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(54) **HYDRAULIC OIL CYLINDER, CORRELATIVE DEVICE THEREOF, HYDRAULIC CUSHION SYSTEM, EXCAVATOR AND CONCRETE PUMP TRUCK**

(57) A hydraulic oil cylinder has a cushion collar (4), which is sleeved in the cushion position of a piston rod and can axially slide along the piston rod (3). In the oil cylinder cavity between an oil hole (1-1) of the rod cavity and the terminal position of the piston end surface of the rod cavity during the piston (6) extending movement, a sealing end surface of the rod cavity (1-2) is provided, which can block the cushion collar and contact with the first end surface of the cushion collar to form a sealing surface. At least a throttle oil channel (3-5) is provided between the cushion collar and the piston rod. During

the piston extending movement, from the moment that the first end surface of the cushion collar contacts with the sealing end surface of the rod cavity and a sealing surface is formed to the moment that the piston reaches the terminal position of the extending movement, the hydraulic oil at the side of the sealing surface close to the piston can be discharged towards the oil hole of the rod cavity through the throttle oil channel. The hydraulic oil cylinder has advantages of facility of manufacturing the cushion structure and good effect. The hydraulic oil cylinder can be used in a hydraulic cushion system, an excavator and a concrete pump truck.

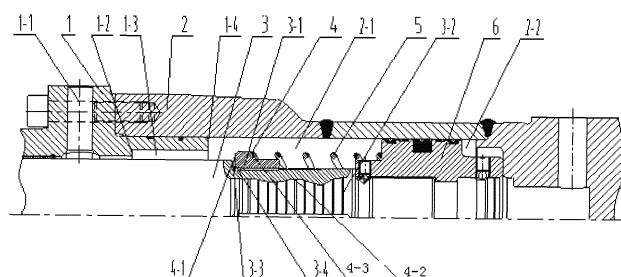


Fig. 2

Description

[0001] The present application claims the benefit of priority to Chinese Patent Application No. 201010235137.7, titled "HYDRAULIC OIL CYLINDER, CORRELATIVE DEVICE THEREOF, HYDRAULIC CUSHION SYSTEM, EXCAVATOR AND CONCRETE PUMP TRUCK", filed with the Chinese State Intellectual Property Office on July 23, 2010, the entire disclosure of which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present application relates to the field of hydraulic technology, and particularly to a hydraulic oil cylinder. The present application also provides related devices for the hydraulic oil cylinder, such as a rod cavity end cover, and a hydraulic buffer system having the hydraulic oil cylinder, an excavator and a concrete pump truck both having the hydraulic oil cylinder.

BACKGROUND OF THE INVENTION

[0003] The hydraulic oil cylinder is a component widely used in the construction machinery, and during the working process of the hydraulic oil cylinder, a piston needs to reciprocate continuously. When a piston rod extends to a limiting position, an end cover may be impacted strongly by a piston end surface, which may cause damage to the hydraulic oil cylinder. Therefore, a buffer device needs to be provided at that position to avoid the damage to the hydraulic oil cylinder caused by the above impact.

[0004] There are great differences among the existing buffer devices according to different applications and different sizes of the hydraulic oil cylinders. A compression spring can be used directly as a buffer device in a small-sized oil cylinder, however, in the hydraulic oil cylinder with a large cylinder diameter and a long stroke, if the compression spring is used as the buffer device, it is hard to obtain a spring having sufficient elasticity, and because that the pressure in the hydraulic oil cylinder is great, the spring will be damaged soon because of being repeatedly compressed. Therefore, the hydraulic oil cylinder with a large cylinder diameter and a long stroke generally use a hydraulic buffer mechanism shown in Figure 1.

[0005] Referring to Figure 1, the buffer device includes a big buffer ring 06, being mounted in an intermediate annular groove arranged on a buffer position of a piston rod, and a big buffer sleeve 04, being sleeved on the buffer position. Corresponding to the big buffer sleeve 04, a buffer inner hole 07, having an inner diameter cooperating with an outer diameter of the big buffer sleeve 04, is provided at a cover opening portion of a rod cavity end cover 01 of the oil cylinder. When the piston rod is extended, the big buffer sleeve 04 is firstly inserted into the buffer inner hole 07 to block an oil-returning oil pas-

sage of the rod cavity in a cylinder barrel 02, and at the same time, a throttling oil channel is formed by a gap between the big buffer sleeve 04 and the buffer inner hole 07; so that, a piston 05 can continue to move in an extending direction, however due to a buffer effect of the throttling oil channel, the movement speed of the piston 05 is slowed down. And when the piston 05 gradually approaches an end position of the extending process of the piston rod 03, the length of the throttling oil channel between the big buffer sleeve 04 and the buffer inner hole 07 is gradually increased, which gradually increases the damping effect of the throttling oil channel, thus the movement of the piston 05 is gradually slowed down until the piston eventually reaches the end position of the extending process of the piston rod 03 smoothly.

[0006] Currently, the above buffer mechanism is widely used in the hydraulic oil cylinder with a large cylinder diameter and a long stroke to provide a better buffer protection for the hydraulic oil cylinder.

[0007] However, the above buffer mechanism also has some obvious disadvantages. Firstly, for the hydraulic oil cylinder with a large cylinder diameter and a long stroke, such as a driving cylinder used for driving a digging arm of an excavator, the hydraulic oil cylinder is generally working in a working condition of huge load and high frequency. In such a case, the big buffer sleeve 04 in the above buffer mechanism needs to repeatedly insert into the above buffer inner hole 07 at a high speed, and because that the fitting interspace between the big buffer sleeve 04 and the buffer inner hole 07 is very small and the piston rod 03 is very heavy, the piston rod 03 is easy to be tilted to one side under the action of gravity. Therefore in the above hydraulic oil cylinder, failures of the buffer mechanism that the buffer sleeve 04 fails to insert into the buffer inner hole 07 are very easy to happen, which may cause the entire hydraulic oil cylinder being not able to operate normally.

[0008] Another key problem of the above buffer mechanism is that, the outer diameter of the big buffer sleeve 04 must fit with the inner diameter of the buffer inner hole 07 precisely, otherwise the buffer effect may not be achieved, thus the buffer mechanism has an extremely high manufacturing precision requirement which is hard to meet for manufacturers with ordinary manufacturing level. Due to the excessive high manufacturing precision requirements, the hydraulic oil cylinder with a large cylinder diameter and a long stroke has become a bottleneck problem for producing construction machineries such as excavators, which severely restricts the production capacity of the manufacturers in downstream production chain.

SUMMARY OF THE INVENTION

[0009] The present application provides a hydraulic oil cylinder, and a buffer system of the hydraulic oil cylinder may realize a buffer effect reliably in an operating condition of large load and high frequency and has a longer

service life. The manufacturing precision requirement for the hydraulic oil cylinder is low, thereby facilitating the production of the hydraulic oil cylinder. The hydraulic oil cylinder particularly facilitates the manufacturing of the hydraulic oil cylinder having a large cylinder diameter and a long stroke.

[0010] The present application further provides related devices used in the above hydraulic oil cylinder, including a piston rod, a rod cavity end cover and a buffer sleeve.

[0011] The present application further provides a hydraulic buffer system having the above hydraulic oil cylinder.

[0012] The present application further provides an excavator having the above hydraulic oil cylinder.

[0013] The present application further provides a concrete pump truck having the above hydraulic oil cylinder.

[0014] The present application provides a hydraulic oil cylinder, wherein a buffer sleeve being able to axially slide along a piston rod is sleeved on a buffer position, located in a rod cavity, of the piston rod; and an end surface of the buffer sleeve away from a piston is a first end surface of the buffer sleeve; a rod cavity sealing end surface is provided in an oil cylinder cavity between a rod cavity oil-passing hole and an end position of a rod cavity end surface of the piston in an extending movement of the piston rod, and is configured to block the buffer sleeve and to abut against the first end surface of the buffer sleeve so as to form a sealing surface; and at least one throttling oil channel is further provided, such that during the extending movement process of the piston rod, the hydraulic oil at a side of the sealing surface close to the piston can flow towards the rod cavity oil-passing hole through the throttling oil channel in a period from a time when the first end surface of the buffer sleeve abuts against the rod cavity sealing end surface to form the sealing surface to a time when the piston reaches an end position of the extending movement.

[0015] Preferably, the throttling oil channel is provided axially and linearly between the piston rod and the buffer sleeve.

[0016] Preferably, an end of the throttling oil channel close to the piston is named a first end, the other end of the throttling oil channel close to the rod cavity oil-passing hole is named a second end, and a cross-sectional area of the throttling oil channel is increased gradually from the first end to the second end.

[0017] Preferably, in the case that the piston rod is extended to a stroke end position, there is a distance between the buffer sleeve and an end point of the sliding movement of the buffer sleeve towards the piston.

[0018] Preferably, in the case that the first end surface of the buffer sleeve contacts the rod cavity sealing end surface to form the sealing surface, an area of an axial action, applied on the buffer sleeve by the hydraulic oil at a side of the sealing surface close to the piston, is greater than an area of an axial action, applied on the buffer sleeve by the hydraulic oil at the other side of the sealing surface close to the rod cavity oil-passing hole.

[0019] Preferably, the piston rod is provided with a buffer position stop shoulder, and in the case that the buffer sleeve is not blocked by the rod cavity sealing end surface, the first end surface of the buffer sleeve is pressed against the buffer position stop shoulder under the action of an elastic member having elasticity.

[0020] Preferably, a piston stop shoulder is provided at the end position of the extending movement of the piston rod, for allowing the buffer sleeve to pass through and stopping the piston at the end position.

