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(54) ## ELECTROHYDRAULIC CONTROL METHOD.

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Description

Field of the Invention

The present invention relates to a method for electrohydraulic control of one or more simultaneously controlled work elements which are supplied with pressure fluid from a common pressure fluid source, each through its valve means, said valve means being connected in parallel to a common pressure conduit from said pressure fluid source and to a common return conduit of a tank, whereby outer input control signals are fed from an outer operating means to an electronic control system, for desired position, speed and acceleration value for said work elements and said electronic control system is supplied with information about the instantaneous position of each of said work elements from position sensing means detecting the position of said work elements and the control of the work elements is carried out by an output signal being delivered from the electronic control system to the pressure fluid source and each valve means.

Background of the Invention

Modern control systems with valves controlling several work elements from a common pressure fluid source are more and more often constructed to receive a so-called load-sensing function. Upon load-sensing, the work elements being activated are scanned and receive a volume flow from a pressure fluid source through a pressure conduit to the work element requiring the highest pressure. In a fully hydraulic solution this is obtained by using several different back valves. The highest sensed pressure signal is returned to the pressure fluid source and controls the source such that it outputs the return pressure value increased by a value required for the valve to be able to control the volume flow with a pressure drop of usually about 25 bar. Thus, the work element requiring the highest pressure is, like the other work elements, subjected to an unnecessary energy loss. In electrohydraulic control systems the highest pressure can be chosen and measured with an electric pressure sensor. Each work element must then have at least one sensor for each force direction, such as two sensors for double-acting cylinders and motors and also at least one pressure sensor positioned on the supply conduit between the pressure fluid source and the valves of the work element. Since electric pressure sensors are considered to involve higher costs and lower reliability than fully hydraulic devices based on back valves, the fully hydraulic alternative has up to now been predominant.

Load-sensing systems and electrohydraulic systems exist substantially in those cases where the requirements are comparatively high, since the cost for the control system is higher than for the simpler conventional control systems.

The load-sensing systems have neither developed as rapidly nor have they received the large market share as many have expected. The explanation for this is probably that the advantages have not been considered to balance the increased cost.

Electrohydraulic control systems have rapidly been developed and continuously take larger and larger market shares. High demands on automatization, increased supervision and security press the development towards electrohydraulic systems having position sensors and ability for position control. Microprocessors and improved pressure and position sensors today make advanced control techniques possible with respect to both function and cost. A relatively rapid and intensive development of electrohydraulics has, however, mainly been directed towards improvements of the conventional hydraulic components and control principles with electrohydraulic solutions rather than creating new control principles and components adapted to the completely new conditions that the access to microprocessors and sensors provides.

US-A-4 625 622 discloses the general state of art as described in the preamble of the independent claim 1. The object of the invention is to obtain an effective load sensing function with a minimum pressure increase by combining use of microprocessor for highly accurate position controlling and signal processing with an economic design of the whole system which requires only use of a minimum amount of simple sensors and highly simplified hydraulic components. The purpose of the invention is not to improve old controlling principles or components, but instead to provide a new concept for electrohydraulic control with the possibility of controlling each condition of position, speed and acceleration. Since the invention furthermore provides a system having a flexible construction, such system can, with the aid of electric pressure sensors in existing cases, also control pressure.

Since the position sensors are required for an effective, flexible and reliable control system, it is not possible to eliminate them from the invention. Other sensors do not have the same self-evident function in the control system. One must of course use certain pressure sensors for measuring effect, moment, force, and the like, however these sensors have a limited function. Thus, the present invention provides a method mainly requiring only position sensors on the work elements in order to be able to co-drive the pressure fluid source and the work elements without any appreciable increase in pressure above the amount of the pressure that the work element having the highest pressure requires.

