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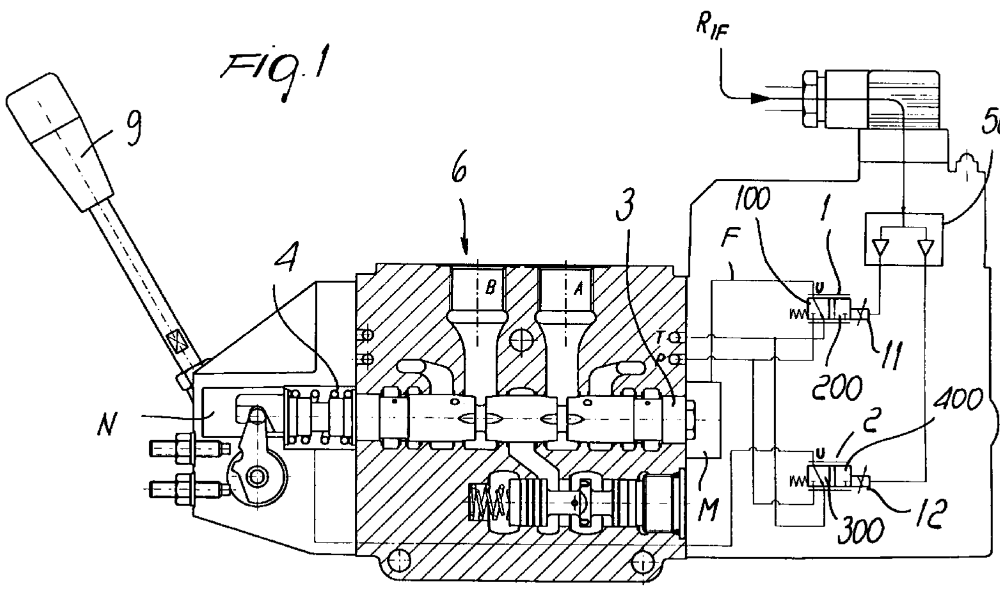
(54) Electrohydraulic device for driving and remotely controlling a hydraulic distributor

(57) An electrohydraulic device for driving and remotely controlling a hydraulic distributor of a directional valve for pressurizing or connecting to the discharge a pair of user devices comprising: two proportional electric valves (1, 2), which are fed by a pressure line (P), have a discharge line (T), and are connected respectively to opposite end chambers (M, N) of a hydraulic distributor (6) adapted to pressurize or connect to the discharge (T) two user devices; remote control means adapted to generate an electric control signal to energize electromagnets (11, 12) of the electric valves (1, 2); and an electronic circuit (5a, 5b) adapted to control and adjust the energization current of the electromagnets as a function of the electric control signal; the energization current drives the electromagnets (11, 12) for the selective feeding of the chambers with a preset pressure or for their connection to the discharge across the electric valves in order to move the slider (3) of the distributor (6) proportionally to the energization current; the electronic circuit is integrated in the body that houses the hydraulic distributor.

Fig. 1



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Description

The present invention relates to an electrohydraulic device for driving and remotely controlling a hydraulic distributor. More particularly, the device according to the present invention is meant to be used in hydraulic systems for actuating user devices with two actuation branches which are selectively connected to a pressurized branch of the hydraulic circuit and to the discharge branch, for example in machines for lifting or moving a load.

Hydraulic actuation devices are known for actuating a hydraulic user device with a speed which is independent of the resisting load that affects said hydraulic user device.

These devices comprise, for example, as disclosed in EPA no. 97100802.4 in the name of the same Applicant, a distributor which can be actuated so as to connect a user device actuation branch to a pressurized branch of a hydraulic circuit and to connect the other user device actuation branch to a discharge branch of the hydraulic circuit.

The hydraulic distributor is provided with a moving slider which moves on command into the chosen position in order to connect one user device or the other to the pressurized branch or to connect them both to the discharge.

In the above-mentioned patent application, the slider actuation unit is constituted by a lever, through which the slider is moved along the axis of its own seat, in contrast with the action of a return spring. It is also possible to actuate the slider of the distributor by means of an automatic actuation device.

There are substantially two types of devices for the automatic actuation of the slider using a so-called open-loop or closed-loop system.

An example of open-loop actuation system uses two proportional valves to actuate the slider; the valves are actuated by means of a joystick and of an electronic control board, which is arranged separately from the body containing the slider.

A drawback of this solution is the fact that several electrical cables are required in order to connect the electronic board to the electric valves which are accommodated proximate to the slider.

Accordingly, this entails possible signal losses and greater possibilities of faults and difficulties in installation.

Moreover, joystick-based control does not allow to adjust the flow-rate/pressure delivered by the electric valves, but only allows to select the electric valve to be actuated.

An example of closed-loop actuation system instead uses four valves of the on-off type, with a position transducer adapted to detect the exact position of the slider of the pilot valve, so as to provide a feedback control (closed-loop control) aimed at substantially eliminating any slider positioning error.

In this case, the electronic board for controlling the valves and the position transducer is accommodated in the same module that contains the slider of the pilot valve.

A drawback of the above solution is the fact that this system is highly dependent on the use of a position transducer and therefore can be used only for a closed-loop actuation and control system.

Another drawback is the fact of requiring a large number of on-off valves.

The aim of the present invention is to provide an electrohydraulic device for driving and remotely controlling a hydraulic distributor which uses the smallest possible number of electric valves, can also be used in an open-loop control system, and allows to minimize the wiring required to connect the electronic part of the device to said electric valves.

Within the scope of this aim, an object of the present invention is to provide an electrohydraulic device for driving and remotely controlling a hydraulic distributor which can also be used in a closed-loop control system.

An object of the present invention is to provide an electrohydraulic device for driving and remotely controlling a hydraulic distributor which can remotely control the flow-rate that can be delivered by the chosen electric valve.

