

Description

The present invention relates to a method of preventing puncture in a load-sensing and pressure-compensating control system for a hydraulic crane when the hydraulic flow requested to the different functions of the crane exceeds the maximum hydraulic flow available. The invention further concerns a device for implementing the method.

Fig. 1 illustrates a conventional hydraulic crane which includes a body 1, a first boom section 2 articulated to the body 1, an outer boom 3 articulated to the first boom section 2, and an extension boom 4 fixed to the outer boom 3. The first boom section is operated by means of a hydraulic lifting cylinder 5, the outer boom 3 is operated by means of a hydraulic outer boom cylinder 6, and the extension boom 4 is operated by means of a hydraulic extension boom cylinder 7.

The control system for controlling the different crane functions (lifting/lowering by means of the lifting cylinder, tilting by means of the outer boom cylinder, and extending/retracting by means of the extension boom cylinder) comprises a pump 10 which pumps hydraulic fluid from a tank 9 to a directional-control-valve block 12 containing a directional-control-valve section for each of the cylinders 5-7, to which the hydraulic fluid is supplied in conventional manner as a function of the position of the slide member in each valve section. The directional-control-valve sections are remote-controlled by a control means 13 with one lever for each crane function. The signals from the control means 13 are transmitted via a cable or a wireless connection to a microprocessor 16 which in turn controls the position of the slide members in the valve sections of the directional-control-valve block 12 as a function of the value of the respective control signal from the control means.

In advanced cranes, the control system, or more precisely the directional-control-valve block 12, can be load-sensing and pressure-compensating, which means that a certain lever position on the control means 13 produces a certain flow to the associated crane function; regardless of the load on this function and regardless of the flow to and load on the remaining crane functions.

However, this only applies as long as the sum of the hydraulic flows requested by the levers of the control means 13 to the different crane functions, is smaller than or equal to the maximum hydraulic flow that the pump 10 can provide. When the total hydraulic flow requested to the different crane functions exceeds that available from the pump, the flow is primarily directed to the crane function(s) with the lightest load. At worst, no hydraulic flow at all is supplied to the function(s) with the heaviest load, and these will then stop working.

If this happens suddenly, there may arise violent jerks in the movements of the crane which are extremely unpleasant and even may lead to overloading of the crane. This phenomenon of one or more crane functions being deprived of flow is called puncture.

The only prior-art solution to this problem consists in oversizing the pump so that the flow therefrom will at all times be sufficient, regardless of the operations indicated by the operator on the control means. However, such oversizing renders the crane control system more expensive and energy-intensive. In mobile systems, it may in addition be difficult to make room for large pumps.

The object of the present invention is, therefore, to provide a method and a device which solve the above-mentioned problem and make it possible to use pumps with lower maximum flow without risking a puncture of the control system.

This object is achieved by a method which is characterised by

- a) measuring the value of each control signal representing a flow requested to a crane function;
- b) adding up the measured values of the control signals; and
- c) comparing the sum of the control-signal values with a maximum-flow value representing the maximum hydraulic flow available and, should the sum exceed the maximum-flow value, multiplying each control signal by a scale factor k_i , wherein $i = 1, \dots, N$, and $k_i < 1$, before supply to a respective means for controlling the hydraulic flow to a crane function, and, should the sum fall below the maximum-flow value, supplying each control signal unmodified to the respective means for controlling the hydraulic flow to a crane function.

This ensures that a hydraulic flow is supplied to all the controlled crane functions, thus avoiding a puncture of the control system and eliminating the risk of overloading.

As recited in appended claim 2, step c) is preferably repeated after the scaling down. The scale factors may then be so chosen that there is only a slight scaling down, since there will be a renewed check on whether the sum is smaller than the maximum-flow value, so that the scaling down can be repeated if need be.

The scale factors can be the same for all the functions or, as recited in appended claim 3, be different for different crane functions, so that certain functions may be prioritised.