This simple and cost-saving control system, according to the invention, requires a combination of three factors in order to operate. First, the position of the work elements must be measured and the measured values input into the electronic system, which then can also calculate the speed and acceleration of the work elements. Second, the valves controlling each work element shall never allow for transmitting an output signal from the electronic control system which is higher than that which allows to realize, in view of limitations of the capacity of the pressure fluid source, the volume flow rate which in every moment can be supplied to the work element via the common supply conduit. Third, the pressure fluid source shall, in order to avoid an increase in pressure, at every moment be controlled such that it delivers to the supply conduit a flow rate lower by a small quantity than that which the valves of the work elements try to transmit from the supply conduit to the work elements. The valve controlling the work element having the highest pressure can in such a case not receive the volume flow it strives to pass out. It will then open to a comparatively large extend, resulting in a reduced pressure drop over the valve and a reduced system pressure in the supply conduit.

Since position control presupposes position sensors and since a well-operating electrohydraulic control system normally is constructed such that it only tries to control such movements that are possible to perform, these two conditions are normally always met. The control of the pressure fluid source takes place by means of control signals of the type " increase" or "decrease". The information to these control signals arrives from the position sensor of the work elements, that is from the information about their position, speed and acceleration. The electronic control system calculates the speeds of each work element and calculates a desired value output signal which is applicable to each work element.

The source of pressure fluid is controlled for an increase or a decrease of its delivered volume flow so that the delivered volume flow is lower than the volume flow which should give all work elements the flow rate that each work element valve strives to pass. By the present invention a method is provided which lacks particular means for pressure-sensing and which instead causes the work element requiring the highest pressure directly, via a comparatively low pressure drop over the valve of this work element, to directly control the pressure in the supply conduit. The control of the work element having the highest pressure requirement will in this manner be controlled by controlling the pressure fluid source. The valve of the work element, however, tries all the time to influence the speed of the work element towards the value that the output signal from the electronic control system indicates. When the work element changes requirement from the highest pressure to some lower pressure, the valve of the work element takes over the control from the pressure fluid source. Thus, in a method according to the invention there are no special devices and no consequent high costs for the almost perfect load-sensing function which is obtained. The function is realized by the electronic system and by only comparison of read and desired values for the speeds of the different work elements. Thus, the cost for the load-sensing co-driving of work elements and the pressure fluid source is very low.

In all hydraulic control systems the speed of the work elements requiring the highest pressure decreases when one tries to pass a larger total volume flow from the supply conduit than the pressure fluid source can supply to the supply conduit. It is advantageous that the desired speeds by the electronic control system are reduced in proportion to their values, so that the total reduced requirement always only tries to pass volume flow to the work element lying below or on the limit of the capacity of the pressure fluid source.

When hydraulic control systems are used under conditions where the work element gets stuck or is not able to output the desired volume flow or speed, it is appropriate to limit the output signal from the electronic control system to the valve of that work element so that the signal is never allowed to be larger than, for instance, 120% of the work element speed calculated via its position sensor, or, for instance, a minimum speed. If the work element gets stuck, the system reacts by raising the system pressure to a maximum. By reducing and adapting the output signal from the electronic control system to the actual work element speed, unnecessary energy losses and capacity losses are avoided.

The valves controlling the volume flow to and from the work elements can be constructed in many ways. Preferably the valves are constructed such that the inlet side can be closed when the volume flow is passed from the work element through the return conduit to the tank. Moreover, the control of the volume flow to and from the work element should preferably be established such that the volume flow to a work element will be lower than the volume flow from the work element. Thereby, an unneeded pressure increase in the valves of the work elements is avoided. As a result when a load, for instance, is lifted, such as when the work element is energy-absorbing and operates as a motor, the speed is controlled on the pressure side of the valve, whereby the pressure drop on the return side to the return conduit is low. Alternatively, when, for instance, a load is lowered, such as when the work element is energy-delivering and operates as a pump, the speed is controlled on the return side of the valve, wherein, advantageously, as large part as possible of the volume flow to the work element can be delivered from the return conduit through back valves, so-called anti-cavitation valves.

In a method according to the present invention, pressure and force can also of course be controlled.

An electric sensor is then arranged on the work element on the side where the pressure shall be controlled. The valve of the work element is now controlled such that the pressure side opens and controls the pressure when this shall increase, and the return side controls the pressure when this shall decrease.

