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

(11) Publication number: **0 191 275**
A1

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **85830286.2**

(22) Date of filing: **20.11.85**

(51) Int. Cl.⁴: **E 02 F 3/30**, E 02 F 3/32, E 02 F 9/22, F 15 B 11/05

(30) Priority: **14.02.85 IT 6714985**

(43) Date of publication of application: **20.08.86 Bulletin 86/34**

(84) Designated Contracting States: **AT BE CH DE FR GB IT LI LU NL SE**

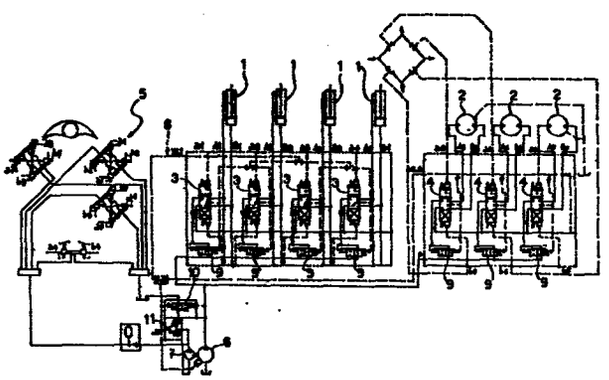
(71) Applicant: **C H S VICKERS S.p.A., Strada Statale 460, Km. 36 Regione San Martino, I-10087 Valperga (Torino) (IT)**
Applicant: **Vickers Systems GmbH, Frölingstrasse 41, D-6380 Bad Homburg (DE)**

(72) Inventor: **Tha, Piero, Via Gioberti 2, I-10087 Valperga Canavese (Torino) (IT)**
Inventor: **Sandrono, Bernardo, Via 4 Novembre 15, I-10086 Rivarolo Canavese (Torino) (IT)**
Inventor: **Testa, Giovanni Maria, Strada La Bassa 6, I-12042 BRA (Cuneo) (IT)**
Inventor: **Sandroni, Raffaele, c/o VICKERS SYSTEMS GMBH Frölingstrasse 41, D-6380 Bad Homburg (DE)**
Inventor: **Warren, Gerald Keith, Rosenweg 15, D-6382 Friedrichsdorf (DE)**

(74) Representative: **Buzzi, Franco et al, c/o Jacobacci-Casetta & Perani S.p.A. Via Alfieri, 17, I-10121 Torino (IT)**

(54) Anti-saturation system for hydraulic control circuits for working members of earth-moving machines.

(57) An anti-saturation system for hydraulic control circuits with pumps and pressure-compensated distributors (3, 4) for working members (1, 2) of earth-moving machines, including depressurising valve means (10) which, in the event of a decrease in the difference between the pressure delivered by the pump (6, 7) and that of the working members (1, 2), act to reduce the delivery supplied to the working members (1, 2) by the respective distributors (3, 4).



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Anti-saturation system for hydraulic control circuits for working members of earth-moving machines

The present invention relates in general to hydraulic control circuits for working members of earth-moving machines.

In particular, the invention relates to hydraulic circuits with pumps and pressure-compensated distributors, of the type including a supply source of hydraulic fluid under pressure and a plurality of hydraulic working members each of which is associated with a respective hydraulic distributor having a spool which can be set with continuous adjustment by respective pilot means in three positions corresponding to movement of the working member in a first direction, stoppage, and movement in a second direction opposite the first, and pressure compensating means associated with the supply source and the distributors for keeping the difference between the pressure supplied by the source and the pressure of the working members substantially constant.

It is known that such pressure compensating means also have the function of ensuring the simultaneity of all the movements of the working members (boom, bucket, depper, swing) independently of the controlled loads.

In hydraulic circuits of this type, whenever the total delivery taken up by the working members tends to be equal to or greater than the delivery supplied by the pump, the system finds itself under saturation conditions. In other words, the pump can no longer increase its delivery to establish a constant pressure difference between the pressure of the load and the supplied

pressure, and this pressure difference tends to diminish when the demand of the working members which are being operated increases at the moment of saturation or if new working members are actuated. In this situation, the pressure compensating means associated with the distributors are fully open and are unable to restrict the deliveries to the respective working members. In short, the delivery goes to the working member at the lower pressure and the simultaneity of the movement is consequently lost.