Another object of the present invention is to provide an electrohydraulic device for driving and remotely controlling a hydraulic distributor offering a high degree of safety against unintentional manual actuation of the slider of the pilot valve.

Another object of the present invention is to provide an electrohydraulic device for driving and remotely controlling a hydraulic distributor having a short slider response time.

Another object of the present invention is to provide an electrohydraulic device for driving and remotely controlling a hydraulic distributor having low hysteresis and excellent sensitivity.

Another object of the present invention is to provide an electrohydraulic device for driving and remotely controlling a hydraulic distributor which ensures high precision in positioning the slider of the pilot valve and a high repeatability which is not affected by variations of internal parameters such as temperature, friction and elasticity of the spring of the slider.

This aim, these objects and others which will become apparent hereinafter are achieved by an electrohydraulic device for driving and remotely controlling a hydraulic distributor of a directional valve for pressurizing or connecting to the discharge a pair of user devices, characterized in that it comprises: two proportional electric valves, which are fed by a pressure line, have a discharge line, and are connected respectively to opposite end chambers of a hydraulic distributor adapted to pressurize or connect to the discharge two user devices; remote control means adapted to generate an electric control signal to energize electromagnets of said electric valves; and an electronic circuit adapted to control and adjust the energization current of said electromagnets as a function of said electric control signal; said energization current driving said electromagnets for the selective feeding of said chambers with a preset pressure or for their connection to the discharge across said electric valves in order to move the slider of said distributor proportionally to said energization current; said electronic circuit being integrated in the body that houses said hydraulic distributor.

Further characteristics and advantages of the apparatus according to the present invention will become apparent from the following detailed description of two preferred but not exclusive embodiments of the device according to the invention, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

Figure 1 is a schematic sectional elevation view of the electrohydraulic device according to the invention in a first embodiment implementing an actuation of the open-loop type;
Figure 2 is a schematic sectional elevation view of the electrohydraulic device according to the present invention, in a second embodiment implementing an actuation and a control of the closed-loop type;
Figure 3 is a block diagram of the electronic circuit in the closed-loop system, according to the first embodiment of the electrohydraulic device according to the present invention;
Figure 4 is a block diagram of a first portion of the electronic circuit in the closed-loop system, according to a second embodiment of the electrohydraulic device according to the present invention;
Figure 5 is a block diagram of a second portion of the electronic circuit in the closed-loop system, according to the second embodiment of the electrohydraulic device according to the present invention;
Figure 6 is a block diagram of a third portion of the electronic circuit in the closed-loop system, according to the second embodiment of the electrohydraulic device according to the present invention; and
Figure 7 is a block diagram of the electronic circuit of the joystick for controlling the electrohydraulic device according to the present invention.

In the various figures, identical reference numerals designate identical elements.

With reference to the above figures, the electrohydraulic device according to the present invention comprises two proportional electric pressure reducing valves 1, 2 adapted to drive the slider 3 of a hydraulic distributor 6, which allows to pressurize or connect to the discharge two user devices A and B.

Figures 1 and 2 illustrate two chambers M and N, arranged respectively to the sides of the slider 3, into which pressure is fed by means of the electric valves 1 and 2 in order to move the slider in one direction or the other according to the user device which is to be driven.

The movement of the slider 3 in one direction occurs by overcoming the resisting force of a spring 4.

The electric valves 1 and 2 are fed with a pressure which is introduced through a line P and the discharges thereof are collected in a discharge line T.

Figure 1 also schematically illustrates a control block 5a for driving the electric valves 1 and 2 by means of an electric signal that originates from control means (not shown), which are conveniently constituted for example by a joystick and are arranged remotely with respect to the hydraulic distributor 6.

The electric signal arriving from the joystick has the purpose of providing proportional control of the hydraulic pressure that is generated by the two electric valves 1 and 2, energizing magnets 11 and 12, respectively, of the electric valves.

Figure 1 is a view of the electrohydraulic device according to the invention in its first embodiment, i.e., in the open-loop configuration, while Figure 2 is a view of the device in the closed-loop configuration.

Thus in Figure 2, differently from Figure 1, the control block, designated here by the reference numeral 5b, receives a feedback signal which arrives from a transducer for the position of the slider 3. The transducer is constituted for example by a differential transformer 7, in which a feeler 8 is connected to the magnetic core 10 of the transformer. The feeler is conveniently constituted by a rod which is constantly in contact with the end of the slider 3, on the side of the chamber M, so as to detect at all times the position of the slider 3 and feed it back to the control block 5b.

The electrohydraulic device according to the present invention can of course be arranged both at the chamber M and at the chamber N without any constructive modification.

Figures 1 and 2 also illustrate an actuation lever 9, by which it is possible to manually move the slider 3. To prevent the possibility of unintentional activation, the actuation lever 9 can be removed.

Figures 3 to 7 instead illustrate in detail the electronic system meant to actuate the electric valves 1 and 2 both in the open-loop configuration and in the closed-loop configuration.

Said figures thus illustrate in detail the components of the blocks 5a and 5b.

With reference to Figure 3, a block diagram of the open-loop configuration of the electronic system of the electrohydraulic device according to the invention is illustrated.

In said figure, the reference numeral 15 designates voltage stabilizing means, which are conveniently constituted by a high-frequency oscillator which stabilizes the average voltage applied to the electromagnets 11 and 12 of the proportional electric valves 1 and 2.

The signal in output from the high-frequency oscillator 15 is fed to a logic gate 16 (AND gate) whose second input is constituted by a signal which is output by an operational amplifier 17 (comparator).

The signal in output from the logic gate 16 drives a MOSFET 18 controlling the electromagnet 11 of the electric valve 1.

Likewise, for the second electric valve 2 and, therefore for the corresponding electromagnet 12, a second logic gate 19, a second operational amplifier 20 (comparator) and a second MOSFET 21 are provided.

The operational amplifier 17 has a first inverting input receiving an output signal from an oscillator 22 (80-200 Hz) with a trimmer for setting the frequency.

