(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 150 019 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
31.10.2001 Bulletin 2001/44

(51) Int Cl.[7]: **F15B 19/00**, B66C 13/16

(21) Application number: **01104876.6**

(22) Date of filing: **28.02.2001**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **28.04.2000 SE 0001608**

(71) Applicant: **Hiab AB**
824 83 Hudiksvall (SE)

(72) Inventors:
- **Andersson, Lars**
  820 65 Forsa (SE)
- **Gustafsson, Per**
  824 40 Hudiksvall (SE)
- **Siren, Sten**
  21600 Pargas (FI)

(74) Representative: **Löfgren, Jonas et al**
Bjerkéns Patentbyrä KB,
Box 1274
801 37 Gävle (SE)

(54) Counter for registering the quantity of lifts of a crane

(57) A hydraulic crane (1) comprising an inner boom 5, a hydraulic cylinder (8) for operating the inner boom (5), and a pressure sensor (34) arranged to measure the pressure in the hydraulic cylinder (8), which crane (1) further comprises a means (36) connected to the pressure sensor (34), which means is adapted to register the lifting up and putting down of a load by detecting the velocity of the pressure variations in said cylinder (8), the means (36) being adapted to register a lifting up and a putting down, respectively, of a load when the velocity of a detected pressure variation exceeds a predetermined value. The invention also relates to a method for registration of the lifting up and the putting down of a load in a hydraulic crane (1) and a method for calculation of the fatigue stress of a hydraulic crane (1) based on the number of registered liftings up and puttings down of load.

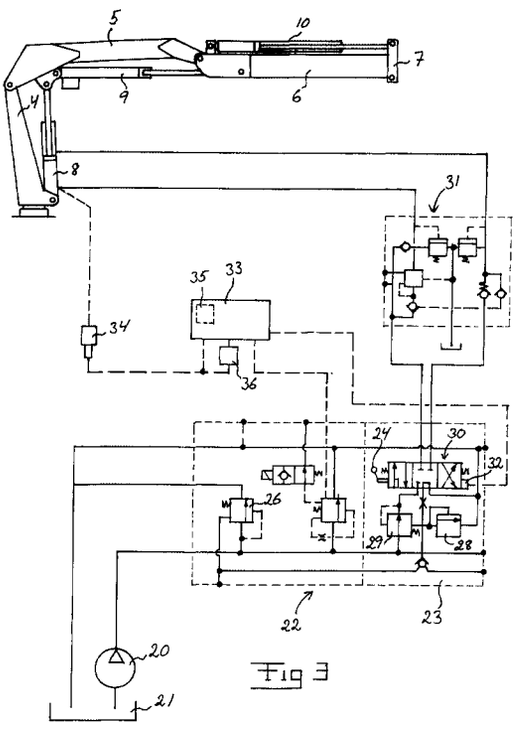


Fig 3

EP 1 150 019 A1

Description

FIELD OF THE INVENTION AND PRIOR ART

[0001] The present invention relates to a hydraulic crane, preferably a lorry crane, a method for calculation of the fatigue stress of such a crane and a method for registration of the lifting up and putting down of a load in such a crane.

[0002] A hydraulic crane is, like all other mechanical constructions, subjected to an accumulating fatigue stress during use. When the fatigue stress has reached a certain value large risks of crane breakdowns ensue, which can result in serious personal injuries or expensive damages to the crane itself or objects in the vicinity of the crane. In order to make possible a safe and trouble-free operation of a crane it is therefor a great need of calculating the accumulated fatigue stres's of the crane. Based on such a calculated fatigue stress, it is possible to estimate the condition of the crane and its need of maintenance.

[0003] A method today used for calculation of the accumulated fatigue stress of hydraulic cranes is based on that the operating time of the crane is registered by means of a time counter. In this connection it is normally registered the time during which the pump included in the hydraulic system is switched in. However, this constitutes a relatively bad measure of the accumulated fatigue stress of the crane, since one and the same crane often is used for many types of working operations having a very varying intensity.

OBJECT OF THE INVENTION

[0004] The object of the present invention is to achieve a hydraulic crane in which it is possible to calculate the accumulated fatigue stress of the crane in a simple and efficient manner.

