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(54) **HYDRAULIC BLOCK OF A POWER BRAKE SYSTEM**

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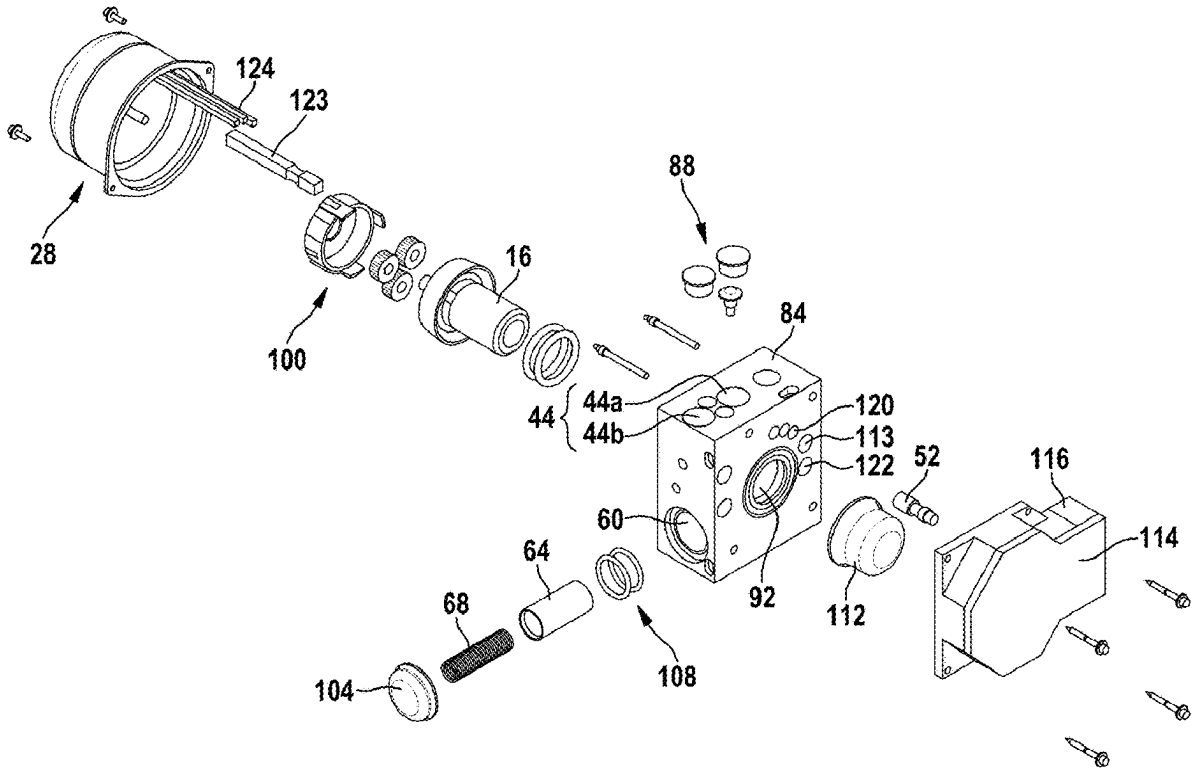
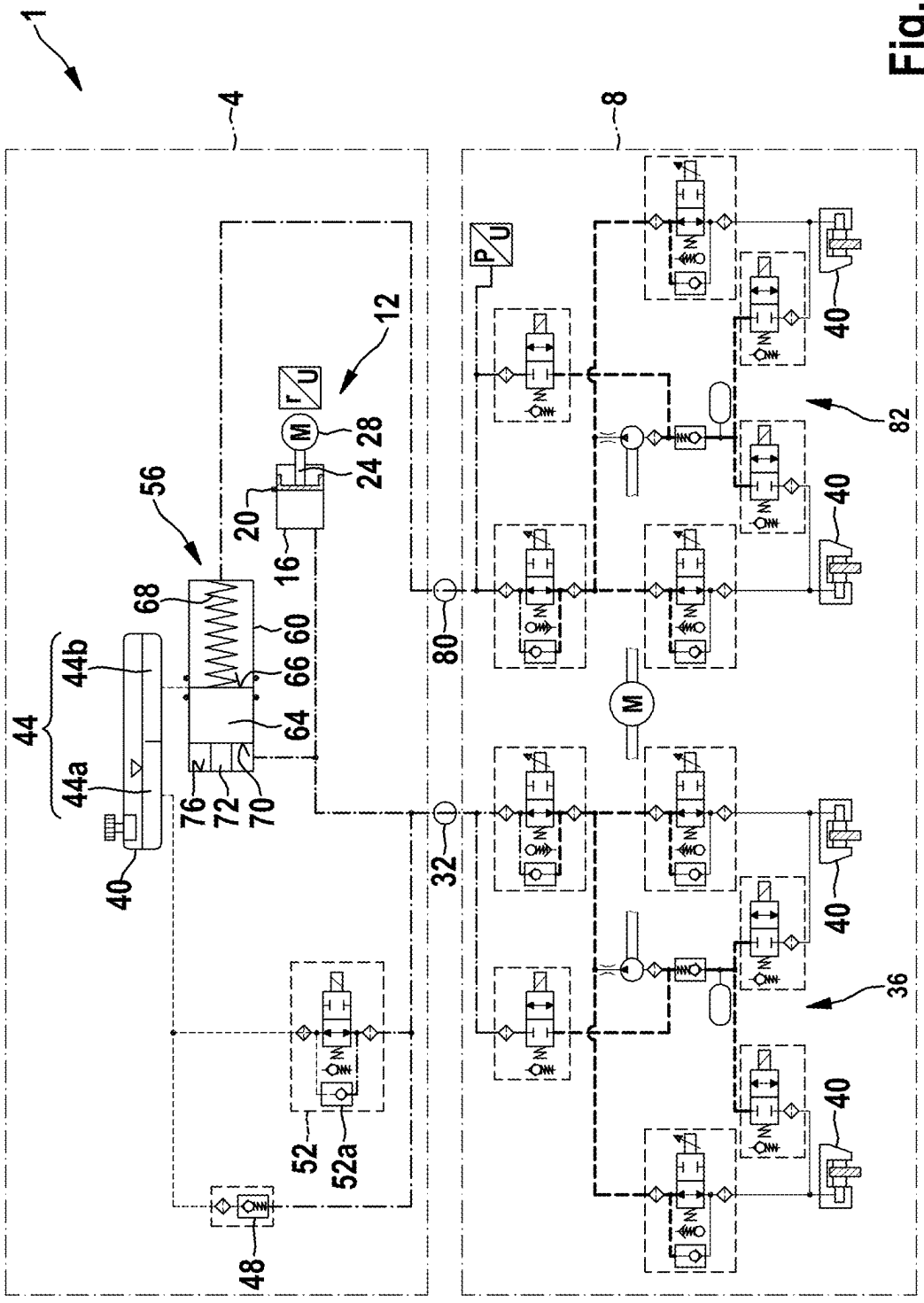
(57) **ABSTRACT**