The object of the present invention is to avoid this disadvantage and this object is achieved by providing, in a hydraulic circuit of the type described above, an anti-saturation system characterised in that it includes valve means which, in the event of a decrease in the difference between the pressure supplied by the source and the pressure of the working members, act to reduce the delivery supplied to the working members by the respective distributors. Normally such valve means are constituted by depressurising valve means.

In practice, the anti-saturation system according to the invention allows a reduction in the delivery taken by the working members by decreasing the passage areas of the various units formed by the spools of the distributors and their respective local compensators.

According to the invention, this may be effected by the association of the depressurising valve means with either the pilot means for the distributors or the compensating means for the distributors.

In the first case, whenever the pilot means for the distributors include hydraulic servocontrol devices, the depressurising valve means act conveniently to reduce the maximum pilot pressure transmitted to the distributors by the hydraulic servocontrol devices.

In the second case, the balancing pressures acting on the compensators associated with the distributors are conveniently reduced, unbalancing the compensators in such a way that they close and restrict the delivery taken by these compensators.

In each case, the depressurising valve means may operate automatically in response to the difference between the pressure supplied by the source and that of the working members, or they may be operated by a voluntary control in order to achieve the conditions of non-saturation of the circuit.

The invention will be described in detail with reference to the appended drawings provided purely by way of non-limiting example, in which:

- Figure 1 is a diagram of a hydraulic control circuit provided with an anti-saturation system according to the invention,
- Figure 2 illustrates a first variant of Figure 1,
- Figure 3 shows a second variant of Figure 1, and
- Figure 4 shows a further variant of a part of the circuit of Figure 1.

Figure 1 illustrates schematically the essential components of a hydraulic control circuit for the working members of an earth-moving machine. In the example illustrated, these working members comprise a series of

hydraulic linear actuators 1 serving to operate the excavating arm (positioning-raising-penetration-reverse excavation) and a series of rotary actuators 2 for the translational movements of the excavator and rotation of the excavating arm. The actuators 1 and 2 are arranged in two distinct groups in the drawing purely for the convenience of illustration.

For supplying and discharging the actuators 1 and 2, respective spool distributors 3, 4 of known types are provided, each of which can be set in three conditions corresponding respectively to movement of the respective actuator 1, 2 in a first direction, stoppage, and movement in a second direction opposite the first. The inlet-outlet connections between the distributors 3, 4 and the respective actuators 1, 2 are indicated A_1, B_1 ..... A_7, B_7 in the drawing.

The settling of the spools of the distributors 3, 4 in the three possible conditions is achieved by the hydraulic piloting effected by a servocontrol valve unit, generally indicated 5, including a series of lever and pedal controls which can be put manually into different positions corresponding to the three conditions of the distributors 3, 4. The outlet-inlet connections between the servocontrols 5 and the respective distributors 3, 4 are indicated a_1, b_1 .... a_7, b_7.

The supply of the distributors 3, 4 (and hence of the working members 1, 2) and that of the servocontrols 5 is effected, in the case of Figure 1, by two separate hydraulic pumps 6, 7.

The pump 6 has a known type of "load sensing"

control which employs a control circuit 8 with selector ball valves which make use of the greater of the pressure signals from the distributors 3, 4 in operation.

Each of the distributors 3, 4 also has a respective associated compensator 9 constituted, in known manner, by a normally-open, two-way directional control valve which has one side connected to the respective working member 1, 2 downstream of the respective distributor 3, 4 and the opposite side connected to the inlet of the respective distributor 3, 4. The compensator devices 9 have the well-known function of keeping the difference between the pressure supplied by the pump 6 and that of the working members 1, 2 substantially constant in use, in order to ensure simultaneity of the various possible working movements of the machine independently of the loads controlled.

The hydraulic servocontrol devices 5 are supplied by the pump 7 under the control of a maximum pressure valve 11. According to the invention, the maximum pressure valve 11 has an associated depressurising valve (vent valve), indicated 10, the function of which is to prevent the hydraulic circuit becoming saturated. The valve 10 is constituted by an automatically-piloted, two-way control valve having one side sensitive to the pressure supplied by the pump 6 and the opposite side sensitive to the pressure in the circuit 8, that is, to the greatest of the pressures of the working members 1, 2.