SUMMERY OF THE INVENTION

[0005] According to the present invention, this object is achieved in that the crane comprises means connected to a pressure sensor in the lifting cylinder of the crane, which means is adapted to register the lifting up and the putting down of a load by detecting the velocity of the pressure variations in said cylinder, the means being adapted to register a lifting up and a putting down, respectively, of a load when the velocity of a detected pressure variation exceeds a predetermined value.

[0006] In this way liftings up and puttings down of load performed by the crane can be registered in a very simple manner and with simple and cheap means. By means of the liftings up and puttings down of load registered by the means it will be possible to determine the number of lifting cycles performed by the crane, which constitutes a measure well related to the accumulated fatigue stress of the crane. It has appeared that the number of performed lifting cycles constitutes a considerably better measure of the fatigue stress of the crane than the time during which the crane has been in operation. Each lifting cycle is namely contributing in increasing the fatigue stress of the crane and the duration of a lifting cycle can vary from for instance 30 seconds, when the crane is used for excavation with a hydraulic bucket, up to several hours, when the crane is used in assembly work in order to for instance lift and position a transformer and to keep this in place until it has been fixed on the intended place. In the first mentioned case, the total fatigue stress of the crane will be considerably higher than in the last mentioned case during one and the same time period.

[0007] According to a preferred embodiment of the invention, the means is connected to one or several sensors arranged to deliver information to the means concerning the control and/or movements of the crane, said means being adapted to determine by means of this information whether or not a lowering movement of the crane is taking place. In this connection the means is adapted not to register a lifting up of load when a rapid pressure variation in the cylinder is detected in connection with a determined lowering movement. In this way the means is prevented from being "fooled" by the rapid pressure variation caused by the induced pressure on the piston side of the cylinder that can ensue during lowering movements due to the fact that a certain pressure is required on the piston stem side in order to open the load holding valve of the hydraulic system.

[0008] The invention also relates to a method for registration of the lifting up and putting down of a load in a hydraulic crane according to claim 5 and a method for calculation of the fatigue stress of a hydraulic crane according to claim 7.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] With reference to the enclosed drawings, a more specific description of embodiment examples of the invention will follow hereinbelow. It is shown in:

Fig 1 a sectional view of a hydraulic crane provided with a bucket,

Fig 2 a sectional view of a hydraulic crane provided with a jib,

Fig 3 a schematic view of an embodiment of the invention, and

Fig 4 a schematic view of a control unit with a number of control devices for control of different crane functions.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0010] In this description the expression operating means is used to designate the hydraulic force members which execute the crane movements ordered by the operator of the crane. The expression operating means consequently embraces the hydraulic cylinders 8, 9, 10, 14, 17 and 19 mentioned hereinbelow. The expression control device refers to the devices, for instance operating levers, by means of which the operator regulates the valve members included in the control system which control the flow of hydraulic fluid to the respective operating means. In the described embodiment, said valve members consist of so-called directional-control-valve sections.

[0011] In fig 1 a hydraulic crane 1 attached to a frame 2 is shown, which frame for instance can be connected to a lorry chassis. The frame is provided with adjustable support legs 3 for supporting the crane 1. The crane comprises a column 4, which is rotatable in relation to the frame 2 around an essentially vertical axis. The crane further comprises an inner boom 5 articulately fastened to the column 4, an outer boom 6 articulately fastened to the inner boom 5 and an extension boom 7 displaceably fastened to the outer boom 6. The inner boom 5 is operated by means of a hydraulic lifting cylinder 8, the outer boom 6 by means of a hydraulic outer boom cylinder 9 and the extension boom 7 by means of a hydraulic extension boom cylinder 10. In the shown example a rotator 11 is articulately fastened at the outer and of the extension boom, which rotator in its turn carries a hydraulic grab tool in the form of a bucket 12. Two bucket parts 13 included in the bucket 12 can be operated in relation to each other by means of a hydraulic grab cylinder 14 for opening and closing of the bucket 12. The rotator 11 is rotatable in relation to the extension boom 7 by means of not shown hydraulic operating means.

[0012] In the example shown in fig 1, the crane 1 is equipped for performing excavations. When the crane 1 is to be used for proper lifting operations the rotator 11 and the bucket 12 can be removed and replaced by a lifting hook. In order to perform lifting operations requiring a great range, the rotator 11 and the bucket 12 are replaced by a jib 15, see fig 2. The jib 15 comprises a jib boom 16, which is articulately fastened in relation to the extension boom 7 and operated by means of a hydraulic jib boom cylinder 17. The jib can further comprise an extension boom 18 which can be operated by means of a hydraulic extension boom cylinder 19. One and the same crane can consequently be used for a large number of different working operations, the intensity (lifting frequency) of which varies considerably.