A hydraulic block of a power brake system, which is designed as a cuboidal housing block. The hydraulic block has a power cylinder bore for receiving a power cylinder, and two chambers, which are arranged above the power cylinder bore and form a brake fluid reservoir. On a side of the power cylinder bore that is opposite to the brake fluid reservoir, a separating cylinder is arranged, which extends perpendicularly to the power cylinder bore and in which a separating piston is arranged, which hydraulically separates a first and a second supply connection to a vehicle dynamics control from one another. The separating cylinder is hydraulically connected to the power cylinder so that pressure of the power cylinder can be applied to a first axial piston side of the separating piston and a brake pressure can be generated via a second axial piston side of the separating piston.




1
4
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12
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76
72
70
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44b
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16
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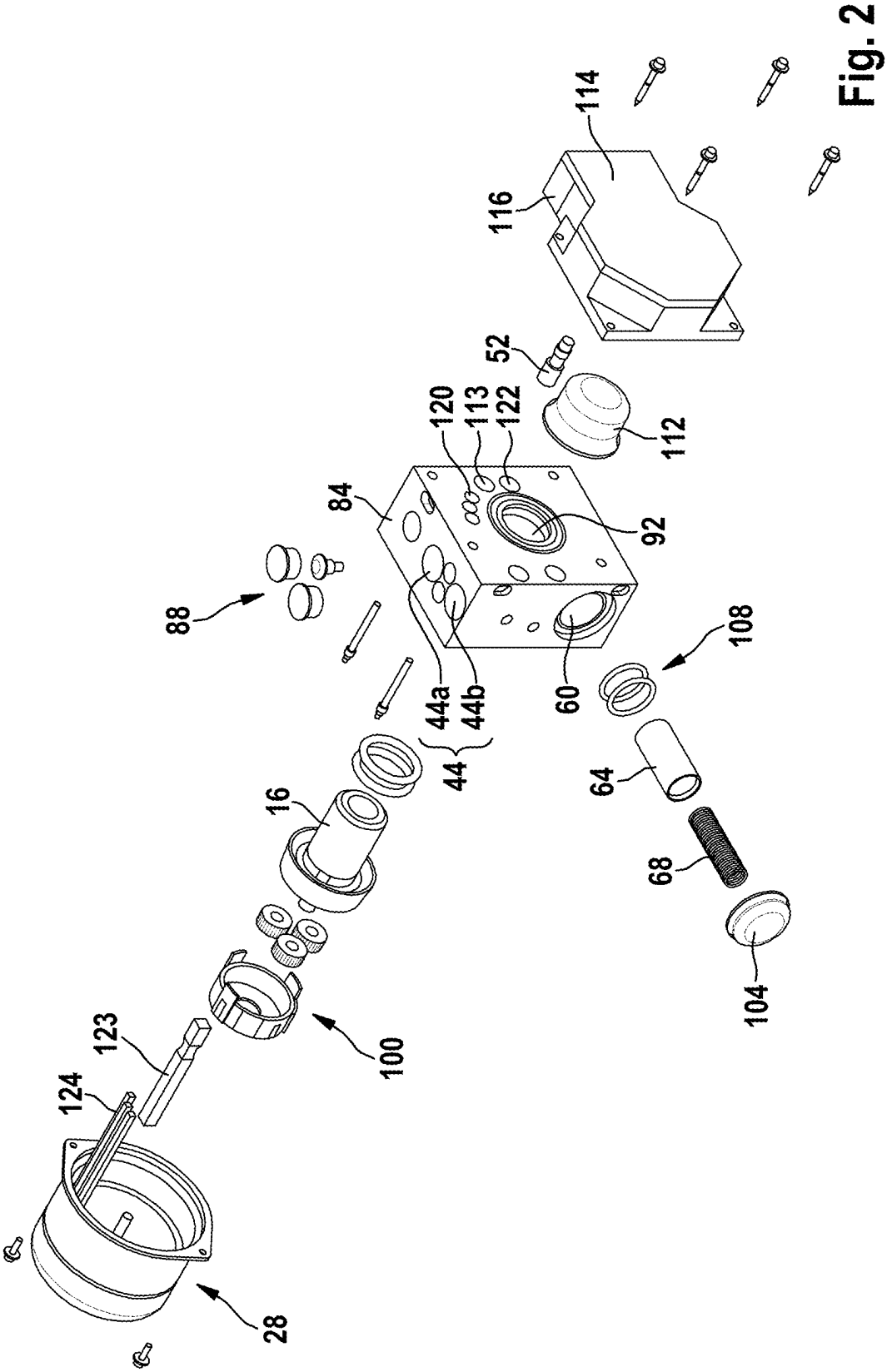
28
80
32
82
36
52
52a
48
P/U
M

