A brake device is disclosed for rail vehicles. In at least one embodiment, the brake device includes an electromagnetic spring pressure brake, the brake force being applied by an elastic force to the part to be braked and a magnetic arrangement being provided for neutralizing the brake force. The magnetic arrangement counteracts the elastic force and consists of a coil arrangement and an armature place that are mobile in relation to each other, the mobile part being connected to the brake element that impinges the part to be braked. The brake device for a rail vehicle according to at least one embodiment of the invention allows a high brake force and short reaction times and is very compact. For this purpose, the mobile part is connected to an axially displaceable plunger which on one end can be impinged upon with the elastic force and which is connected on the other end to the brake element.
BRAKE DEVICE FOR A RAIL VEHICLE

PRIORITY STATEMENT

[0001] This application is the national phase under 35 U.S. C. §371 of PCT International Application No. PCT/EP2007/053603 which has an International filing date of Apr. 13, 2007, which designated the United States of America and which claims priority on German application Nos. 10 2006 028 289.2 filed Jun. 20, 2006, the entire contents of which is hereby incorporated herein by reference.

FIELD

[0002] At least one embodiment of the invention generally relates to a brake device, for example for a rail vehicle.

BACKGROUND

[0003] From DE 103 03 874, an electromagnetically liftable spring pressure brake for a rail vehicle is known. The spring pressure brake essentially includes a magnetic body, a brake disk and an armature disk. Pressure springs act on the armature disk and force this against the brake disk. For the opening of the brake, the armature disk is attracted by the magnetic body. The magnetic body is placed over the transmission input shaft and connected by bolts to the transmission housing for the purpose of supporting the brake torque.

[0004] The brake disk is fastened in a rotationally secure manner on the transmission input shaft. Because of the kind of installation of the spring pressure brake in the region of the transmission input shaft, the brake, in spite of its low brake torque, can deliver satisfactory results, particularly as a parking brake. The brake has smaller dimensions than pneumatic or hydraulic brake systems, operates with less loss and has fewer vulnerable components.

[0005] The problem of the low brake torque is solved by the brake being able to be installed only in the region of the transmission input shaft and preferably being used as a parking brake. The brake is too weak to act directly, without interposed transmission, on that wheel of the rail vehicle which is to be braked. This would be desirable, however, to allow braking operations at high speeds with short reaction times with direct braking of the moved parts situated close to the wheel.

SUMMARY

[0006] At least one embodiment of the invention provides a brake device which attains a high brake force, short reaction time and small dimensions.

[0007] In at least one embodiment, a brake arrangement for rail vehicles includes an electromagnetic spring pressure brake, wherein the brake force is applied by spring force to the part to be braked and, for the neutralization of the brake force. A magnet arrangement is provided, which acts against the spring force and includes a coil arrangement with armature plate which are movable relative to each other, the moving part thereof being connected to the brake device acting on the part to be braked, by the fact that the moving part is connected to an axially displaceable plunger, which, on the one hand, can be subjected to the spring force and, on the other hand, is connected to the brake device.

[0008] The term "brake device" should here be taken to denote that part of the brake arrangement which comes in contact with the part to be braked. Thus the brake device can act on the part to be braked according to the principle of a block, shoe or disk brake.

[0009] In order that the plunger is only displaced axially, in at least one embodiment a guide can be provided for the plunger. The spring, when slackened, forces the plunger with or via the brake device against the part to be braked. For example, the spring can force the plunger against the inner face of a wheel to be braked. In this state, the brake arrangement is closed. For the opening of the brake arrangement, the magnet arrangement is provided. This includes a coil arrangement with armature plate which are movable relative to each other, the moving part being connected to the plunger. For example, the moving part can be located at that end of the plunger on which the spring force also acts. The non-moving part of the magnet arrangement is fixed to a fixed part, for example to a fixed part of the spring pressure brake. For the opening of the brake arrangement, an appropriate voltage must be applied to the coil arrangement.