The purpose of the amplifier is to supply a variable current to the activated electromagnet.

A signal from an amplifier 23 of the proportional-integral type is instead sent to the non-inverting input of the operational amplifier 17.

The signal entering the proportional-integral amplifier 23 is the result of a plurality of signals which arrive at an adder node 24.

In particular, the adder node 24 receives a first signal constituted by the reference signal Rif which arrives from the control joystick and is processed appropriately so as to obtain a signal Rif 1.

In detail, the signal Rif 1 is obtained so that it is positive for values that are higher than the voltage used as zero (neutral position of the joystick) and can thus drive the electromagnet 11 of the proportional valve 1.

This processing occurs in a block 25.

A maximum-value trimmer 26 is arranged after the block 25 and has the purpose of setting the maximum value of the current of the electromagnet 11.

A minimum-value current trimmer 27 is instead meant to supply a minimum initial current value in order to overcome the resisting force of the spring 4 of the slider 3.

The adder node 24 thus adds the current signal, limited by the trimmer 26, and the minimum-current signal supplied by the trimmer 27, and subtracts from this sum a signal corresponding to the detected current of the electromagnet 11.

Detection of the current of the electromagnet 11 occurs by means of a current signal amplifier 28 and of a filter 29.

The signal produced in the adder node 24 is therefore the signal that is sent to the non-inverting input of the operational amplifier 17.

The above applies to the actuation of the electric valve 1. For the electric valve 2, actuation is provided in a similar way and therefore Figure 3 illustrates a second reference signal processing block 30, a second adder node 31, a second maximum-current trimmer 32 and a second threshold current trimmer 33.

Accordingly, the signal in output from the second adder node 31 is amplified by a second amplifier of the proportional-integral type 34, whose output constitutes a first non-inverting input of the operational amplifier 20; the second inverting input of said amplifier is a signal that arrives from a second oscillator 35 having a trimmer for setting the frequency.

Figure 4 illustrates the second embodiment of the electronic system of the device according to the invention, in which closed-loop control of the position of the slider 3 is achieved by means of the transducer 7 and the feeler 8.

Figure 5 is a view of the method for obtaining a signed position error signal, which is then used in the circuit portion shown in Figure 4. Accordingly, the block diagram of Figure 5 is described first.

A low-voltage stabilized sine-wave oscillator 35 supplies the primary winding 36 of the differential transformer 7, in which the voltage on the secondary windings 37 and 39 is a function of the position of the magnetic core 10 and is rectified and amplified, in a conditioning device 38, into a voltage signal which can vary over a given voltage interval for the maximum stroke, the minimum stroke and the neutral position of the slider 3.

The AC voltage read on the secondary windings 37 and 39 arranged in series is then amplified and rectified in the conditioning device 38 and added to the value of the neutral position voltage of the joystick.

The signal Rif arriving from the joystick is filtered by an RC network 40 and is locked by means of a resistor to the neutral position voltage, block 41, in order to maintain the slider 3 in the neutral position if the control signal from the joystick is interrupted.

The error signal from the adder node 42 is amplified by an amplifier 43 of the proportional-integral type and constitutes the signed position error signal. The signal is used as reference for the loop for controlling the current of the electromagnets, shown in Figure 4.

With reference to Figure 4, the difference between the open-loop control diagram shown in Figure 3 and the closed-loop control diagram shown in Figure 4 lies in the fact that in the second case there is provided a feedback loop for the position of the slider 3 which uses the position error signal E generated in Figure 5.

An absolute position error is extracted from the signed position error E by means of a processing block 44, from which the absolute position error signal |E| is obtained which is added in an adder node 45 to the voltage signal that is proportional to the instantaneous current of the electromagnets detected as in the previous case of open-loop control.

The signal produced by the adder node 45 is therefore the current error signal obtained by subtracting the amplified and filtered current signal from the absolute position error signal.

The signal in output from the adder node 45 is then sent to a proportional-integral amplifier 46, whose output is the inverting input for an operational amplifier 47, the non-inverting input whereof is constituted by a signal arriving from an oscillator 48.

The electromagnets 11 and 12 are never driven simultaneously; for this purpose, two comparators 49 and 50 are provided, the input of which is the signed position error signal E and the neutral reference signal Rif_{neutro} of the joystick, so as to activate the chosen electromagnet as a function of the sign of the slider position error E, detected by means of the position transducer 7.

While the average value of the current remains exclusively a function of the position error E (position detected by the LVDT transducer), the instantaneous value changes at the frequency of the oscillator 48 (at low frequency), so as to keep the magnetic core 10 under constant oscillation, avoiding the problems linked to initial separation friction.

Figure 6 illustrates the logic system of the safeties of the electronic part of the device according to the invention.

Said figure illustrates a first window comparator 8, whose task is to monitor the position error arriving from the comparator node 42 of Figure 5. If the error E remains high in absolute value for longer than a given preset time, set by a delay device 55, the device enters the safe mode. The controls are disabled and the output driving transistor 56, which normally actuates an electric valve 57 for connection to the discharge, is switched off.

There is also a minimum supply voltage safety, comparator 58, and a latch circuit 56 maintains the system in the safety conditions even when the normal operating conditions are restored.

A second window comparator 57 determines whether the position reference signal Rif is or not within acceptable limits, i.e., whether it is not lower than the minimum allowable value and not higher than the maximum allowable value. If one of these two abnormal situations occurs, the window comparator 57 locks off the system.

The electronic system described so far is integrated in the housing of the hydraulic distributor, thus minimizing the wiring.

The block diagram of the logic system of the joystick is illustrated with reference to Figure 7.

The figure illustrates three mutually identical schematic portions, which are dedicated respectively to actuation along three Cartesian coordinated axes x, y and z.

Power is supplied to the joystick circuit from a DC source with a voltage which can vary between 10 and 30V and supplies the circuits of the joystick after passing through a noise filter and a circuit for protecting against polarity reversal.

