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EUROPEAN PATENT APPLICATION

published in accordance with Art. 158(3) EPC

21 Application number: **79900791.9**

51 Int. Cl.³: **F 15 B 11/04, F 15 B 11/16,**
B 66 C 13/12

22 Date of filing: **07.07.79**

Data of the international application taken as a basis:

86 International application number:
PCT/JP 79/00181

87 International publication number:
WO 80/00268 (21.02.80 80/4)

30 Priority: **13.07.78 JP 95725/78**
26.07.78 JP 90447/78

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43 Date of publication of application: **17.09.80**
Bulletin 80/19

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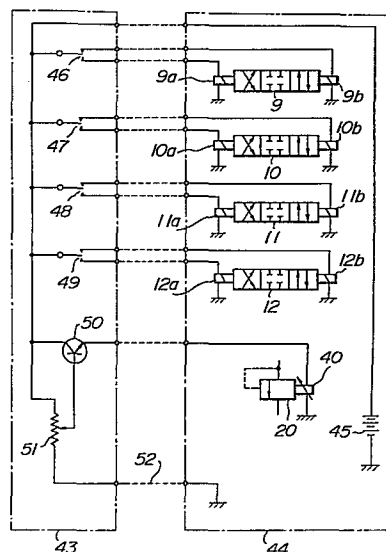
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54 DEVICE FOR REMOTE CONTROL OF HYDRAULIC CRANES.

57 A device for remote control of a hydraulic crane which includes a hydraulic pump, a plurality of fluid actuators for hoisting a boom tilting cylinder, a boom telescopic cylinder, a hoisting motor and a turning motor or the like connected in parallel via oil passages to hydraulic oil supply and exhaust circuits connected to a hydraulic oil tank, operation selecting solenoid valves connected to the oil passage, a proportional solenoid relief valve provided in the oil passage for bypassing the exhaust side of the pump to the tank for controlling the exhaust side hydraulic oil from the hydraulic pump in a crane body and automotive body side, respectively, operation selecting switches for the respective operation selecting solenoids and a potentiometer for controlling the proportional solenoid relief valve in an operation terminal unit, wherein the solenoids of the solenoid valves are electrically connected via cables to the switches and potentiometer. In order to control the crane hoisting speed, the conventional relief valve heretofore provided at the exhaust side of the hydraulic pump as a hydraulic oil source is constructed of the proportional solenoid relief valve instead of the conventional flow control valve to thereby control the hydraulic oil and accordingly the operating oil pressure at the exhaust side of the pump. This controls the operating speed of the fluid actuator for hoisting to thereby enable an economical and

smooth hoisting operation as well as its remote speed control.



Technical Field

This invention relates to a wired-type remote-control device for a hydraulic crane.

Background Art

Generally speaking, when selection of crane operations of a mobile hydraulic crane is remotely controlled, e.g., to effect such operations as luffing, extension and retraction of the boom, lifting and lowering of a load, and swivel motion of the boom, it is necessary to remotely control the velocity of the crane motion, because if the velocity control function is not provided, there is a risk of crane upset caused by sway of the load, thereby crane upset is very dangerous. Accordingly, a remote-control device without velocity control function can be applied only to light load operations, such as operations with small working radii or operations with lightweight loads.

Two methods have been proposed heretofore for controlling the velocity of crane motion: namely, a method by controlling the accelerator of an automobile

engine by an electric motor, which engine drives a hydraulic pump for supplying hydraulic oil to hydraulic actuators, such as a derrick cylinder, a boom telescoping cylinder, a winch motor, and a swiveling motor; and another method by controlling the flow rate of hydraulic oil with a flow control valve disposed in a hydraulic control circuit for controlling the aforesaid hydraulic actuators.

However, the first method has a shortcoming in that the response in velocity control is slow and that it is difficult to stop a suspended load exactly at a desired location. The second method has an advantage in that its operation is smooth and its response time is free from delay, but the second method has shortcomings in that a proportional electromagnetic flow control valve to be used for controlling the flow rate has a complicated construction and costly and that the oil pressure rises even during low-speed running to the set pressure of a relief valve normally provided in the hydraulic control circuit, e.g., to 145 kg/cm², so that a high load is continuously applied to a hydraulic pump under normal operation, resulting in an increased temperature of the hydraulic oil and an increased noise from the engine and the hydraulic circuit.

Disclosure of Invention

An object of the present invention is to provide a remote-control device for a hydraulic crane with an excellent velocity control function and free from the aforesaid shortcomings.

The present inventor has confirmed from both theoretical and empirical aspects the fact that velocity control through pressure control provides a better velocity control system than other conventional systems, in contrast to a general common sense in the past among specialists of hydraulic technique that a pressure control system for regulating the velocity of crane motion is undesirable because it may cause instability in control. The present invention was accomplished based on the confirmation of such fact, and the present invention makes it possible to effect smooth velocity control at a low cost by using a proportional electromagnetic relief valve in controlling the velocity of crane motion.