[0010] The magnetic field which is thereby generated attracts the armature plate and the moving part moves together with the plunger counter to the spring force, so that the brake device located at the other end of the plunger is moved away from the part to be braked. The brake arrangement is now open. In the event of a power failure, the brake arrangement automatically closes due to the collapsing magnetic field and the slackening spring. This is important for safety reasons, to enable the rail vehicle to be brought to a halt even if the electrical devices should fail. The plunger allows force to be transmitted in a line of application directly to the part to be braked. Where necessary, the plunger can transmit an increased brake force to that part of the rail vehicle which is to be braked. The configuration of the plunger and its dimensions in the contact zone with the part to be braked are independent thereof.

[0011] Advantageous refinements of the brake arrangement according to embodiments of the invention can respectively be derived from the combinations of features in the individual subclaims.

[0012] It can advantageously be provided that the moving part is the armature plate.

[0013] The moving part is connected to the plunger. As the moving part, the armature plate can be fixed to the plunger; for example, by one of its narrow sides. Since the armature plate needs no current supply, the plunger can be moved in the axial direction free from cable connections.

[0014] Preferably, the brake arrangement is configured as an actuator unit, i.e. the magnet arrangement is located in a housing which accommodates both a pressure spring and that part of the plunger which faces the pressure spring, as well as the armature plate, that part of the plunger which faces away from the pressure spring jutting out of the housing.

[0015] The housing can serve as an abutment both for the pressure spring and for the non-moving part of the magnet arrangement.

[0016] The plunger, which justs only partially out of the housing, can receive guidance from the housing. The brake arrangement acquires, by virtue of the housing, a compact construction. The housing additionally has a protective function for the components inside: The mutual alignment of the components can be realized already during the manufacturing process of the brake arrangement and not just when installed on the rail vehicle. This reduces the number of error sources which can lead to operating disturbances. The housing can be
configured, for example, as a hollow cylinder, which at its one end is closed by a base and the other end of which is open. The pressure spring can be fixed by its one end to the base and can rest against the latter and, on its other end, can bear the plunger. The magnet arrangement is located in the housing, for example level with the plunger end connected to the pressure spring. The moving part of the magnet arrangement is connected to the plunger. The fixed part of the magnet arrangement can be fastened to the housing. The moving part can be formed both by the armature plate and by the coil arrangement.

0017. Advantageously, it can further be provided that the magnet arrangement has an electromagnet configured as a U-yoke with inner winding.

0018. The U-yoke optimally guides by virtue of its shape, together with an armature plate, the magnetic flux generated by an application of voltage to the winding. This increases the magnetic attraction forces which are generated. The winding can be a coil wound around the yoke, or the winding lies within the grooves of the U-yoke.

0019. It can advantageously be provided that the winding is configured as a separate winding over a U-yoke.

0020. The magnet arrangement can have more than one coil arrangement. For example, a multiplicity of U-yokes can be provided. If the winding is configured as a separate winding over a U-yoke, the electromagnet can be activated individually. As a result of the individual activation of the electromagnets, the brake force is cascable. The windings can be connected in parallel. Both the number of activated electromagnets and the current intensity can be varied. The windings can also, however, be connected in series. A large number of options are conceivable. An electrical device, for example a control system comparable to the control structures of magnetic levitation, allows the brake force to be continuously adjusted. A gentle braking can thereby be achieved. Unnecessarily loud switching noises when the brake is closed or opened can be prevented.

0021. One advantageous embodiment of the invention can provide that the winding is configured as a ring winding over both U-yokes.

0022. The U-yokes are symmetrically arranged and can be activated symmetrically due to the ring winding. This allows force to be transmitted symmetrically to the plunger and prevents the plunger from tilting, thereby increasing the operating reliability of the brake arrangement. Any guide which is present for the plunger is subjected to lesser load. This saves on repair costs.

0023. A further advantageous embodiment of the invention can provide that the coil arrangement and the armature plate surround the plunger in a ring shape.

0024. The coil arrangement and the armature plates can be configured, for example, as circular plates with a central passage for the plunger. This shaping of the coil arrangement and of the armature plate achieves an optimal force density, given a predefined volume of the arrangement. The moving part of the magnet arrangement is fixed to the plunger. The moving part can be, for example, the coil arrangement. This includes a yoke in the form of the circular plate, which yoke has a circular groove in which the coil is located. The current can be supplied to the coil via the plunger. Inside the plunger, for example, cables can be laid, which are run to the coil through a bore on the plunger. To prevent the magnetic field from being disturbed by the plunger when voltage is applied to the coil, the plunger can include non-magnetizable material. Given appropriate external geometric ratios, an oval shaping of the magnet arrangement may also be chosen.