A reference source 60 supplies a stabilized DC voltage ensuring a constant output which is exclusively a function of the position and is not affected by the construction tolerance of the potentiometers of the joystick, which will be described hereinafter.

The reference numerals 61 designate polarity switches, while the reference numerals 62 designate the respective potentiometers for the three coordinated axes. Said potentiometers supply in output a voltage which is proportional to the movement of the lever of the joystick (not shown), which is then limited by suitable trimmers 63 in order to limit the maximum flow-rate of oil to the electric valves 1 and 2.

The potentiometers 62 have a central neutral region with zero resistance, so that when the actuation lever is in the inactive position the output control voltage has an assuredly unique value (neutral value of the control voltage) which is not affected by any instabilities of the inactive position.

Additional trimmers 64 are provided in order to adjust the acceleration ramp, i.e., the relation between the movement of the lever of the joystick and the output voltage.

The signal in output from the trimmer 64 is sent to an adder node 65 and then to an amplifier 66.

The signal in output from the joystick is differential (Rif+, Rif-) so as to allow to avoid the influence of live voltage drops and of noise: in this case, therefore, two conductors dedicated to the output signal are used.

With reference to the above figures, the operation of the device according to the present invention is as follows.

The positioning of the slider 3 of the distributor 6 is driven and controlled remotely by the joystick, which has its own electronic system which combines with the electronic control board that is integrated in the body that accommodates the slider 3.

The electric output signal of the joystick energizes the electromagnets 11 and 12 of the electric proportional valves and said electric valves, supplied by the low-pressure line P, generate a pressure which is proportional to the electric signal arriving from the joystick; the pressure moves the slider 3 to pressurize or connect to the discharge the chosen user device.

The joystick provides in output a voltage which can vary between a minimum value and a maximum value, with an intermediate value corresponding to a zero hydraulic flow rate on the user devices A and B. As already explained earlier, and as described in detail hereinafter, the output signal of the joystick can be used in two different modes: in closed-loop mode and in open-loop mode.

In the first mode (open-loop mode), a proportional current is generated which supplies one of the two electric pressure reducing valves 1 and 2, producing a proportional movement of the slider 3. In the second mode (closed-loop mode), the electric signal emitted by the joystick is compared with the signal of the position transducer 7, so as to obtain the position of the slider 3 as a function of the joystick control voltage, thus eliminating any imprecisions that may be present in the electric valves or in the mechanical system for moving the slider.

The pressure of the actuation oil (pressure line P) is a function of the energization current of the electromagnets 11 and 12 and the position of the slider 3 is an almost linear function of the current.

In the inactive position, i.e., when the joystick actuation rod is arranged in a central position (neutral region), the outlets U of the electric valves 1 and 2 connect the chambers M and N to the discharge T: in this inactive configuration, the slider 3 moves into the central position and the two users A and B are connected to the discharge.

Consider, first of all, the closed-loop configuration of the device according to the present invention wherein the position of the slider 3 is detected by the differential-transformer transducer 7, by means of the feeler 8, and converted into an analog voltage signal whose value can vary between a neutral position value of the slider 3, a maximum stroke value and a minimum stroke value.

The voltage in output from the transducer is compared in the node 42 with the electric reference signal Rif arriving from the joystick and the difference between the two signals is amplified by the amplifier 43 and used as a signed position error signal E, which is used as reference for the control loop of the current of the electromagnets 11 and 12 (see figures 4 and 5).

The two electromagnets 11 and 12 are never driven simultaneously: the comparators 49 and 50 are used to select one or the other of the two electromagnets, depending on the sign of the position error E.

In the closed-loop configuration, in addition to detecting the position of the slider 3, the energization current of the electromagnets 11 and 12 is also detected (this detection is also performed in the open-loop configuration described hereinafter).

The amplifier 28 used for this detection acquires only at periodic intervals the actual current of the electromagnet and the missing part of the current is reconstructed by means of the RC circuit 29, having the same time constant as the L/R coil.

The value of the current thus detected is compared in the node 45 with the absolute position error |E| and the resulting difference signal is amplified by the amplifier 46 and then compared in the comparator 47 with the output signal of the oscillator 48.

The signal in output from the comparator 47 (square wave) activates and deactivates the involved electromagnet 11 or 12.

As regards instead open-loop control, the operation is similar except for the fact that no position control by means of the probe 8 and the transducer 7 of the slider 3 is present and accordingly the safeties for the slider position error are not present too.

The only control loop that is present is the one related to the activation current of the two electromagnets 11 and 12.

The input signal Rif arriving from the joystick follows two separate but mirror-symmetrical paths for the two electromagnets 11 and 12.

The processing performed on the signal in the blocks 25 and 30 causes the first block to have, as output, a signal Rif 1 which is positive for values that are higher than the voltage corresponding to the neutral voltage region of the joystick, and is therefore capable of activating the electromagnet 11, while it causes the second block to have as output a signal Rif 2 which is positive for voltage values that are lower than the neutral voltage value (inactive position of the joystick control rod), so as to activate the electromagnet 12.

The signals Rif 1 and Rif 2 are then compared respectively with the detected value of the current of the electromagnets, nodes 24 and 31, and the resulting difference signals (current error signals) are respectively compared with the output voltages of the low-frequency oscillators 22 and 35 to then supply the electromagnets 11 and 12 of the proportional electric valves 1 and 2.

In both configurations, in the closed-loop one as well as in the open-loop one, oscillators 15 are provided for stabilizing the supply voltage so as to make the operation of the device independent of the particular external supply voltage.

The generation of the electric output signal of the joystick can follow in a substantially linear manner the position of the actuation lever of said joystick, with a neutral central region corresponding to the inactive position of the actuation lever, or the output signal can be linked adjustably (by means of the trimmers 64) to the movement of the actuation lever; i.e., the slope of the output signal of the joystick can be altered at will.

In this manner, the voltage value of the output signal can be changed though the same stroke is performed with the joystick actuation lever.