To fulfil the aforesaid object, a remote-control device of hydraulic crane is characterized in that the side of crane body and vehicle body is provided with a hydraulic control circuit connected to a hydraulic pump and a hydraulic oil reservoir, hydraulic actuators

connected in parallel to said hydraulic control circuit through hydraulic lines, operation-selecting solenoid valves inserted in said lines, and a proportional solenoid relief valve disposed in a line bypassing a discharge side of said hydraulic pump to said reservoir so as to control oil pressure at said discharge side, said hydraulic actuators including a derrick cylinder, a boom telescoping cylinder, a winch motor, a swiveling motor, or the like; wherein an operating terminal equipment is provided with crane operation-selecting switches for each of said operation-selecting solenoid valves and a potentiometer for controlling said proportional solenoid relief valve; and that solenoids of said solenoid valves are electrically connected to said switches and said potentiometer by cables, respectively.

Brief Description of Drawings

Fig. 1 is a hydraulic circuit diagram of a remote-control device according to the present invention;

Fig. 2 is a schematic sectional view of a proportional solenoid relief valve to be used in the hydraulic circuit of Fig. 1;

Fig. 3 is an electric control circuit diagram

of the remote-control device;

Fig. 4 is a plan view of an operating terminal equipment;

Fig. 5 is a sectional view taken along the line V-V of Fig. 4;

Fig. 6 is a graph showing the relationship between the oil pressure at pump discharge outlet and the swivel speed; and

Fig. 7 is a graph showing the relationship between the oil pressure at pump discharge outlet and wind up speed.

Best Mode of Carrying Out the Invention

The invention will be now described by referring to the drawings.

Referring to Fig. 1 illustrating the fundamental construction of the hydraulic circuit of a remote-control device according to the present invention, a hydraulic pump 1 is driven by the engine of a crane vehicle, a hydraulic oil reservoir 2 is mounted on the crane vehicle, a hydraulic oil feed line 3 is connected to the discharge side of the hydraulic pump 1, and a hydraulic oil return line 4 is to drain the hydraulic oil to the

reservoir 2. A derrick cylinder 5, a winch motor 6, a boom telescoping cylinder 7, and a swiveling motor 8 are connected in parallel to the hydraulic oil feed and return lines 3 and 4, through operation-selecting solenoid valves 9, 10, 11 and 12 and lines 15a, 15b, 16a, 16b, 17a, 17b, 18a and 18b. The operation-selecting solenoid valves 9, 10, 11 and 12 have solenoids 9a, 9b, 10a, 10b, 11a, 11b, 12a and 12b.

A return bypass line 19 is provided so as to bypass the discharge side of the hydraulic pump 1 in the aforesaid hydraulic circuit to the hydraulic oil reservoir 2, and a proportional solenoid relief valve 20 is disposed on the bypass line 19.

Fig. 2 shows an example of the structure of the proportional solenoid relief valve 20. In the proportional solenoid relief valve shown in Fig. 2, a main valve casing 21 has a valve bore defining hollow space 22 therein, and a main spool 23 is slidably fitted in the hollow space 22 so as to be movable in the longitudinal axial direction thereof. A land 24 provided on the main spool 23 defines a pressure chamber 25 in the hollow space 22, and this chamber 25 has a port 26 communicating with the hydraulic oil feed line 3 at the discharge side of the hydraulic pump 1 and a drain port 27 to be connected to the

reservoir 2. A spring 28 acts on the main spool 23 in such a manner that a valve operating end 29 of the main spool 23 is normally seated at a main valve seat 30 at the drain port 27. An orifice 31 extends through the land 24 in the longitudinal axial direction of the spool 23, so that the pressure chamber 25 communicates with an upper chamber 32. The upper chamber 32 is connected to one end of a pilot line 33, the opposite end of which line 33 is connected to a pilot valve 34 at a port 35 thereof. The pilot valve 34 has a drain port 36 for communicating a valve chamber 37 of the pilot valve 34 with the hydraulic oil reservoir 2, and a pilot spool 38 slidably fitted in the valve chamber 37. An actuating rod 39 is secured to the pilot spool 38 at one end thereof, while the opposite end of the actuating rod 39 is provided with a solenoid coil 40 movably held in the magnetic field of a coil magnet 41, so that the pilot spool 38 is urged against a valve seat 42 by a force proportional to an electric current flowing through the coil 40.

The function of controlling the discharge oil pressure of the hydraulic pump 1 and accordingly the oil pressure in the hydraulic oil feed line 3 by the proportional solenoid relief valve of the aforesaid construction will now be described. The oil pressure

in the hydraulic oil feed line 3 as produced by the hydraulic pump 1 is applied to the pilot spool 38 in the pilot valve 34 through the port 26, the pressure chamber 25, the orifice 31, and the upper chamber 32 of the main valve casing 21, the pilot line 33, and the port 35. As long as the force acting on the pilot spool 38 due to the oil pressure from the hydraulic oil feed line 3 is smaller than the aforesaid force urging the pilot spool 38 to the valve seat 42, the pilot spool 38 is kept as seated on the valve seat 42, so that the pressure in the upper chamber 32 due to the hydraulic oil coming through the orifice 31 balances the pressure in the pressure chamber 25. As a result, the main spool 32 is lightly urged against the main valve seat 30 by the elasticity of the spring 28, and the flow of the hydraulic oil from the pressure chamber 25 to the reservoir 2 is inhibited. Thus, the continuously rotating hydraulic pump 1 causes its discharge pressure and accordingly the oil pressure in the hydraulic oil feed line 3 to keep rising.