[0013] Besides the crane elements shown in fig 1 and 2, the crane 1 can also be provided With a hydraulically controllable winch, which can be used in combination with a lifting hook either with or without jib 15. The crane 1 can also be provided with other types of hydraulic grab tools than a bucket, for instance grab tools for handling scrap or pallets with building material such as stone or building plates.

[0014] The control system for controlling the different crane functions, i.e. lifting/lowering by means of the lifting cylinder 8, tilting by means of the outer boom cylinder 9, extension/retraction by means of the extension boom cylinder 10 etc, comprises a pump 20 which pumps hydraulic fluid from a reservoir 21 to a directional-control-valve block 22. The directional-control-valve block 22 comprises a directional-control-valve section 23 for each of the hydraulic operating means 8, 9, 10, 14, 17, 19, to which hydraulic fluid is supplied in a conventional manner depending on the position of the slide member in the respective valve section 23. The position of the slide members in the directional-control-valve sections 23 is controlled either via a number of control devices in the form of control levers 24, each of which being connected to its own slide member, or by remote control via a control unit 25, see fig 4, comprising a control lever for the respective slide member. In case of remote control, the control signals are transmitted via cable or a wireless connection from the control unit 25 to a microprocessor, which in its turn controls the position of the slide members in the valve sections 23 of the directional-control-valve block 22 depending on the magnitude of the respective control signal from the control unit 25.

[0015] Each separate directional-control-valve section 23 consequently controls the size and the direction of the flow of hydraulic fluid to a specific operating means and thereby controls a specific crane function. For the sake of clarity, only the directional-control-valve section 23 for the lifting cylinder 8 is illustrated in fig 3.

[0016] The directional-control-valve block 22 further comprises a shunt valve 26 pumping excessive hydraulic fluid back to the reservoir 21, and an electrically controlled dump valve 27 which can be caused to return the entire hydraulic flow from the pump directly to the reservoir 21.

[0017] In the shown embodiment, the directional-control-valve block 22 is of load-sensing and pressure-compensating type, which implies that the hydraulic flow supplied to an operating means is at all times proportional to the position of the slide member in the corresponding directional-control-valve section 23, i.e. proportional to the position of the lever 24. The directional-control-valve section 23 comprises a pressure-limiting device 28, a pressure-compensating device 29 and the directional-control-valve 30 proper. Directional-control-valve blocks and directional-control-valve sections of this type are well-known and available on market. However, also other types of directional-control-valves than the one described here can be used.

[0018] A load holding valve 31 is arranged between the respective operating means and the associated directional-control-valve section 23, which load holding valve makes sure that the load will remain hanging when

the hydraulic system runs out of pressure owing to the dump valve 27 being caused to return the entire hydraulic flow from the pump 20 directly to the reservoir 21.

[0019] A sensor 32 is arranged on each of the directional-control-valve sections 23 in order to detect the movements of the valve slide member in the respective directional-control-valve section 23. These sensors 32 are connected to a processing unit 33 suitably constituted by a microprocessor. By means of these sensors 32 the processing unit 33 can obtain information that a certain valve slide member is influenced and thereby how the crane is controlled. In case the valve slide members are regulated via a remote control unit 25, the processing unit 33 can instead be adapted to obtain information about how the crane is controlled by reading the control signals transmitted from the control unit 25.

[0020] The crane further comprises a load sensing means in the form of a pressure sensor 34 adapted to measure the hydraulic pressure in the lifting cylinder 8. The pressure sensor 34 is, just as the sensors 32 in the valve sections 23, connected to the processing unit 33.

