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(54) **Hose breakage safety system.**

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Description

The invention relates to a method to prevent an accidental movement from occuring when there is or is going to occur a sudden loss of pressure in a hydraulic system or in a hose or a part of a lifting device or lifting apparatus which is susceptible to breakage, for which an electrical non-return valve is placed near one end of the hose or the part susceptible to breaking as well as a pressure sensor placed near the other end of the hose or the part susceptible to breaking, which pressure sensor emits an electrical signal being proportional to the measured pressure and which electrical signal is compared continuously with a desired signal and the valve is closed as soon as the signal from the pressure sensor deviates from the desired signal by more than the preset limits.

The use of a hose breakage safety system is generally known in the case of earthmoving machines. In the French patent application FR 2.497.851 is described a system with which it is possible to stop the flow of the oil out of a hydraulic system as soon as a breakage in for example a hose occurs. Due to pressure drop a signal from a pressure sensor will be sent to an electric non-return valve and the outflow of oil from the hydraulic cylinder stopped. However often breakage will occur at the beginning of a movement; when the arm of an earthmoving machine begins to move the oil pressure will be at a maximum and at that moment there will be a greater chance of breakage. The system as described in the French patent application FR 2.497.851 however will not react fast enough to stop such an arm of an earthmoving machine within the time needed to fall down, when a breakage occurs and especially as a breakage occurs at the beginning of a movement of the arm of an earthmoving machine.

Other known systems comprise, for example, a valve in which a ball is placed against the pressure of a slack spring; as soon as through the fact that the hose has broken, the oil will be able to flow out freely, and the valve bangs shut. A number of other systems also operate by means of the flow of velocity of the oil out of the cylinder becoming greater after a hose breakage has occurred. A disadvantage of these known systems is that such a valve can never work very fast, because the flow velocity of the oil through the non-return valve can never be the maximum. Another disadvantage is that if operation is too high speed the valve can go into action spontaneously and will thereby block the operation of the machine, which brings the work to a standstill.

The object of the invention is a hose breakage safety system in which, if a breakage occurs in a hose, it will automatically and almost immediately block the lifting arm, so that the latter remains in the position which deviates only slightly from the position at which the breakage occurred, and where the lowering of the lifting arm can be achieved at maximum speed if the hydraulic system is in order.

This is achieved with a method according to the invention as soon as a lifting device is put into operation an electrical pulse, which will open the valve for a specific short time, is sent to the electrical valve, and in that more or less simultaneously the pressure sensor will carry out a pressure measurement for a predetermined period of time, which pressure measurement is converted by the pressure sensor into an electrical pulse, the size of which is a measure of the measured pressure, following which the electrical valve is opened if the electrical pulse coming from the pressure sensor corresponds within preset limits to a predetermined electrical pulse level, and in that after opening of the electrical valve the signal coming from the pressure sensor is compared continuously with a desired signal and the valve is closed as soon as the signal from the pressure sensor deviates from the desired signal by more than the preset limits.

It has been found in practice that in earthmoving equipment provided with a hose breakage safety system according to the invention, if there is a sudden breakage of a hose during the downward movement of the lifting arm, the latter will make only a slight further fall after the hose breaks. This fall is much smaller than in the case of machines provided with hose breakage safety systems known hitherto. A pressure sensor which has a working range of 10 - 50 bar and which can be loaded to a pressure of at least 400 bar is preferably used, so that the pressure surges can be properly absorbed.

It has been found that a hose breakage safety system according to the invention is extremely suitable for use in earthmoving machines, and in particular in machines operating with a single cylinder. This means that with such a machine provided with the safety system according to the invention the lifting arm or boom can be lowered very slowly because during the downward movement of the boom the electrical non-return valve is fully open and the downward movement is determined by the main valve, which can be very important where the machine is being used for the very accurate placing of parts in, for example, building.