The electronic system of the joystick includes a device for protection in case of lack of supply voltage; if this case occurs, the output signal is automatically placed in a high-impedance condition in order to make the slider 3 return to the neutral position.

Further there is provided a device for protection against short circuits on the output, a device for protection against the breakdown of a potentiometer 62, and a device for protection against power supply noise.

The device for protection against power supply noise includes a double filtering system to limit overvoltages. A varistor contains high-value pulsed voltages, while an LC circuit with a high-value capacitor limits the overvoltages having a modest amplitude but a longer duration (sudden disconnection of loads, opening and closing of circuits).

As regards instead the purely hydraulic operation of the device according to the invention, and with reference to Figures 1 and 2, the operation is as follows.

Assume that the joystick is moved from the inactive position (neutral region) and that the corresponding electric signal generated thereby, Rif, energizes the magnet 11 of the electric valve 1. In this case, the position 200 of the electric valve 1 moves into the position 100, allowing the connection of the pressure line P to the outlet U.

The pressure in input to the electric valve 1 is always constant, while the pressure at the outlet U is exclusively a function of, and proportional to, the amount of current acting on the electromagnet 11 at that time.

The reduced pressure of the outlet U passes, by means of the line F, into the chamber M, in which it acts on the area of the slider 3, pushing the slider to the left in the drawing and thus allowing the flow of pressure towards the user device A.

Conversely, the chamber N, by means of the connection line Z, is connected to the outlet U of the electric valve 2, which connects it to the discharge T by means of its position 300.

Assume that the joystick actuation lever is actuated again, so that the electric signal Rif thus generated energizes the electromagnet 12 of the electric valve 2: the following situation occurs.

The position 400 of the electric valve 2 moves into the position 300, allowing to connect the outlet U to the pressure line P.

In this case, too, the pressure in input to the electric valve 2 is always constant, while the pressure at the outlet U is purely a function of, and proportional to, the amount of current acting on the electromagnet 12 at that time.

The reduced pressure of the outlet U then passes, through the line Z, to the chamber N, pressurizing it and thus acting on the slider 3 so as to move it to the right in the figure, thus allowing the inflow of pressure to the user device B of the distributor 6.

At the same time, the chamber M is connected to the discharge T.

In the case of closed-loop operation, in both of the directions of motion of the slider 3, the probe 8 of the position transducer 7 detects, in each instant, the position of the slider 3 and converts it into an electric voltage, which is compared to the reference voltage arriving from the joystick, as explained hereinafter.

Any control that is not the electric signal Rif arriving from the joystick is recognized as an error by the position transducer 7, which initially locks in position the slider 3 and then, if the error persists, locks the entire circuit by connecting the electric valves 1 and 2 to the discharge T.

The fault reporting system allows to lock the device very quickly, while indicating visually the fault state.

In practice it has been observed that the electrohydraulic device according to the present invention fully achieves the intended aim, since it allows to drive and control remotely a hydraulic distributor, moving the slider according to requirements so as to activate or deactivate the user devices connected to the distributor.

Remote control by means of the joystick allows to actuate the two proportional electric valves, which in turn generate a hydraulic pressure which is proportional to the electric signal sent by the joystick, in order to actuate the movement of the slider.

The possibility to operate both in open-loop mode and in closed-loop mode makes the device according to the present invention highly versatile: in the second version (closed loop) it is possible to control with feedback the position of the slider, automatically excluding any external control other than the electric control that arrives from the joystick.

The device thus conceived is susceptible of several modifications and variations, all of which are within the scope of the inventive concept.

Thus, for example, as regards the control of the energization current of the electromagnets 11 and 12, it is possible to limit the maximum value of the current to a value which is proportional to the absolute position error |E| and to modulate the current with a square wave at an adjustable frequency (low frequency) independently for the two electromagnets 11 and 12.

In this manner, the duty cycle of the low modulating frequency remains constant, while in the previously described case it varies according to the current and therefore with high current values the ability of the magnetic core 10 to vibrate may disappear.

Moreover, the above described embodiment allows to independently adjust the modulating frequencies for the two electromagnets 11 and 12, so as to adapt the frequency to the characteristics of the electric valve and of the hydraulic circuit.

Finally, all the details may be replaced with other technically equivalent elements.

In practice, the materials employed, so long as they are compatible with the specific use, as well as the dimensions, may be any according to requirements and the state of the art.

Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. An electrohydraulic device for driving and remotely controlling a hydraulic distributor of a directional valve for pressurizing or connecting to the discharge a pair of user devices, characterized in that it comprises: two proportional electric valves, which are fed by a pressure line, have a discharge line, and are connected respectively to opposite end chambers of a hydraulic distributor adapted to pressurize or connect to the discharge two user devices; remote control means adapted to generate an electric control signal to energize electromagnets of said electric valves; and an electronic circuit adapted to control and adjust the energization current of said electromagnets as a function of said electric control signal; said energization current driving said electromagnets for the selective feeding of said chambers with a preset pressure or for

their connection to the discharge across said electric valves in order to move the slider of said distributor proportionally to said energization current; said electronic circuit being integrated in the body that houses said hydraulic distributor.

2. An electrohydraulic device according to claim 1, characterized in that it comprises a position transducer adapted to detect the position of said slider and to convert it into an analog voltage signal.

3. An electrohydraulic device according to claim 1, characterized in that said electronic circuit comprises means for detecting the current of said electromagnets and means for comparing the detected current with said actuation signal arriving from the remote control signals, in order to generate a current error signal.

4. An electrohydraulic device according to claim 2, characterized in that said electronic circuit comprises comparison means adapted to compare said analog voltage signal with said control signal that arrives from the remote control means, in order to generate a signed cursor position error signal, said position error signal being fedback to said electric valves.

5. An electrohydraulic device according to claims 3 and 4, characterized in that it comprises comparison means adapted to compare said cursor position error signal with the output signal of said current detection means.