As a result of the aforesaid rising of the oil pressure in the hydraulic oil feed line 3, when the oil pressure acting on the pilot spool 38 through the pilot line 33 surpasses the aforesaid pressure generated by the electric current in the coil 40 for

urging the pilot spool 38 against the valve seat 42, that oil pressure pushes the pilot spool 38 so as to move away from the valve seat 42. Thus, the oil pressure is released to the hydraulic oil reservoir 2 through the port 36, resulting in a reduction of the pressure in the upper chamber 32 of the main valve casing 21, so that the main spool 23 is pushed up by the oil pressure in the pressure chamber 25 for causing the main spool 23 to move away from the main valve seat 30 and to open the port 27 toward the hydraulic oil reservoir 2. Whereby, an oil pressure which is proportional to the electric current flowing through the solenoid coil 40 can be maintained at the hydraulic oil feed line 3.

As described above, when the electric current flowing through the solenoid coil 40 increases successively from zero, the oil pressure in the hydraulic oil feed line 3 can be successively increased. Besides, when the electric current flowing through the solenoid coil 40 is controlled at a desired value, the oil pressure at the discharge outlet port of the pump 1 can be controlled at a desired level which is proportional to the aforesaid electric current in the solenoid coil.

In carrying out the present invention, the construction of the proportional solenoid relief valve

is not restricted to the aforesaid construction, but a suitable electric oil pressure proportional control valve of conventional construction can be also used.

Fig. 3 illustrates an electric circuit for controlling the aforesaid operation-selecting solenoid valves 9, 10, 11 and 12 and the proportional solenoid relief valve 20, wherein 43 represents a crane body side and automobile body side control circuit and 44 represents an operating terminal equipment. A power source 45 can be an automobile battery mounted on a crane body, and crane operation-selecting switches 46, 47, 48 and 49 control electric currents to solenoids 9a, 9b, 10a, 10b, 11a, 11b, 12a and 12b of the operation-selecting solenoid valves 9, 10, 11 and 12. A transistor 50 controls the value of electric current to the proportional solenoid relief valve 20, and a multi-core cable 52 is for electric connection between the crane body and automobile body side circuit 43 and the operating terminal equipment 44. The cable 52 is preferably a chloroprene sheathed cabtyre cable, and its length can be suitably determined so as to be convenient for the crane operation, for instance, a five to ten meter cable section will be sufficient for most cases.

A potentiometer 51 in the aforesaid electric

control circuit comprises a coil of resistive wire, and the voltage of the power source 45 is applied across the resistive wire coil, and a desired voltage is produced at a brush by moving the brush along the resistive wire. The voltage at the brush is applied to a base electrode of the transistor 50, so that a large current proportionate to the base voltage, i.e., the brush voltage of the potentiometer, is delivered from an emitter electrode of the transistor. In the illustrated example, the transistor is assumed to act as a current amplifier with a voltage amplification value 1. Thus, the oil pressure at the discharge outlet of the hydraulic pump 1 can be regulated and set at a value which is proportionate to the output voltage from the transistor (the electric current is proportionate to the voltage in this case) by the proportional solenoid relief valve.

Therefore, the oil pressure at the discharge outlet of the pump can be adjusted at an arbitrary value by operating the brush position of the potentiometer, thereby the velocity of motions of various crane parts can be adjusted at an arbitrary value.

Figs. 4 and 5 show an example of the operating terminal equipment, which equipment comprises a handle portion 53, a switch board 54, and a potentiometer

housing 55, and the four crane operation-selecting switches 46, 47, 48 and 49 corresponding to the four kinds of crane operations are disposed on the switch board 54 along a rectilinear line. The potentiometer 51 located in the housing 55 has a rotary shaft 56 carrying a pinion 57 secured thereto, and a sector gear 58 meshing the pinion 57 is secured to a shaft 59. A velocity-control trigger 60 has one end thereof secured to the shaft 59 and the opposite end projecting below the handle portion 53, so that when the trigger 60 is pulled against the elasticity of a spring 61, the sector gear 58 is turned so as to rotate the potentiometer 51. The current amplifying transistor 50 is disposed in the housing 55 and electrically connected to the sliding contact of the potentiometer 51. The cabtyre cable 52 is inserted through the handle portion 53, so as to connect the operating terminal equipment 43 to the crane body and vehicle body side electric circuit 44 as described above.

With the remote-control device of the aforesaid construction, an operator working at a location remote from the crane body and vehicle body at first makes a crane operation ready to start, such as upward rising or downward depending on the boom, lifting or lowering a load, telescoping or retracting of the

boom, or clockwise or counterclockwise swivel motion, by holding the operating terminal equipment 43 in hand and selectively actuating the operation-selecting switch 46, 47, 48 or 49, and then the pressure of the hydraulic operating oil is raised by actuating the trigger 60 in such a manner that the pressure of the hydraulic oil is controlled in response to the upward or downward condition of the boom, presence or absence or magnitude of a load, and the extending and retracting condition of the boom, whereby the velocity of the crane operation can be controlled.