This was hitherto not possible with machines provided with a hitherto known hose breakage safety system, such as described in the French patent application 2.497.851 since in the case of such a system the flow through the non-return valve is always limited, both by a minimum and a maximum throughflow, and thus the speed of fall of the boom is determined by the rate of throughflow through the non-return valve. It was also found that such a hose breakage safety system is very suitable for all devices which are designed with a single cylinder, such as fire ladders, tipping lorries etc.

The invention will be explained in further detail

with reference to the drawing. In the drawing:

Figure 1 shows schematically a part of the hydraulic system provided with a hose breakage safety system according to the invention during lifting;

Figure 2 shows the same schematic part from Figure 1, now with the lever in the neutral position;

Figure 3 shows the same part from Figure 1 during the lowering of the lever arm;

Figure 4 shows the same part as that in Figures 1, 2 and 3, now if a breakage has occurred in the hose;

Figure 5 shows schematically a view of a multifunctional machine, provided with various hose breakage safety systems.

Figures 1, 2, 3 and 4 show schematically a part of the hydraulic system of a multifunctional machine, which could be, for example, a hydraulic excavator or a shovel loader, which in addition to excavation operations could also carry out lifting work and then has to be provided with a hose breakage safety system. In the case of such machines which can carry out several types of operations it is particularly important for them to be provided with a good and quick-acting hose breakage safety system.

Figures 1, 2, 3 and 4 show a cylinder 1 of a lifting arm 2 of, for example, an excavator. An electrical non-return valve 4 is provided near the inflow aperture 3 of the cylinder 1.

The oil runs through a hose 5 via the non-return valve 4 to the cylinder 1. The oil supply and discharge is regulated by a control valve 6 by means of an operating lever 7. Said operating lever 7 switches a mechanical switch 8 on and off depending on the position of the lever. An electrical pressure sensor 9 is placed near the inflow aperture of the hose 5 on the control valve 6.

A control unit 10, provided with the desired electronics, ensures the correct operation of the hose breakage safety system.

Figure 1 shows how the system works when the arm or boom is lifted. During the lifting the switch 8 is not activated, so the hose breakage safety system monitor is not in operation. The machine is, however, automatically safeguarded against breakage of the hose, due to the fact that when pressure no longer comes through at the ingoing port or inflow aperture of the cylinder 1 the non-return valve 4 automatically falls shut and no further oil can flow out, and it can thus no longer flow back. The lifting arm, boom or mast 2 will thus automatically stop.

Figure 2 shows the neutral position. In this position also the hose breakage safety system is not in operation. The non-return valve 4 is closed in this position and nothing can happen if the hose breaks.

Figure 3 shows what happens if the lifting arm 2 is being lowered. During lowering the non-return valve 4 must be kept open. However, in order to be able to open the non-return valve and keep it open, a number of conditions must be met. The operating lever 7 must be placed in the position for lowering of the mast 2. As a result of this the switch 8 will be depressed and the control unit 10 will consequently receive current and immediately afterwards emit a brief measured pulse, as a result of which the non-return valve 4 is opened during the brief pulse period; the hose will thereby come to pressure and at the other side of the hose 5 the pressure sensor 9 will observe a pressure wave. This pressure sensor 9 will convert the measured pressure into an electrical signal which is sent to the control unit 10. The latter compares the received electrical pulse with the outgoing pulse and, if it corresponds thereto within a predetermined limit, this will indicate that the hose is in good condition. The control unit 10 will now open the valve 4, and said valve 4 remains open so long as pressure is measured by the pressure sensor 9.

Figure 4 shows the situation in which the hose 5 is broken. No pressure will now be measured by the pressure sensor 9, and so no electrical pulse will be emitted to the control unit 10. The valve 4 will now remain closed, and it will not be possible to lower the lifting arm.

