disc brake fins [0146] (**74**) Second brake disc through hole [0147] (**8**) Elastic damping gasket [0148] (**9**) Filtering structure [0149] (**10**) Bearing [0150] (**11**) Compression spring [0151] (**12**) Guide element [0152] (**13**) Piston [0153] (**14**) Fluid Access [0154] (**15**) High pressure gasket [0155] (**16**) Electric motor [0156] (**17**) Pinion [0157] (**18**) Pressing members [0158] (**19**) Turbofan skeleton [0159] (**191**) Turbofan blades [0160] (**20**) Bushing

DESCRIPTION OF THE INVENTION

[0161] As can be seen in the figures, especially in FIGS. **3**, **5** and **7**, as well as in exploded views in FIGS. **4**, **6** and **8**, the invention consists of a brake device in which the element that rotates jointly with the shaft to brake (as it is configured to be coupled to same) is the lining disc (**5**), while the first brake disc (**6**) and the second brake disc (**7**), which are located on both sides of the lining disc (**5**), do not comprise rotation jointly with the shaft, as is common in most of the existing braking systems on the market, but instead have a floating connection with respect to the shaft, which allows axial displacement thereof.

[0162] FIGS. **1**A-**1**D show a perspective view of different embodiments that the first brake disc (**6**) and the second brake disc (**7**) may have, in such a way that all the figures show an annulus-shaped brake disc (**6**, **7**), comprising an outer friction zone or section (**61**, **71**) that can be solid, as shown in FIGS. **1**A and **1**C, or comprise a plurality of internal channels (**62**, **72**) that are open and arranged radially, as shown in FIGS. **1**B and **1**D. In the same way, FIGS. **1**C and **1**D show that the brake discs (**6**, **7**) can comprise a plurality of fins, called brake fins (**63**, **73**) as they are located on the brake disc (**6**, **7**), and these fins can be part of the same casting as the rest of the disc or can be fixed by mechanical means such as screws, pins, or welding. These brake discs (**6**, **7**) also have four fixing lugs, evenly distributed on the outer perimeter, each comprising a first brake disc through hole (**64**) and second brake disc through hole (**74**), said hole having an axial direction.

[0163] In FIG. **2**, it can be seen what the connection of a first brake disc (**6**) with a lining disc (**5**) would be. Said lining disc (**5**) is located between the two brake discs (**6**, **7**), and like these, it comprises a circular through hole in the center, which allows placement of the shaft or bushing (**20**) to which it can be connected.

[0164] The lining disc (**5**) shown in FIG. **2** comprises a support disc (**51**) comprising an outer area, wherein, on the first and second surfaces of said support disc (**51**), four first linings (**52**) and four second linings (**53**) are fixed rigidly and respectively, being evenly distributed, so that the first four linings (**52**) are in contact with the first brake disc (**6**).

[0165] In a central part of the support disc (**51**), the lining disc (**5**) comprises three evenly distributed pass-through sliding connection housings (**54**), wherein said three connection housings (**54**) comprise an axial direction and being configured to be assembled tightly or loosely, respectively, with three transmitting guides (**2**) of the guiding support (**1**). To ensure that said fitting is suitable and to avoid unwanted vibrations or frequencies in the operation of the brake device, an elastic damping gasket (**8**) is located between each fitting of said sliding connection housings (**54**) with the transmitting guides (**2**). In this way, the rotation of a shaft connected to the guiding support (**1**) is shared by the lining disc (**5**), but said lining disc (**5**) can move in the axial direction of the shaft, regardless of the displacement of said shaft.

[0166] Since the support disc (**51**) can heat up due to the friction of the linings (**52**, **53**) with the brake discs (**6**, **7**), the lining disc (**5**) comprises a plurality of heat dissipation lining fins (**55**) located on the perimeter of the center circular through hole. These lining fins (**55**) act by not only dissipating the accumulated heat, since, when the lining disc (**5**) rotates, when coupled to the shaft, they generate a forced current that can ventilate the entire brake device.