The invention also concerns a device for implementing the method, which shows the features recited in appended claim 5.

The invention can be applied to hydraulic cranes with load-sensing and pressure-compensat-

ing control systems. The crane functions of such a crane may, for instance, include lifting/lowering the first boom section, tilting the outer boom, extending/retracting the extension boom, lifting/lowering the jib boom, and rotating the crane.

An embodiment of the present invention will be described below with reference to the accompanying drawings, in which

Fig. 1, which already has been described, illustrates a conventional hydraulic crane with associated control system, and

Fig. 2 is a flow chart for implementing the method.

In order to avoid that a load-sensing and pressure-compensating crane control system of the type illustrated in Fig. 1 is punctured when the hydraulic flow requested by an operator to the different crane functions exceeds the maximum hydraulic flow available, the control signals from the control means are processed in the following manner (see the flow chart in Fig. 2). In a first step 20 is measured the value of each of the control signals Q_1 - Q_N representing a flow requested to a crane function and being transmitted from the control means 13 to the microprocessor 16. In the subsequent step 21, the thus-established values of the control signals Q_1 - Q_N are added up, which gives the sum Q_p . Then, the sum Q_p is, in step 22, compared with a maximum-flow value Q_{max} representing the maximum hydraulic flow available from the pump. Should the sum Q_p exceed the maximum-flow value Q_{max} , the system would be punctured unless the control signals Q_1 - Q_N were modified before being transmitted to the directional-control-valve block 12. To prevent such a puncture, each control signal Q_i is, in step 23, multiplied by a scale factor k_i , wherein $i = 1, \dots, N$, which optionally may be the same for all the control signals. Thereafter, the control signals Q_i are, in step 24, scaled down to q_i , and the adding up of step 21 and the comparison of step 22 are repeated. Should the sum Q_p for the requested hydraulic flow still exceed the maximum-flow value Q_{max} , another scaling down of the control signals is performed. If, on the other hand, the sum Q_p is smaller than or equal to the maximum-flow value Q_{max} , the control signals are, in step 25, transmitted as they are to the respective directional-control-valve section in the directional-control-valve block 12. This program is repeated at suitable intervals, thereby avoiding a puncture of the system.

It should also be pointed out that the control-signal value need not be measured directly after the control means 13, but may instead be measured by establishing the displacement of the slide member in the valve 12 caused by the signal. The thus-established values are returned to the micro-

processor 16, whereupon the method is implemented in the manner described above. This variant may be used not only in remote-controlled systems, but also in hand-lever-controlled, load-sensing and pressure-compensating valves.

Finally, it should be observed that, by using the flow chart in Fig. 2, the expert may easily implement the invention to take the shape of a program in the microprocessor 16.

Claims

- Method of preventing puncture in a load-sensing and pressure-compensating control system for a hydraulic crane when the hydraulic flow requested to the different functions of the crane exceeds the maximum hydraulic flow available, characterised by
 - a) establishing the value of each control signal (Q_1 - Q_N) representing a flow requested to a crane function;
 - b) adding up the established values of the control signals (Q_1 - Q_N); and
 - c) comparing the sum (Q_p) of the control-signal values with a maximum-flow value (Q_{max}) representing the maximum hydraulic flow available and, should the sum (Q_p) exceed the maximum-flow value (Q_{max}), multiplying each control signal by a scale factor k_i , wherein $i = 1, \dots, N$, and $k_i < 1$, before supply to a respective means (12) for controlling the flow to a crane function, and, should the sum fall below the maximum-flow value, supplying each control signal unmodified to the respective means (12) for controlling the flow to a crane function.
- Method as claimed in claim 1, characterised by repeating step c) after the multiplication by the scale factors k_i .
- Method as claimed in claim 1 or 2, characterised by using scale factors k_i with different values for the control signals to different crane functions.
- Method as claimed in any one of the preceding claims, characterised by establishing the value of each control signal (Q_1 - Q_N) by measuring the displacement caused by said signal of a control element provided in each means (12) for controlling the flow to a crane function.
- Device for preventing puncture in a load-sensing and pressure-compensating control system for a hydraulic crane, said control system comprising load-sensing and pressure-compensat-



ing control systems. The crane functions of such a crane may, for instance, include lifting/lowering the first boom section, tilting the outer boom, extending/retracting the extension boom, lifting/lowering the jib boom, and rotating the crane.