Figure 5 shows a number of experiments which were carried out with a machine always provided with a number of generally known hose breakage safety systems. It was found that as soon as breakage was simulated without the operating person being aware of it the lifting arm always made a considerable fall. The machine provided with the present hose breakage safety system was, however, found to give the best result. The lifting arm did actually make a slight fall from the position where the breakage occurred (from position A, the initial position for all experiments, to position B), but this was only a small part of the full potential fall length. An additional advantage of the present hose breakage safety system is that during normal use, i.e. when no breakage has occurred in the hose, the lifting arm or lever 2 can be moved at virtually the maximum possible speed from the top position to the bottom.

Machines which are equipped with a hose breakage safety system according to the invention are also provided with a switch by means of which the safety system can be switched off. This is important in particular for, for example, being able to use an earth-moving machine as an excavator, in which case the boom does not, of course, need to make any downgoing movement.

Claims

1. Method to prevent an accidental movement from occuring when there is or is going to occur a sud-

den loss of pressure in a hydraulic system or in a hose (5) or a part of a lifting device or lifting apparatus which is susceptible to breakage, for which an electrical non-return valve (4) is placed near one end of the hose (5) or the part susceptible to breaking as well as a pressure sensor (9) placed near the other end of the hose (5) or the part susceptible to breaking, which pressure sensor (9) emits an electrical signal being proportional to the measured pressure and which electrical signal is compared continuously with a desired signal and the valve (4) is closed as soon as the signal from the pressure sensor (9) deviates from the desired signal by more than the preset limits, **characterized in that** as soon as a lifting device is put into operation an electrical pulse, which will open the valve (4) for a specific short time, is sent to the electrical valve (4), and in that more or less simultaneously the pressure sensor (9) will carry out a pressure measurement for a predetermined period of time, which pressure measurement is converted by the pressure sensor (9) into an electrical pulse, the size of which is a measure of the measured pressure, following which the electrical valve (4) is opened if the electrical pulse coming from the pressure sensor (9) corresponds within preset limits to a predetermined electrical pulse level, and in that after opening of the electrical valve (4) the signal coming from the pressure sensor (9) is compared continuously with a desired signal and the valve is closed as soon as the signal from the pressure sensor deviates from the desired signal by more than the preset limits.

Patentansprüche

1. Verfahren zur Vermeidung einer nicht voraussehbaren Bewegung, wenn ein plötzlicher Druckverlust in einer hydraulischen Anlage oder in einem Schlauch (5) oder einem Teil eines Hebezeugs oder Hebegeräts auftritt, welcher zerstörungsgefährdet ist, für welches ein elektrisches Rückschlagventil (4) in der Nähe eines Endes eines Schlauches (5) oder des zerstörungsgefährdeten Teils sowie weiter ein Druckfühler (9) in der Nähe des anderen Endes des Schlauches (5) oder des zerstörungsgefährdeten Teils angeordnet ist, wobei der Druckfühler (9) ein elektrisches Signal abgibt, das proportional zum gemessenen Druck ist und das ständig mit einem gewünschten Signal verglichen wird, wobei das Ventil (4) geschlossen ist, sobald das Signal aus dem Druckfühler (9) von dem gewünschten Signal um mehr als die vorgegebenen Grenzen abweicht, dadurch gekennzeichnet, daß, sobald ein Hebezeug in Betrieb genommen wird, ein elektrischer Impuls, der das Ventil (4) über eine spezifisch kurze Zeit öffnet, an das Elektroventil (4) gesendet wird und dadurch, daß mehr oder weniger gleichzeitig der Druckfühler (9) eine Druckmessung über einen vorbestimmten Zeitraum vornimmt, wobei die Druckmessung durch den Druckfühler (9) in einen elektrischen Impuls umgewandelt wird, dessen Größe ein Maß des gemessenen Drucks ist, wobei danach das Elektroventil (4) geöffnet wird, wenn der elektrische Impuls, aus dem Druckfühler (9) kommend, innerhalb der vorgegebenen Grenzen einem vorbestimmten elektrischen Impulsniveau entspricht und dadurch , daß nach Öffnen des Elektroventils (4) das aus dem Druckfühler (9) kommende Signal ständig mit einem gewünschten Signal verglichen wird und das Ventil geschlossen wird, sobald das Signal aus dem Druckfühler von dem gewünschten Signal um mehr als die vorgegebenen Grenzen abweicht.