0025. It can advantageously be provided that the coil arrangement and the armature plate are of rectangular configuration.

0026. The rectangular coil arrangement is formed by a yoke in the form of a rectangular plate, which in the middle has a longitudinally running groove. The groove could also have a different course. The first-named variant has the advantage, however, that when voltage is applied to a coil present inside the groove, the rectangular armature plate is attracted with a maximum force density given a predefined volume.

0027. It can further advantageously be provided that the coil arrangement, on the face facing the armature plate, is additionally provided with a permanent magnet, the magnetic force thereof being chosen such that it is less than the spring force.

0028. The permanent magnet can fully or partially cover the armature-side end face of the yoke. Permanent magnets which are placed in this way can be connected to the yoke in a particularly simple manner.

0029. The permanent magnet could also, however, be placed inside the yoke with similar effect. The permanent magnet pulls the armature plate in the direction of the coil arrangement. Since the brake, when the coil arrangement is switched off, for example in the event of a power failure, must operate with a prescribed brake force, the brake is equipped with a restoring force which is greater than the magnetic force of the permanent magnet and which, moreover, generates a sufficient brake pressure prescribed under safety regulations. With the brake open, the current consumption, due to the permanent magnet, can be reduced. This saves costs.

0030. The version of the brake device having pure electromagnets is adequate for the field of underground railways, in conjunction with a permanently excited synchronous drive. For higher brake forces, for example in the field of standard-gauge railways, the hybrid magnets disclosed in this illustrative embodiment can be used.

0031. One advantageous embodiment of the invention can provide that that part of the plunger which juts out of the housing is of lever-like configuration.

0032. That force of the spring pressure brake which is transmitted by way of the plunger to the part to be braked can be further increased by the lever-like construction of the plunger.

0033. Advantageously, it can further be provided that a plurality of coil arrangements and associated armature plates are arranged one behind the other on the plunger.

0034. The magnet arrangements are arranged along the plunger, the respectively moving part thereof being fixedly connected to the plunger and the non-moving part thereof being connected to a fixed part. The effects of the magnet arrangements arranged along the plunger are combined upon this. The number of magnet arrangements can be dimensioned in accordance with the required brake force. Brake arrangements having different brake force requirements can be made up of identical components, in that only the number of magnet arrangements is varied. This simplifies the manufacturing process and saves costs. The brake arrangements can also easily be subsequently converted.

0035. The arrangement allows voltage to be applied individually to the magnet arrangements and hence allows a
continuous adjustment of the brake force. The diameter of the brake arrangement can be reduced by the position of the magnet arrangements.

[0036] It can further advantageously be provided that the housing is mounted such that it is longitudinally displaceable in relation to the motional direction of the plunger.

[0037] The longitudinally displaceable mounting of the housing allows adjustment of the brake device. As a result of the declination in brake force, it can be adjusted. With the brake open, the new position of the brake arrangement, for adjustment purposes, can be longitudinally displaced on the mounting and fixed in the new position in a particularly simple and precise manner.

[0038] It can also advantageously be provided that the housing is longitudinally displaceable by way of a drive.

[0039] It is cheaper and safer to automate the longitudinal displacement of the housing by way of a drive. With the brake open, the drive displaces the housing to a new position, which is previously determined on the basis of parameters of the closed brake. For this, the distance between the coil arrangement and armature plate can be determined, for example, electronically. When the brake is closed, this distance is a measure of the remaining thickness of the brake device. The distance can be determined by way of a sensor or sensorlessly. The distance can be determined, for example, by an inductivity measurement. For this, a sinusoidal voltage can be applied to an additional coil in the yoke of the coil arrangement and, through measurement of the current, conclusions drawn on the distance to the armature plate.

[0040] This can be done through a mathematical model or by comparison with a desired value.

[0041] If the brake arrangement has to be adjusted on the basis of the measurement finding, once the brake is opened the drive can displace the housing to the new position. The housing can be fixed at this new position by a latching mechanism, or the drive supports the housing. Since forces act on the housing when the brake is closed, it is advantageous to secure said housing by an end stop. A reliable operation of the brake device can thereby be ensured, even if the supporting drive or the latching device should fail.