[0167] As can be seen in FIG. **2**, between each lining of the first linings (**52**) or second linings (**53**) there is a channeled gap (**56**), which can be larger or smaller, depending on the size and number of linings included in the disc. Said channeled gaps (**56**) are specially designed to direct the particles generated in the wear of the linings (**52**, **53**), due to friction with the brake discs (**6**, **7**), radially outwards, wherein a filtering structure (**9**) can be located concentric to the lining disc (**5**), between the first brake disc (**6**) and the second brake disc (**7**), as shown in FIGS. **4** and **8**, or covering both brake discs (**6**, **7**), as shown in FIGS. **5**A and **5**B.

[0168] In addition to the mentioned elements, the operation of the brake device also requires a first casing (**3**) that can be rigidly connected to a frame, since it does not move with respect to the shaft, with said first casing (**3**) located next to the first disc (**6**), on the opposite side on which the lining disc (**5**) is located, which, like the brake discs (**6**, **7**) can be supported on a bearing (**10**) that can be connected to the shaft in order to be able to transmit the transverse loads; and a first pusher element (**13**, **17**, **18**) movable in the axial direction with respect to the first casing (**3**) by means of a drive system located between the first casing (**3**) and the first brake disc (**6**).

[0169] This drive system of the device is configured to axially move, in a pushing direction towards the first linings (**52**), the first pusher element (**13**, **17**, **18**) which is always in contact with the first brake disc (**6**), moving it in said direction, contacting the first lining (**52**) of the lining disc (**5**). This pushing (**5**) also generates an axial displacement in said lining disc (**5**), as it is connected to the transmitting guides (**2**) in a floating manner, in the same direction, until the second linings (**53**) contact the second brake disc (**7**), so that the generated tightening of the linings (**52**, **53**) with the brake discs (**6**, **7**) causes friction that leads to the braking of the shaft.

[0170] The brake discs (**6**, **7**) are coupled through the through holes (**64**, **74**) on guide elements (**12**), also arranged in the axial direction, to be able to move axially with respect to the shaft and the first casing (**3**) in a floating manner.

[0171] These guide elements (**12**) each comprise a guide screw threaded to a nut, and in addition to fixing the axial travel of the brake discs (**6**, **7**), they also allow the length of their displacement to