An embodiment of the present invention will be described below with reference to the accompanying drawings, in which

Fig. 1, which already has been described, illustrates a conventional hydraulic crane with associated control system, and

Fig. 2 is a flow chart for implementing the method.

In order to avoid that a load-sensing and pressure-compensating crane control system of the type illustrated in Fig. 1 is punctured when the hydraulic flow requested by an operator to the different crane functions exceeds the maximum hydraulic flow available, the control signals from the control means are processed in the following manner (see the flow chart in Fig. 2). In a first step 20 is measured the value of each of the control signals Q_1-Q_N representing a flow requested to a crane function and being transmitted from the control means 13 to the microprocessor 16. In the subsequent step 21, the thus-established values of the control signals Q_1-Q_N are added up, which gives the sum Q_p . Then, the sum Q_p is, in step 22, compared with a maximum-flow value Q_{max} representing the maximum hydraulic flow available from the pump. Should the sum Q_p exceed the maximum-flow value Q_{max} , the system would be punctured unless the control signals Q_1-Q_N were modified before being transmitted to the directional-control-valve block 12. To prevent such a puncture, each control signal Q_i is, in step 23, multiplied by a scale factor k_i , wherein $i = 1, \dots, N$, which optionally may be the same for all the control signals. Thereafter, the control signals Q_i are, in step 24, scaled down to q_i , and the adding up of step 21 and the comparison of step 22 are repeated. Should the sum Q_p for the requested hydraulic flow still exceed the maximum-flow value Q_{max} , another scaling down of the control signals is performed. If, on the other hand, the sum Q_p is smaller than or equal to the maximum-flow value Q_{max} , the control signals are, in step 25, transmitted as they are to the respective directional-control-valve section in the directional-control-valve block 12. This program is repeated at suitable intervals, thereby avoiding a puncture of the system.

It should also be pointed out that the control-signal value need not be measured directly after the control means 13, but may instead be measured by establishing the displacement of the slide member in the valve 12 caused by the signal. The thus-established values are returned to the micro-

processor 16, whereupon the method is implemented in the manner described above. This variant may be used not only in remote-controlled systems, but also in hand-lever-controlled, load-sensing and pressure-compensating valves.

Finally, it should be observed that, by using the flow chart in Fig. 2, the expert may easily implement the invention to take the shape of a program in the microprocessor 16.

Claims

1. Method of preventing puncture in a load-sensing and pressure-compensating control system for a hydraulic crane when the hydraulic flow requested to the different functions of the crane exceeds the maximum hydraulic flow available, characterised by
 - a) establishing the value of each control signal (Q_1-Q_N) representing a flow requested to a crane function;
 - b) adding up the established values of the control signals (Q_1-Q_N); and
 - c) comparing the sum (Q_p) of the control-signal values with a maximum-flow value (Q_{max}) representing the maximum hydraulic flow available and, should the sum (Q_p) exceed the maximum-flow value (Q_{max}), multiplying each control signal by a scale factor k_i , wherein $i = 1, \dots, N$, and $k_i < 1$, before supply to a respective means (12) for controlling the flow to a crane function, and, should the sum fall below the maximum-flow value, supplying each control signal unmodified to the respective means (12) for controlling the flow to a crane function.
2. Method as claimed in claim 1, characterised by repeating step c) after the multiplication by the scale factors k_i .
3. Method as claimed in claim 1 or 2, characterised by using scale factors k_i with different values for the control signals to different crane functions.
4. Method as claimed in any one of the preceding claims, characterised by establishing the value of each control signal (Q_1-Q_N) by measuring the displacement caused by said signal of a control element provided in each means (12) for controlling the flow to a crane function.
5. Device for preventing puncture in a load-sensing and pressure-compensating control system for a hydraulic crane, said control system comprising load-sensing and pressure-compensat-