[0021] The crane 1 further comprises a means 36 adapted to register when the crane lifts up and puts down, respectively, a load. The means 36, which henceforth is denominated "lifting counter", registers this by detecting the velocity of the pressure variations in the lifting cylinder 8 of the crane, which pressure variations are measured by the pressure sensor 34 associated with the lifting cylinder 8. During lifting up of a load, the pressure in the lifting cylinder 8 very rapidly increases just at the moment when the load is lifted up from the underlay and becomes free hanging. The same rapid pressure variation occurs when the load is put down and no more is carried by the crane. These pressure variations are much more rapid than the pressure variations caused by the normal natural oscillations which at all times are present in the steel structure of the crane, and hereby the lifting counter 36 can separate "liftings up" and "oscillations". A lifting up and a putting down, respectively, of a load is consequently registered when the velocity of the pressure variation in the lifting cylinder 8 exceeds a certain predetermined value.

[0022] When it comes to loads which are very small for the crane (approximately smaller than 10 % of the maximum capacity of the crane) it might be problematic to register a lifting up and a putting down of a load in the above described way. However, these small loads bring about a so small contribution to the accumulated fatigue stress that they can be neglected in this connection. However, a more serious complication for the lifting counter 36 is the induced pressure on the piston side of the lifting cylinder that can ensue during lowering movements due to the fact that a certain pressure is required on the piston stem side in order to open the load holding valve 31 associated with the lifting cylinder 8. Practical tests have shown that this can give such a rapid pressure variation that it "fools" the lifting counter. However, this problem can be solved in that the lifting counter 36, via the sensors which register the movements of the slide members in the directional-control-valve sections 23, obtains information whether or not a lowering movement of the crane is taking place or not. In this connection, the lifting counter 36 is adapted not to register a lifting up of a load when a rapid pressure variation in the lifting cylinder 8 takes place in connection with a simultaneous registration of a lowering movement. The crane can also be provided with other types of sensors than the ones here described in order to give the lifting counter 36 information whether or not the crane performs a lowering movement by detection of the control and/or the movements of the crane.

[0023] The lifting counter 36 is suitably constituted by a microprocessor and is preferably connected to the processing unit 33, to which it transmits information concerning registered liftings up and puttings down of a load. In fig 3 the lifting counter 36 is shown as a unit separated from the processing unit 33, but it can with advantage be integrated with this.

[0024] The crane 1 further comprises means 35, preferably integrated with the processing unit 33, for calculation of the accumulated fatigue stress of the crane, this means 35 being adapted to calculate said fatigue stress based on the number of registered liftings up and puttings down of a load by the lifting counter 36. It is here realised that a lifting up and a subsequent putting down of a load correspond to one performed lifting cycle. The calculated fatigue stress is presented to the operator and/or maintenance personal of the crane by means of suitable display means. It is also possible to let the processing unit 33 emit a signal or an alarm when the accumulated fatigue stress has attained a certain predetermined value.

[0025] The information from a lifting counter 36 of the type here described can also be used for other functions in a crane than for calculation of accumulated fatigue stress. The information can for instance be used in a system for controlling the maximum allowed lifting force of a hydraulic crane, as more closely described in a patent application filed simultaneously with the present patent application.

[0026] The invention is of course not limited to the embodiments described above, a number of modifications thereof are on the contrary possible within the scope of the subsequent claims.

Claims

1. A hydraulic crane (1) comprising an inner boom (5), a hydraulic cylinder (8) for operating the inner boom (5), and a pressure sensor (34) arranged to measure the pressure in the hydraulic cylinder (8), **characterized in that** the crane (1) further comprises a means (36) connected to the pressure sensor (34), which means is adapted to register the lifting up and the putting down of a load by detecting the velocity

of the pressure variations in said cylinder (8), said means (36) being adapted to register a lifting up and a putting down, respectively, of a load when the velocity of a detected pressure variation exceeds a predetermined value.

2. A crane according to claim 1, **characterized in that** the means (36) consists of a microprocessor.

3. A crane according to any of the preceding claims, **characterized in that** the means (36) is connected to one or several sensors (32) which are adapted to deliver information to the means (36) concerning the control and/or the movements of the crane, said means (36) being adapted to determine by means of this information whether or not a lowering movement of the crane (1) is taking place, and that the means (36) is adapted not to register a lifting up of a load when a rapid pressure variation in said cylinder (8) is detected in connection with a determined lowering movement.

4. A crane according to any of the preceding claims, **characterized in that** the crane (1) further comprises means (35) for calculating the fatigue stress of the crane (1), said calculating means (35) being adapted to calculate the fatigue stress based on the number of liftings up and puttings down of load registered by the registration means (36).