It will become apparent that the vent valve 10

allows the maximum pilot pressure of the distributors 3, 4 to be reduced as a result of the opening of the maximum pressure valve 11 as soon as the difference between the pressure delivered by the pump 6 and the pressure of the working members 1, 2 plus the elastic load acting on the valve 10 in the same sense as the pressure of the working members 1, 2 tends to fall, that is, when the circuit tends to become saturated. Clearly, the reduction in the pilot pressure involves a reduction in the delivery taken up and hence ensures the simultaneity of the various movements of the working members 1 and 2 in every case.

Figure 2 illustrates a circuit similar to that described above and therefore only the differences will be explained in detail, the same reference numerals being used for parts identical or similar to those of Figure 1.

The circuit differs from that described above solely in that the servocontrol devices 5 are supplied by the same pump 6 through a pressure reduction valve 12. In this case the vent valve 10 acts on the pressure reduction valve 12, with an effect entirely similar to that described above.

It should be noted that the vent valve 10 could be operated voluntarily by the operator instead of automatically. This operation, which can be carried out mechanically, hydraulically, electrically or even pneumatically, must be effected so as to bring the pilot pressure of the distributors 3, 4 to a value such as to satisfy the non-saturated conditions of the circuit.

It is also clear that the reduction in the pilot pressure could be achieved by systems different from the vent valve 10, for example by means of a pressuring valve or by means of control systems in parallel with the existing pilot pressure control system and actuated by the reduction of the difference between the delivered pressure and that of the working members 1, 2 below a calibrated value.

A control system of this kind is shown in Figure 4, wherein parts corresponding to those of Figure 1 are indicated with the same reference numerals.

In this case the two-way control valve 10, sensitive on one side to the pressure of the main pump 6 and on the opposite side to the pressure of the working members 1, 2, is placed in parallel to the maximum pressure valve 11 through which the maximum pilot pressure of the distributors 3, 4 is shutted. In order to stabilize the pressure generated by the maximum pressure valve 11 and the rate of flow pulsated by the pump 7, an accumulator 13 is provided on the line connecting such pump 7 and the valve 11. For example, the accumulator can have a capacity of 0.70 liter and a pre-loading pressure in the range of 13 bar.

A second accumulator 14 is provided for stabilizing the rate of flow controlled by the valve 10 and for making up the rate of flow requests of the servo-control devices 5. For example, the accumulator 14 has a capacity corresponding to a half of that of accumulator 13, i.e. of 0.35 liter, and a pre-loading pressure also of about 13 bar.

Moreover, a check valve 15, having the function of preventing fluid reflow towards the pump 7, and a restriction 16 for the calibration of the rate of flow towards the valve 10 are provided between valve 10 and pump 7.

The circuit of Figure 4 further comprises a two-ways and two-positions valve 17 placed downstream the valve 10 and hydraulically piloted by means of a pressure signal of the pump 7, the function of which is that of allowing no-load maneuvers of the working member in case of stop of the heat engine of the machine.

To the valve 17 is further added an anti-stall circuit of the valve 10, having the function of avoiding that the latter intervene so as to prevent any action by the working members 1, 2 in the situation in which one of the working members (for instance one of the cylinders 1) is at the end of stroke, and thus the pressure supplied by the pump 6 and the load signal pressure are equal and same to the maximum pressure of the circuit. Just in order to avoid the intervention of the valve 10 in such situation, the said anti-stall circuit comprises a pressure reduction valve 18 placed in the piloting line of the valve 10 by the working members pressure. The valve 18 is calibrated so as to prevent the intervention of the valve 10 in the above mentioned conditions, and to calibrated restrictions 19, 20 are associated thereto, the function of which is that of avoiding influences by the valve 18 on the load signal.

The invention also provides for acting on the

restriction of the delivery taken up by the working members 1, 2 rather than on the maximum pilot pressure, by operating on the compensating device 9. This possibility is illustrated in Figure 3, in which parts identical or similar to those already described above are indicated by the same reference numerals.

In this case, the vent valve 10 acts in such a way as to effect closure of the compensators 9, so as to reduce the delivery to the working members 1, 2 in a manner proportional to the respective control areas of the distributors 3, 4, until equilibrium between the delivery supplied and that taken up is re-established.