Because the position sensors of the work elements measure the received volume flow to the work elements and because, through the output signals from the electronic control system to the work element valves it is possible with the aid of the electronic control system, to determine the volume flow that flows from the supply conduit to the work elements, therefore the total volume flow flowing from the supply conduit to the work elements can, be easily calculated with sufficient accuracy. If a volume flow meter is inserted after the pressure fluid source in the supply conduit, a fast indication can be obtained if the supply conduit should break or a larger leakage should arise. It is accordingly possible, with the aid of the electronic system, to obtain an out-pumping protection which automatically and very rapidly closes the pressure fluid source.

The invention is in the following described more in detail in preferred embodiments with reference being made to the accompanying drawings, wherein:

Brief Description of the Drawings

Figure 1 schematically shows an apparatus for carrying out the method according to the invention with components included in the apparatus;
Figure 2 schematically shows another embodiment of a part of the apparatus according to Figure 1; and
Figure 3 schematically shows another embodiment of another part of the apparatus according to Figure 1.

Detailed Description of the Preferred Embodiment(s)

The embodiment shown in Figure 1 includes an outer impulse generating control means 1, which for instance is controlled by an operator and which delivers desired input values to an electronic control system 2. The electronic system 2 controls a number of work elements for driving a machine, for instance, a crane. Two such work elements 3 and 4 are shown in Figure 1. The electronic control system 2 also controls a pressure fluid source 5 via an electric set device 6.

In the illustrated embodiment the work element 3 is of a linear type, such as as hydraulic cylinder, and is provided with a position sensor 7, for instance a potentiometer, a digital sensor, or another conventional sensor. The work element 3 is controlled by a valve 8 connected to a pressure or supply conduit 9 from the pressure fluid source 5 and to a return conduit 10 connected to a tank 11. The work element 4, as exemplified, is of a rotating type, is provided with a position sensor 12, and is controlled by a valve 13 connected to the supply conduit 9 and the return conduit 10. The work elements 3, 4 and other work elements not shown, are all connected in parallel to the supply conduit 9 and the return conduit 10.

The electronic system 2 receives input signals about desired movements of the work elements from the outer impulse generating means 1 and, when required, reduces these input signals down to output signal levels such that the pressure fluid source can effect the desired movements with possibly lower speed via output signals to the work elements 3 and 4 controlled by the valves 8 and 13. The electronic system 2, via the set device 6, controls the pressure fluid source 5 which feeds to the supply conduit 9 a volume flow lower by a small quantity than the volume flow that the valves 8 and 13 try to pass from the supply conduit 9 to the work elements 3 and 4. The control of the pressure fluid source 5 is based on the summing-up of the speeds of the work elements calculated from information including input from the position sensors 7 and 12 and the sum of the output signals delivered to the valves 8 and 13.

The control system is constructed such that it is essentially the position sensors 7 and 12 and the calculations of speed and acceleration that control the output signals from the electronic control system to both the valves 8 and 13 of the work elements 3 and 4, and the set device 6 of the pressure fluid source 5. The valves 8 and 13 can preferably be constructed such that they are independent of the pressure drop over the valves 8 and 13 and deliver a volume flow which is more or less proportional to the input signals. Inasmuch as the work elements and the pressure fluid source are controlled by information from position sensors, their quality substantially determines control results. The remaining components can have relatively great deficiencies without effecting the total result. The apparatus in its entirety can accordingly operate well both in a new, unworn condition and a worn-in condition.

The pressure fluid source 5 is preferably constructed as a variable reset pump but can also be a fixed non-reset pump provided with a shunt valve which, via the set device 6, shunts off undesired volume flow from the supply conduit 9 to the return conduit 10.

The position sensors 7 and 12 can be constructed in many ways, and way for instance be potentiometers or other all-electric devices. As position sensors, volume meters can also be used which measure the volume delivered out of or supplied into one side of a work element and thereby calculate their position, speed and acceleration. Measurement with volume meters is particularly useful in dangerous environments where electric sensors can be unsuitable. Volume meters or sensors can also, if they can be made at low cost and with good accuracy, be an alternative to all-electric position sensors.