6. An electrohydraulic device according to claim 4, characterized in that it comprises low-voltage oscillator means adapted to generate a signal which can be compared with said current error signal in order to drive said electromagnets.

7. An electrohydraulic device according to claim 4, characterized in that said electromagnet current detection means comprise an amplifier with a cascade-connected filter.

8. An electrohydraulic device according to one or more of the preceding claims, characterized in that said electronic circuit comprises a voltage-stabilizing oscillator which is suitable to stabilize the voltage across said electromagnets.

9. An electrohydraulic device according to claim 2, characterized in that said position transducer comprises a differential transformer having a magnetic core and to which a feeler is connected, said feeler being meant to make contact, at all times, with said slider to detect its position.

10. An electrohydraulic device according to claim 4, characterized in that it comprises a window comparator for the cursor position error signal in order to keep the movement of said slider within preset limits.

11. An electrohydraulic device according to claim 1, characterized in that it comprises a window comparator for the control signal arriving from said remote control means, in order to keep the voltage value of said control signal within preset values.

12. An electrohydraulic device according to claim 1, characterized in that it comprises a circuit for protection against power supply noise.

13. An electrohydraulic device according to claims 10 and 11, characterized in that it comprises an electric valve for connecting the device to the discharge, adapted to deactivate the device following an error signal arriving from said window comparators.

14. An electrohydraulic device according to claim 1, characterized in that said remote control means comprise a joystick having an electronic circuit of its own.

15. An electrohydraulic device according to claim 13, characterized in that said joystick comprises, for movement along each one of three coordinated Cartesian axes, a polarity switch for reversing motion, a potentiometer with an output voltage which is proportional to the movement of the actuation lever of said joystick, and a trimmer for adjusting the output control signal in order to limit the maximum flow-rate of said pressure line of said electric valves.

16. An electrohydraulic device according to claim 14, characterized in that said joystick further comprises a trimmer for adjusting the acceleration ramp of said output control signal in order to vary the voltage provided as output for a same movement of said control lever.

17. An electrohydraulic device according to claim 14, characterized in that the output control signal of said joystick is a differential voltage signal.