Fig. 6 is a graph showing the relationship between the oil pressure kg/cm^2 at the outlet of the pump as indicated on the abscissa and the swiveling speed r.p.m. as indicated on the ordinate, which relationship was obtained by plotting data collected from experiments under various operating conditions. The curve (A) is for the boom retracted at a 75° slope with no load, the curve (B) is for the boom retracted at a horizontal position with no load, the curve (C) is for the boom extended at a horizontal position with no load, and the curve (D) is for the boom extended at a horizontal position with a 500 kg load. Fig. 7 is a graph showing the relationship between the oil pressure kg/cm^2 at the discharge outlet of the pump as

indicated on the abscissa and lifting speed in r.p.m. (with four wires) as indicated on the ordinate, which relationship was obtained by plotting data collected from experiments with suspended loads of 0 ton (W0), 0.2 ton (W1), 0.5 ton (W2), 1.0 ton (W3) and 1.5 ton (W4). The dash-dot lines M and H show boundaries of unstable zones of oil pressure control due to a minimum oil pressure and an excessively large flow rate, respectively.

Industrial Applicability

According to the present invention, the operating velocity of hydraulic actuators for operating a crane is controlled by regulating the oil pressure at the discharge side of a hydraulic pump, i.e., the pressure of hydraulic oil, by using a proportional solenoid relief valve, so that the operation is smooth and there is no time delay. Besides, as compared with a case of using a proportional solenoid flow rate control valve, the control valve has a simpler construction and less expensive. With the pressure control system of the present invention, the crane can be operated at a lowest possible oil pressure for each velocity for the entire velocity range from a low velocity to a high velocity, so that no wasteful load

is applied to the hydraulic pump for saving energy consumption at an engine and the noise level of the engine and the hydraulic circuit can be minimized.

Claim

1. A remote-control device for hydraulic crane comprising, a hydraulic oil reservoir; a hydraulic pump connected to said hydraulic oil reservoir; a hydraulic oil feed-return circuit connected to said hydraulic pump and said hydraulic oil reservoir; a derrick cylinder, a boom telescoping cylinder, a winch motor, and a swivel motor, said cylinders and said motors being connected in parallel to said hydraulic oil feed-return circuit through operation-selecting solenoid valves; a proportional solenoid relief valve connecting to a discharge side of said hydraulic pump to said hydraulic oil reservoir so as to shunt said hydraulic pump; and an operating terminal equipment related to a crane body, said operating terminal equipment having operation-selecting switches electrically connected to said operation-selecting solenoid valves, respectively, and a potentiometer electrically connected to said proportional solenoid relief valve, whereby control velocity of different parts of the hydraulic crane is controlled by selectively actuating different crane parts inclusive of said derrick cylinder, said boom telescoping cylinder, said winch motor, and said swivel motor, thereby regulating flow of the hydraulic oil with said proportional solenoid relief valve.

(amended)

2. A device as defined in claim 1, wherein the device is characterized in that said operation-selecting solenoid valve has a main valve casing, and a main pool is slidably fitted in a valve bore of said main valve casing, said main pool having a land dividing said valve bore into a pressure chamber and a pilot pressure chamber, said pressure chamber having a port connected to the discharge side of said hydraulic pump and an exhaust port connected to said hydraulic oil reservoir, said main pool being biased so as to normally close said exhaust port by a valve actuating end thereof, said pilot pressure chamber being connected to said hydraulic oil reservoir through a pilot valve, said pilot valve being so formed as to close a valve opening thereof by an actuating rod connected to a movable coil operatively related to a magnet, said movable coil being connected to said potentiometer so as to receive an output current therefrom, said actuating rod being acted by a valve closing force which is proportionate to said output current from said potentiometer.

(amended)

3. A device as defined in claim 1, wherein the device is characterized in that said operating terminal equipment is provided with a handle portion, a switch board extending upwardly from forward end of the handle portion substantially at right angles thereto, and a potentiometer housing disposed at a lower portion of said forward end of the handle portion, said switch board having said operation-selecting switches disposed thereon along a rectilinear line, said potentiometer housing journaling a velocity-control trigger so as to be able to rotate said potentiometer and to project a part of the trigger below said handle portion.