Revendications

1. Procédé pour empêcher que ne se produise un mouvement accidentel lorsqu'il se produit ou va se produire une perte soudaine de pression dans un système hydraulique ou dans une tubulure (5) ou une partie d'un dispositif ou un appareil de levage susceptible de se rompre, procédé pour lequel on place une valve anti-retour électrique (4) au voisinage d'une extrémité de la tubulure (5) ou de la partie susceptible de se rompre, ainsi qu'un détecteur de pression (9) placé au voisinage de l'autre extrémité de la tubulure (5) ou de la partie susceptible de se rompre, ledit détecteur de pression (9) émettant un signal électrique proportionnel à la pression mesurée et ce signal électrique étant comparé de manière continuelle avec un signal désiré et on ferme la valve (4) dès que le signal provenant du détecteur de pression (9) dévie par rapport au signal désiré d'une valeur supérieure à la limite préfixée, caractérisé en ce qu'on envoie à la valve électrique (4) une impulsion électrique qui ouvrira la valve (4) pour un bref temps spécifique, dès que l'on met en service un dispositif de levage, et que le détecteur de pression (9) effectue plus ou moins simultanément une mesure de pression pendant une période prédéterminée, cette mesure de pression étant convertie par le détecteur de pression (9) en une impulsion électrique, dont la taille est une mesure de la pression mesurée, à la suite de quoi la valve électrique (4) est ouverte si l'impulsion électrique venant du détecteur de pression (9) correspond, dans des limites préfixées, à un niveau prédéterminé d'impulsion électrique, et qu'après ouverture de la valve électrique (4), le signal venant du détecteur de pression (9) est comparé de manière-

re continue avec un signal désiré et la valve est fermée dès que le signal provenant du détecteur de pression dévie par rapport au signal désiré d'une amplitude supérieure aux limites préfixées.