[0021] Preferably, the first end surface of the buffer sleeve abuts against the rod cavity sealing end surface to form a surface sealing or a linear sealing.

[0022] Preferably, a main body of the throttling oil channel is a throttling groove arranged axially and linearly on a surface of the piston rod.

[0023] Preferably, in the case that the buffer sleeve is blocked by the rod cavity sealing end surface and slides relatively towards the piston, a flow sectional area of the throttling groove is reduced accordingly.

[0024] Preferably, an oil-passing groove is arranged on the buffer position stop shoulder at a position corresponding to an end point of the throttling groove.

[0025] Preferably, one or a plurality of annular grooves functioning as balancing grooves are provided on an outer surface of the buffer position of the piston rod, or on an inner diameter surface of the buffer sleeve, and a cross section of the annular groove is V-shaped, U-shaped, square or other forms.

[0026] Preferably, the throttling oil channel includes two sections, that is, a front section close to the piston and a rear section close to the rod cavity oil-passing hole; a main body of the front section is a throttling groove axially provided on a surface of the piston rod, and a main body of the rear section is a hidden oil channel extending axially in the piston rod.

[0027] Preferably, the throttling oil channel includes a hidden oil channel extending axially in the piston rod and a plurality of throttling oil holes communicating a surface of the piston rod with the hidden oil channel, the throttling oil holes are axially distributed on the surface of the piston rod, and the closer the throttling oil hole is to an outlet of the hidden oil channel, the larger the hole diameter of the throttling oil hole is; and the outlet of the hidden oil channel is a second end of the throttling oil channel, and the throttling oil holes are a first end of the throttling oil channel.

[0028] Preferably, a main body of the throttling oil channel is a chamfered surface axially arranged on the surface of the piston rod.

[0029] Preferably, a transition sleeve cooperating with the piston rod is sleeved on the buffer position, and the throttling oil channel is arranged on the transition sleeve.

[0030] Preferably, one or a plurality of annular grooves functioning as balancing grooves are provided on the transition sleeve, and a cross section of the annular groove is V-shaped, U-shaped, square or other forms.

[0031] Preferably, the rod cavity sealing end surface

is provided on the rod cavity end cover.

[0032] Preferably, the piston stop shoulder is an end surface of a cover opening of the rod cavity end cover.

[0033] The present application also provides a hydraulic oil cylinder related device, in particular a piston rod, wherein the piston rod is provided with a buffer position stop shoulder located at a starting point of the buffer position and at least one throttling oil channel extending axially on a surface of the piston rod, a first end of the throttling oil channel is an end close to a position where a rod cavity end surface of a piston is located after the piston is mounted, and a second end of the throttling oil channel is the other end located on a side wall of an undercut of the buffer position stop shoulder.

[0034] Preferably, a cross-sectional area of the throttling oil channel is increased gradually from the first end to the second end.

[0035] Preferably, a main body of the throttling oil channel is a throttling groove extending axially on the surface of the piston rod, and the cross-sectional area of the throttling groove is gradually increased from the first end to the second end by gradually increasing a depth of the throttling groove.

[0036] Preferably, the buffer position of the piston rod is provided with a plurality of annular grooves functioning as balancing oil grooves.

[0037] The present application further provides another hydraulic oil cylinder related device, in particular a rod cavity end cover, from a top end to a cover opening of the rod cavity end cover, a rod cavity oil-passing hole and a rod cavity sealing end surface are sequentially provided, and the rod cavity sealing end surface is a stepped surface having an integral annular shape provided in an inner cavity of the rod cavity end cover.

[0038] Preferably, the cover opening of the rod cavity end cover functions as the piston stop shoulder.

[0039] The present application further provides a hydraulic oil cylinder related device, in particular a buffer sleeve, the buffer sleeve has an outer diameter smaller than an inner diameter of a cylinder barrel of a hydraulic oil cylinder in which the buffer sleeve works, an inner diameter of the buffer sleeve is configured to enable the buffer sleeve to be sleeved on a piston rod buffer position and to slide freely in an axial direction; upon assembling, a first end surface, away from the piston, of the buffer sleeve is configured to abut against a sealing end surface, located in an oil cylinder cavity between a rod cavity oil-passing hole and an end position of an extending movement of the piston rod, so as to form a sealing surface.

[0040] Preferably, an end surface of the buffer sleeve opposite to the first end surface is provided with a central protruding portion cooperating with a compression spring.

[0041] The present application provides a hydraulic buffer system including the hydraulic oil cylinder described in any one of the above technical solutions.

[0042] The present application also provides an exca-

vator including at least one hydraulic oil cylinder described in any one of the above technical solutions.

[0043] The present application also provides a concrete pump truck including at least one hydraulic oil cylinder described in any one of the above technical solutions.

[0044] In the hydraulic oil cylinder provided by the present application, when the piston rod is extended to the buffer position, the first end surface of the buffer sleeve cooperates with the rod cavity sealing end surface arranged in the oil cylinder cavity at a rod cavity side to form a sealing surface so as to block the oil passage. The rod cavity is divided into two cavity bodies by the sealing surface, a cavity body located at a side of the sealing surface close to the piston is referred to as a buffer oil cavity, and the other cavity body is located at a side of the sealing surface close to the rod cavity oil-passing hole. The hydraulic oil in the buffer oil cavity being pushed by the piston has a higher oil pressure and may press the first end surface of the buffer sleeve against the rod cavity sealing end surface tightly, such that the sealing effect of the sealing surface, formed by the first end surface of the buffer sleeve and the rod cavity sealing end surface abutted together, is more reliable. The oil cylinder is further provided with a throttling oil channel, and the throttling oil channel may provide an oil passage for the hydraulic oil in the buffer oil cavity to flow to a side of the rod cavity oil-passing hole in a period from the sealing surface is formed to the piston reaches the end position of the extending movement. Due to the formed sealing surface, which blocks the oil passage, the hydraulic oil can flow, only through the throttling oil channel, towards the rod cavity oil-passing hole, and the oil passage of the throttling oil channel is very narrow, thus a passing capability of the hydraulic oil is restricted, such that the movement of the piston is subjected to a great resistance, thereby realizing the buffer effect.

[0045] In a preferred embodiment of the present application, the above throttling oil channels may be arranged axially and linearly between the piston rod and the buffer sleeve, such that the hydraulic oil in the buffer oil cavity may be discharged smoothly and directly to the side of the rod cavity oil-passing hole, and an axial range of the throttling oil channel is easy to determine, which ensures that the throttling oil channel can be formed after the sealing surface is formed so as to avoid blocking during the buffer process. Further, the cross-sectional area of the throttling oil channel can be changed according to the requirements, specifically, an end of the throttling oil channel close to the piston has a smaller cross-sectional area and the other end of the throttling oil channel close to rod cavity oil-passing hole has a larger cross-sectional area.

[0046] In a further preferred embodiment, a main body of the throttling oil channel is a throttling groove arranged axially on the surface of the piston rod, and a cross-sectional area of the throttling groove is gradually increased from the first end to the second end. In this way, as the

piston rod moves to the end position, the buffer sleeve slides relatively on the piston rod to gradually approach the first end of the throttling oil channel, thus the discharging capacity from a side of the sealing surface close to the buffer oil cavity to the other side of the sealing surface close to the rod cavity oil-passing hole is gradually reduced, the resistance for the extending movement of the piston is gradually increased, and the movement speed of the piston is gradually reduced, thereby achieving a good buffer effect. Due to the throttling grooves arranged axially and linearly, in the case of a constant width, the throttling effect can be well controlled by controlling the depth variation of the throttling groove, thereby realizing a smooth buffer process. The depth of the throttling groove is easy to control during the machining process, thus the throttling groove has a good manufacturability.

[0047] In a further preferred embodiment of the present application, in the case that the throttling groove is provided, a plurality of annular grooves functioning as balancing oil grooves are provided on the outer diameter surface of the piston rod or the inner diameter surface of the buffer sleeve, and the balancing oil grooves can cooperate with the throttling groove, such that the hydraulic oil may distributed evenly on the inner diameter surface of the buffer sleeve, which ensures that the first end surface of the buffer sleeve will not be inclined when abutting against the rod cavity sealing end surface, thereby ensuring the tightness of the sealing surface.

[0048] In another preferred embodiment of the present application, the following condition has to be satisfied: when the first end surface of the buffer sleeve contacts with the rod cavity sealing end surface to form the sealing surface, an area of an axial action, applied on the buffer sleeve by the hydraulic oil at a side of the sealing surface close to the piston, is greater than an area of an axial action, applied on the buffer sleeve by the hydraulic oil at the other side of the sealing surface close to the rod cavity oil-passing hole. The above condition is easy to be satisfied by designing the two end surfaces of the buffer sleeve. If the above condition is not satisfied, the oil pressure at two sides of the sealing surface are substantially same at the moment when the sealing surface is formed, and when the first end surface of the buffer sleeve is pressed towards the rod cavity sealing end surface at a certain speed, the first end surface of the buffer sleeve may not be pressed tightly against the rod cavity sealing end surface at the above moment, which may affect the smoothness of the buffer process at that time point. If the above condition is satisfied, a total pressure V_1 is obtained by multiplying the oil pressure at the side of the sealing surface close to the piston by the area of the axial action applied on the buffer sleeve at the same side, and a total pressure V_2 is obtained by multiplying the oil pressure at the other side of the sealing surface close to the rod cavity oil-passing hole by the area of the buffer sleeve at the other side. Because the oil pressure at two sides of the sealing surface are substantially same at the moment when the sealing surface is formed, a total

pressure at a side having a larger area is relatively large, i.e. $V_1 > V_2$, thus in this way, the buffer sleeve can be tightly pressed against the rod cavity sealing end surface, thereby ensuring the smoothness of the buffer process.