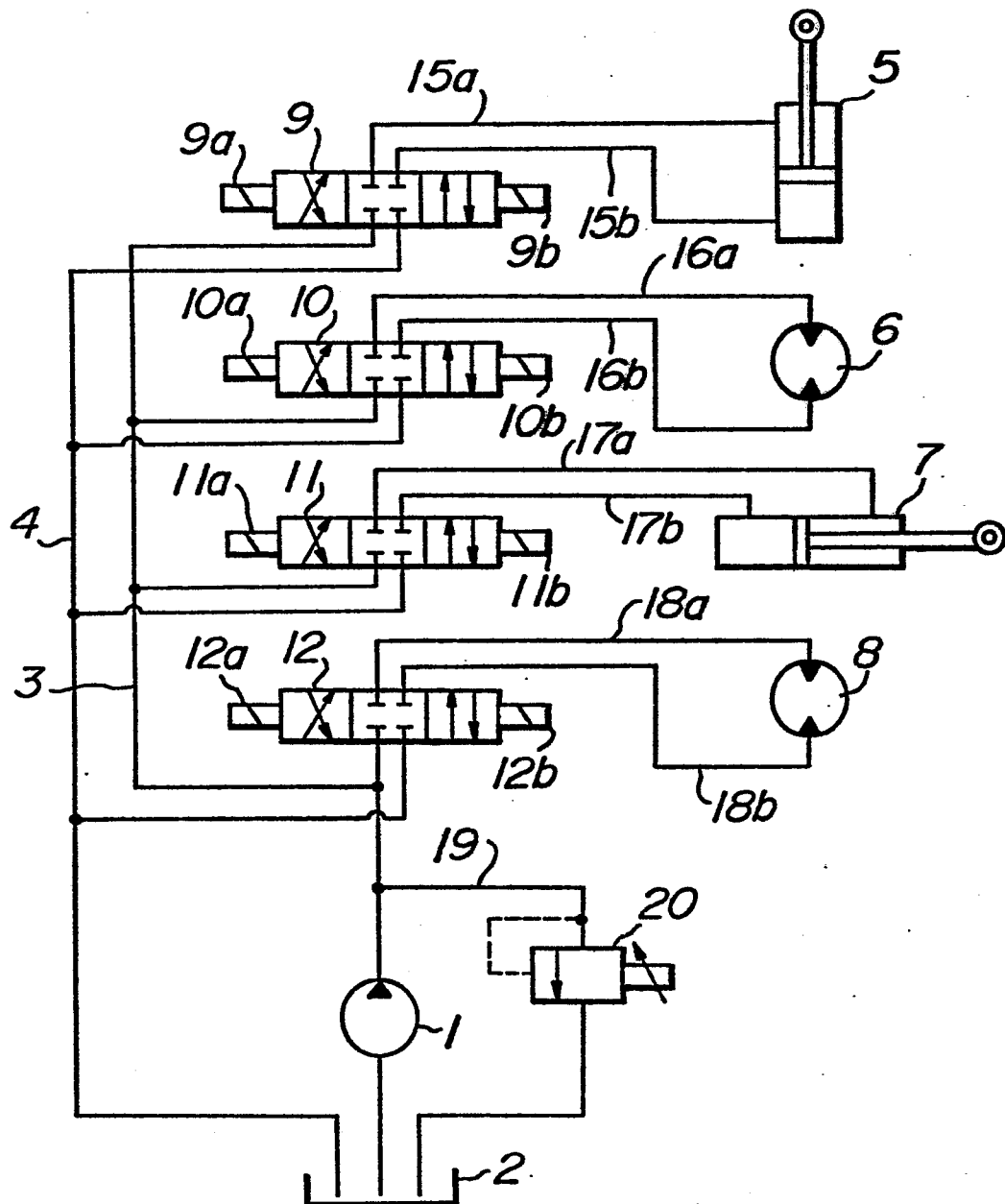
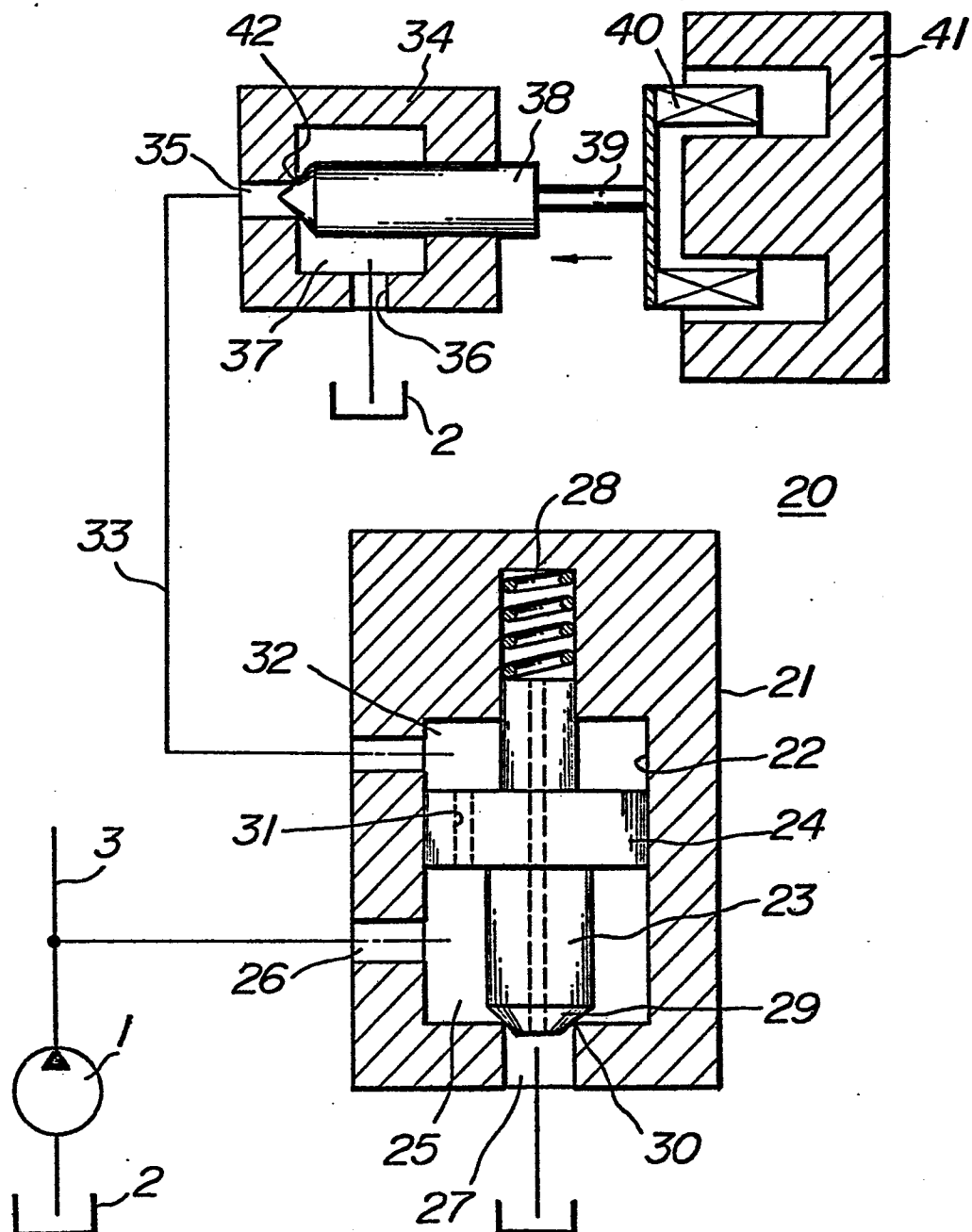
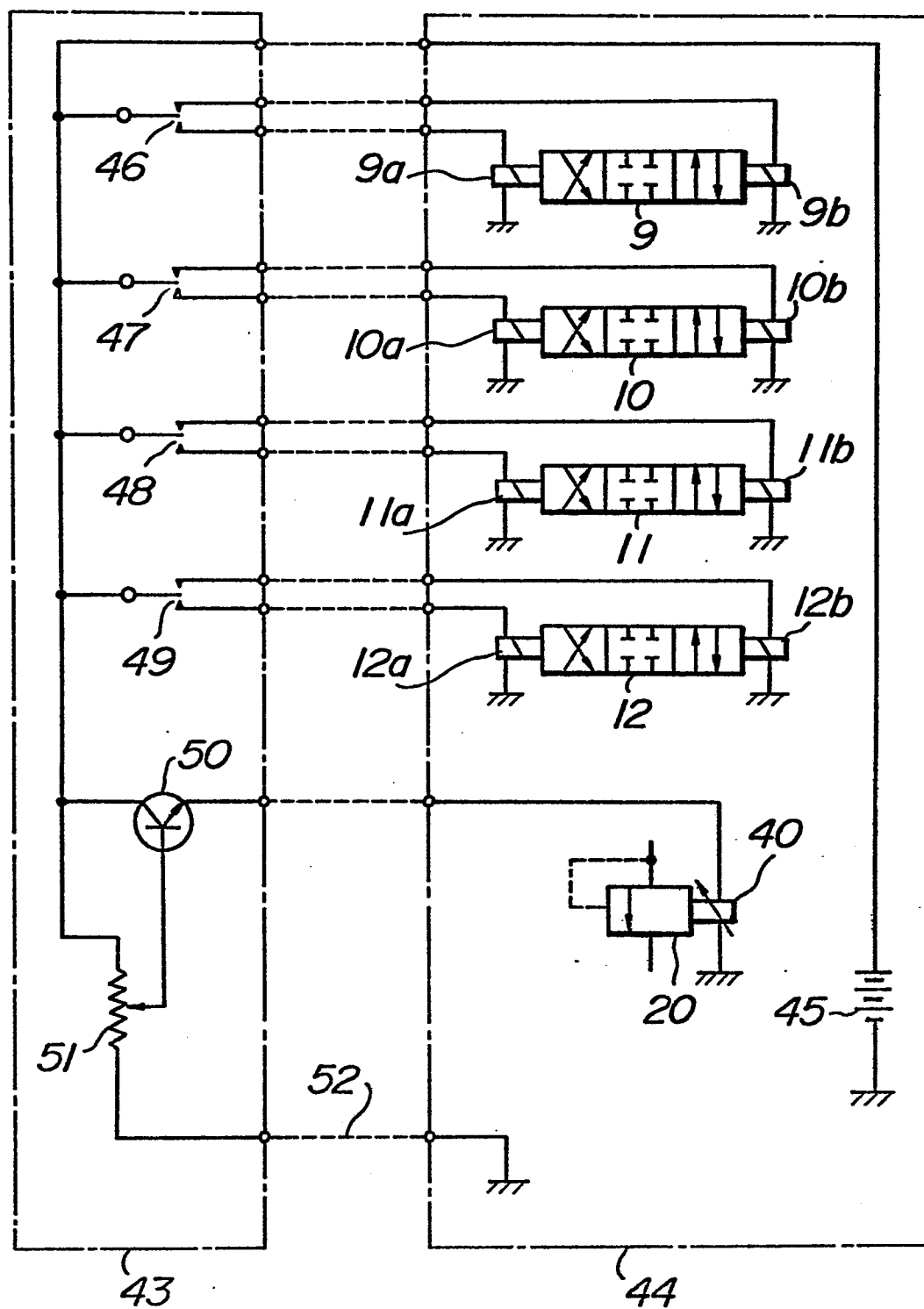
FIG. 1