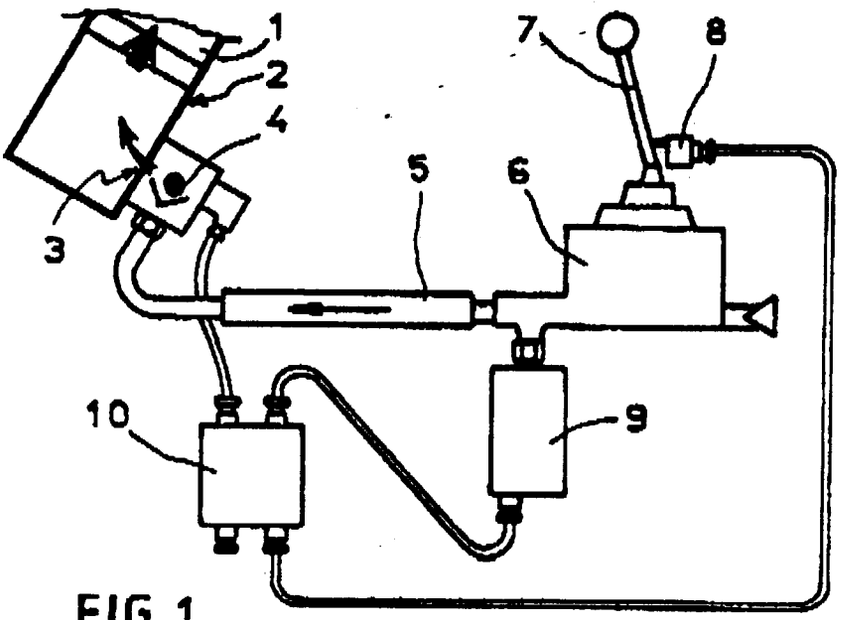


FIG.1

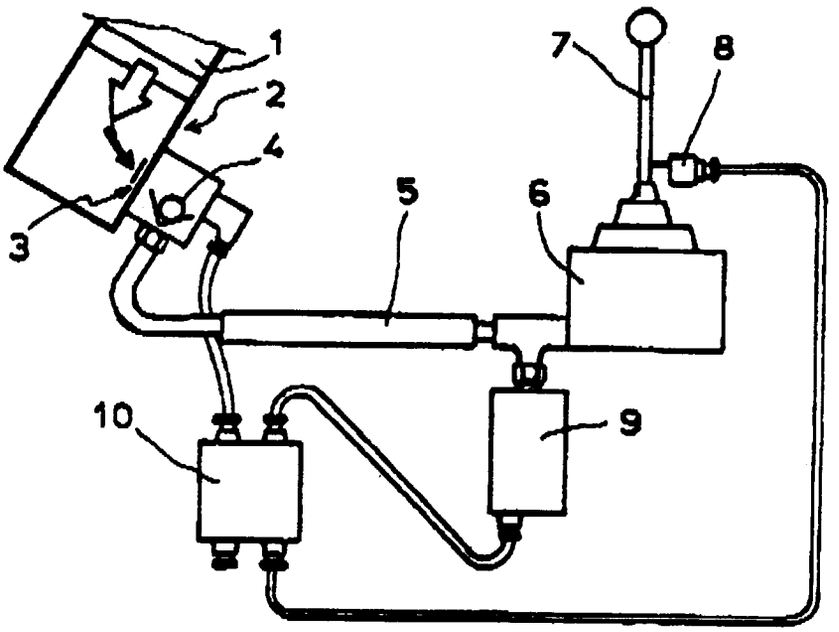


FIG.2

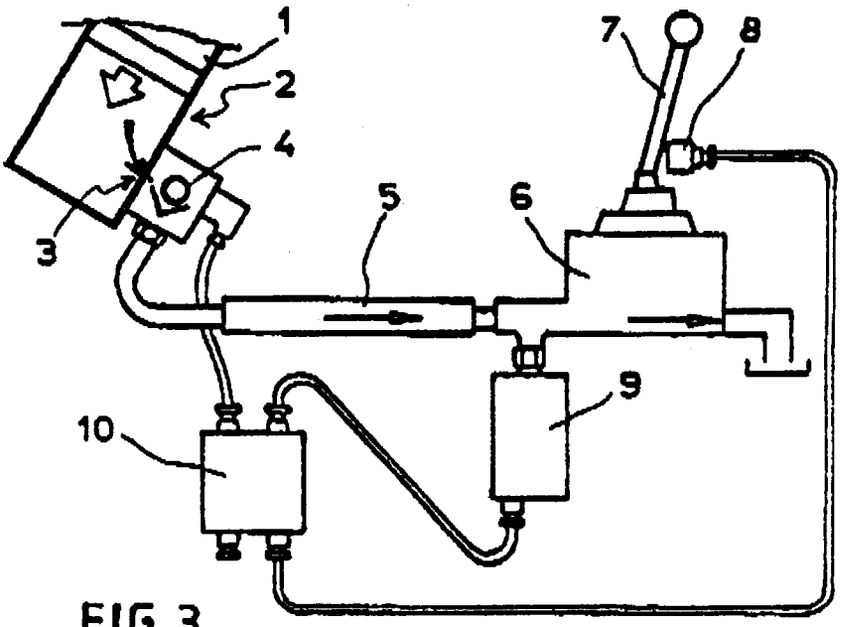