Figure 2 illustrates such an alternative embodiment having a volume meter 14 as a position sensor instead of a position sensor 7 according to Figure 1. The work element 3 is constructed as a piston/cylinder device, the volume meter 14 is arranged between the cylinder, and a directional valve 15 provided with sensor 16.

Figure 3 illustrates an embodiment in which a volume meter 17 is positioned in the supply conduit 9 downstream from the pressure fluid source 5, and is connected to the electrical control system 2. Thereby, a fast indication can be obtained if any leakage should arise in, for instance, a broken hose in the supply conduit 9. The volume flow delivered from the pressure fluid source 5 is measured and a signal derived therefrom is sent to the electrical control system 2. This signal is compared with signals corresponding to the sum of all volume flows delivered from the supply conduit to the work elements, and, as the measured value for each work element 3, 4 is valid, the volume flow calculable from the position measurement by means of the position sensors 7, 12, 14, or, if another value exists, for instance 10% lower, the volume flow belonging to a flow from the supply conduit to a work element proportional to the control signals of the valves 8, 13, 15. The technique required for designing and building the electronic control system 2 is known and commonly used today for instance in numerically controlled machine tools and robots and in electronic control systems in many other civil and military applications. The apparatus can of course be provided with additional functions, such as memories etc., making it possible for a machine controlled by the apparatus to execute and repeat as well as record movements automatically as well as, for instance, allow permmitted and unpermitted operation field and mode of movements. Besides the fact that each work element can be given a setable and resetable and permitted and unpermitted movement field, the permitted field can be position by position given a maximum speed making the speed slowly decrease towards the end positions and so that accelerations and dynamic forces are maximized.

Claims

1. A method for electrohydraulic control of one or more simultaneously controlled work elements which are supplied with pressure fluid from a common pressure fluid source, each through its valve means, said valve means being connected in parallel to a common pressure conduit from said pressure fluid source and to a common return conduit of a tank,
characterized in that the control of the work elements (3, 4) at each time occurs by a combination of

feeding outer input control signals from an outer operating means (1) to an electronic control system (2) for desired position, speed and acceleration value for said work elements (3, 4);

supplying said electronic control system (2) with input information about the instantaneous position of each of said work elements (3, 4) from position sensing means (7, 12, 14) detecting the position of said work elements (3, 4);

calculating, in said electronic control system (2) , speed and acceleration of said work elements (3, 4) based on said input information about said position;

calculating output signal from the electronic control system to the pressure fluid source (5) and each valve means (8, 13, 15) which is either the input signal desired from said outer input control signals or at most the limited output signal from the electronic control system (2) which is possible to achieve considering the limitations of the pressure fluid source in effect and volume flow or the limited value in position, speed and acceleration in optional combination corresponding to limitations in the movement of each work element that within all its movement field is position by position given such an allowed speed that constant maximum allowed acceleration is not exceeded;

calculating and controlling the volume flow flowing via said valve means (8, 13, 15) from the pressure fluid source (5) to the work elements (3, 4) to increase or decrease so that the sum of the output signals from the electronic control system to all said valve means strives to control out a total volume flow which always is a small quantity larger than what the pressure fluid source via the output signal from the electronic control system is delivering to the pressure conduit (9), and consequently in each case the working element requiring the highest pressure is supplied a lower volume flow than what the output signal from the electronic control system to the valve means of this work element tries to control, the valve will then open to a comparatively large extent resulting in a low pressure drop over the valve and consequently the work element requiring the highest pressure directly controls the pressure in the supply conduit and will first-hand to be controlled by the control of pressure fluid source.

2. A method according to claim 1, **characterized in** that the fluid volume flow from the pressure conduit (9) to each work element (3, 4) is controlled by an output control signal from the electronic

control system (2) supplied to said valve means of the work element such that a speed resulting from what the output control signal maximum strives to control is not higher than for instance 120% of the actual speed existing at this moment.

3. A method according to claim 1 or 2, **characterized in** that said valve means (8, 13, 15) of the work elements (3, 4) always strives to control out a higher speed for the volume flow from the work element to the return conduit (10) than for the volume flow from the pressure conduit (9) to the work element.