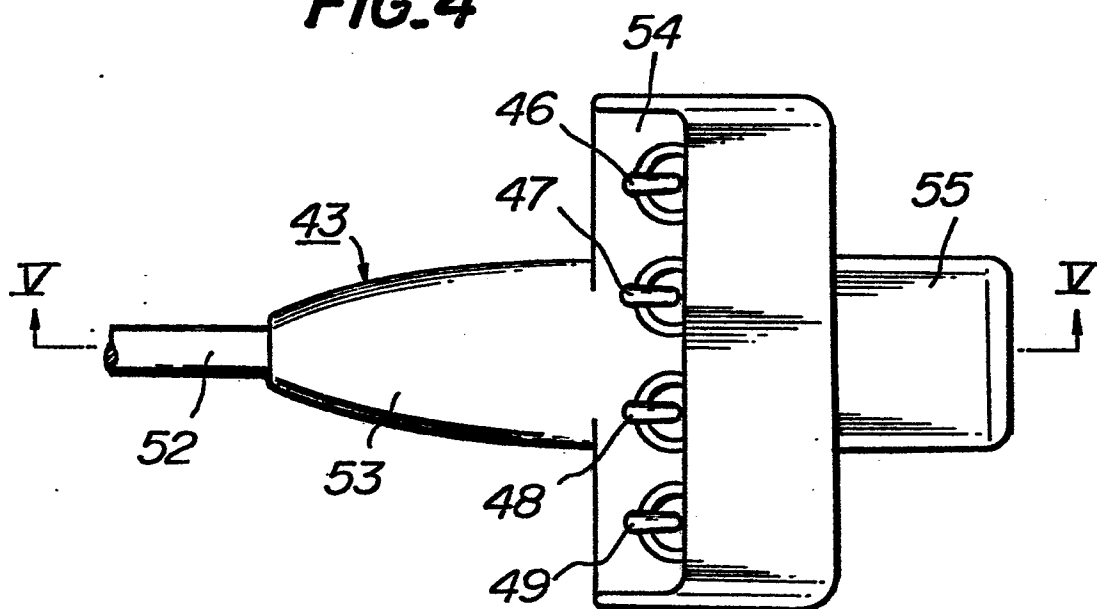
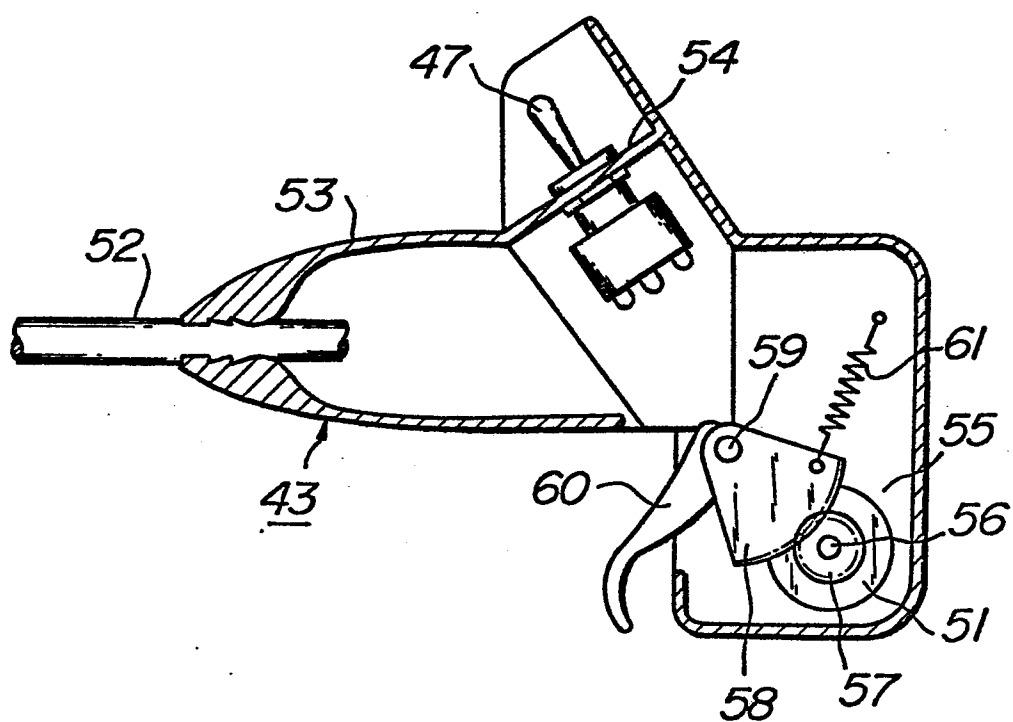
FIG. 2