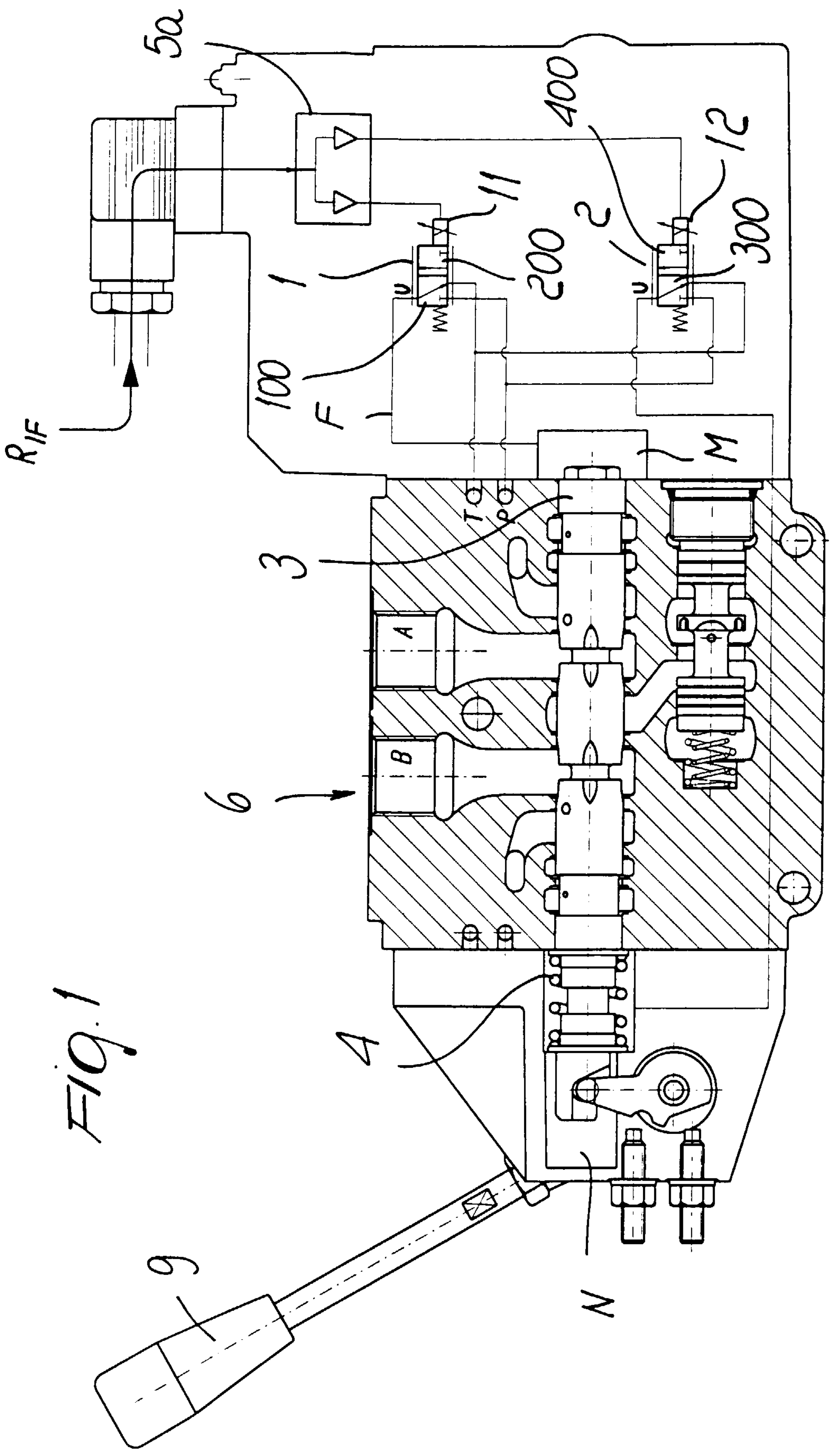

Fig. 1

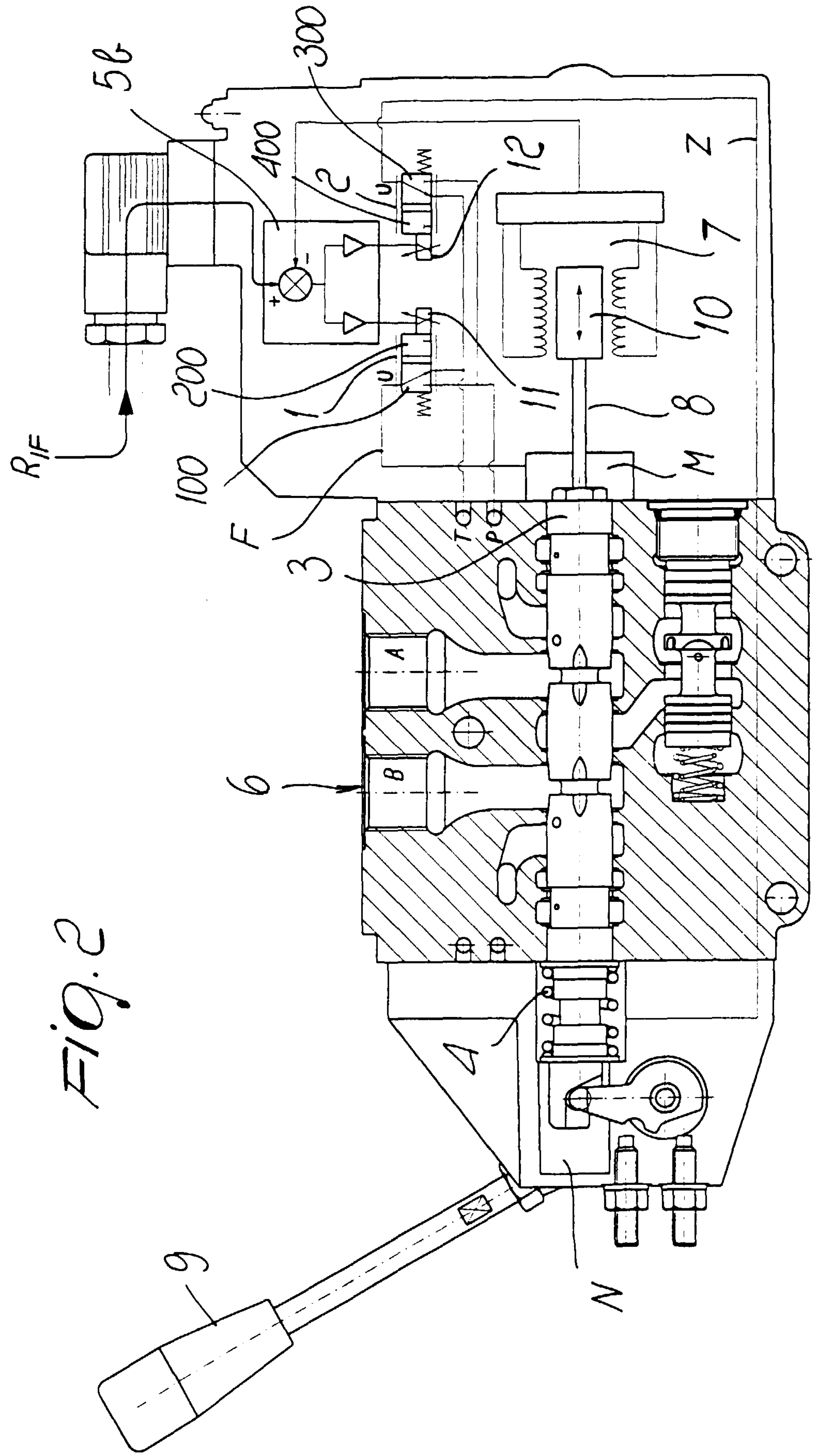

Fig.2

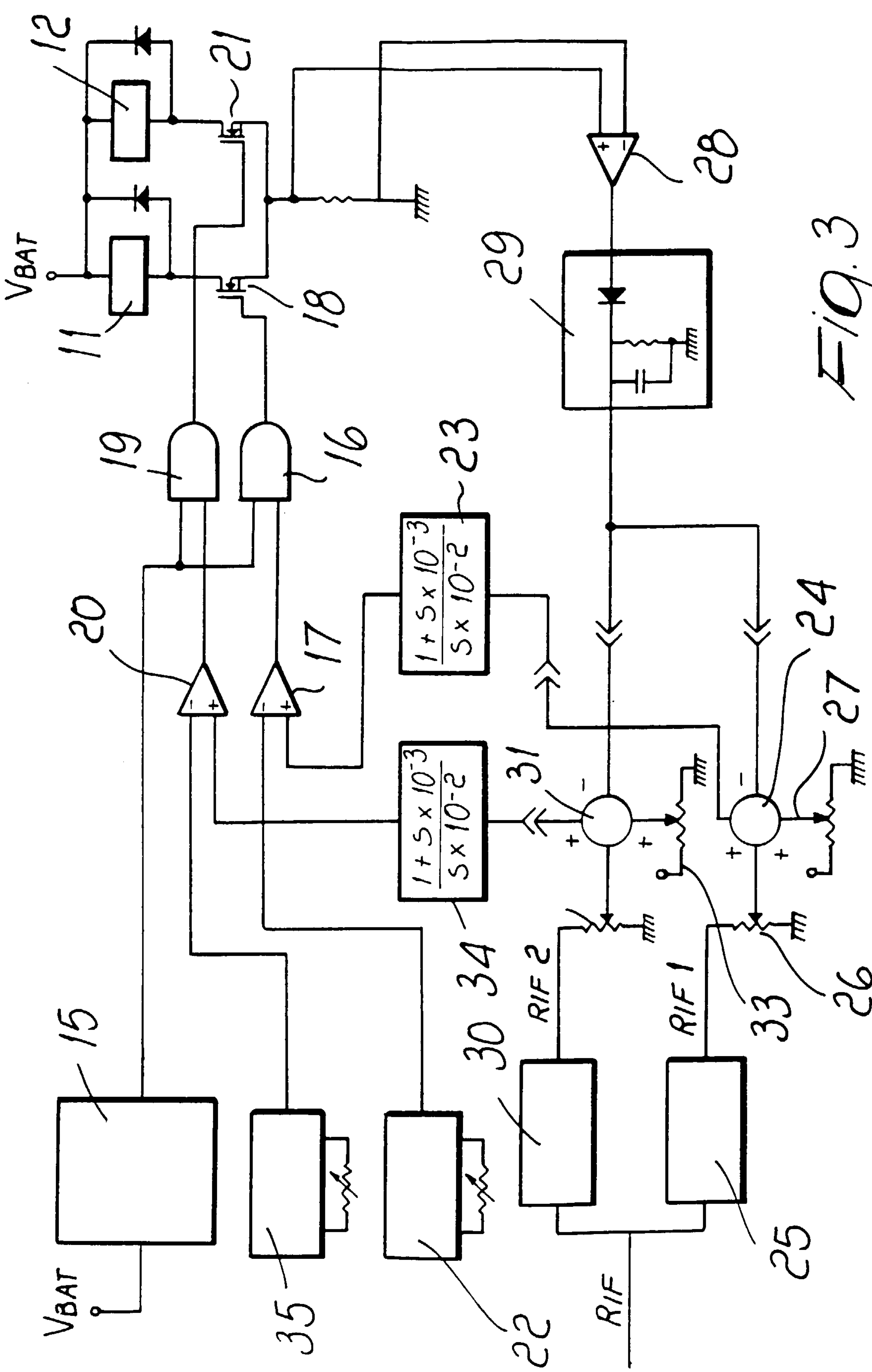