Fig. 1


114
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52
120
113
122
112
84
92
88
108
60
44a
44b
44
64
16
68
104
100
123
124
28

Fig. 2

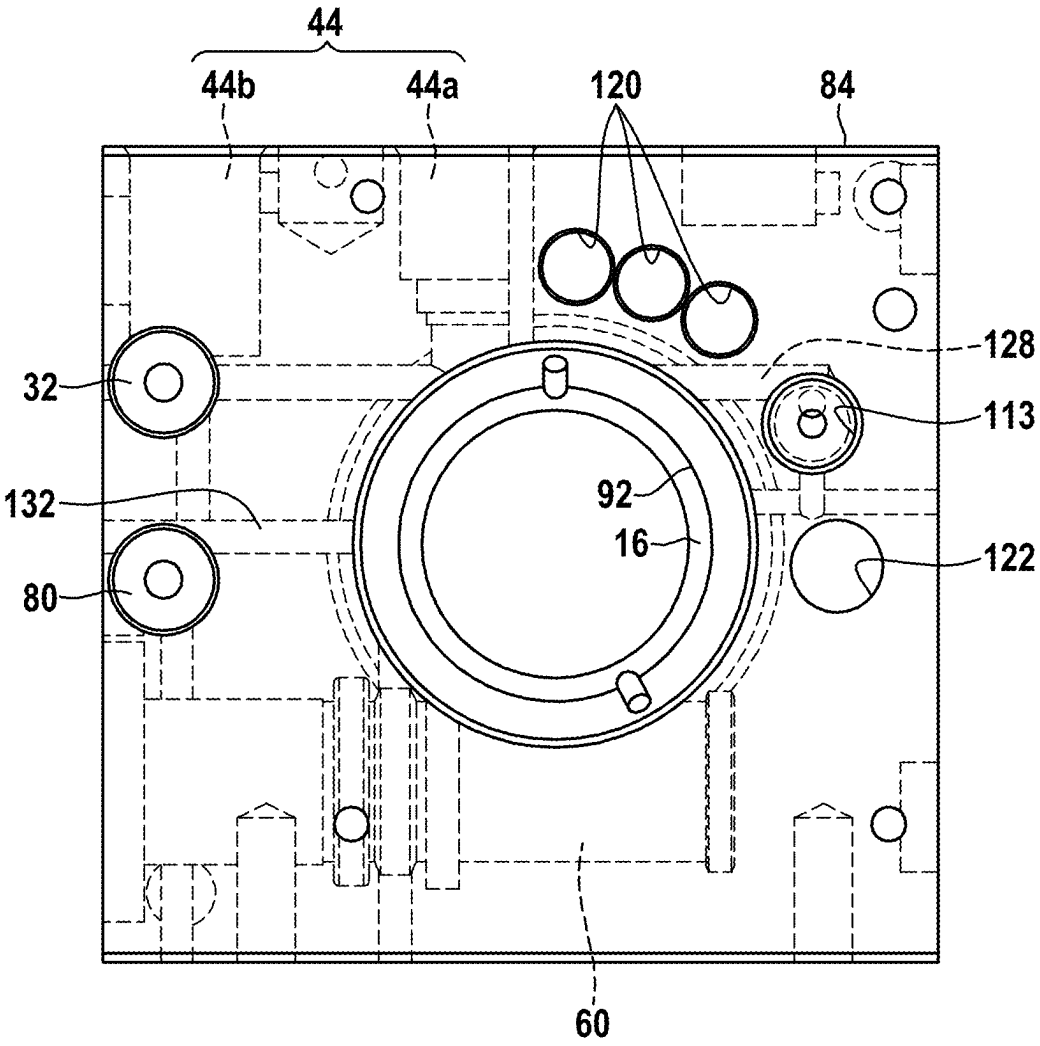

Fig. 3

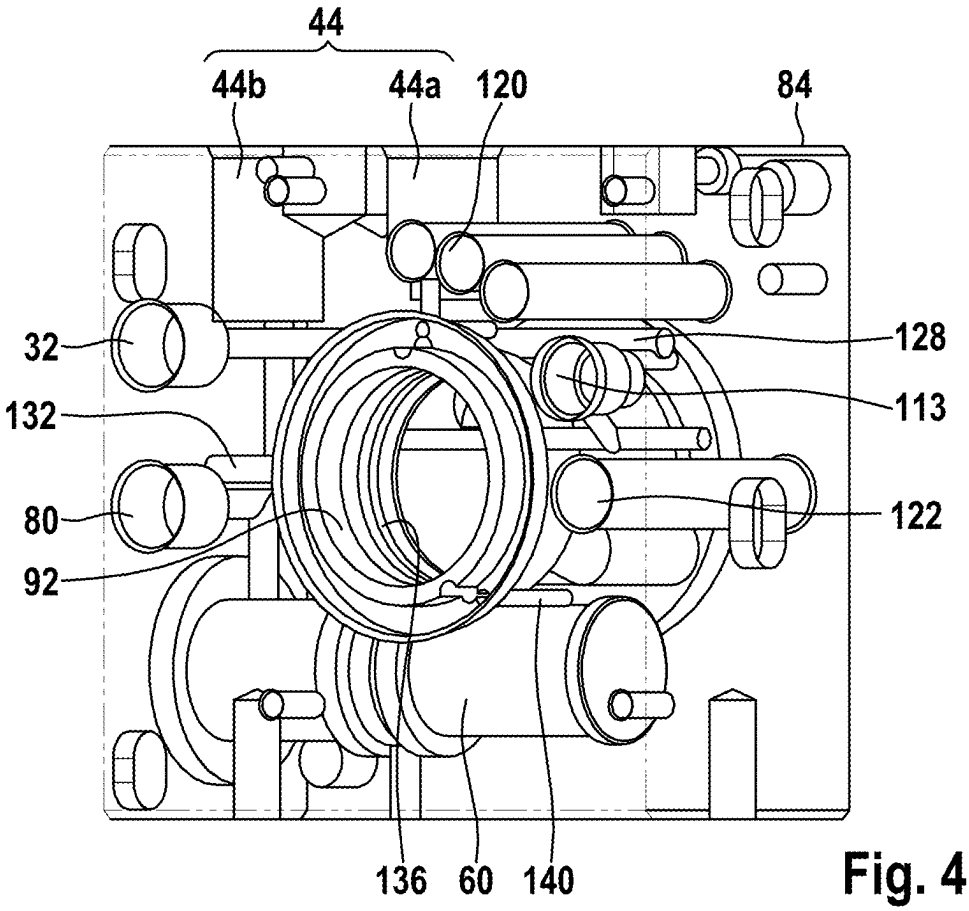
44
44b
44a
120
84
32
128
132
113
80
122
92
136
60
140

Fig. 4

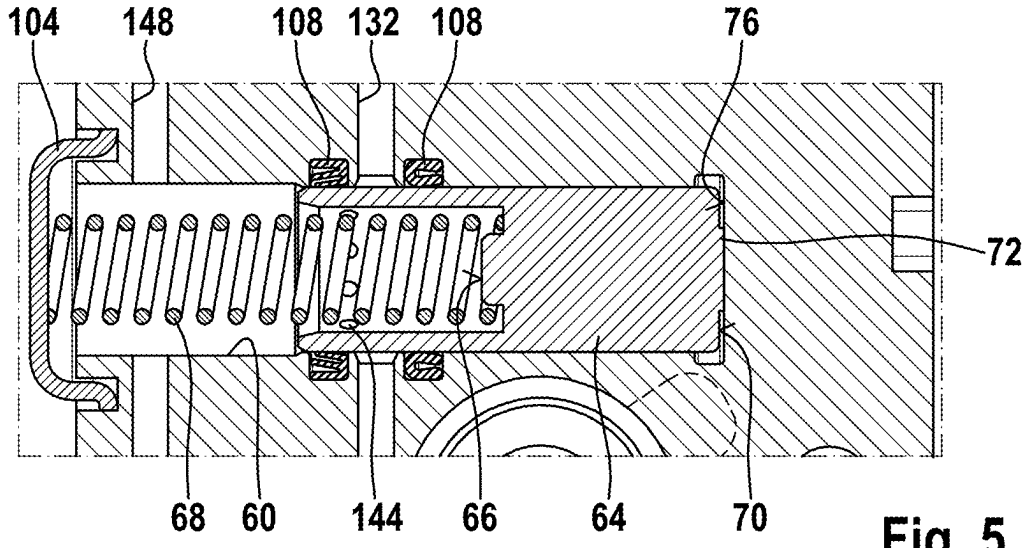
104
148
108
132
108
76
72
68
60
144
66
64
70

Fig. 5

HYDRAULIC BLOCK OF A POWER BRAKE SYSTEM

FIELD

[0001] The present invention relates to a hydraulic block of a power brake system. Moreover, the present invention relates to a master-brake-cylinder-free brake system comprising such a hydraulic block.