Again in this case, the vent valve 10 could be controlled voluntarily.

It should also be noted that, as an alternative to a single vent valve 10 connected to the logic circuit 8, a series of such valves could be used, each associated with a respective distributor 3, 4.

Naturally, the constructional details and embodiments may be varied widely with respect to those described and illustrated, without thereby departing from the scope of the present invention.

CLAIMS

1. Anti-saturation system for hydraulic control circuits for working members of earth-moving machines, comprising a supply source of hydraulic fluid under pressure, a plurality of hydraulic working members each of which is associated with a respective hydraulic distributor having a spool which can be set with continuous adjustment by respective pilot means in three positions corresponding to movement of the working member in a first direction, stoppage, and movement in a second direction opposite the first, and pressure compensating means associated with the supply source and the distributors for keeping the difference between the pressure supplied by the source and the pressure of the working members substantially constant, characterised in that it includes valve means (10) which in the event of a decrease in the pressure difference, act to reduce the delivery supplied to the working members (1, 2) by the respective distributors (3, 4).

2. Anti-saturation system according to Claim 1, characterised in that the said valve means are constituted by depressurising valve means (10).

3. System according to Claim 2, characterised in that the depressurising valve means (10) are sensitive to the pressure difference and act automatically in response to decreases therein.

4. System according to Claim 2 or Claim 3, characterised in that the depressurising valve means (10) are associated with pilot means (5) for the distributors (3,

4).

5. System according to Claim 2 or Claim 3, characterised in that the depressurising valve means (10) act on the compensating means (9).

6. System according to Claim 4, in which the pilot means for the distributors include hydraulic servocontrol devices, characterised in that the depressurising valve means (10) act to reduce the maximum pilot pressure transmitted to the distributors (3, 4) by the hydraulic servocontrol devices (5).

7. System according to Claim 6, having a secondary source of pressurised fluid connected under the control of a maximum pressure valve to the said hydraulic servocontrol devices for transmitting pilot pressure to the distributors, characterised in that the depressurising valve means (10) include a directional control valve sensitive on one side to the pressure of the primary supply source (6) and on the other to the pressure of the working members (1, 2), and arranged to control the opening of the maximum pressure valve (11).

8. System according to Claim 6, in which the servocontrol devices are supplied by the supply source through a pressure reduction valve, characterised in that the depressurising valve means (10) include a control valve sensitive on one side to the pressure of the supply source (6) and on the other to the pressure of the working members (1, 2) plus an elastic load acting on the valve means (10) in the same sense as the pressure of the working members (1, 2), and arranged to control the opening of the pressure reduction valve

(12).

9. System according to Claim 6, having a secondary source of pressurised fluid connected under the control of a maximum pressure valve to the said hydraulic servo-control devices for transmitting pilot pressure to the distributors, characterised in that the depressurising valve means comprise:

- a directional control valve (10) sensitive on one side to the pressure of the primary supply source (6) and on the other to the pressure of the working members (1, 2), the said directional control valve being placed in parallel to the said maximum pressure valve and being adapted to effect opening thereof,
- an anti-stall circuit of the said directional control valve (10) including a pressure reduction valve (18) calibrated for preventing the intervention of the directional control valve (10) in the conditions in which the pressure supplied by the said primary supply source is equal to the pressure of the working members (1, 2) and same to the maximum pressure of the circuit.

10. System according to claim 9, characterised in that it further comprises a first accumulator (13) for stabilising the rate of flow of the said secondary supply source (7) and the pressure generated by the said maximum pressure valve (11), and a second accumulator (14) for stabilising the pressure controlled by the said directional control valve (10).

11. System according to Claim 5, characterised in that the depressurising valve means include a directional control valve (10) sensitive on one side to the pressure

of the supply source (6) and on the other to the pressure of the working member (1, 2) plus an elastic load acting on the valve means (10) in the same sense as the pressure of the working members (1, 2), and arranged to control the closure of the pressure compensating means (9) associated with the distributors (3, 4).