4. A method according to any of claims 1-3, **characterized in** that in case of energy absorbing work elements the speed is determined by the fluid flow from the pressure conduit (9) to the work elements wherein said valve means (8, 13, 15) via the flow from the work elements to the return conduit (10) strives to control out a higher speed, for instance 30% higher.

5. A method according to claims 1-3, **characterized in** that in case of energy delivering work elements, the speed is determined by the flow from the work elements to the return conduit (10), and wherein said valve means (8, 13) completely block the flow from the pressure conduit (9) to the work elements.

6. A method according to claims 1-5, **characterized in** that the movements and the speeds desired by operator input generating means (1) are achieved, if limited, proportional to the limited access of volume flow from the pressure fluid source (5) to the work elements (3, 4).

7. A method according to claims 1-6, **characterized in** that the delivered volume flow from the pressure fluid source (5) is measured and the measured value is returned as input signal to the electronic control system (2) for comparison with the sum of all volume flows flowing from the pressure conduit (9) to the work elements (3, 4).

Patentansprüche

1. Verfahren zum elektrohydraulischen Steuern eines oder mehrerer gleichzeitig gesteuerter Arbeitselemente, die je über ihre Ventileinrichtung von einer gemeinsamen Druckfluidquelle mit Druckfluid gespeist werden, wobei die Ventileinrichtung parallel mit einer gemeinsamen Druckleitung von der Druckfluidquelle und mit einer gemeinsamen Rückführleitung eines Behälters verbunden ist,

   dadurch gekennzeichnet,

   daß die Steuerung der Arbeitselemente (3, 4) zu jeder Zeit erfolgt durch eine Kombination von Zuführen äußerer Eingabesteuersignale von einer äußeren Betriebseinrichtung (1) zu einem elektronischen Steuersystem (2) für einen gewünschten Positions-, Geschwindigkeits- und Beschleunigungswert für diese Arbeitselemente (3, 4);
   Speisen des elektronischen Steuersystems (2) mit einer Eingabeinformation hinsichtlich der augenblicklichen Position eines jeden der Arbeitselemente (3, 4) von einer Positionsfühleinrichtung (7, 12, 14), welche die Position der Arbeitselemente (3, 4) erfaßt;
   Berechnen der Geschwindigkeit und Beschleunigung der Arbeitselemente (3, 4) in dem elektronischen Steuersystem (2) auf der Grundlage der Eingabeinformation über diese Position;
   Berechnen eines Ausgabesignals von dem elektronischen Steuersystem an die Fluiddruckquelle (5) und an jede Ventileinrichtung (8, 13, 15), welches entweder das von den äußeren Eingabesteuersignalen gewünschte Eingabesignal oder höchstens das begrenzte Ausgabesignal von dem elektronischen Steuersystem (2) ist, so daß ein Berücksichtigen der Grenzen der Fluiddruckquelle in Funktion und des Volumenstromes oder des begrenzten Wertes in Position, Geschwindigkeit und Beschleunigung in wahlweiser Kombination erzielt werden kann, welche den Grenzen der Bewegung jedes Arbeitselementes entspricht, welchem innerhalb seines Bewegungsfeldes positionsweise eine derartige zulässige Geschwindigkeit gegeben wird, daß die konstante zulässige Beschleunigung nicht überschritten wird;
   Berechnen und Steuern des über die Ventileinrichtung (8, 13, 15) von der Fluiddruckquelle (5) zu den Arbeitselementen (3, 4) fließenden Volumenstromes zwecks Zunahme oder Abnahme, so daß die Summe der Ausgabesignale von dem elektronischen Steuersystem zu allen Ventileinrichtungen einen Gesamtvolumenstrom zu steuern bestrebt ist, der immer um einen geringen Betrag größer als der ist, den die Fluiddruckquelle über das Ausgabesignal von dem elektronischen Steuersystem zu der Druckleitung (9) liefert und folglich in jedem Fall das den höchsten Druck erfordernde Arbeitselement mit einem geringeren Volumenstrom versorgt wird als demjenigen, welchen das Ausgabesignal von dem elektronischen Steuersystem zu der Ventileinrichtung dieses Arbeitselementes zu steuern bestrebt ist, wobei sich dann das Ventil zu einem verhältnismäßig großen Ausmaß öffnet und sich ein geringer Druckabfall am Ventil ergibt;