BACKGROUND INFORMATION

[0002] German Patent Application No. DE 10 2018 220 573 A1 relates to a hydraulic block for a hydraulic unit of a hydraulic vehicle power brake system. The hydraulic block has a power cylinder bore orthogonal to the master brake cylinder bore and a receptacle for a pedal travel simulator. The receptacle for the pedal travel simulator is attached in parallel with the power cylinder bore in the hydraulic block.

[0003] German Patent Application No. DE 10 2017 204 407 A1 describes a hydraulic block for a hydraulic vehicle power brake system. Connections for wheel brakes are attached along a transverse side with connections for a brake fluid storage container or along a longitudinal side in a large side of the hydraulic block.

SUMMARY

[0004] An object of the present invention is to provide a hydraulic block of a power brake system that requires reduced installation space and is economical to produce.

[0005] The object may be achieved by a hydraulic block for a power brake system with certain features of the present invention. Advantageous developments and example embodiments of the present invention are disclosed herein.

[0006] The present invention provides a hydraulic block of a power brake system, which is designed as a cuboidal housing block. The hydraulic block has a power cylinder bore for receiving a power cylinder, and two chambers, which are arranged above the power cylinder bore and form a brake fluid reservoir.

[0007] According to an example embodiment of the present invention, the cuboidal housing block is preferably formed from an extruded aluminum block. Such an extruded aluminum block is simple and cost-effective to produce so that the costs of such a hydraulic block can be kept low. The weight for the hydraulic block can be reduced by using aluminum or an aluminum alloy. The first and the second chamber of the brake fluid reservoir are formed in the housing so that no further attachment parts are necessary and installation space can be saved.

[0008] On a side of the power cylinder bore that is opposite to the brake fluid reservoir, a separating cylinder is arranged, which extends perpendicularly to the power cylinder bore and in which a separating piston is arranged, which hydraulically separates a first and a second supply connection to a vehicle dynamics control from one another. The power cylinder bore advantageously extends in the thickness direction of the hydraulic block, while the separating cylinder extends in the longitudinal direction. Due to the larger length of the separating cylinder in comparison to the power cylinder bore, the thickness of the hydraulic block does not have to be increased due to the perpendicular arrangement of the separating cylinder so that the installation space required for the hydraulic block can be kept low. By disconnecting the supply connections, the separating cylinder can provide the necessary safety so that, if one brake circuit leaks, the other brake circuit remains operable. The separating cylinder additionally has the advantage that, contrary to other circuitry, which comprises a separate separating valve for separating a brake circuit, only a single separating cylinder is necessary for the separation. This can again reduce installation space for such a hydraulic block.

[0009] The separating cylinder is hydraulically connected to the power cylinder so that pressure of the power cylinder can be applied to a first axial piston side of the separating piston and a brake pressure can be generated via a second axial piston side of the separating piston. The separating cylinder thus serves not only to separate the brake circuits but also to build pressure in one of the circuits.

[0010] According to an example embodiment of the present invention, particularly preferably, the hydraulic block is designed to be master-cylinder-free. In other words, this means that no master brake cylinder actuated by a brake pedal is arranged in the hydraulic block. Through a hydraulic block designed in this way, the space for a master cylinder can thus be saved so that the components and the installation space for such a hydraulic block can be reduced significantly and the hydraulic block can be produced economically.

[0011] In a preferred embodiment of the present invention, the first axial piston side of the separating piston is designed such that, when this piston side abuts against a separating cylinder base, a portion of this piston side is spaced apart from the separating cylinder base. The piston side thus abuts only partially against the separating cylinder base. Such a design results in the formation of a space, in which brake fluid is arranged, between the piston side and the separating cylinder base. The pressure of this brake fluid can thus continue to act on a portion of the piston surface in order to be able to move it in the separating cylinder. Advantageously, the piston side is provided with a central extension that abuts against the separating cylinder base.

[0012] In a further preferred embodiment of the present invention, an EMC contact for a controller is provided via a cover of the power cylinder. No separate EMC (electromagnetic compatibility) contact is thus provided. The EMC contact is thus formed by the already present cover of the power cylinder. The cover of the power cylinder thus directly fulfills multiple functions. Space for a separate EMC contact can thus be saved so that the size of the hydraulic block can be reduced.