[0049] Other preferred embodiments of the present application also provide throttling oil channels in other forms, which also can achieve a good discharging effect.

[0050] The present application also provides a plurality of parts for the hydraulic oil cylinder, for example a piston rod, a rod cavity end cover and a big buffer sleeve, and these parts are all designed specifically to realize the above buffer mechanism.

[0051] The present application also provides a hydraulic buffer system having the above hydraulic oil cylinder, and the hydraulic buffer system having the above hydraulic oil cylinder can achieve a good and stable buffer effect.

[0052] The present application also provides an excavator and a concrete pump truck both having the above hydraulic oil cylinder, and by using the above hydraulic oil cylinder, the excavator and the concrete pump truck can obtain a longer trouble-free service time.

BRIEF DESCRIPTION OF THE DRAWINGS

[0053] Figure 1 is the hydraulic oil cylinder described in the background art having a buffer mechanism in which a buffer sleeve is inserted into a buffer inner hole;

[0054] Figure 2 is a mechanical structural view of a hydraulic oil cylinder according to a first embodiment of the present application;

[0055] Figure 3 is a part drawing of a piston rod in the first embodiment of the present application;

[0056] Figure 4 is a view of the piston rod 3 taken along the line A-A;

[0057] Figure 5 is a sectional view of the piston rod 3 taken along the line C-C;

[0058] Figure 6 shows the hydraulic oil cylinder, in a state when a sealing surface starts to form, according to the first embodiment of the present application;

[0059] Figure 7 shows the hydraulic oil cylinder, in a state when the piston moves to an end position, according to the first embodiment of the present application;

[0060] Figure 8 is a mechanical structural view of a hydraulic oil cylinder according to a second embodiment of the present application;

[0061] Figure 9 is a part drawing of a transition sleeve in the second embodiment of the present application;

[0062] Figure 10 is a part drawing of a buffer sleeve in the second embodiment of the present application, wherein a balancing oil groove is provided on an inner diameter surface of the buffer sleeve;

[0063] Figure 11 is a schematic view of a throttling oil channel suitable for using in a buffer mechanism having a transition sleeve;

[0064] Figure 12 is schematic view of another throttling oil channel suitable for using in the buffer mechanism having the transition sleeve; and

[0065] Figure 13 is a schematic view of a throttling oil channel suitable for using in a buffer mechanism having no transition sleeve.

DETAILED DESCRIPTION OF THE INVENTION

[0066] The first embodiment of the present application provides a hydraulic oil cylinder with a buffer device provided in a rod cavity side of the hydraulic oil cylinder.

[0067] Referring to Figure 2, Figure 2 is a mechanical structural view of the hydraulic oil cylinder according to the first embodiment of the present application.

[0068] As shown in Figure 2, the hydraulic oil cylinder includes a rod cavity end cover 1, a cylinder barrel 2, a piston rod 3, a buffer sleeve 4, a spring 5 and a piston 6.

[0069] The cylinder barrel 2 provides a space to seal the hydraulic oil for the hydraulic oil cylinder, an inner cavity of the cylinder barrel 2 is divided into a rod cavity 2-1 and a rodless cavity 2-2 by the piston 6 which is movable axially along a cavity body of the inner cavity, and a cavity body at which the piston rod 3 is located is the rod cavity 2-1. An outer diameter surface of the piston 6 cooperates with an inner diameter surface of the cylinder barrel 2 and multiple sealing rings are provided on the outer diameter surface so as to completely isolate the hydraulic oil in the rod cavity 2-1 from the hydraulic oil in the rodless cavity 2-2.

[0070] The cylinder barrel 2 is sealed by an end head, located at a side of the rod cavity 2-1 of the cylinder barrel 2, of the rod cavity end cover 1, and a rod cavity oil-passing hole 1-1 is provided on the rod cavity end cover 1 and is connected to an oil tube so as to provide a passage for the hydraulic oil in the whole inner cavity of the cylinder barrel 2 to flow into or out of the rod cavity 2-1. A passage for the hydraulic oil to flow into or out of the rodless cavity 2-2 is provided by a rodless cavity oil-passing hole provided on a rodless cavity end cover of the cylinder barrel 2. This embodiment only describes the buffer device at the rod cavity side and does not involve the situation at a side of the rodless cavity 2-2.

[0071] A buffer mechanism of the hydraulic oil cylinder includes the buffer sleeve 4, the spring 5, and structures provided on the piston 6, the piston rod 3 and the rod cavity end cover 1 for forming the buffer mechanism.

[0072] The buffer sleeve 4 is sleeved on a buffer position, located in the rod cavity 2-1, of the piston rod 3. The buffer position is a piston rod section with a certain length on the piston rod 3 starting from an end surface of the piston 6 at the side of the rod cavity 2-1, and at this rod section the buffer process must be performed to avoid the damage to the rod cavity end cover 1 caused by direct impacting of the piston 6. The piston rod 3 is provided with a buffer position stop shoulder 3-4 at a position having a certain distance from the end surface of the piston 6, and the buffer position is a piston rod section starting from the buffer position stop shoulder 3-4 to a position at which a second end surface 4-2 of the buffer sleeve 4 is located when the piston 6 reaches an end position of

the extending movement. The buffer sleeve 4 may slide on the piston rod 3 within the above position range of the buffer position. An inner diameter of the buffer sleeve 4 is configured in a way which enables the buffer sleeve 4 to slide axially along the piston rod 3 and meanwhile keeps a small gap between the buffer sleeve 4 and the piston rod 3; an outer diameter of the buffer sleeve 4 is significantly smaller than an inner diameter of the cylinder barrel 2, and a length of the buffer sleeve 4 accounts for a part of the length of the buffer position. An end surface of the buffer sleeve 4, facing a top end of the oil cylinder, i.e. an end surface at a side of the rod cavity end cover 1, is a plane having a chamfered outer edge, and the plane is referred to as a first end surface 4-1 of the buffer sleeve 4. The other end of the buffer sleeve 4 is referred to as a second end surface 4-2 of the buffer sleeve 4, and a protruding portion 4-3 for fixing the spring 5 is further provided on the buffer sleeve 4. The design of the buffer sleeve needs to preferably ensure the establishment of the following conditions, when the first end surface of the buffer sleeve contacts with a rod cavity sealing end surface to form the sealing surface, an area of an axial action, applied on the buffer sleeve by the hydraulic oil at a side of the sealing surface close to the piston, is greater than an area of an axial action, applied on the buffer sleeve by the hydraulic oil at the other side of the sealing surface close to the rod cavity oil-passing hole. For example, in the first embodiment, a part of the first end surface of the buffer sleeve is shielded by the rod cavity sealing end surface 1-2 such that the area of the axial action applied on the first end surface of the buffer sleeve by the hydraulic oil is obviously smaller than that on the other end surface.

[0073] The spring 5 is a compression spring having compression tension and is surroundingly provided on the piston rod 3, a bottom end of the spring 5 abuts against an end surface, at the side of the rod cavity 2-1, of the piston 6, and a spring protruding portion for fixing the spring is provided on the above end surface of the piston 6. A rear end of the spring 5 abuts against the protruding portion 4-3 of the buffer sleeve 4. By resting against the end surface of the piston 6, the spring 5 may abut against the buffer sleeve 4 with its elastic force, such that the first end surface 4-1 of the buffer sleeve 4 may abut against the buffer position stop shoulder 3-4 of the piston rod 3 when the piston 6 is not moved to the buffer position. The elastic force of the spring 5 is configured in a way, as long as it is enough for making the buffer sleeve 4 abut against the buffer position stop shoulder 3-4 when the buffer sleeve 4 is not blocked, i.e., the spring 5 provides a reset function.

[0074] The rod cavity oil-passing hole 1-1 and the rod cavity sealing end surface 1-2 are sequentially provided on the rod cavity end cover 1 from a cover top to a cover opening. The rod cavity sealing end surface 1-2 is a stepped surface having an integral annular shape provided in an inner cavity of the rod cavity end cover 1, and the stepped surface is facing the piston 6. When the buff-

er process starts, the rod cavity sealing end surface 1-2 can cooperate with the first end surface 4-1 of the buffer sleeve so as to form a sealing surface for separating the hydraulic oil in the rod cavity 2-1. The rod cavity end cover 1 also has a buffer sleeve passing section 1-3 extending from the rod cavity sealing end surface 1-2 towards the piston 6, an inner diameter of a cavity body at where the buffer sleeve passing section 1-3 is located is larger than an inner diameter of the cavity body at where the rod cavity sealing end surface 1-2 is located, is smaller than an inner diameter of the cylinder barrel 2 at where the piston 6 is located, and is also larger than an outer diameter of the buffer sleeve 4 such that the buffer sleeve 4 can enter this section smoothly. An end surface of the cover opening of the rod cavity end cover 1 abuts against an inner wall surface of the cylinder barrel to form a piston stop shoulder 1-4 for locating an end point of the movement of the piston 6.

[0075] The piston rod 3 is provided with a plurality of structures related to the buffer mechanism, and except for the buffer position, related to the mounting of the buffer sleeve 4, and the buffer position stop shoulder 3-4, other structures are further provided, such as throttling grooves, balancing oil grooves and oil-passing grooves, which will be described in detail hereinafter. Referring to Figure 3, Figure 3 is a part drawing of the piston rod 3; referring to Figure 4, Figure 4 is a view of the piston rod 3 taken along the line A-A; and referring to Figure 5, Figure 5 is a sectional view of the piston rod 3 taken along the line C-C.