[0042] It can be considered advantageous that the housing is longitudinally displaceable by way of a pinion drive.

[0043] The pinion drive can, for example, be part of a transmission step. The drive can generate the required linear motion for the displacement of the housing by way of this transmission. For this, any chosen embodiments can be used, for example linear, self-locked worm drives or direct spindle drives. The transmission transmits the rotation of a drive motor to the pinion drive, which linearly displaces a rod, for example. This rod can connect to the back of the housing of the spring pressure brake and can displace this.

BRIEF DESCRIPTION OF THE DRAWINGS

[0044] An illustrative embodiment is explained with reference to the drawing, wherein:

[0045] FIG. 1 shows a schematic longitudinal section of a brake arrangement according to an embodiment of the invention.

[0046] FIG. 2 shows a schematic longitudinal section of a rectangularly configured magnet arrangement,

[0047] FIG. 3 shows a schematic longitudinal section of a magnet arrangement with hybrid magnet,

[0048] FIG. 4 shows a schematic longitudinal section of a brake device with adjustment device, and

[0049] FIG. 5 shows a schematic longitudinal section of a detail of an adjustment device.

DETAILED DESCRIPTION OF THE EXAMPLE EMBODIMENTS

[0050] FIG. 1 shows a schematic longitudinal section of an illustrative embodiment of the brake arrangement 1 according to the invention. Wherein in the figures devices are represented which are similar or act the same; these devices are provided with the same reference symbols.

[0051] The housing 3 of the spring pressure brake is formed by a hollow cylinder, which at its one end is closed off by a base 4 and at its other end is open. A spring 5 extending in the longitudinal direction inside the housing 3 bears with its one end against the base 4 and with its other end against a plunger 2. The plunger 2 juts partially out of the open end of the housing 3 and has at its tip a brake device 8. A magnet arrangement is disposed in the housing 3, in this illustrative embodiment a multiple arrangement being represented. A variant having one or more such magnet arrangements is also possible.

[0052] The magnet arrangement here includes armature plates 7, which are fixed to the plunger 2, and a coil arrangement 6, which is fixedly connected to the wall of the housing. The brake device 8 is provided at one end of the plunger 2 and can be pressed by the expansion, i.e. the pressure of the spring 5, against the tread of a wheel 9 indicated in FIG. 1. As a result of voltage being applied to the coil arrangement 6, magnetic attraction forces are generated between the coil arrangement 6 and the armature plates 7 fastened to the plunger 2. The plunger 2 and thus the brake device 8 can hence be released from the wheel 9 counter to the compressive force of the spring 5. The brake is then open.

[0053] The embodiment represented in FIG. 1 can also be modified such that the coil arrangement 6 is fastened to the plunger 2, and the armature plates 7 to the housing 3.

[0054] FIG. 2 shows a schematic longitudinal section of a rectangularly configured magnet arrangement on a plunger 2. The magnet arrangement includes two coil arrangements 6 which are arranged symmetrically on the plunger 2 and the associated armature plates 7 of which are respectively connected to a fastening element 10 running parallel to the plunger 2. The coil arrangement 6 includes a U-shaped yoke 11 with inner winding 12. The end sides of the U-shaped yoke 11 point to the associated armature plate 7. The winding 12 is indicated as a single conductor cross section in the groove of the U-shaped yoke 11. The winding 12 can also, however, by led by each of the two grooves of the U-shaped yokes 11 in a ring shape around the plunger 2.

[0055] In an annular magnet arrangement, both the armature plates 7 and the U-shaped yokes 11 include annular disks having a central hole through which the plunger 2 runs. The U-shaped yokes 11 are connected to the plunger 2. The armature plates 7 are fixed to two opposite fastening elements 10 running parallel to the plunger 2. In each of the two yoke disks runs the annular groove, in which a winding 12 is disposed. The lead wires to this winding 12 can be realized through a bore in the plunger 2.