und wobei folglich das den höchsten Druck erfordernde Arbeitselement direkt den Druck in der Zufuhrleitung steuert und aus erster Hand durch die Steuerung der Fluiddruckquelle zu steuern ist.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß der Fluidvolumenstrom von der Druckleitung (9) zu jedem Arbeitselement (3, 4) von einem Ausgabesteuersignal von dem elektronischen Steuersystem (2) gesteuert wird, das der Ventileinrichtung des Arbeitselementes zugeführt ist, so daß eine Geschwindigkeit, die sich aus dem ergibt, was das Ausgabesteuersignal-Maximum zu steuern bestrebt ist, nicht höher als beispielsweise 120% der in diesem Augenblick vorhandenen tatsächlichen Geschwindigkeit ist.

3. Verfahren nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die Ventileinrichtung (8, 13, 15) der Arbeitselemente (3, 4) immer bestrebt ist, eine höhere Geschwindigkeit für den Volumenstrom von dem Arbeitselement zu der Rückführleitung (10) als für den Volumenstrom von der Druckleitung (9) zu dem Arbeitselement zu steuern.

4. Verfahren nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, daß im Fall Energie absorbierender Arbeitselemente die Geschwindigkeit durch den Fluidstrom von der Druckleitung (9) zu den Arbeitselementen bestimmt wird, wobei die Ventileinrichtung (8, 13, 15) über den Strom von den Arbeitselementen zu der Rückführleitung (10) eine beispielsweise 30% höhere Geschwindigkeit auszusteuern bestrebt ist.

5. Verfahren nach den Ansprüchen 1 bis 3, dadurch gekennzeichnet, daß im Fall Energie liefernder Arbeitselemente die Geschwindigkeit durch den Strom von den Arbeitselementen zu der Rückführleitung (10) bestimmt wird, wobei die Ventileinrichtung (8, 13) den Strom von der Druckleitung (9) zu den Arbeitselementen vollständig blokkiert.

6. Verfahren nach den Ansprüchen 1 bis 5, dadurch gekennzeichnet, daß die Bewegungen und die Geschwindigkeiten, die von der Eingabe erzeugenden Betriebseinrichtung (1) erwünscht sind, erreicht werden, falls sie begrenzt sind, und zwar proportional zu dem begrenzten Volumenstrom-Zugang von der Druckfluidquelle (5) zu den Arbeitselementen (3, 4).

7. Verfahren nach den Ansprüchen 1 bis 6, dadurch gekennzeichnet, daß der von der Druckfluidquelle (5) abgegebene Volumenstrom gemessen wird und der gemessene Wert als Eingabesignal an das elektronische Steuersystem (2) zum Vergleich mit der Summe aller Volumenströme zurückgeführt wird, die von der Druckleitung (9) zu den Arbeitselementen (3,4) fließen.

Revendications

1. Méthode pour la commande électrohydraulique d'un ou plusieurs éléments de travail commandés simultanément qui sont alimentés avec un fluide sous pression provenant d'une source commune de fluide sous pression, chacun par l'intermédiaire de son dispositif de distribution, lesdits dispositifs de distribution étant connectés en parallèle à un conduit de pression commun venant de ladite source de fluide sous pression et à un conduit de retour commun allant à un bac, caractérisée en ce que la commande des éléments de travail (3,4) à chaque instant est effectuée par une combinaison de :

fourniture de signaux extérieurs de commande d'entrée, fournis par un dispositif extérieur de manoeuvre (1) à un système de commande électronique (2), pour une valeur désirée de position, de vitesse et d'accélération desdits éléments de travail (3,4) ;

fourniture audit système de commande électronique (2) d'informations d'entrée relatives à la position instantanée de chacun desdits éléments de travail (3,4) par des dispositifs de détection de position (7,12,14) qui détectent la position desdits éléments de travail (3,4);

calcul, dans ledit système de commande électronique (2), de la vitesse et de l'accélération desdits éléments de travail (3,4), sur la base desdites informations d'entrée relatives à ladite position ;