[0076] The piston rod 3 is provided with at least one throttling oil channel, and a main body of the throttling oil channel is a throttling groove 3-1 located on an outer diameter surface of the piston rod 3 and extending axially. The throttling groove 3-1 is provided on the piston rod, a starting point (or referred to as a first end) of the throttling groove 3-1 is located at a position close to a rod cavity end surface of the piston, and an end point (or referred to as a second end) of the throttling groove 3-1 reaches a sidewall of an undercut of the buffer position stop shoulder 3-4 of the piston rod 3. Relative to the end point, the first end is located at the position close to the rod cavity end surface of the piston; and in fact, the position of the starting point of the throttling groove 3-1 needs to cooperate with an end position of the extending movement of the piston 6, such that there is an appropriate hydraulic buffer capability before the piston 6 reaches the end position. In the present embodiment, the first end has been shielded completely by the buffer sleeve 4 before the piston 6 reaches the end position.

[0077] The buffer position stop shoulder 3-4 is provided with oil-passing grooves 3-3 corresponding to outlets of the throttling grooves 3-1, as can be seen from Figure 4, the position of the oil-passing grooves 3-3 are precisely aligned to the outlets of the throttling grooves 3-1, and there are four oil-passing grooves 3-3 corresponding to four throttling grooves 3-1. These oil-passing grooves 3-3 provides an outflowing passage for the hydraulic oil

flowing out of the outlets of the throttling groove 3-1, such that the flow direction of the hydraulic oil flowing out of the throttling grooves 3-1 during the buffer process is more stable, and these oil-passing grooves 3-3 also provides an outlet for the hydraulic oil at the moment when the first end surface 4-1 of the buffer sleeve 4 abuts against the rod cavity sealing end surface, thereby avoiding the situation that a hydraulic damping is suddenly increased and ensuring the smooth operation.

[0078] A plurality of annular grooves, which are referred to as balancing oil grooves 3-2, are uniformly distributed on the circumferential surface of the buffer position of the piston rod 3. The cross sections of the balancing oil grooves 3-2 may be U-shaped, V-shaped or square or other forms, which are determined according to the requirements, and a depth of the balancing oil grooves 3-3 may also be determined by experiments according to the requirements. The balancing oil grooves 3-2 are provided to realize an oil-pressure balance when the hydraulic oil flows through the throttling grooves 3-1, thereby avoiding an untighten sealing of the sealing surface during the buffer process caused by the buffer sleeve 4 being tilted under an unbalanced oil pressure.

[0079] The operation process of the buffer mechanism of the hydraulic oil cylinder according to the present embodiment will be illustrated hereinafter. Figure 2 shows a state when the piston 6 has not yet reached to the buffer position; referring to Figure 6, a state when the buffer process is beginning is showed; and referring to Figure 7, a state when the buffer process is finished is showed.

[0080] At the position shown in Figure 2, the piston rod 3 has just begun the extending movement and not yet reached the position where the buffer process needs to start. At this time, under the action of the elastic force of the spring 5, the first end surface 4-1 of the buffer sleeve 4 abuts against the buffer position stop shoulder 3-4 of the piston rod 3. And the buffer sleeve 4 is pressed against the buffer position stop shoulder 3-4 during the period before the piston 6 moves to the buffer position, and the period after the first end surface 4-1 of the buffer sleeve 4 is separated from the rod cavity sealing end surface 1-2 by the retracting movement of the piston rod 3, therefore, the spring 5 provides a reset function. Along with the extending movement of the piston rod 3, the hydraulic oil in the rod cavity 2-1 is pushed by the piston to flow towards the rod cavity oil-passing hole 1-1 and flow out from the rod cavity oil-passing hole 1-1. The buffer sleeve 4 moves along with the piston 6 and the piston rod 3 and after moving a certain distance may pass through the buffer sleeve passing section 1-3 of the rod cavity end cover 1, and because the outer diameter of the buffer sleeve 4 is smaller than the buffer sleeve passing section 1-3, the buffer sleeve 4 will not be blocked and may continue to move along with the piston rod 3. As the buffer sleeve 4 enters the buffer sleeve passing section 1-3, the oil passage of the hydraulic oil in the rod cavity 2-1 is partially blocked, the hydraulic oil can flow, only through the gap between the buffer sleeve 4 and

the buffer sleeve passing section 1-3, towards the rod cavity oil-passing hole 1-1, thus the damping action from the oil passage applied on the piston 6 is significantly increased; as the buffer sleeve 4 enters further in the buffer sleeve passing section 1-3 gradually, the blocking extent of the oil passage of the hydraulic oil is gradually increased, and the hydraulic damping applied on the piston 6 is gradually increased, and then the damping action of the oil passage reaches a substantially constant stable period until the buffer sleeve 4 is completely into the buffer sleeve passing section 1-3.

[0081] After the buffer sleeve 4 is moved in the buffer sleeve passing section 1-3 for a certain time, the first end surface 4-1 of the buffer sleeve 4 gradually approaches the rod cavity sealing end surface 1-2 on the rod cavity end cover 1. When moving to the position shown in Figure 6, the first end surface 4-1 of the buffer sleeve 4 abuts against the rod cavity sealing end surface 1-2 on the rod cavity end cover 1 so as to form an integral sealing surface, such that the oil passage of the hydraulic oil, pushed by the piston 6, in the rod cavity 2-1 flowing towards the rod cavity oil-passing hole 1-1 through the gap between the buffer sleeve 4 and the buffer sleeve passing section 1-3 of the rod cavity end cover 1 is completely blocked, and being blocked by the sealing end surface 1-2, the buffer sleeve 4 stops moving forward along with the piston rod 3.

[0082] The oil pressure at two sides of the sealing surface are substantially same at the moment when the sealing surface is formed, and when the first end surface 4-1 of the buffer sleeve 4 is pressed towards the rod cavity sealing end surface 1-2 at a certain speed, the first end surface 4-1 of the buffer sleeve 4 may not be pressed tightly against the rod cavity sealing end surface 1-2 at the above moment, which may affect the smoothness of the buffer process at that time point. For solving the above problem, the following condition is satisfied in design: when the first end surface 4-1 of the buffer sleeve 4 contacts with the rod cavity sealing end surface 1-2 to form the sealing surface, an area of an axial action, applied on the buffer sleeve by the hydraulic oil at a side of the sealing surface close to the piston, is greater than an area of an axial action, applied on the buffer sleeve by the hydraulic oil at the other side of the sealing surface close to the rod cavity oil-passing hole. In this embodiment, areas of two end surfaces of the buffer sleeve 4 are same, however, after the sealing surface is formed, the first end surface 4-1 is partially shielded, thereby satisfying the above condition. After the above condition is satisfied, a total pressure $V1$ is obtained by multiplying the oil pressure at the side of the sealing surface close to the piston by the area of the axial action applied on the buffer sleeve at the same side, and a total pressure $V2$ is obtained by multiplying the oil pressure at the other side of the sealing surface close to the rod cavity oil-passing hole by the area of the buffer sleeve at the other side. Because the oil pressure at two sides of the sealing surface are substantially same at the moment when the

sealing surface is formed, a total pressure at a side having a larger area is relatively large, i.e. $V1 > V2$, thus in this way, the buffer sleeve can be tightly pressed against the rod cavity sealing end surface 1-2, thereby ensuring the smoothness of the process of forming the sealing surface.

[0083] After the sealing surface is formed, the buffer sleeve 4 and the rod cavity end cover 1 form a one-way valve, thereby blocking the oil passage. At this point, the hydraulic oil in the rod cavity is divided into two cavity bodies, and one cavity body at a side close to the piston 6 is referred to as a buffer oil cavity T. The hydraulic oil in the buffer oil cavity T is pushed by the piston 6, and a main passage of the hydraulic oil flowing towards the rod cavity oil-passing hole 1-1 is restricted by the formed sealing surface, thus the pressure of the buffer oil cavity T is further increased, and the increased oil pressure is enough to press the buffer sleeve 4 against the rod cavity sealing end surface 1-2 tightly, which makes the sealing surface more reliable. At this time, the hydraulic oil can flow, only through the throttling groove 3-1, towards the side of the sealing surface having the rod cavity oil-passing hole 1-1. During an initial stage of the formation of the sealing surface, a depth of the throttling groove 3-1 at the second end side is relatively larger, such that the flow capability of the throttling groove 3-1 is relatively higher and more hydraulic oil may flow through the throttling groove 3-1. As the piston rod 3 continues to move, the sealing surface moves backward relative to the piston rod 3, such that the depth of the throttling groove 3 communicating two sides of the sealing surface with each other is gradually reduced, which gradually reduces the flow capability of the throttling groove 3. During the above process, when flowing through the throttling groove 3-1, the hydraulic oil flows through the balancing oil grooves 3-2 and fills a rod section at where the buffer sleeve is located, such that the oil pressure on the buffer sleeve at various positions in the circumferential direction are balanced which ensures that the buffer sleeve 4 will not be tilted, thereby ensuring the sealing effect of the sealing surface.

[0084] After reaching the position shown in Figure 7, the piston 6 is blocked by the piston stop shoulder 1-4 formed at the end surface of the cover opening of the rod cavity end cover 1, thus cannot move forward; and the piston rod 3 reaches the end position of the extending process, and at this time, the first end of the throttling groove 3-1 has already entered into the buffer sleeve 4, thus the throttling oil channel is substantially blocked and the buffer process is finished. It should be noted that when the piston 6 moves to the end position, there is still a distance L between the second end surface of the buffer sleeve 4 and the rod cavity end surface of the piston 6, which ensures that the normal movement of the piston 6 will not be blocked by the buffer sleeve 4. The distance L is a distance between the buffer sleeve and an end point of the sliding movement of the buffer sleeve towards the piston, when the piston rod is extended to the end

position of the stroke.