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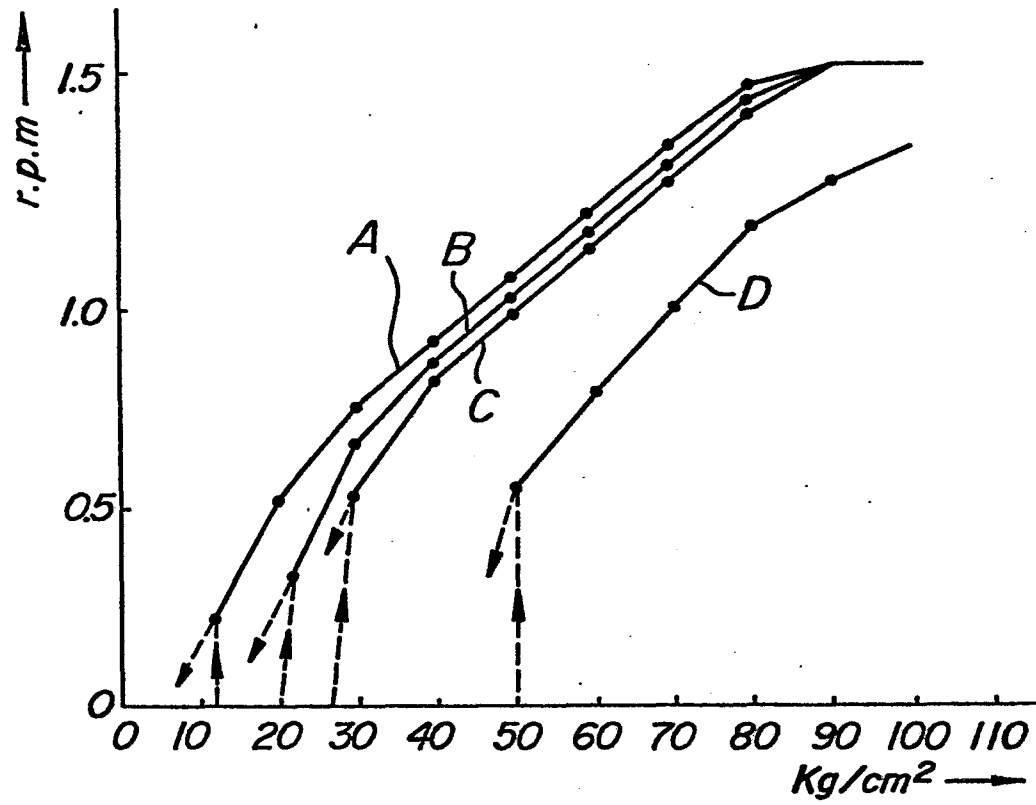
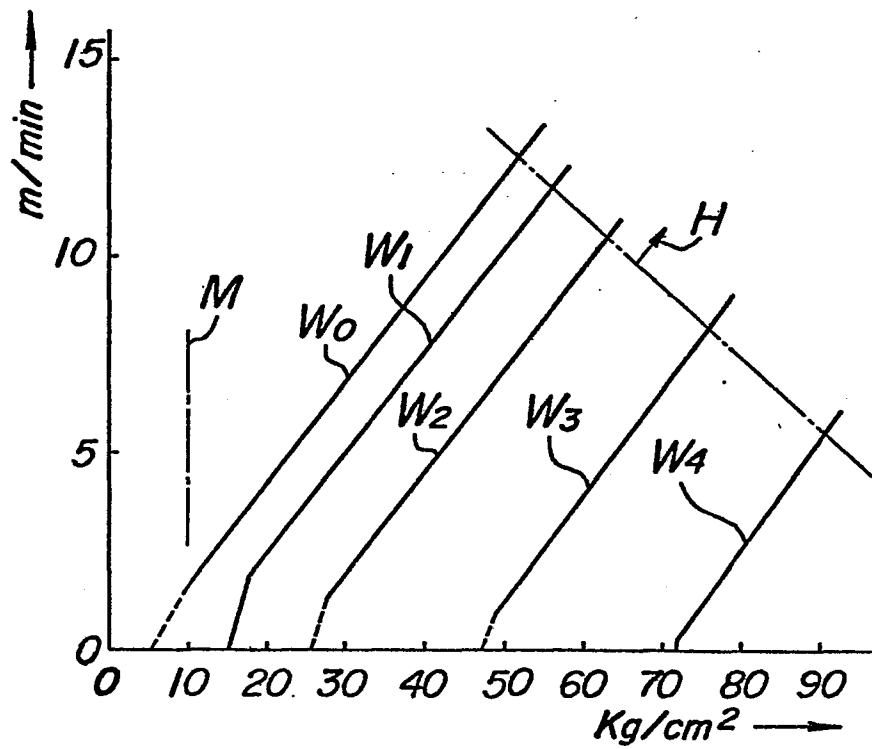
FIG. 3