12. System according to Claim 2, characterised in that the depressurising valve means are controlled voluntarily.

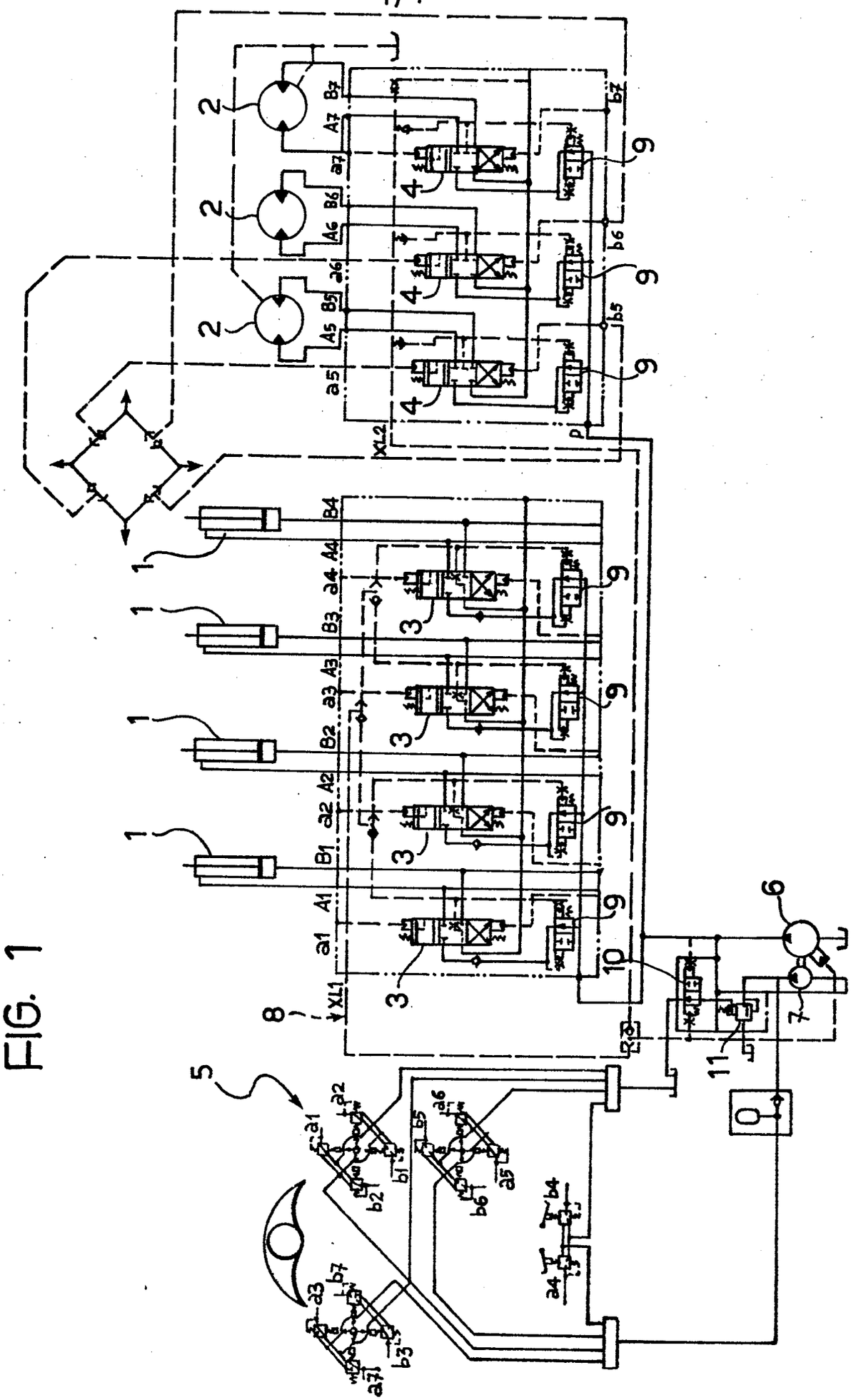
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FIG. 1