ing valve means (12) for controlling the hydraulic flow to the different crane functions, and means (13) for controlling the valve means (12) by control signals,

characterised by the device comprising

means for establishing the value of each control signal (Q_1-Q_N),

means for adding up the established values of the control signals (Q_1-Q_N),

means for comparing the sum (Q_p) of the measured values with a maximum-flow value (Q_{max}) representing a maximum hydraulic flow available, and

means for multiplying the control signals by a scale factor k_i , wherein $i = 1, \dots, N$, and $k_i < 1$, should the sum (Q_p) exceed the maximum-flow value (Q_{max}).

6. Device as claimed in claim 5, characterised in that the means for establishing the control-signal values include means for establishing the displacement of a slide member in the valve means (12).

Patentansprüche

1. Verfahren zum Verhindern von Durchbruch in einem lastführenden und druckausgleichenden Steuersystem für einen hydraulischen Kran, wenn die für die verschiedenen Funktionen des Krans angeforderte Hydraulikströmung die verfügbare maximale Hydraulikströmung übersteigt, gekennzeichnet durch
 - a) das Feststellen des Wertes jedes Steuersignals (Q_1-Q_N), das eine für eine Kranfunktion angeforderte Strömung darstellt;
 - b) das Summieren der festgestellten Werte der Steuersignale (Q_1-Q_N); und
 - c) das Vergleichen der Summe (Q_p) der Steuersignale mit einem Maximumströmungswert (Q_{max}), der die verfügbare maximale Hydraulikströmung darstellt und, falls die Summe (Q_p) den Maximumströmungswert (Q_{max}) überschreiten sollte, das Multiplizieren jedes Steuersignals mit einem Skalenfaktor k_i , worin $i = 1, \dots, N$, und $k_i < 1$, vor dem Zuführen an ein jeweiliges Glied (12) zum Steuern der Strömung an eine Kranfunktion und, falls die Summe kleiner sein sollte als der maximale Strömungswert, das Zuführen jedes Steuersignals unverändert an das jeweilige Glied (12) zum Steuern der Strömung an eine Kranfunktion.
2. Verfahren nach Anspruch 1, gekennzeichnet durch das Wiederholen des Schritts c) nach der Multiplikation mit den Skalenfaktoren k_i .

3. Verfahren nach Anspruch 1 oder 2, gekennzeichnet durch das Anwenden von Skalenfaktoren k_i mit verschiedenen Werten für die Steuersignale an verschiedene Kranfunktionen.

4. Verfahren nach einem der vorhergehenden Ansprüche, gekennzeichnet durch das Feststellen des Wertes jedes Steuersignals (Q_1-Q_N) durch Messen der Verschiebung, die das genannte Signal eines Steuerelements in jedem Glied (12) zum Steuern der Strömung an eine Kranfunktion verursacht.

5. Anordnung zum Verhindern von Durchbruch in einem lastführenden und druckausgleichenden Steuersystem für einen hydraulischen Kran, wobei das Steuersystem lastführende und druckausgleichende Ventilglieder (12) zum Steuern der Hydraulikströmung an verschiedene Kranfunktionen und Mittel (13) zum Steuern der Ventilglieder (12) durch Steuersignale umfasst, gekennzeichnet durch

Mittel zum Feststellen des Wertes jedes Steuersignals (Q_1-Q_N),

Mittel zum Summieren der festgestellten Werte der Steuersignale (Q_1-Q_N),

Mittel zum Vergleichen der Summe (Q_p) der gemessenen Werte mit einem Maximumströmungswert (Q_{max}), der eine verfügbare maximale Hydraulikströmung darstellt, und

Mittel zum Multiplizieren der Steuersignale mit einem Skalenfaktor k_i , worin $i = 1, \dots, N$, und $k_i < 1$, falls die Summe (Q_p) den maximalen Strömungswert (Q_{max}) überschreiten sollte.