[0056] FIG. 3 shows a schematic longitudinal section of a magnet arrangement with hybrid magnet. The magnet
arrangement includes an armature plate 7 and a hybrid magnet. The hybrid magnet includes a U-shaped yoke 11, on whose end faces there is disposed a permanent magnet 13, and a winding 12. The permanent magnet 13 can also, however, be disposed inside the yoke, for example, or only partially cover the end faces. The winding 12 is indicated by a conductor cross section in the groove of the U-shaped yoke 11.

[0057] The armature plate 7 arranged opposite the end faces is attracted by the permanent magnet 13. Through appropriate application of voltage to the winding 12, the attraction force on the armature plate can be further reinforced.

[0058] If a direct drive with cuboid housing is disposed around a wheel axle, the brake arrangement 1 can be fastened to the housing of the direct drive, the plunger 2 of the brake arrangement 1 running parallel to the wheel axle and, when the brake is closed, pressing onto the inner faces of the wheels 9 fastened to the wheel axle.

[0059] FIG. 4 shows a schematic longitudinal section of a brake arrangement 1 according to the invention, according to a variant having an adjustment device 16. That illustrative embodiment of a brake arrangement 1 which is represented in FIG. 1 is supplemented by the adjustment device 16. The adjustment device 16 is located on the back of a line comprising the housing 3 of the spring pressure brake and the plunger 2, which plunger points in the direction of the wheel 9 and bears at its end the brake device 8. In this line, the base 4 of the housing 3 is connected by a rod 17 to the adjustment device 16. The housing 3 rests on bearings 18 and, when the brake arrangement 1 is open, can be displaced along the line on these bearings 18. The adjustment device 16 can displace the spring pressure brake to a suitable position by way of the rod 17. On this position, a latching device (not represented) can fix the position of the spring pressure brake. It is also possible, however, for the adjustment device 16 to fix the position of the spring pressure brake at a renewed displacement. The spring 5 present inside the housing 3 presses down against the then fixed base 4 and displaces the plunger 2 in the direction of the wheel 9, until the brake device 8 bears against said wheel. In this position, the spring 5 has a certain length. The length of the spring 5 determines the brake force with which the brake device 8 is pressed against the wheel 9. In order to keep the brake force constant if the brake device 8 becomes worn, the spring 5 must be adjusted.

[0060] To this end, the adjustment device 16 displaces the mounted spring pressure brake in the direction of the wheel 9. The distance by which the spring pressure brake must be displaced can be determined when the brake device 1 is closed. For this, a device (not represented) which controls the adjustment device 17 can determine the distance between a coil arrangement 6 and the associated armature plate 7. This measurement variable provides a measure of the wearing of the brake device 8 and can be determined by way of a sensor or sensorlessly, for example by way of an inductivity measurement of a coil (not represented) which, for this purpose, is additionally present in the coil arrangement 6. In the represented brake arrangement 1, the forces generated in the pressing of the brake device 8 are transmitted to the rod 17, and thus to the adjustment device 16, via the spring 5 resting against the housing floor 4. Since, if the rod mounting within the adjustment device 16 were to fail, the safety of the brake arrangement 1 would no longer be ensured, an end stop 19 is provided for the rod 17. The end stop 19 can be fastened together with the adjustment device 16 on a baseplate 20, which also bears the bearings 18 of the spring pressure brake. The baseplate 20 can be fixedly connected, for example, to the bogie of a rail vehicle (not represented).

[0061] FIG. 5 shows a schematic longitudinal section of a transmission step 21 for the adjustment. The transmission step 21 has a drive 22 with rotary output shaft. The output shaft can be configured as a twistable, self-locked spindle drive 23. This linearly displaces a supporting wedge 24, which bears against the edge of a mounted circular segment 25. Through a displacement of the supporting wedge 24, the mounted circular segment 25 is rotated either clockwise or counterclockwise about the center of its circle, which center coincides with a bearing shaft 26. The peripheral edge of the circular segment 25 bears serrated indentations, which engage in diametrically opposed serrated indentations in the adjacent longitudinal side of the rod 17. Through rotation of the circular segment 25 about the bearing shaft 26, the rod 17 is set in a linear motion. The represented transmission step 21 can be used for the adjustment mechanism of the adjustment device 16 (see FIG. 8). Any other chosen embodiments, such as, for example, linear, self-locked worm or direct spindle drives (not represented), can alternatively be provided as the adjustment mechanism of the adjustment device 16 (see FIG. 8).