5. A method for registration of lifting up and putting down of a load in a hydraulic crane (1) comprising an inner boom (5), a hydraulic cylinder (8) for operating the inner boom (5), and a pressure sensor (34) for measuring the pressure in the hydraulic cylinder (8), **characterized in that** the lifting up and the putting down, respectively, of a load is registered by detection of the velocity of the pressure variations in said cylinder (8), a lifting up and a putting down, respectively, of a load being registered when the velocity of a detected pressure variation exceeds a predetermined value.

6. A method according to claim 5, **characterized in that** it is determined by means of information from a sensor (32) concerning the controls and/or the movements of the crane whether or not a lowering movement of the crane (1) is taking place, and that a lifting up of a load is not registered when a rapid pressure variation in said cylinder (8) is detected in connection with a determined lowering movement.

7. A method for calculation of the fatigue stress of a hydraulic crane (1) comprising an inner boom (5), a hydraulic cylinder (8) for operating the inner boom (5), and a pressure sensor (34) for measuring the pressure in the hydraulic cylinder (8), **characterized in that** the lifting up and the putting down, respectively, of a load is registered by detection of the velocity of the pressure variations in said cylinder (8), a lifting up and a putting down, respectively, of a load being registered when the velocity of a detected pressure variation exceeds a predetermined value, and that the fatigue stress is calculated based on the number of registered liftings up and puttings down of load.

8. A method according to claim 7, **characterized in that** it is determined by means of information from sensors (32) concerning the control and/or the movements of the crane whether or not a lowering movement of the crane (1) is taking place, and that a lifting up of a load is not registered when a rapid pressure variation in said cylinder (8) is detected in connection with a determined lowering movement.