[0085] When the piston rod 3 starts to retract, i.e., when the piston 6 starts to move rightwards, the piston rod 3 is at the end position of the extending stroke, and the buffer sleeve 4 and the rod cavity end cover 1 are in a contact sealing state. For making the oil flow into the rod cavity quickly so as to push the piston rod 3 to retract, there is the distance L between the buffer sleeve 4 and the end point of the sliding movement of the buffer sleeve 4 towards the piston 6. Under the action of the hydraulic oil, the buffer sleeve 4 compresses the spring 5 and slides towards the piston 6, thus the first end surface 4-1 of the buffer sleeve 4 is separated from the rod cavity sealing end surface 1-2 of the rod cavity end cover 1. During the retraction process of the piston rod 3, the buffer sleeve 4 and the rod cavity end cover 1 cooperate with each other to function as a one-way valve.

[0086] The greater the distance L, the larger the separation distance between the first end surface 4-1 of the buffer sleeve 4 and the rod cavity sealing end surface 1-2 of the rod cavity end cover 1, and the more the flow quantity of the hydraulic oil flowing into the rod cavity. The smaller the distance L, the smaller the separation distance between the first end surface 4-1 of the buffer sleeve 4 and the rod cavity sealing end surface 1-2 of the rod cavity end cover 1, and the fewer the flow quantity of the hydraulic oil flowing into the rod cavity.

[0087] In fact, due to a gap provided between the buffer sleeve 4 and the piston rod 3, a few amount of hydraulic oil can also enter into the throttling groove 3-1 through the above gap to be discharged. Thus in this way, when the first end of the throttling groove 3-1 is shielded completely by the buffer sleeve 4, the piston 6 will not be stuck due to excessive hydraulic oil stored in the buffer oil cavity. Of course, the first end of the throttling groove 3-1 can also be exposed out of the buffer sleeve 4 when the piston rod 3 reaches the end position of the extending process. The position of the first end of the throttling groove 3-1 and the positional relationship thereof with the buffer sleeve 4 can be designed according to the buffer damping needs.

[0088] During the buffer process, the damping effect of the hydraulic oil is gradually increased from the time when the buffer sleeve 4 enters the buffer sleeve passing section 1-3 of the rod cavity end cover 1; specifically, along with the changing of the depth of the throttling groove 3-1, the throttling capability is gradually increased and the hydraulic damping is gradually increased, such that the speed of the piston 6, before reaching the end position, is gradually reduced. At the final short distance, an oil channel can be formed only by the gap between the buffer sleeve 4 and the piston rod 3. During the whole buffer process, the hydraulic damping is gradually increased, thereby avoiding the impact on the rod cavity end cover 1 and the cylinder barrel 2.

[0089] In the above buffer mechanism, under the premise that a width of the throttling groove 3-1 is not changed, a changing curve of the throttling capability of

the throttling groove 3-1 can be controlled by controlling the changing of the depth of the throttling groove 3-1, thereby ensuring the piston 6 having a very smooth buffer process.

[0090] In fact, instead of being provided on the piston rod 3, the balancing oil grooves may also be provided on an inner diameter surface of the buffer sleeve 4, which may have the same effect as being provided on the piston rod 3. Figure 10 shows a buffer sleeve 4 with balancing oil grooves 4-4 provided on its inner diameter surface. In addition, instead of being annular groove, the balancing oil grooves 3-3 can also be thread groove, however, the annular groove used in the present embodiment is preferable, because it is easy to process and has a better balancing effect.

[0091] In the above embodiments, the passages, communicating the cavity bodies at two sides of the sealing surface with each other after the sealing surface is formed, are all referred to as the throttling oil channel, and in the above embodiments, the main body of the throttling oil channel is the throttling groove, however, the composition of the throttling oil channel is different at different times. At the moment when the sealing surface is formed, the oil-passing groove 3-3, provided on the buffer position stop shoulder and corresponding to the throttling groove, functions as an opening of the second end of the throttling passage and has an important effect for realizing the smoothness of the buffer process. If the throttling groove is shielded completely by the buffer sleeve when the buffer sleeve 4 slides to the end position of the buffer position, the gap between the buffer sleeve 4 and the piston rod 3 also constitutes a part of the throttling oil channel.

[0092] In the above embodiments, the second end of the throttling oil channel is provided on the side wall of the buffer position stop shoulder. In fact, the second end of the throttling oil channel may be provided at other positions, as long as the second end of the throttling oil channel is still in the inner cavity of the hydraulic oil cylinder when the piston reaches the end position.

[0093] In the above embodiments, the planar sealing surface, formed by the rod cavity sealing end surface abutting against the first end surface of the buffer sleeve, is a surface contacting sealing surface, and actually, a corresponding design can be performed to the rod cavity sealing end surface and the first end surface of the buffer sleeve, such that the formed sealing surface may be a planar sealing structure, a conical sealing structure, a curved surface sealing structure, or other surface sealing structures, or a linear sealing structures.

[0094] The second embodiment of the present application provides a hydraulic oil cylinder, a rod cavity side of which is provided with a buffer device. The second embodiment is substantially identical with the first embodiment, except that a transition sleeve 12 is sleeved on the buffer position of the piston rod 3.

[0095] Referring to Figure 8, Figure 8 is the hydraulic oil cylinder provided by the second embodiment of the

present application. The second embodiment is derived by modifying the first embodiment, and in the following description, parts that are identical with the first embodiment are indicated by the same reference numerals.

[0096] Differing from the first embodiment, the transition sleeve 12 is sleeved on the buffer position of the piston rod 3 of the hydraulic oil cylinder, a radial length of the transition sleeve 12 is enough to take up most of the length of the buffer position, and an inner diameter of the transition sleeve 12 cooperates with the outer diameter of the buffer position of the piston rod 3, such that the transition sleeve 12 may be tightly sleeved on the buffer position of the piston rod 3.

[0097] Figure 9 is a part drawing of the transition sleeve 12. As can be seen from Figure 9, an outer diameter surface of the transition sleeve 12 is provided with a throttling groove 12-1 extending axially, and a depth of the throttling groove 12-1 is gradually increased from a rear end of the transition sleeve 12, close to the piston, to a front end of the transition sleeve 12, close to the rod cavity oil-passing hole. The throttling groove 12-1 has a first end located at a position close to a rear end surface of the transition sleeve 12, and a second end located at a front end surface of the transition sleeve 12. Four throttling grooves 12-1 are evenly distributed on the outer diameter surface of the transition sleeve 12 to form the throttling oil channel together. Meanwhile, the outer diameter surface of the transition sleeve 12 is further provided with a plurality of annular grooves functioning as the compensating oil grooves 12-4.

[0098] In fact, instead of being provided on the transition sleeve 12, the compensating oil groove may also be provided on the inner diameter surface of the buffer sleeve 4, which may have the same effect as being provided on the transition sleeve 12. Figure 10 shows a buffer sleeve 4 with compensating oil grooves provided on its inner diameter surface.

[0099] The working process of the above hydraulic oil cylinder is identical with that of the first embodiment, which will not be described in detail herein.

[0100] The second embodiment has the following advantages. By using the above technical solution, there is no need to machine throttling grooves extending axially on the buffer position of the piston rod 3. Due to the piston rod 3 having a relatively long length, it is difficult to machine throttling grooves, having relatively high precision requirement, on the surface of the piston rod 3. It is relatively simple and convenient to machine throttling grooves 12-1 on the transition sleeve 12 having a shorter length.

[0101] Further, there are a variety of options for the structure and size of the throttling groove, in the above technical solution, the throttling grooves with different size and structure can be obtained by changing a piston shaft sleeve, which may meet the buffer requirement flexibly.

[0102] In the above two embodiments, the main bodies of the throttling oil channels are both throttling grooves.

In fact, the throttling oil channel may use other structural forms, which are shown in Figures 11 to 13.

[0103] Figure 11 shows a throttling oil channel suitable for using in a buffer mechanism having a transition sleeve. The throttling oil channel can include two sections, a front section close to the first end is a throttling groove 12-1 axially provided on the surface of the transition sleeve 12, a rear section close to the second end is a hidden oil channel 12-2 extending axially in the transition sleeve, and the above way can also have the throttling effect. The section of the throttling groove 12-1 can also be designed in this way that the depth thereof is gradually increased from the first end to the second end so as to achieve the smooth buffer effect.

[0104] Figure 12 shows another throttling oil channel suitable for using in a buffer mechanism having a transition sleeve. As shown, the throttling oil channel includes a hidden oil channel 12-2 extending axially in the transition sleeve 12 and a plurality of throttling oil holes 12-3 communicating the surface of the piston rod with the hidden oil channel. The throttling oil holes are axially distributed on the surface of the piston rod, and the closer the throttling oil hole is to the front end surface of the transition sleeve 12, the larger the hole diameter of the throttling oil hole is. In this way, as the buffer sleeve slides on the piston rod, the piston rod 3 gradually approaches the end position of the extending process, thus the discharging capacity is gradually reduced and the hydraulic damping effect is gradually increased, which gradually slows down the speed of the piston, thereby achieving a relatively smooth buffer process.

[0105] Figure 13 shows another throttling oil channel. The throttling oil channel is a chamfered surface 3-5 axially arranged on the surface of the piston rod 3. The chamfered surface 3-5 is inclined from a portion close to the piston to the buffer position stop shoulder 3-4, and one or more chamfered surfaces can be arranged. In this way, the hydraulic oil can flow out through the chamfered surface 3-5 after the sealing surface is formed by the first end surface 4-1 of the buffer sleeve 4 and the sealing end surface 1-2 on the rod cavity end cover 1, thereby forming the throttling oil channel. By using the chamfered surface 3-5 to form the throttling oil channel, it can also ensure that when the piston rod 3 gradually approaches the end position of the extending process, the discharging capability is gradually reduced and the hydraulic damping effect is gradually increased, which gradually slows down the speed of the piston 6, thereby achieving a relatively smooth buffer process.