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FIG. 4**FIG. 5**

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FIG. 6**FIG. 7**

INTERNATIONAL SEARCH REPORT

0015296

International Application No PCT/JP79/00181

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) *		
According to International Patent Classification (IPC) or to both National Classification and IPC		
F15B 11/04, F15B 11/16, B66C 13/12		
II. FIELDS SEARCHED		
Minimum Documentation Searched *		
Classification System	Classification Symbols	
I P C	F15B 11/04, F15B 11/02, F15B 11/16, F15B 9/09, B66C 13/12	
Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched *		
Jitsuyo Shinan Koho 1926 ~ 1978		
III. DOCUMENTS CONSIDERED TO BE RELEVANT 14		
Category *	Citation of Document, 15 with indication, where appropriate, of the relevant passages 17	Relevant to Claim No. 18
X	JP, A, 50-97782 1975-8-4 F. R. Sandolet S.A.S.	1
X	JP, B1, 46-28257 1971-8-17 Anstalt vor Electro Hydraulische Anlagen	1
X	JP, B1, 47-24795 1972-7-7 Robert Bosch GmbH	1
A	Kaneko Toshio "Shinpan Yuatsu Kiki to Oyo Kairo". (1966-11-25) NIKKAN KOGYO SHINBUNSHA P227-336	1
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IV. CERTIFICATION		
Date of the Actual Completion of the International Search *		Date of Mailing of this International Search Report *
September 27, 1979 (27.09.79)		October 8, 1979 (08.10.79)
International Searching Authority *		Signature of Authorized Officer 19
Japanese Patent Office		