[0062] Example embodiments being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the present invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

1. A brake arrangement for rail vehicles, comprising:
   - an electromagnetic spring pressure brake, a brake force is being applicable by spring force to a part to be braked, to the brake force; and
   - a magnet arrangement to acts against the spring force, the magnet arrangement including a coil arrangement and an armature plate, the coil arrangement with armature plate being movable relative to each other, a moving part of the magnet arrangement being connected to a brake device acting on the part to be braked, wherein the moving part is connected to an axially displaceable plunger which is subjectable to the spring force and which is connected to the brake device, the magnet arrangement further including an electromagnet configured as a U-shaped yoke with inner winding.

2. The brake arrangement as claimed in claim 1, wherein the winding is configured as a separate winding over the U-shaped yoke.

3. The brake arrangement as claimed in claim 1, wherein the magnet arrangement includes two U-shaped yokes, and wherein the winding is configured as a ring winding over both U-shaped yokes.

4. A brake arrangement for rail vehicles, comprising:
   - an electromagnetic spring pressure brake, a brake force is being applicable by spring force to a part to be braked, to neutralize the brake force; and
   - a magnet arrangement to acts against the spring force, the magnet arrangement including a coil arrangement and an armature plate, the coil arrangement and the armature plate being movable relative to each other, a moving part of the magnet arrangement being connected to a brake device acting on the part to be braked, wherein the moving part is connected to an axially displaceable plunger
which is subjectable to the spring force and which is connected to the brake device, the coil arrangement, on a face facing the armature plate, being additionally provided with a permanent magnet, a magnetic force of the permanent magnet being less than the spring force.

5. A brake arrangement for rail vehicles, comprising:

an electromagnetic spring pressure brake, a brake force being applicable by spring force to a part to be braked, to neutralize the brake force; and

a magnet arrangement to acts against the spring force, including a coil arrangement and an armature plate, the coil arrangement and the armature plate being movable relative to each other, a moving part of the magnetic arrangement being connected to a brake device acting on the part to be braked, wherein the moving part is connected to an axially displaceable plunger which is subjectable to the spring force and which is connected to the brake device, the magnet arrangement being located in a housing which is mounted on bearings such that it is longitudinally displaceable in relation to a motional direction of the plunger.

6. The brake arrangement as claimed in claim 5, wherein the housing is longitudinally displaceable via a drive.

7. The brake arrangement as claimed in claim 6, wherein the housing is longitudinally displaceable via a pinion drive.

8. The brake arrangement as claimed in claim 5, wherein the moving part is the armature plate.

9. The brake arrangement as claimed in claim 8, wherein the housing accommodates both the spring for the spring force, a part of the plunger facing the spring and the armature plate, and a part of the plunger which faces away from the spring, jutting out of the housing.

10. The brake arrangement as claimed in claims 1, wherein the coil arrangement and the armature plate surround the plunger in a ring shape.

11. The brake arrangement as claimed in claim 1, wherein the coil arrangement and the armature plate are of rectangular configuration.

12. The brake arrangement as claimed in claim 1, wherein a plurality of coil arrangements and associated armature plates are arranged one behind the other on the plunger.

13. (canceled)

14. (canceled)

15. The brake arrangement as claimed in claim 1, wherein the moving part is the armature plate.

16. The brake arrangement as claimed in claim 4, wherein the moving part is the armature plate.

17. The brake arrangement as claimed in claim 4, wherein the coil arrangement and the armature plate surround the plunger in a ring shape.

18. The brake arrangement as claimed in claim 4, wherein the coil arrangement and the armature plate are of rectangular configuration.

19. The brake arrangement as claimed in claim 4, wherein a plurality of coil arrangements and associated armature plates are arranged one behind the other on the plunger.

20. The brake arrangement as claimed in claim 5, wherein the coil arrangement and the armature plate surround the plunger in a ring shape.

21. The brake arrangement as claimed in claim 5, wherein the coil arrangement and the armature plate are of rectangular configuration.

22. The brake arrangement as claimed in claim 5, wherein a plurality of coil arrangements and associated armature plates are arranged one behind the other on the plunger.

* * * * *