[0106] An embodiment of a hydraulic buffer system of the present application may be achieved by using the hydraulic oil cylinder according to the present application to replace the existing oil cylinder in a hydraulic buffer system.

[0107] An embodiment of an excavator of the present application may be achieved by using the hydraulic oil cylinder according to the present application in an excavator.

[0108] An embodiment of the concrete pump truck of the present application may be achieved by using the hydraulic oil cylinder according to the present application in a concrete pump truck. The hydraulic oil cylinder according to the present application may also be used in other types of construction machinery.

[0109] The present application is illustrated by the above disclosed preferred embodiments; however, the preferred embodiments are not intended to limit the present application. For the person skilled in the art, many variations and modifications may be made to the present application without departing from the spirit or scope of the present application, and the protection scope of the present application is defined by the claims.

Claims

1. A hydraulic oil cylinder, wherein
a buffer sleeve being able to axially slide along a piston rod is sleeved on a buffer position, located in a rod cavity, of the piston rod, and an end surface of the buffer sleeve away from a piston is a first end surface of the buffer sleeve;
a rod cavity sealing end surface is provided in an oil cylinder cavity between a rod cavity oil-passing hole and an end position of a rod cavity end surface of the piston in an extending movement of the piston rod, and is configured to block the buffer sleeve and to abut against the first end surface of the buffer sleeve so as to form a sealing surface; and
at least one throttling oil channel is further provided, such that during the extending movement process of the piston rod, the hydraulic oil at a side of the sealing surface close to the piston can flow towards the rod cavity oil-passing hole through the throttling oil channel in a period from a time when the first end surface of the buffer sleeve abuts against the rod cavity sealing end surface to form the sealing surface to a time when the piston reaches an end position of the extending movement.
2. The hydraulic oil cylinder according to claim 1, wherein the throttling oil channel is provided axially and linearly between the piston rod and the buffer sleeve.
3. The hydraulic oil cylinder according to claim 1, wherein an end of the throttling oil channel close to the piston is a first end, the other end of the throttling oil channel close to the rod cavity oil-passing hole is a second end, and a cross-sectional area of the throttling oil channel is increased gradually from the first end to the second end.
4. The hydraulic oil cylinder according to claim 1, wherein in the case that the piston rod is extended to a stroke end position, there is a distance between the buffer sleeve and an end point of the sliding movement of the buffer sleeve towards the piston.
5. The hydraulic oil cylinder according to claim 1, wherein in the case that the first end surface of the buffer sleeve contacts the rod cavity sealing end surface to form the sealing surface, an area of an axial action, applied on the buffer sleeve by the hydraulic oil at a side of the sealing surface close to the piston, is greater than an area of an axial action, applied on the buffer sleeve by the hydraulic oil at the other side of the sealing surface close to the rod cavity oil-passing hole.
6. The hydraulic oil cylinder according to claim 1, wherein the piston rod is provided with a buffer position stop shoulder, and in the case that the buffer sleeve is not blocked by the rod cavity sealing end surface, the first end surface of the buffer sleeve is pressed against the buffer position stop shoulder under the action of an elastic member having elasticity.
7. The hydraulic oil cylinder according to claim 1, wherein a piston stop shoulder is provided at the end position of the extending movement of the piston rod, for allowing the buffer sleeve to pass through and stopping the piston at the end position.
8. The hydraulic oil cylinder according to claim 1, wherein the first end surface of the buffer sleeve abuts against the rod cavity sealing end surface to form a surface sealing or a linear sealing.
9. The hydraulic oil cylinder according to any one of claims 1 to 8, wherein a main body of the throttling oil channel is a throttling groove arranged axially and linearly on a surface of the piston rod.
10. The hydraulic oil cylinder according to claim 9, wherein in the case that the buffer sleeve is blocked by the rod cavity sealing end surface and slides relatively towards the piston on the piston rod, a flow sectional area of the throttling groove is reduced accordingly.
11. The hydraulic oil cylinder according to claim 9, wherein the piston rod is provided with a buffer position stop shoulder, and an oil-passing groove is arranged on the buffer position stop shoulder at a position corresponding to an end point of the throttling groove.
12. The hydraulic oil cylinder according to any one of claims 1 to 8, wherein one or a plurality of annular grooves functioning as balancing grooves are provided on an outer surface of the buffer position of the piston rod, or on an inner diameter surface of the buffer sleeve, and a cross section of the annular

groove is V-shaped, U-shaped, square or other forms.

13. The hydraulic oil cylinder according to any one of claims 1 to 8, wherein the throttling oil channel comprises two sections, that is, a front section close to the piston and a rear section close to the rod cavity oil-passing hole; a main body of the front section is a throttling groove axially provided on a surface of the piston rod, and a main body of the rear section is a hidden oil channel extending axially in the piston rod. 5
14. The hydraulic oil cylinder according to any one of claims 1 to 8, wherein the throttling oil channel comprises a hidden oil channel extending axially in the piston rod and a plurality of throttling oil holes communicating a surface of the piston rod with the hidden oil channel, the throttling oil holes are axially distributed on the surface of the piston rod, and the closer the throttling oil hole is to an outlet of the hidden oil channel, the larger the hole diameter of the throttling oil hole is. 10 15 20
15. The hydraulic oil cylinder according to any one of claims 1 to 8, wherein a main body of the throttling oil channel is a chamfered surface axially arranged on a surface of the piston rod. 25
16. The hydraulic oil cylinder according to any one of claims 1 to 8, wherein a transition sleeve cooperating with the piston rod is sleeved on the buffer position, and the throttling oil channel is arranged on the transition sleeve. 30
17. The hydraulic oil cylinder according to any one of claims 1 to 8, wherein one or a plurality of annular grooves functioning as balancing grooves are provided on a transition sleeve, and a cross section of the annular groove is V-shaped, U-shaped, square or other forms. 35 40
18. The hydraulic oil cylinder according to any one of claims 1 to 8, wherein the rod cavity sealing end surface is provided on a rod cavity end cover. 45
19. The hydraulic oil cylinder according to any one of claims 1 to 8, wherein a piston stop shoulder is an end surface of a cover opening of a rod cavity end cover. 50
20. A hydraulic oil cylinder related device, in particular a rod cavity end cover, wherein from a top end to a cover opening of the rod cavity end cover, an oil-passing hole and a rod cavity sealing end surface are sequentially provided, and the rod cavity sealing end surface is a stepped surface having an integral annular shape provided in an inner cavity of the rod 55

cavity end cover.

21. The hydraulic oil cylinder related device according to claim 20, wherein the cover opening of the rod cavity end cover functions as a piston stop shoulder.
22. A hydraulic oil cylinder related device, in particular a buffer sleeve, wherein the buffer sleeve has an outer diameter smaller than an inner diameter of a cylinder barrel of a hydraulic oil cylinder in which the buffer sleeve works, an inner diameter of the buffer sleeve is configured to enable the buffer sleeve to be sleeved on a piston rod buffer position and to slide freely in an axial direction; upon assembling, a first end surface, away from the piston, of the buffer sleeve is configured to abut against a sealing end surface, located in an oil cylinder cavity between a rod cavity oil-passing hole and an end position of an extending movement of the piston rod, so as to form a sealing surface.
23. The hydraulic oil cylinder related device according to claim 22, wherein an end surface of the buffer sleeve opposite to the first end surface is provided with a central protruding portion cooperating with a compression spring.
24. A hydraulic buffer system, comprising the hydraulic oil cylinder according to any one of claims 1 to 19.
25. An excavator, comprising the hydraulic oil cylinder according to any one of claims 1 to 19.
26. A concrete pump truck, comprising the hydraulic oil cylinder according to any one of claims 1 to 19.