6. Anordnung nach Anspruch 5, dadurch gekennzeichnet, dass die Mittel zum Feststellen der Steuersignale Mittel zum Feststellen der Verschiebung eines Gleitglieds in den Ventilgliedern (12) enthalten.

Revendications

1. Procédé pour empêcher la perforation d'un système de commande détecteur de charge et compensateur de pression pour une grue hydraulique lorsque l'écoulement hydraulique sollicité pour les fonctions différentes de la grue excède l'écoulement hydraulique maximal disponible, caractérisé par le fait que
 - a) l'on établit la valeur de chaque signal de commande (Q_1-Q_N) représentant un écoulement sollicité pour une fonction de la grue;
 - b) l'on additionne les valeurs des signaux de commande (Q_1-Q_N) ainsi établies; et
 - c) l'on compare le total (Q_p) des valeurs des signaux de commande avec une valeur



d'écoulement maximal (Q_{max}) représentant l'écoulement hydraulique maximal disponible et, dans le cas où le total (Q_p) est supérieur à la valeur d'écoulement maximal (Q_{max}), l'on multiplie chaque signal de commande par une échelle k_i , dans laquelle $i = 1, \dots, N$, et $k_i < 1$, avant de le fournir à des moyens respectifs (12) de commande de l'écoulement à une fonction de la grue, et, dans le cas où le total est inférieur à la valeur d'écoulement maximal, l'on fournit tous les signaux de commande non-modifiés aux moyens respectifs (12) de commande de l'écoulement à une fonction de la grue.

2. Procédé selon la revendication 1, **caractérisé** par le fait que l'on répète l'étape c) après la multiplication par les échelles k_i .
3. Procédé selon la revendication 1 ou 2, **caractérisé** par le fait que l'on utilise des échelles k_i ayant des valeurs différentes pour les signaux de commande à des fonctions différentes de la grue.
4. Procédé selon une quelconque des revendications précédentes, **caractérisé** par le fait que l'on établit la valeur de chaque signal de commande (Q_1-Q_N) en mesurant le déplacement provoqué par le signal d'un élément de commande prévu dans chaque moyen (12) de commande de l'écoulement à une fonction de la grue.
5. Dispositif pour empêcher la perforation d'un système de commande détecteur de charge et compensateur de pression pour une grue hydraulique, ledit système de commande comprenant des moyens de vanne détecteurs de charge et compensateurs de pression (12) destinés à commander l'écoulement hydraulique aux fonctions différentes de la grue, et des moyens (13) destinés à commander les moyens de vanne (12) à l'aide de signaux de commande, **caractérisé** par
 - des moyens d'établissement de la valeur de chaque signal de commande (Q_1-Q_N);
 - des moyens d'addition des valeurs des signaux de commande (Q_1-Q_N) ainsi établies;
 - des moyens de comparaison du total (Q_p) des valeurs mesurées avec une valeur d'écoulement maximal (Q_{max}) représentant l'écoulement hydraulique maximal disponible; et
 - des moyens de multiplication des signaux de commande par une échelle k_i , dans laquelle $i = 1, \dots, N$, et $k_i < 1$, dans le cas où le total (Q_p)

est supérieur à la valeur d'écoulement maximal (Q_{max}).

6. Dispositif selon la revendication 5, **caractérisé** en ce que les moyens d'établissement des valeurs des signaux de commande comprennent des moyens d'établissement du déplacement d'un élément coulissant dans les moyens de vanne (12).