[0013] Preferably, electrical contacts for a controller and a switching valve for switching a connection between the first chamber of the brake fluid reservoir and the first supply connection are arranged in the area of a quadrant around a cover of the power cylinder. Both the electrical contacts and the switching valve are connected to a printed circuit board of the controller. Particularly preferably, a rotor sensor contact is also arranged in the area of the quadrant. These contacts and the switching valve are arranged in a limited area. In comparison to an arrangement in which the contacts are distributed over the entire side of the hydraulic block, the size of the printed circuit board and thus also the size of the controller can be reduced so that the installation space required for the hydraulic block can be kept low as a result of such an arrangement.

[0014] In an advantageous development of the present invention, the electrical contacts for the controller and the switching valve are arranged on a side of the power cylinder

that faces toward an electrical plug of the controller. The printed circuit board of the controller is connected to both the electrical plug and the contacts. The distance between the electrical plug and the contacts can be minimized by a corresponding arrangement of the contacts. The printed circuit board thus only has to have a length between the contacts and the electrical plug. This makes it possible to further reduce the size of the printed circuit board and thus the size of the controller.

[0015] Advantageously, an undercut, via which the switching valve is connected to the first chamber of the brake fluid reservoir, is formed at the power cylinder bore. The undercut is designed as a limited area with a larger diameter than the core diameter of the power cylinder bore. As a result, a hydraulic line is formed, by means of which the brake fluid can be directed around the power cylinder bore. A displacement of the power cylinder bore to form a hydraulic bore is thus not necessary. As the entire hydraulic block is enlarged by such a displacement, a compact and space-saving form for the hydraulic block can be maintained through such an undercut.

[0016] In a further advantageous embodiment of the present invention, the separating piston has at least one through-hole via which a supply connection for the vehicle dynamics control is connected to the second chamber of the brake fluid reservoir in a home position of the separating piston. In order to bring the separating piston into a home position, at which a portion of the piston side abuts against the separating cylinder base, a separating piston spring is advantageously arranged on an opposite piston side. This home position is thus assumed by the separating piston spring when the piston side facing away from the separating piston spring is pressure-less. For connecting the second chamber of the brake fluid reservoir to the supply connection for the vehicle dynamics, the separating cylinder is connected to the brake fluid reservoir via a hydraulic line. In the home position, it is thus possible for the vehicle dynamics control to be supplied with brake fluid from the brake fluid reservoir through the through-hole in the separating piston. The through-hole in the separating piston, which advantageously interacts with seals, thus simultaneously forms a valve between the brake fluid reservoir and the vehicle dynamics control. The separating cylinder thus has multiple functions so that the number of components is reduced and installation space is saved.

[0017] According to an expedient embodiment of the present invention, the hydraulic block forms two supply connections for a vehicle dynamics control, which are oriented toward the controller and arranged vertically one above the other. The vertical arrangement of the supply connections results in a space-saving arrangement of these connections in the hydraulic block so that the width of the hydraulic block does not need to be increased.

[0018] According to a further expedient embodiment of the present invention, the switching valve and the power cylinder are connected to a supply connection for a vehicle dynamics control via a common horizontal connection bore. As a result, it is not necessary to provide a separate bore for both the switching valve and the power cylinder. This reduces the production time.

[0019] Space is also not required for this separate additional bore, so the hydraulic block requires less installation space.

[0020] The present invention additionally specifies a master-brake-cylinder-free brake system comprising the hydraulic block according to the present invention. A master-brake-cylinder-free brake system has the advantage that space for a master cylinder and the hydraulic lines required for it can be saved so that the entire brake system requires less space. Such a brake system also offers the advantages already mentioned with regard to the hydraulic block.

[0021] Embodiment examples of the present invention are shown in the figures and explained in more detail in the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] FIG. **1** shows a brake system according to an embodiment example of the present invention.

[0023] FIG. **2** shows an exploded view of an embodiment example of a hydraulic block, according to the present invention.

[0024] FIG. **3** shows a front view of an embodiment example of the hydraulic block, according to an example embodiment of the present invention.

[0025] FIG. **4** shows a perspective view of the hydraulic block shown in FIG. **2**.

[0026] FIG. **5** shows a sectional representation of an embodiment example of the separating cylinder with a separating piston, according to the present invention.

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS

[0027] FIG. **1** shows a brake system **1** according to an embodiment example of the present invention. The brake system **1** comprises two units **4**, **8**. A first unit **4** comprises a power brake pressure generator **12** with a power cylinder **16**, in which a power piston **20** can be moved, and a spindle drive assembly **24**. The spindle drive assembly **24** is connected to a motor **28** of the power brake pressure generator **12**, via which a rotational movement of the spindle drive assembly **24** is converted into a translational movement of the power piston **20**. A brake pressure is provided at a first supply connection **32** via the translational movement of the power piston **20**. A first brake circuit **36** of the second unit **8** designed as a vehicle dynamics control is connected to this first supply connection **32**. This brake pressure is used to actuate two wheel brakes **40** of the first brake circuit **36**.