calcul d'un signal de sortie, envoyé par le système de commande électronique à la source de fluide sous pression (5) et à chaque dispositif de distribution (8,13,15), qui est soit le signal d'entrée désiré faisant partie desdits signaux extérieurs de commande d'entrée, soit au plus le signal de sortie limité du système de commande électronique (2) qu'on peut obtenir compte tenu des limitations de l'effet et du débit volumique de la source de fluide sous pression, soit la valeur limitée en position, en vitesse et en accélération en combinaison optionnelle correspondant aux limitations du mouvement de chaque élément de travail qui prend, à l'intérieur de toute sa plage de déplacement et position par position, une vitesse allouée telle qu'une accélération autorisée maximale constante n'est pas dépassée ;

calcul et réglage du débit volumique s'écoulant de la source de fluide sous pression

(5) aux éléments de travail (3,4) par l'intermédiaire desdits dispositifs de distribution (8,13,15),en augmentation ou en diminution d'une manière telle que la somme des signaux de sortie envoyés par le système de commande électronique à tous les dispositifs de distribution tend à régler un débit volumique total qui est toujours un peu plus grand que celui que la source de fluide sous pression fournit au conduit de pression (9) sous l'action du signal de sortie du système de commande électronique et par conséquent, dans chaque cas, l'élément de travail nécessitant la pression la plus élevée reçoit un débit volumique plus petit que celui que le signal de sortie appliqué par le système de commande électronique au dispositif de distribution de cet élément de travail essaie de régler, le dispositif de distribution s'ouvrant donc à un degré relativement grand entraînant une faible chute de pression à travers le dispositif de distribution, et par conséquent l'élément de travail nécessitant la pression la plus élevée commande directement la pression dans le conduit d'alimentation et est commandé directement par le réglage de la source de fluide sous pression.

2. Méthode suivant la revendication 1, caractérisée en ce que le débit volumique de fluide allant du conduit de pression (9) à chaque élément de travail (3,4) est commandé par un signal de commande de sortie fourni par le système de commande électronique (2) audit dispositif de distribution de l'élément de travail, d'une manière telle qu'une vitesse, résultant de ce que le signal maximal de commande de sortie s'efforce de régler, n'est pas supérieure par exemple à 120% de la vitesse réelle existant à cet instant.

3. Méthode suivant la revendication 1 ou 2, caractérisée en ce que lesdits dispositifs de distribution (8,13,15) des éléments de travail (3,4) s'efforcent toujours de produire une plus grande vitesse pour le débit volumique allant de l'élément de travail au conduit de retour (10) que pour le débit volumique allant du conduit de pression (9) à l'élément de travail.

4. Méthode suivant une quelconque des revendications 1 à 3, caractérisée en ce que, dans le cas d'éléments de travail absorbant de l'énergie, la vitesse est déterminée par l'écoulement de fluide du conduit de pression (9) aux éléments de travail, et lesdits dispositifs de distribution (8,13,15) au moyen de l'écoulement de fluide des éléments de travail vers le conduit de retour (10) s'efforcent de produire une plus grande vitesse,par exemple de 30% supérieure.

5. Méthode suivant les revendications 1 à 3, caractérisée en ce que, dans le cas d'éléments de travail fournissant de l'énergie, la vitesse est déterminée par l'écoulement de fluide des éléments de travail au conduit de retour (10) et lesdits dispositifs de distribution (8,13) empêchent complètement l'écoulement du conduit de pression (9) aux éléments de travail.

6. Méthode suivant les- revendications 1 à 5, caractérisée en ce que les mouvements et les vitesses désirés par le dispositif de génération d'entrée d'opérateur (1) sont effectués, s'ils sont limités, proportionnellement à la valeur limitée du débit volumique allant de la source de fluide sous pression (5) aux éléments de travail (3,4).

7. Méthode suivant les revendications 1 à 6, caractérisée en ce que le débit volumique fourni par la source de fluide sous pression (5) est mesuré et la valeur mesurée est renvoyée comme signal d'entrée au système de commande électronique (2) pour comparaison avec la somme de tous les débits volumiques allant du conduit de pression (9) aux éléments de travail (3,4).