be delimited from the head of said screw to the nut to which it is threaded.
[0172] As can be seen in FIGS. **4** and **8**, the couplings of each guide element (**12**) with the through holes (**64**, **74**) comprise an elastic damping gasket (**8**) that facilitates sliding, dampen the possible vibrations generated, and also prevent possible thermal expansion from being able to affect the operation of the device.
[0173] In order for the brake discs (**6**, **7**) to be sufficiently separated so as not to contact the linings (**52**, **53**) except when they are pushed by the first pusher element (**13**, **17**, **18**), the brake device comprises compression springs located on the guide elements (**12**), which generate a controlled compression stress aimed at separating said discs (**6**, **7**) as much as possibly allowed by the screws, nuts and pusher element.
[0174] One of the main novelties of the claimed brake device is that the drive system is configured so that the displacement in the direction opposite to the pushing displacement by the first pusher element (**13**, **17**, **18**), when it is desired to stop exerting the brake, is the minimum necessary and sufficient to allow the rotation of the lining disc (**5**), jointly with the shaft, without residual friction with the brake discs (**6**, **7**). In this way, the distance that the brake discs (**6**, **7**) must travel again towards the brake linings (**52**, **53**) to carry out a new braking is reduced to a minimum. In other words, the braking time known as "Time to lock" (TTL) is reduced since the displacement in the direction opposite to the pushing displacement consists of a retraction of the first pusher element (**13**, **17**, **18**).
[0175] This configuration allows the braking time to be shorter, so that even when the linings (**52**, **53**) are worn, the distance to be traveled by the brake discs (**6**, **7**) is always the minimum, and this is due to the fact that the brake discs (**6**, **7**) as well as lining disc (**5**) are mounted in a floating manner.
[0176] The retraction of the first pusher element (**13**, **17**, **18**) generated by the drive system can be due to three embodiments shown in exploded views in FIGS. **4**, **6** and **8**.
[0177] In the embodiment of FIG. **4**, also shown in FIGS. **3**A-**3**B, the first casing (**3**) comprises a cylindrical ring-shaped cavity in which a piston (**13**) is located. When a fluid, liquid or gas, is introduced into said cavity, axial displacement of said piston (**13**) (not visible in FIG. **4**) takes place, which moves the first brake disc (**6**) towards the lining disc (**5**), generating a first friction. Said displacement continues until moving the lining disc (**5**) against the second brake disc (**7**), wherein a tightening between the two linings (**52**, **53**) with the two brake discs (**6**, **7**) is generated.
[0178] When it is desired to stop braking, the fluid is no longer introduced into the cavity of the first casing (**3**), and it is a high pressure gasket (**15**) that moves the retraction into said cavity.
[0179] This high pressure gasket (**15**) is shown in FIG. **9** and preferably consists of two gaskets or rubbers made of ethylene propylene diene or EPDM, with a U-shaped section, fixed to each side of the internal cavity, arranged concentrically to the piston.
[0180] As can be seen in schematic FIGS. **10**A-**10**C, when said gasket (**15**) deforms elastically in the axial displacement, in the pushing direction, a deformation energy is stored that causes the piston (**13**) to be retracted when it no longer exerts the pushing force. In this way, the displacement of the retraction will always be the same; it will always be the minimum necessary so that the lining disc (**5**) can rotate without friction with the brake discs (**6**, **7**), which is especially suitable for preventing energy from being drawn off when braking is not desired. In the same way, wear of the linings (**52**, **53**) is prevented from causing a longer braking time due to the longer stroke to be traveled by the pusher.
[0181] In the embodiments shown in FIGS. **5**-**8**, the displacement of the first pusher element (**13**, **17**, **18**) in the axial direction is no longer hydraulic or pneumatic, but electrical.
[0182] In this way, in the embodiment shown in FIGS. **5**A-**5**B and **6**, the drive system comprises two electric motors (**16**) fixed to the first casing (**3**), each of which is connected by a thread configured to convert rotation into longitudinal displacement with an axially movable pusher (**18**), which can directly press the first brake disc (**6**) or a piston (**13**) located between them.

[0183] In this way, these two electric motors (**16**) allow the first brake disc (**6**) to be moved in an aligned manner, as they are diametrically opposite one another, towards the lining disc (**5**) in the same way as with the fluid. To perform the retraction, it is enough for the electric motors (**16**) to move a minimum rotation in the direction opposite to the pushing direction to generate sufficient clearance between the brake discs (**6**, **7**) and the lining disc (**5**) to that the latter can rotate without residual friction.
[0184] In the embodiment shown in FIGS. **7**A-**7**B and **8**, the brake device comprises only one electric motor (**16**) that overcomes the possible misalignments or eccentricities of the first brake disc (**6**), in its axial displacement, with a geared system.
[0185] In this way, said embodiment comprises a pinion (**17**) connected to a shaft of the electric motor (**16**), meshed with an inner toothing of the piston (**13**), which comprises a thread on an outer surface, threaded with a thread of the internal cavity of the first casing (**3**). The operation of this embodiment consists of the fact that the electric motor (**16**) rotates the pinion (**17**), which in turn transmits the rotational movement to the piston (**13**), transforming said rotation into an axial displacement.
[0186] Therefore, the electric motor (**16**) can axially move the piston (**13**) in any of the axial directions, either to perform the pushing that generates the braking or to carry out the retraction.
[0187] This embodiment also shows a turbofan skeleton (**19**) that can be connected to the shaft through the bushing (**20**), which can rotate about itself, generating an current outside the brake discs (**6**, **7**) and the lining disc (**5**) due to a plurality of blades (**191**) located on a cylindrical surface of said turbofan (**19**), which allows device components that are likely to overheat to be cooled, taking advantage of the rotation of the shaft.