[0028] The first unit **4** additionally comprises a brake fluid reservoir **44**, which is divided into two chambers **44***a*, **44***b*. A first chamber **44***a* of the brake fluid reservoir **44** is connected to the power cylinder **16** and the first supply connection **32** via a check valve **48** that closes the first chamber **44***a*. Parallel to the check valve **48**, a 2/2-way switching valve **52** is arranged, which is open in a current-less state. The switching valve **52** is additionally formed with a switching check valve **52***a* blocking in the direction of the brake fluid reservoir **44**.

[0029] Moreover, the first unit **4** comprises a separating valve **56** supplied with brake fluid via the second chamber **44***b* of the brake fluid reservoir **44**. The separating valve **56** comprises a separating cylinder **60** and a separating piston **64** which can be moved in the separating cylinder **60**. A separating piston spring **68** is arranged on a second axial piston side **66** and pushes the separating piston **64** in one direction. The separating piston **64** additionally has a separating piston extension **72** on a piston side facing away from

the separating piston spring **68**, so that a first axial piston side **70** of the separating piston **64** does not abut flush against a separating cylinder base **76**.

[0030] On a side of the separating cylinder **60** on which the separating piston spring **68** is arranged, the separating cylinder is hydraulically connected to a second supply connection **80**. The first axial piston side **70** is connected to both the power brake pressure generator **12** and the first supply connection **32**. When a pressure is generated on the first axial piston side **70** by the power brake pressure generator **12**, the separating piston **64** is moved toward the separating piston spring **68** so that a brake pressure is also generated at the second supply connection **80** via the second axial piston side **66** in addition to the pressure at the first supply connection **32**. A brake pressure can thereby be generated in the second brake circuit **82** of the second unit **8**.

[0031] The second unit **8** shown in FIG. **1** shows a conventional vehicle dynamics control, such as an ESP control, which is not described further here.

[0032] FIG. **2** shows an exploded view of an embodiment example of a hydraulic block **84**. The first unit **4** is formed entirely by this hydraulic block **84**. The first and second chambers **44***a*, **44***b* of the brake fluid reservoir **44** are arranged on a top side of the hydraulic block **84**. These chambers **44***a*, **44***b* are sealed via sealing plugs **88**. A power cylinder bore **92**, which receives the power cylinder **16**, is arranged centrally in the thickness direction in the hydraulic block **84**. The power piston **20** in the power cylinder **16** can be moved axially in the power cylinder **16** via a gear mechanism **100** that can be driven by the motor **28**.

[0033] The separating cylinder **60** is additionally formed in the hydraulic block **84**. This separating cylinder **60** is arranged on the opposite side of the power cylinder bore **92** to the brake fluid reservoir **44** so that the separating cylinder **60** is located below the power cylinder bore **92**. The separating cylinder **60** is perpendicular to the power cylinder bore **92**. The separating piston **64**, which can be moved in an axial direction of the separating cylinder **60**, is arranged in the separating cylinder **60**. Between a separating cylinder cap **104** and the separating piston **64**, the separating piston spring **68** is arranged, via which the separating piston **64** is acted upon by a spring force in a direction facing away from the separating cylinder cap **104**. For sealing the separating piston **64** in the separating cylinder **60**, two seals **108** are additionally arranged in the separating cylinder **60**.

[0034] A cover **112** of the power cylinder **16**, with which said power cylinder can be closed, is arranged on a side of the hydraulic block **84** that is opposite to the motor **28**. The switching valve **52**, which is received in a correspondingly formed switching valve bore **113** in the hydraulic block **84**, is additionally attached to this side. The cover **112** and the switching valve **52** protrude into a controller **114** arranged on this side. The controller **112** comprises an electrical plug **116**, via which the controller **114** is contacted and which protrudes laterally from the hydraulic block **84** when the controller **114** is mounted.

[0035] In the area of the switching valve **52** around the power cylinder **16**, the hydraulic block **84** forms additional contact bores **120**, via which electrical contacts **124** for the motor **28** can be connected to the controller **114** by the hydraulic block **84**. Additionally, in the area of the switching valve **52** around the power cylinder **16**, a rotor sensor contact bore **122** is arranged, via which a rotor sensor contact **123** is connected to the controller **114**. The contact bores **120**, the switching valve bore **113**, and the rotor sensor contact bore **122** are arranged in this embodiment example in a quadrant around the cover **112** of the power cylinder **16**. In particular, the contact bores **120** and thus the contacts **124**, the rotor sensor contact **123**, and the switching valve **52** are arranged on a side of the power cylinder bore **92** that faces the electrical plug **116** of the switching device **114**. Moreover, the first and second supply connections **32**, **80** are arranged on the side of the controller **114**.

[0036] FIG. **3** shows a front view of an embodiment example of the hydraulic block **84**. This embodiment example shows how the components and the hydraulic lines are arranged in the hydraulic block **84**. A horizontal connection bore **128** connects the switching valve **52** and the power cylinder **16** to the first supply connection **32** for the vehicle dynamics control **8**. In the embodiment example shown in FIG. **3**, the supply connections **32**, **80** for the vehicle dynamics control are arranged vertically one above the other and oriented toward the controller **114**. The supply connections **32**, **80** and the contact bores **120** are arranged on two sides opposite to the power cylinder bore **92**. For supplying brake fluid to the separating cylinder **60**, a supply line **132**, formed via vertical and horizontal bores, is formed in the hydraulic block **84** and connects the second chamber **44***b* of the brake fluid reservoir **44** to the separating cylinder **60**.