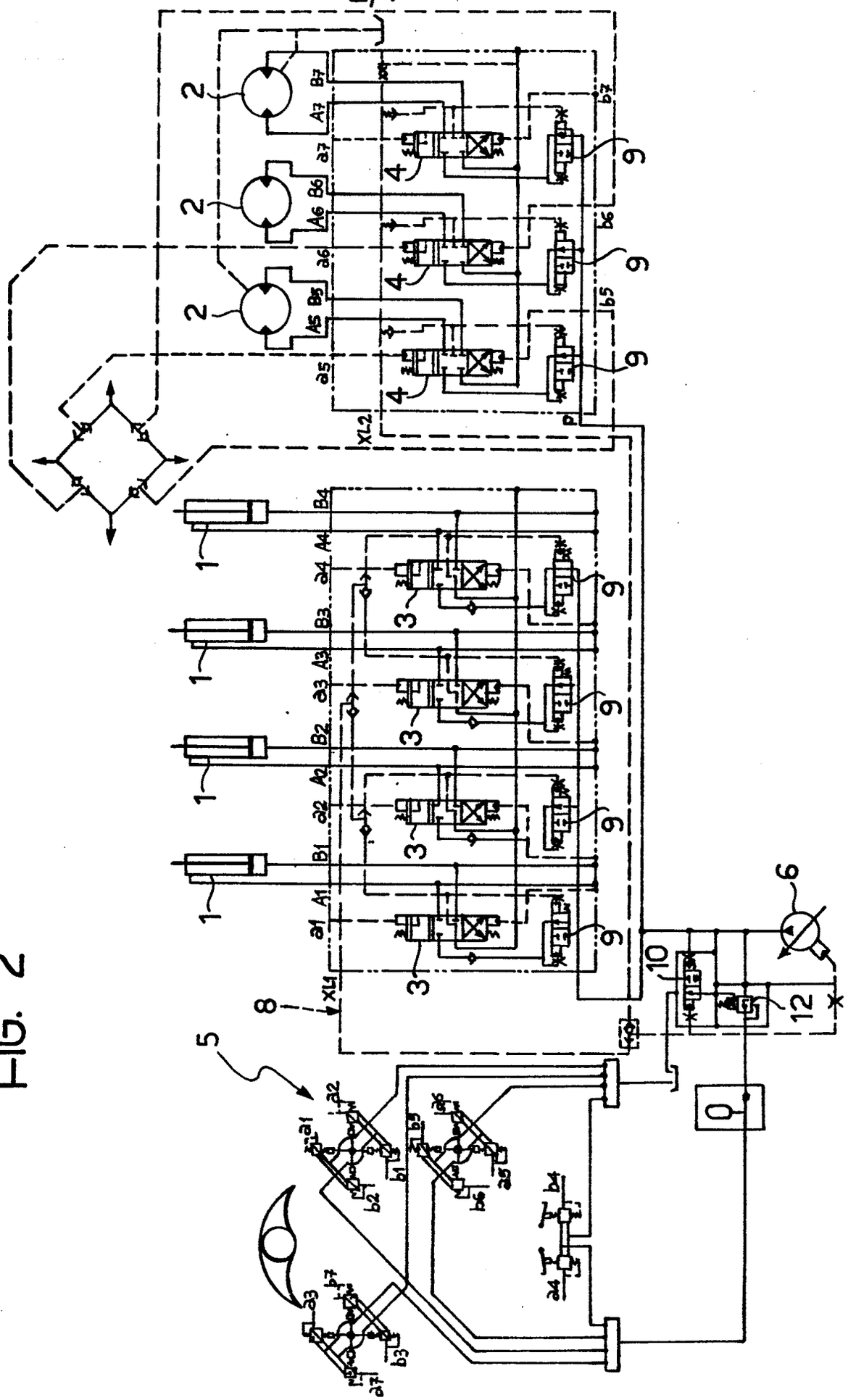


FIG. 2

FIG. 3

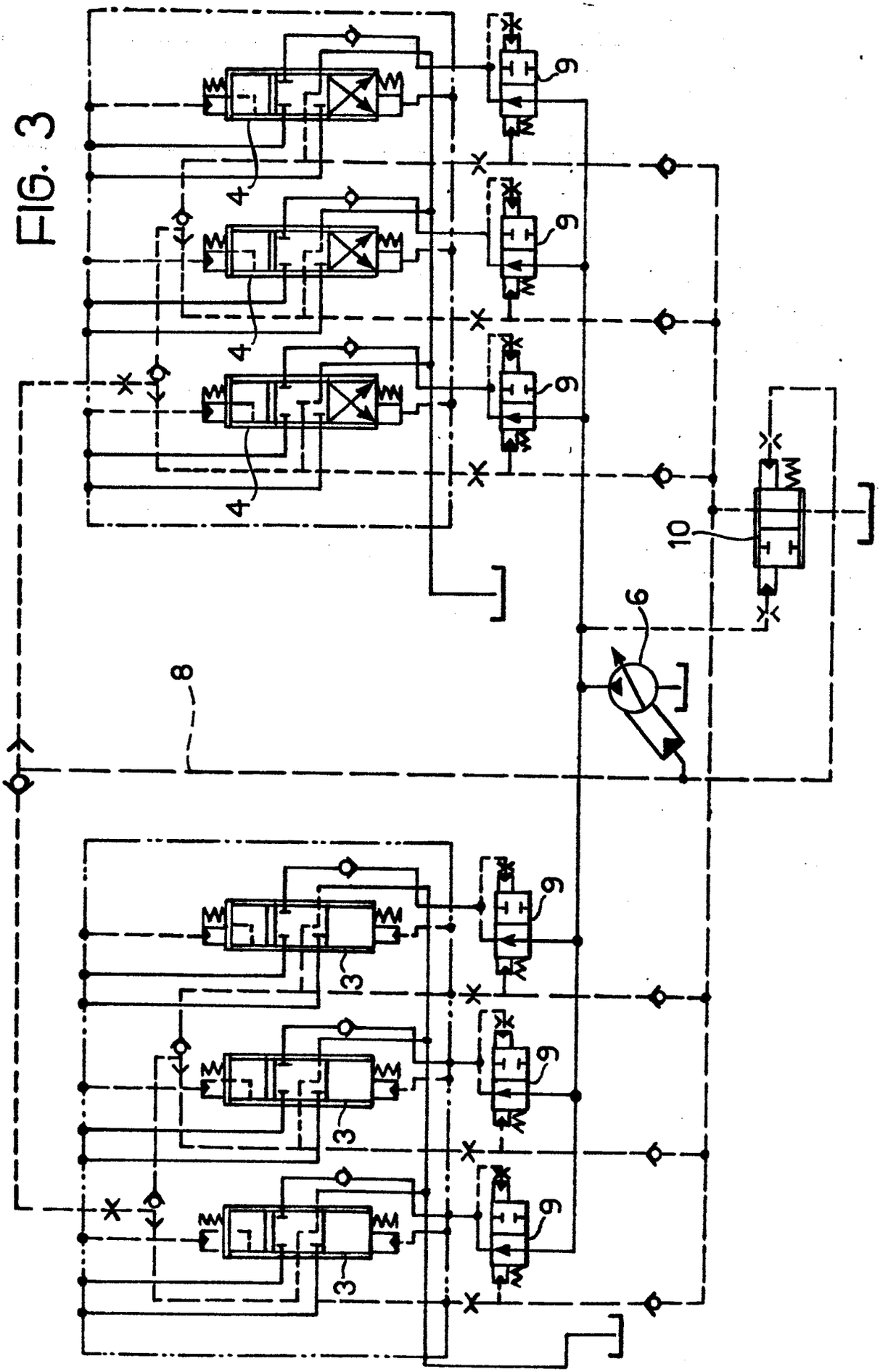
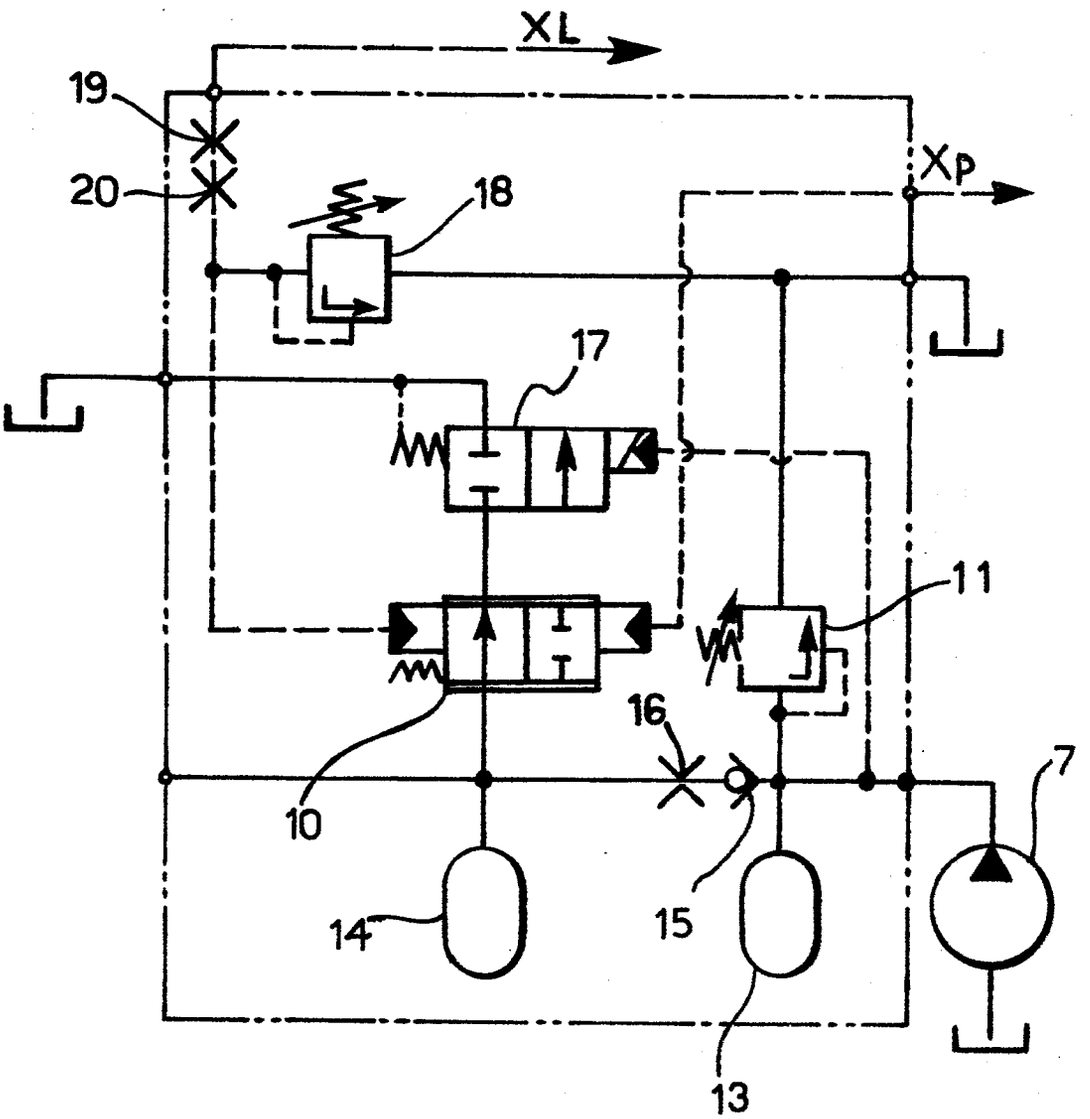


FIG. 4



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EUROPEAN SEARCH REPORT

0191275
Application number

EP 85 83 0286

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.4)
X	US-A-3 916 624 (MACHENS et al.) * Whole document * ---	1-9,11,12	E 02 F 3/30 E 02 F 3/32 E 02 F 9/22 F 15 B 11/05
X	US-A-3 156 098 (A.M. LA ROU) * Column 1, lines 27-63; claims 1-3 * ---	1-3	
A		4,7-9,12	
X	GB-A- 911 053 (PARKER-HANNIFIN CORP.) * Page 1, lines 48-69; claims 1-25 * ---	1-3	
A		4,7-9,12	TECHNICAL FIELDS SEARCHED (Int. Cl.4)
A	GB-A-1 057 752 (ORENSTEIN-KOPPEL UND LUBECKER MASCHINENBAU AG) * Page 1, lines 68-74 * ---	1	E 02 F F 15 B
A	US-A-3 543 646 (MITSUBISHI) * Whole document * ---	1	
A	US-A-4 343 152 (HABIGER) * Abstract * ---	1	
A	US-A-4 139 987 (T. BUDZICH) * Abstract * ---	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20-02-1986	ANGIUS P.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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