Claims

1. A brake device that attachable on a rotating shaft, wherein the brake device comprises: a guiding support, rigidly attachable on the shaft, comprising at least one longitudinal transmitting guide oriented in the same axial direction of the shaft, located in an eccentric position with respect to the shaft, when the guiding support is assembled on the shaft; a first fixed support casing; a first pusher element movable in the axial direction with respect to the first casing; a lining disc comprising: a support disc coupled to the at least one transmitting guide of the guiding support in a floating manner; a first lining fixed to a first surface of the support disc; and a second lining fixed to a second surface of the support disc; a first brake disc movable in the axial direction with respect to the first casing; and a second brake disc; wherein the lining disc is located between the first brake disc and the second brake disc; wherein the guiding support is configured to transmit a rotation of the shaft to the lining disc, which is configured to rotate jointly with the shaft; wherein the first pusher element and the first brake disc are connected, forming an axial displacement unit; wherein the first casing comprises a drive system configured to, when activated, move the first pusher element, in the axial direction, towards the lining disc, pushing the first disc brake towards the first lining of said lining disc; wherein the first brake disc is configured to exert a pushing pressure on the first lining in the axial direction, generating friction, and to move said lining disc towards the second brake disc, when it is pushed by the first pusher element; wherein the drive system is configured to, when deactivated, retract the first pusher element, moving in an opposite direction to the direction of pushing on the first brake disc, in the axial direction; wherein the first brake disc is configured to move in the opposite direction to the direction of pushing on the lining disc, in the axial direction, jointly with the retraction of the first pusher element; and wherein the floating coupling of the lining disc on the transmitting guide together with the rotation of said lining disc are configured to separate it from the two brake discs when the first brake disc moves in the opposite direction.
2. The brake device according to claim 1, comprising: a second fixed support casing, arranged at an

opposite end part of the first casing; a second pusher element movable in the axial direction with respect to the second casing; wherein the second pusher element and the second brake disc are fixed, forming an axial displacement unit; wherein the second casing comprises a drive system configured to, when activated, move the second pusher element, in the axial direction, towards the lining disc, pushing the second brake disc towards the second lining of said lining disc; wherein the second brake disc is configured to exert a pushing pressure on the second lining in the axial direction, and to move said lining disc towards the first brake disc, when it is pushed by the second pusher element; wherein the drive system of the second casing is configured to, when deactivated, retract the second pusher element, moving in an opposite direction to the direction of pushing on the second brake disc; wherein the second brake disc is configured to move in the opposite direction to the direction of pushing on the lining disc, in the axial direction, jointly with the retraction, in said opposite direction, of the second pusher element; wherein the floating coupling of the lining disc on the transmitting guide; together with the rotation of said lining disc on the shaft are configured to separate said lining disc from the two brake discs, without generating residual friction, when the first and second pusher element are retracted, moving the brake discs in the opposite direction to the pushing direction.

3. The brake device according to claim 1, wherein the support disc of the lining disc comprises: an outer perimeter area on the first and second surfaces of the support disc in which the linings are fixed; and at least one pass-through sliding connection housing, which comprises the axial direction; wherein said sliding connection housing is coupled to the at least one longitudinal transmitting guide in a loosely fitted attachment.

4. The brake device according to claim 3, comprising an elastic damping gasket; located between each fitted coupling of each transmitting guide and the sliding connection housing of the lining disc.

5. The brake device according to claim 1, wherein the lining disc comprises a plurality of heat dissipation lining fins arranged on a perimeter of a central through hole of the support disc, wherein: said plurality of lining fins are rigidly attached to the support disc by means of a rigid connection means; or wherein said plurality of lining fins and the support disc comprise a single casting.

6. The brake device according to claim 1, wherein the linings disc comprises a plurality of first linings and second linings, fixed, respectively, in an outer area of the first and second surfaces of the support disc, said linings being separated by radial channeled gaps; wherein the linings comprise a blade shape.

7. The brake device according to claim 1, comprising a particle filtering structure arranged concentrically covering the lining disc, configured to retain particles detached from the linings.

8. The brake device according to claim 7, wherein the filtering structure is a cylindrical-shaped framework, arranged covering the first and second brake discs.

9. The brake device according to claim 1, wherein at least one brake disc comprises an annulus shape, with a central disc through hole, concentric to the shaft, comprising the axial direction and a solid outer friction section against linings.