FIG.3

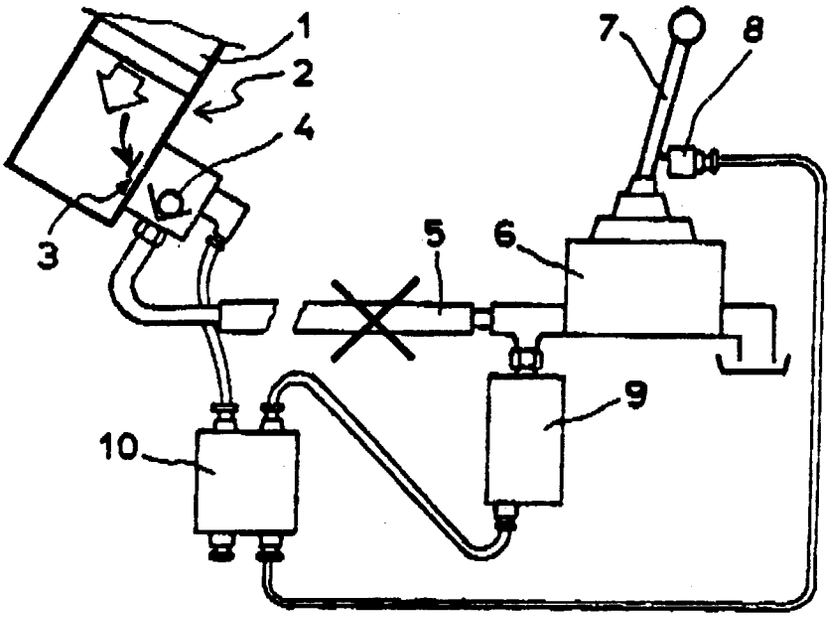


FIG.4

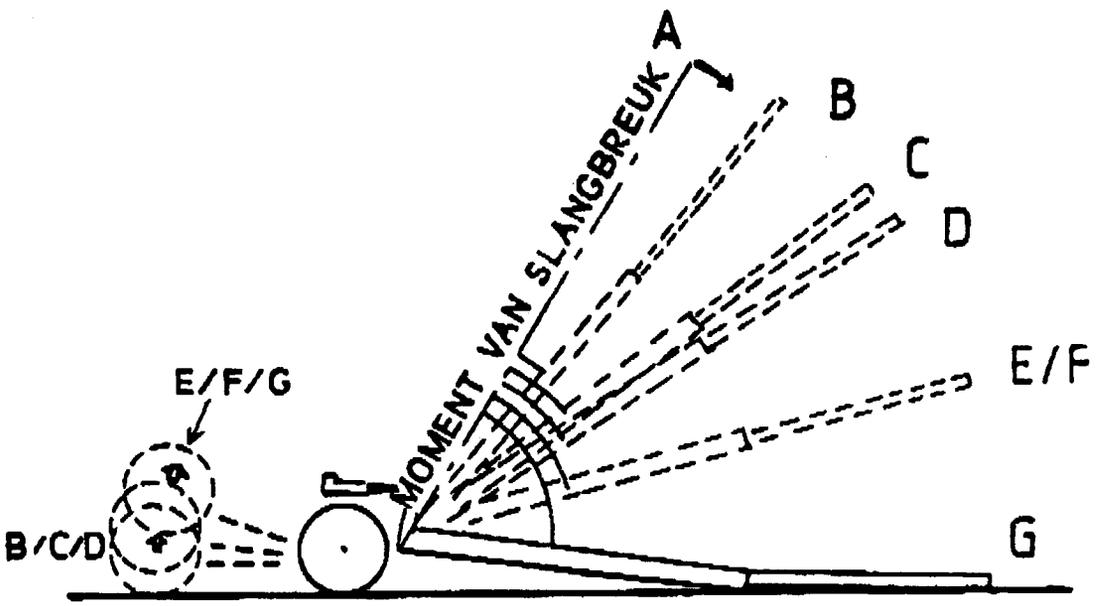


FIG.5