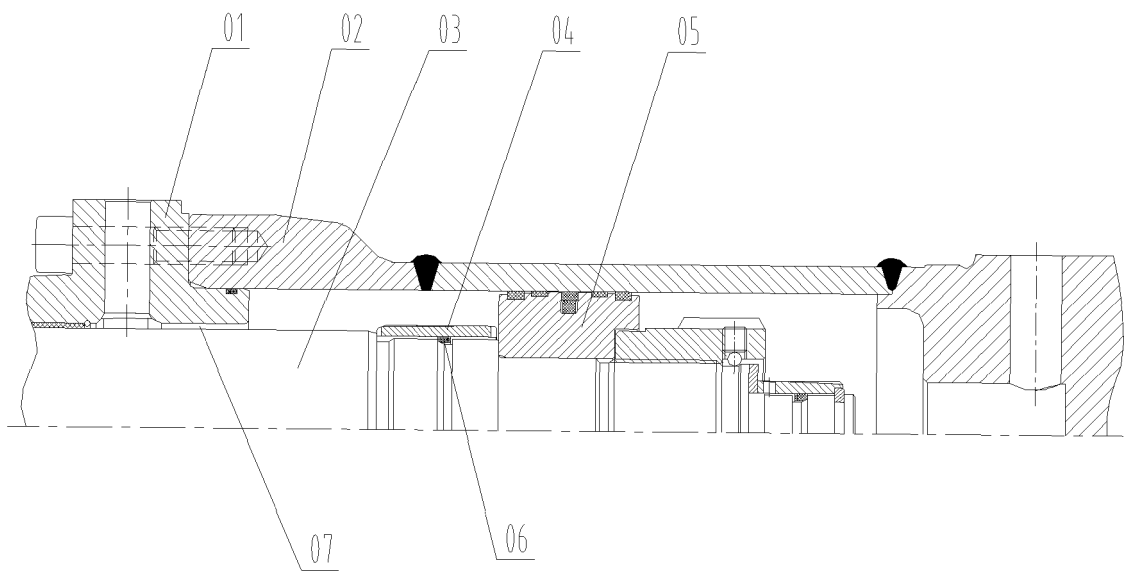


Fig. 1

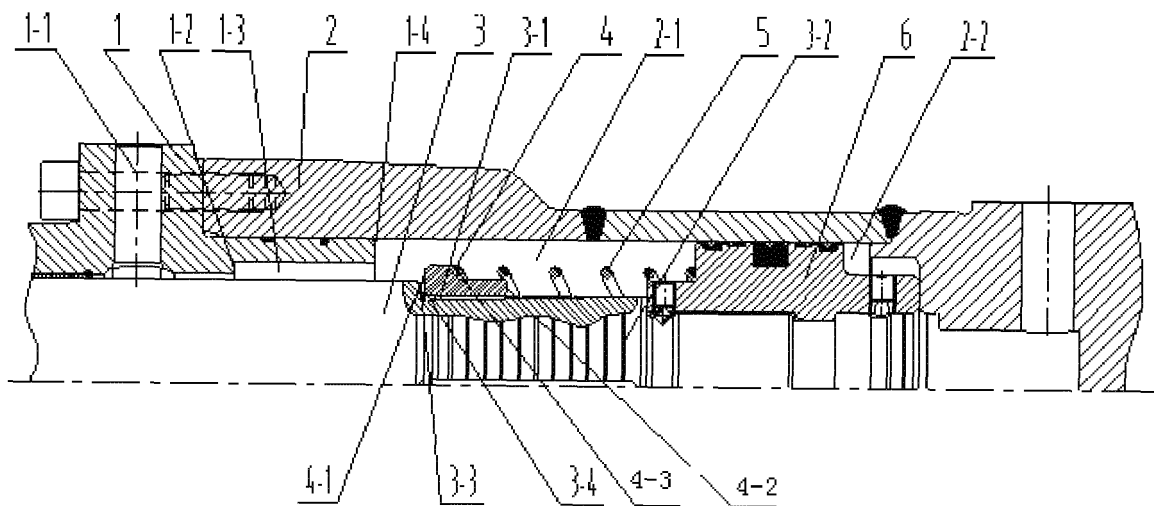


Fig. 2

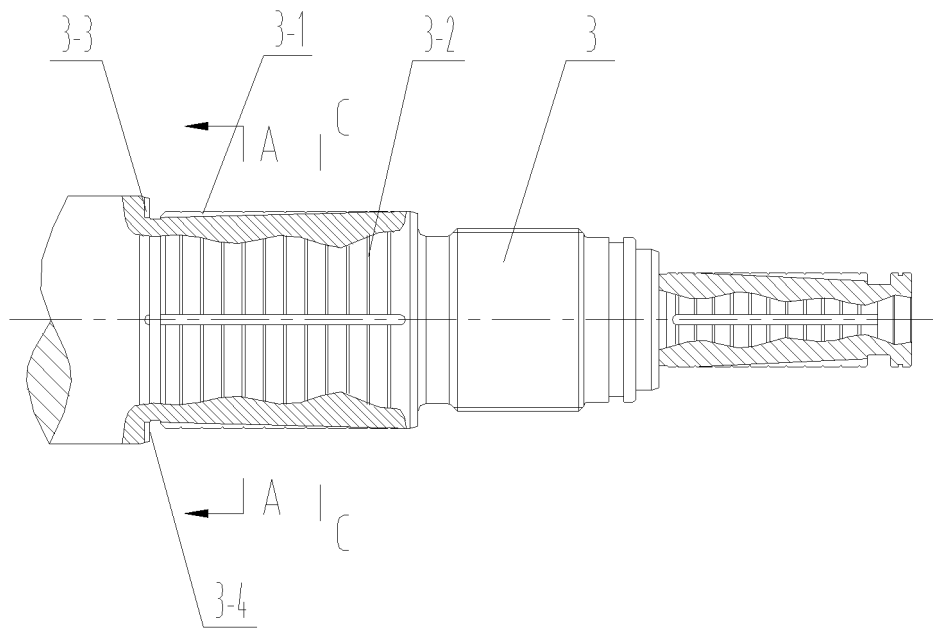


Fig. 3

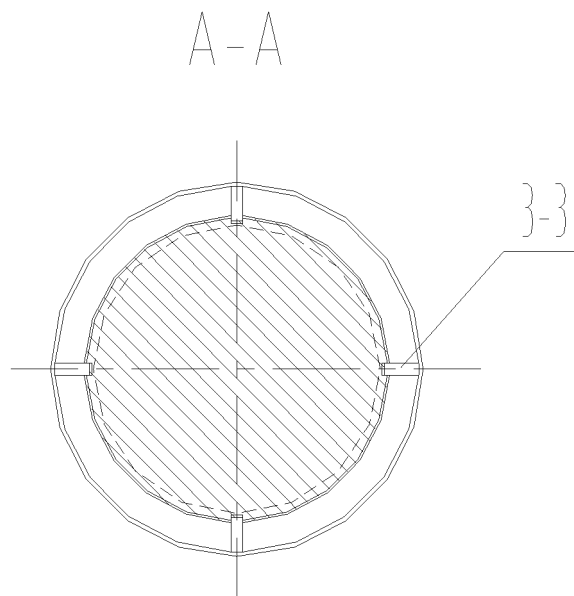


Fig. 4

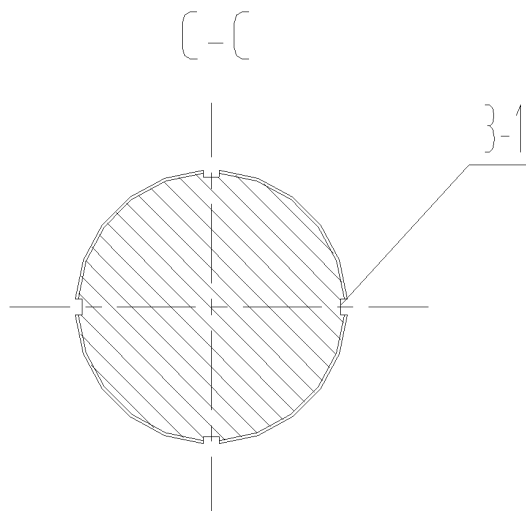


Fig. 5

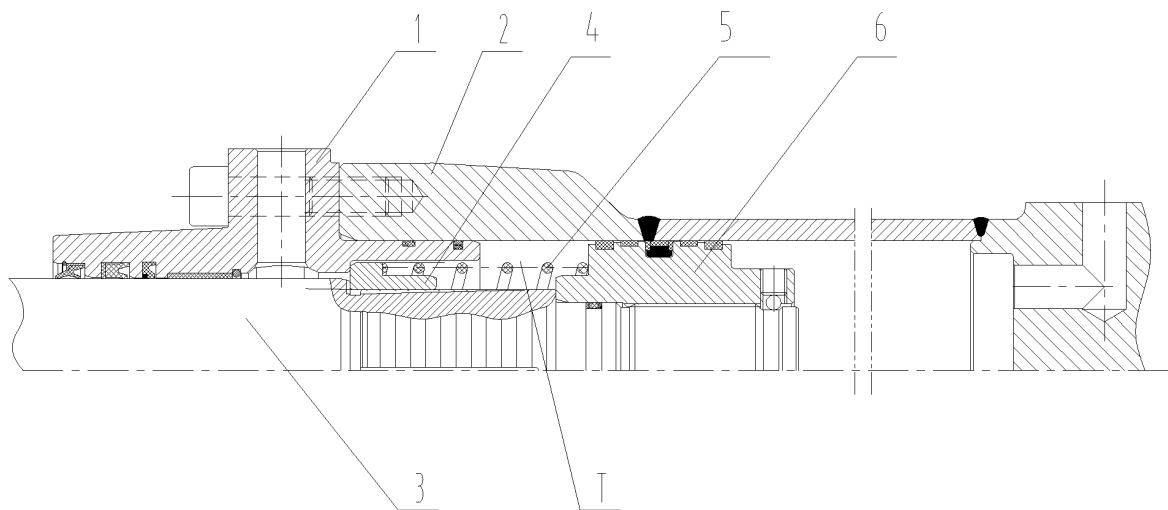


Fig. 6

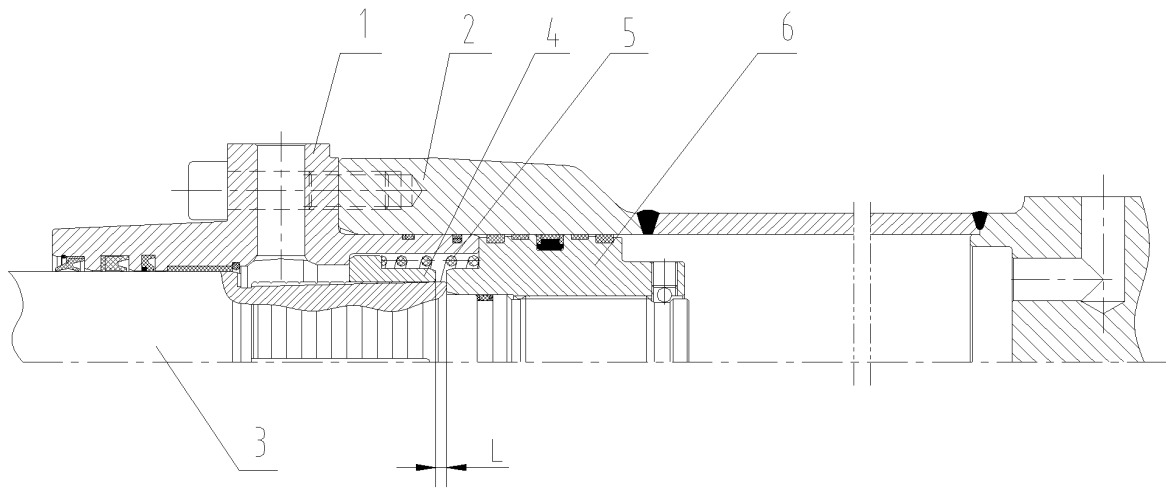


Fig. 7

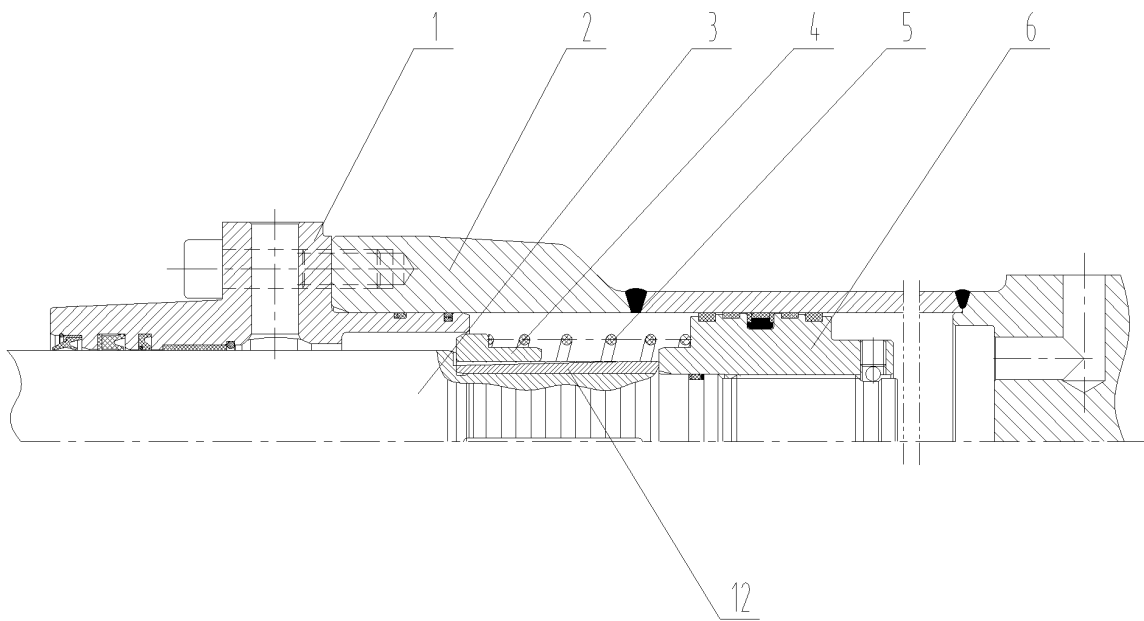


Fig. 8

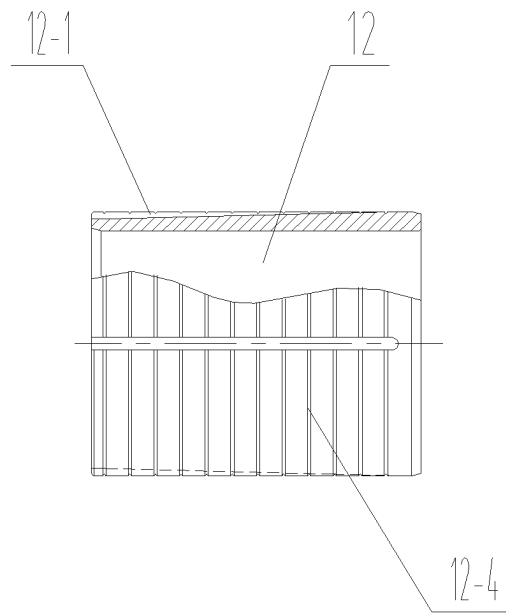


Fig. 9

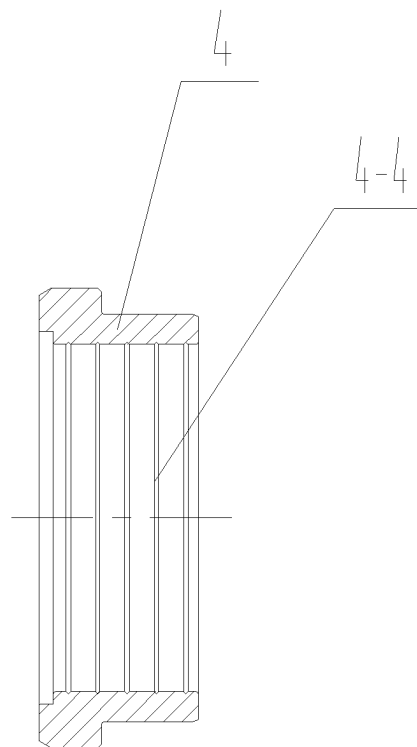


Fig. 10

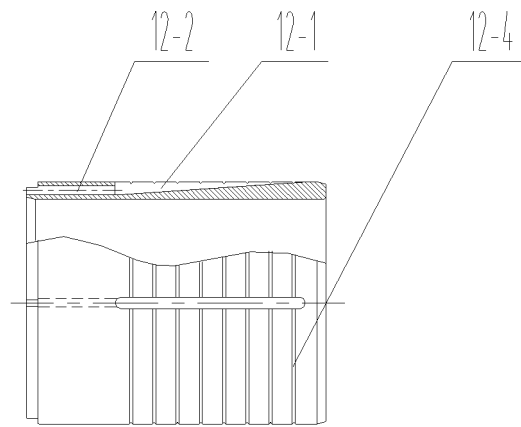


Fig. 11

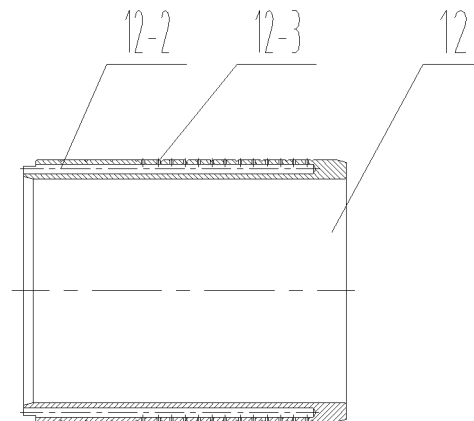


Fig. 12

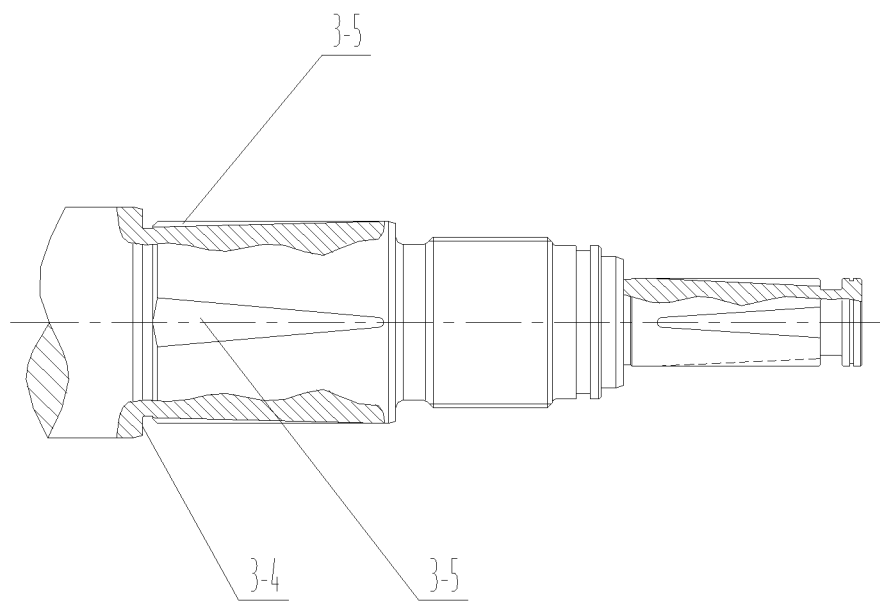


Fig. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2011/076025

A. CLASSIFICATION OF SUBJECT MATTER

F15B 15/14(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC:F15B, E02F

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI, CNPAT, CNKI hydraulic+, cushion+, seal+, sleeve?, cylinder, piston, passage, channel

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN201836140U(SANY HEAVY IND CO LTD)18 May 2011(18.05.2011) paragraphs [0057]-[0091] of the description, figures 2-13	1-26
PX	CN201836139U(SANY HEAVY IND CO LTD)18 May 2011(18.05.2011) paragraphs [0066]-[0109] of the description, figures 2-13	1-26
A	CN1800657A(VOLVO CONSTR EQUIP HOLDING SWEDEN AB)12 Jul.2006 (12.07.2006) claims 1-6 and figs.4-6	1-26
A	JP11-132203A(HITACHI CONSTRUCTION MACHINERY)18 May 1999 (18.05.1999)	1-26

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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Date of the actual completion of the international search
12 Jul.2011(12.07.2011)

Date of mailing of the international search report
13 Oct. 2011 (13.10.2011)

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2011/076025

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	the whole document	1-26
	US5694827A(EUCLID HITACHI HEAVY EQUIPMEN)09 Dec.1997 (09.12.1997)	
	the whole document	

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

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CN201836140U	18.05.2011	NONE	
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REFERENCES CITED IN THE DESCRIPTION

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