10. The brake device according to claim 1, wherein at least one brake disc comprises an annulus shape, with a central disc through hole, concentric to the shaft, comprising the axial direction and an outer friction section against the linings, comprising at least one internal channel configured for the passage of a fluid.

11. The brake device according to claim 1, wherein at least one brake disc comprises a plurality of heat dissipation brake fins, wherein preferably, said brake fins are located on an outer perimeter of said brake disc, arranged in a radial direction.

12. The brake device according to claim 1, comprising a bearing, preferably a roller bearing, attachable on the shaft.

13. The brake device according to claim 1, comprising at least one compression spring located between the brake discs, configured to exert a separation pressure between said brake discs.

14. The brake device according to claim 1, comprising at least one guide element, fixed to the first casing, oriented in the axial direction of the shaft; wherein the first brake disc comprises a first disc through hole loosely fitted to said guide element; wherein the second brake disc comprises a second disc through hole fitted to the guide element.

15. The brake device according to claim 14, comprising an elastic damping gasket located between each guide element with each brake disc through hole.

16. The brake device according to claim 14, comprising a plurality of guide elements each comprising a guide screw inserted into a brake disc through hole, of the same plurality of through holes, of each of the brake discs, wherein said guide screws are configured to guide the displacement of the first brake disc in the axial direction of the shaft and are fixed to the casing of the brake device.

17. The brake device according to claim 16, comprising a plurality of compression springs, each one mounted concentrically on each guide screw, said compression springs being located between the first brake disc and the second brake disc, said compression springs; being configured to exert a separation pressure between said brake discs.

18. The brake device according to claim 1, wherein the pusher element of the axial drive system comprises: a piston configured to generate a pushing load on a lateral surface of the first brake disc; wherein said piston is configured to be housed and moved longitudinally in a cavity of the casing in one pushing direction and in a retraction direction, opposite to the pushing direction.

19. The brake device according to claim 1, wherein the axial drive system comprises: at least one fluid access, located in the casing, said access being configured to introduce and extract fluid in the cavity of said casing; wherein the introduction and extraction of said fluid is configured to move the piston in the axial direction, in a pushing and recovery direction, respectively; and a high pressure gasket located in the cavity of the casing, configured to exert transverse pressure on a lateral surface of the piston; wherein said high pressure gasket is configured to retract the piston into the cavity of the casing when the axial drive system is deactivated.

20. The brake device according to claim 13, wherein the piston comprises a cylindrical ring shape and the compression springs comprise a conical shape; or the piston comprises a conical ring shape and the compression springs comprise a cylindrical shape.

21. The brake device according to claim 18, wherein the axial drive system comprises: an electric motor fixed to the casing, configured to rotate a pinion toothed, connected to a shaft of said motor; wherein the piston comprises a ring shape comprising a thread on an outer cylindrical surface and a toothing on an inner cylindrical surface, meshed with the pinion; wherein the casing comprises an internal thread in the cavity, threaded with the thread of the piston; wherein the electric motor is configured to rotate the pinion, transmitting the rotation to the piston which, upon rotation, is configured to be screwed into or unscrewed from the casing, moving axially, moving the brake disc.

22. The brake device according to claim 1, wherein the axial drive system comprises: two electric motors fixed to the casing; wherein the pusher element comprises two pressing members, each of which is connected by a threaded attachment to a shaft of the electric motor, said pressing members being configured to push the brake disc; in the axial direction; wherein upon actuation of the electric motors, the threaded attachment of the pressing members transforms the rotation of the motor into an axial displacement of the pressing members, moving them in said axial direction.

23. The brake device according to claim 1, comprising a turbofan skeleton comprising a hollow cylindrical shape and a plurality of turbofan blades, separated by cavities, said turbofan blades arranged on a lateral surface of the turbofan, wherein said turbofan is arranged concentrically surrounding the brake discs and the lining disc, it is connected to the rotating shaft, and it is configured to rotate about itself, with respect to the first casing, generating forced ventilation in the brake device.