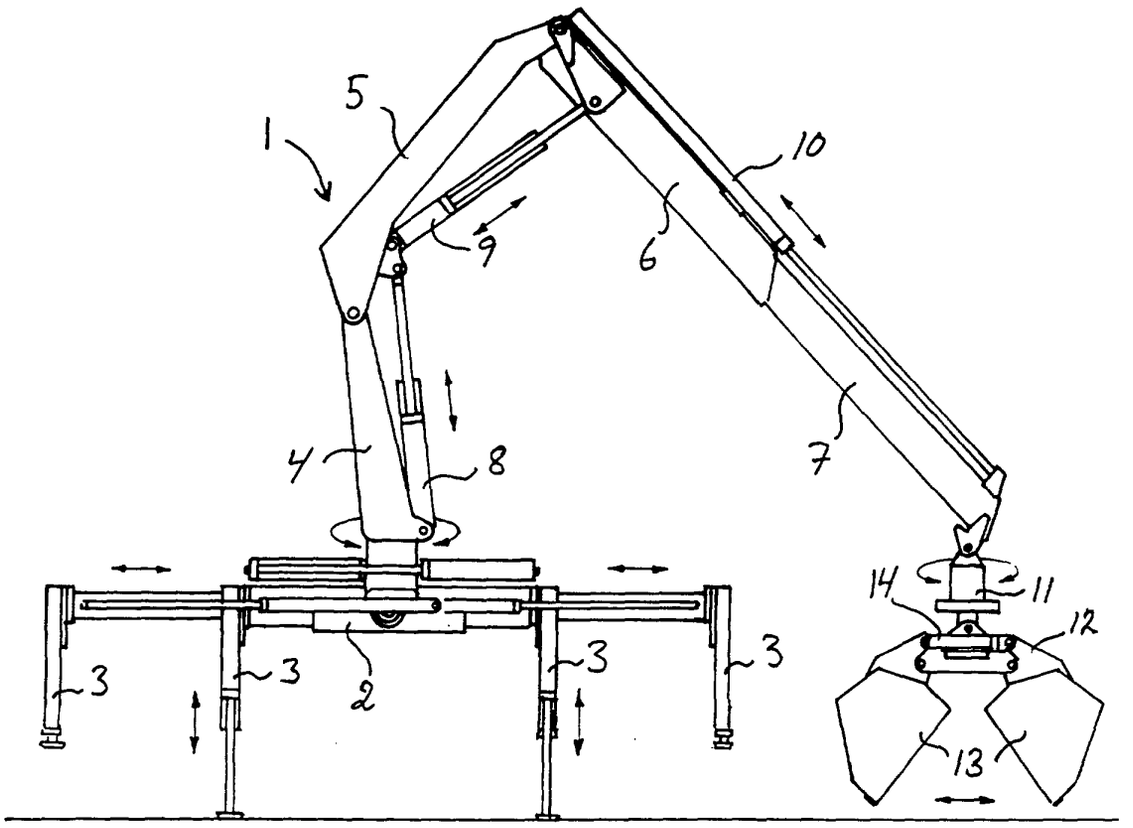


Fig 1

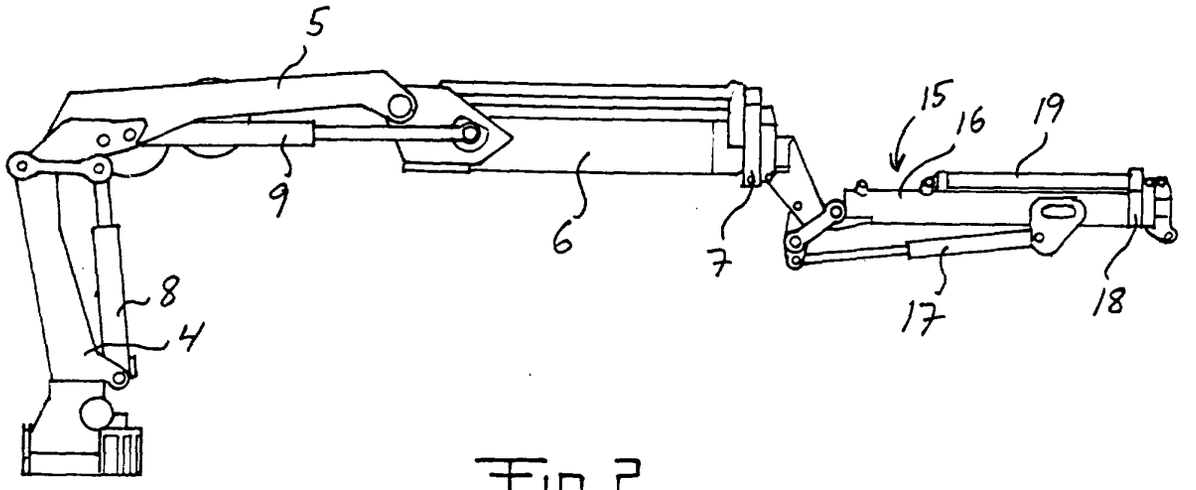


Fig 2

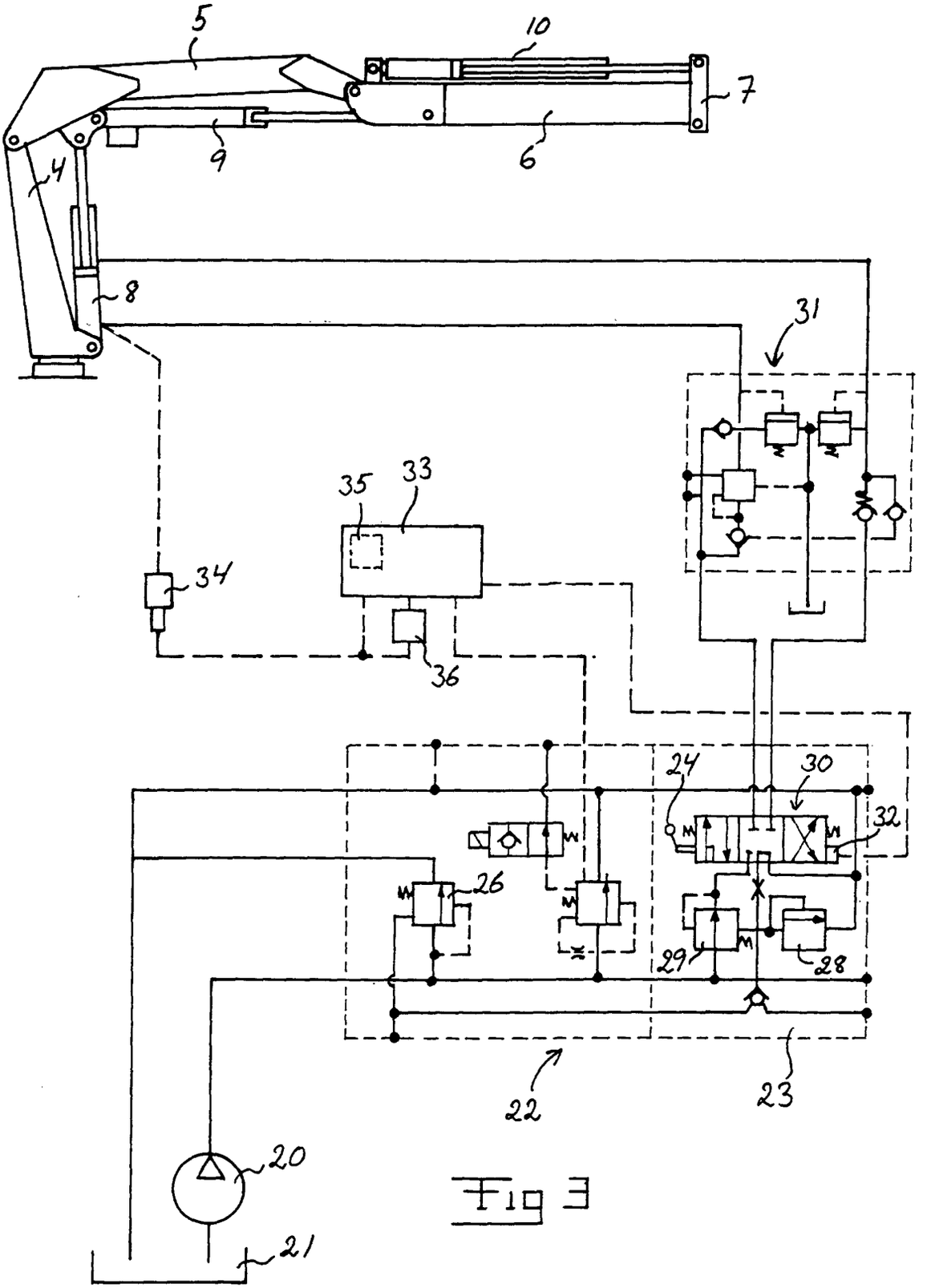


Fig 3

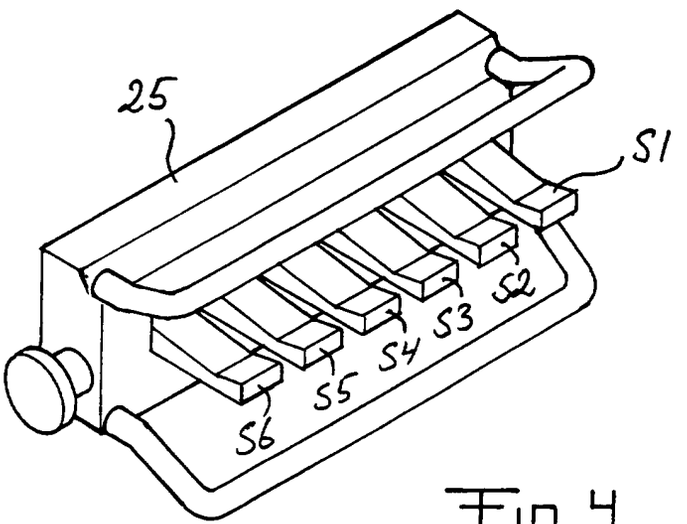


Fig 4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 10 4876

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	PATENT ABSTRACTS OF JAPAN vol. 006, no. 260 (M-180), 18 December 1982 (1982-12-18) & JP 57 154504 A (KOMATSU SEISAKUSHO KK), 24 September 1982 (1982-09-24) * abstract *	1,5,7	F15B19/00 B66C13/16
A	EP 0 749 934 A (INGENIEURSBUERO HELMUT SUDHOP ;BRANDMAIER MESSEN STEUERN SOFT (DE)) 27 December 1996 (1996-12-27) * abstract *	1,5,7	
A	EP 0 737 851 A (BRUGER & FISCHER KRANANLAGEN U) 16 October 1996 (1996-10-16) * abstract *	1,5,7	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

F15B
B66C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	30 July 2001	Toffolo, O

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 01 10 4876

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

30-07-2001

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 57154504 A	24-09-1982	NONE	
EP 0749934 A	27-12-1996	DE 29503416 U	20-07-1995
EP 0737851 A	16-10-1996	DE 19514050 A	24-10-1996

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82