[0037] FIG. **4** shows a perspective view of the hydraulic block **84** shown in FIG. **2**. In this figure, it can be seen that an undercut **136**, via which the switching valve bore **113** is connected to the first chamber **44***a* of the brake fluid reservoir **44**, is formed in the power cylinder bore **92**. It is additionally shown that the power cylinder bore **92** is connected to a rear region of the separating cylinder **60** via a frontal bore **140**.

[0038] A sectional representation of an embodiment example of the separating cylinder **60** with a separating piston **64** is shown in FIG. **5**. The separating piston **64** is pushed toward the separating cylinder base **76** via the separating piston spring **68** arranged between the separating piston **64** and the separating cylinder cap **104**. On a side facing the separating cylinder base **76**, the separating piston **64** has the central separating piston extension **72**, via which the separating piston **64** does not abut flush against the separating cylinder base **76**. As a result, a pressure of the power cylinder **16** that acts in the area of the separating cylinder base **76** can continue to act on the separating piston **64** so that said separating piston is displaced toward the separating cylinder cap **104**.

[0039] The supply line **132** connected to the brake fluid reservoir **44** is arranged in the area of a center of the separating cylinder **60** so that it is connected to the separating cylinder **60** in the area of the separating piston **64**. On both sides of the supply line **132**, the seals **108** abut against the separating piston **64** so that the rest of the separating cylinder **60** is sealed toward the supply line **132**. The separating piston **64** has circumferential through-holes **144** that lie between the two seals **108** in a home position, in which the separating piston **64** abuts against the separating cylinder base **76**. As a result, a connection between the supply line **132** and a supply connection bore **148** leading to the second supply connection **80** is free in the home position.

[0040] This connection is closed as soon as the separating piston **64** is moved toward the separating cylinder cap **104**

via the pressure of the power cylinder **16**. The separating piston **64** thereby simultaneously forms a valve.

1-10. (canceled)

11. A hydraulic block of a power brake system, comprising:

a cuboidal housing block including a power cylinder bore configured to receive a power cylinder, and two chambers, which are arranged above the power cylinder bore and form a brake fluid reservoir;

wherein, on a side of the power cylinder bore that is opposite to the brake fluid reservoir, a separating cylinder is arranged, which extends perpendicularly to the power cylinder bore and in which a separating piston is arranged, which hydraulically separates a first and a second supply connection to a vehicle dynamics control from one another, wherein the separating cylinder is hydraulically connected to the power cylinder so that pressure of the power cylinder can be applied to a first axial piston side of the separating piston and a brake pressure can be generated via a second axial piston side of the separating piston.

12. The hydraulic block according to claim **11**, wherein the first axial piston side of the separating piston is configured such that, when the first axial piston side abuts against a separating cylinder base, a portion of the first axial piston side is spaced apart from the separating cylinder base.

13. The hydraulic block according to claim **11**, wherein an EMC contact for a controller is provided via a cover of the power cylinder.

14. The hydraulic block according to claim **11**, wherein electrical contacts for a controller and a switching valve for switching a connection between a first chamber of the two changes of the brake fluid reservoir and the first supply connection are arranged in an area of a quadrant around a cover of the power cylinder.

15. The hydraulic block according to claim **14**, wherein the electrical contacts for the controller and the switching valve are arranged on a side of the power cylinder that faces an electrical plug of the controller.

16. The hydraulic block according to claim **14**, wherein an undercut, via which the switching valve is connected to the first chamber of the brake fluid reservoir, is formed at the power cylinder bore.

17. A hydraulic block according to claim **11**, wherein the separating piston has at least one through-hole, via which a supply connection for the vehicle dynamics control is connected to a second chamber of the two chambers of the brake fluid reservoir in a home position of the separating piston.

18. The hydraulic block according to claim **11**, wherein the hydraulic block forms two supply connections for the vehicle dynamics control which are oriented toward the controller and arranged vertically one above the other.

19. The hydraulic block according to claim **11**, wherein the switching valve and the power cylinder are connected to a supply connection for the vehicle dynamics control via a common horizontal connection bore.

20. A master-brake-cylinder-free brake system, comprising:

a hydraulic block of a power brake system, including:

a cuboidal housing block including a power cylinder bore configured to receive a power cylinder, and two chambers, which are arranged above the power cylinder bore and form a brake fluid reservoir,

wherein, on a side of the power cylinder bore that is opposite to the brake fluid reservoir, a separating cylinder is arranged, which extends perpendicularly to the power cylinder bore and in which a separating piston is arranged, which hydraulically separates a first and a second supply connection to a vehicle dynamics control from one another, wherein the separating cylinder is hydraulically connected to the power cylinder so that pressure of the power cylinder can be applied to a first axial piston side of the separating piston and a brake pressure can be generated via a second axial piston side of the separating piston.

* * * * *