FIG.1

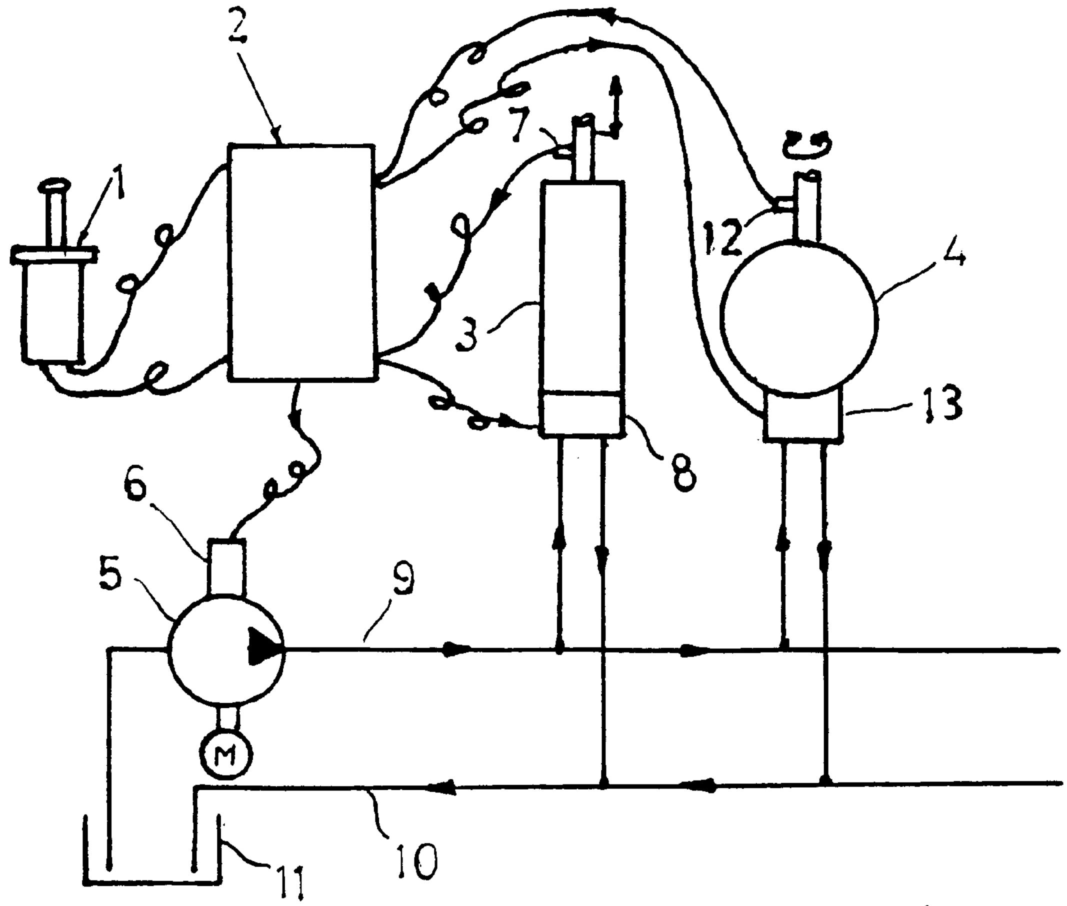

FIG.2

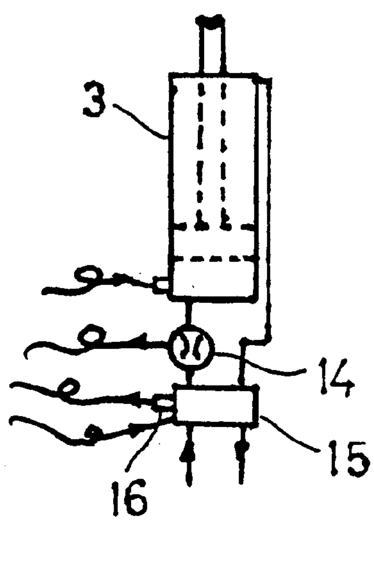

FIG.3