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Fig. 3

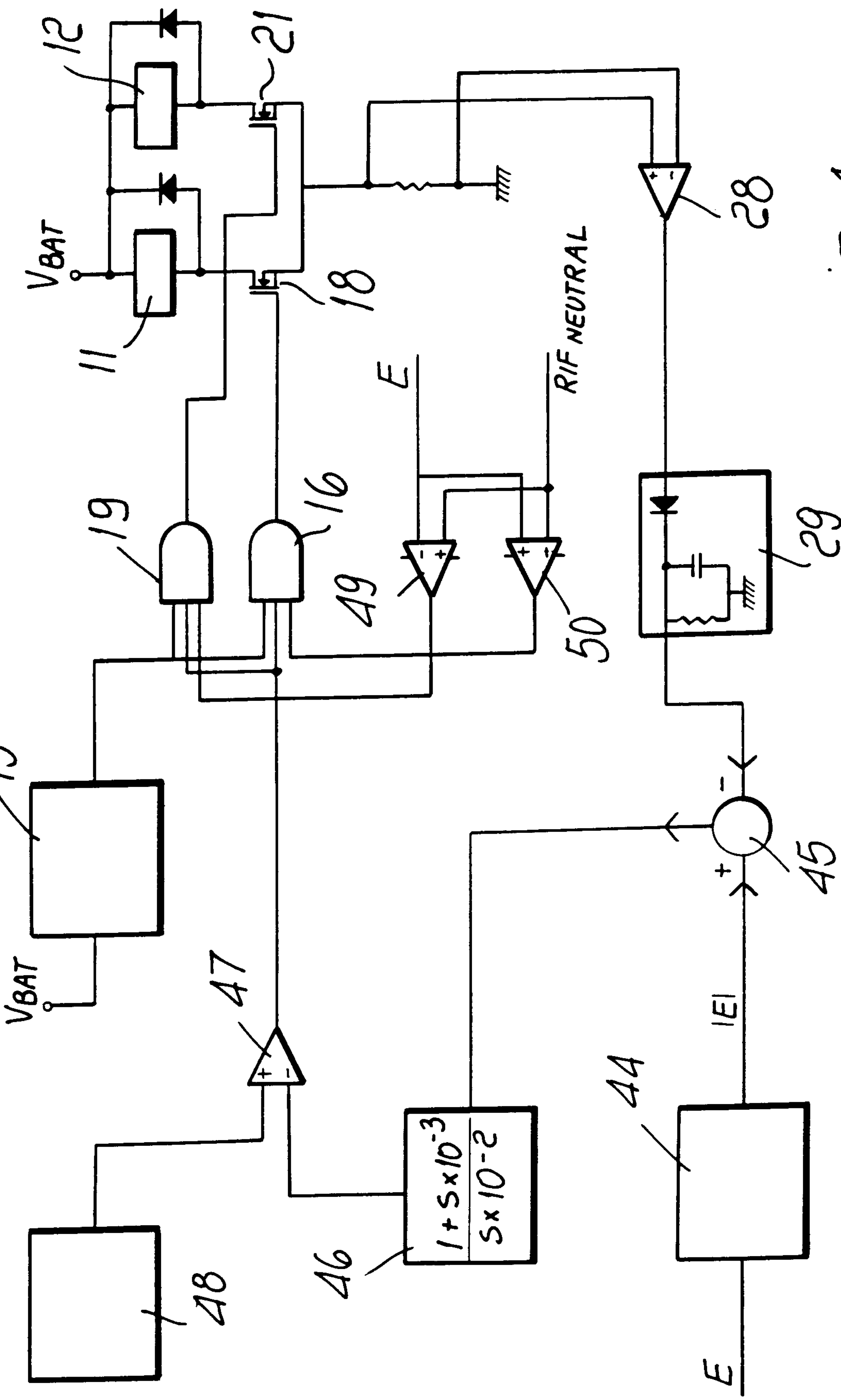
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Fig.4

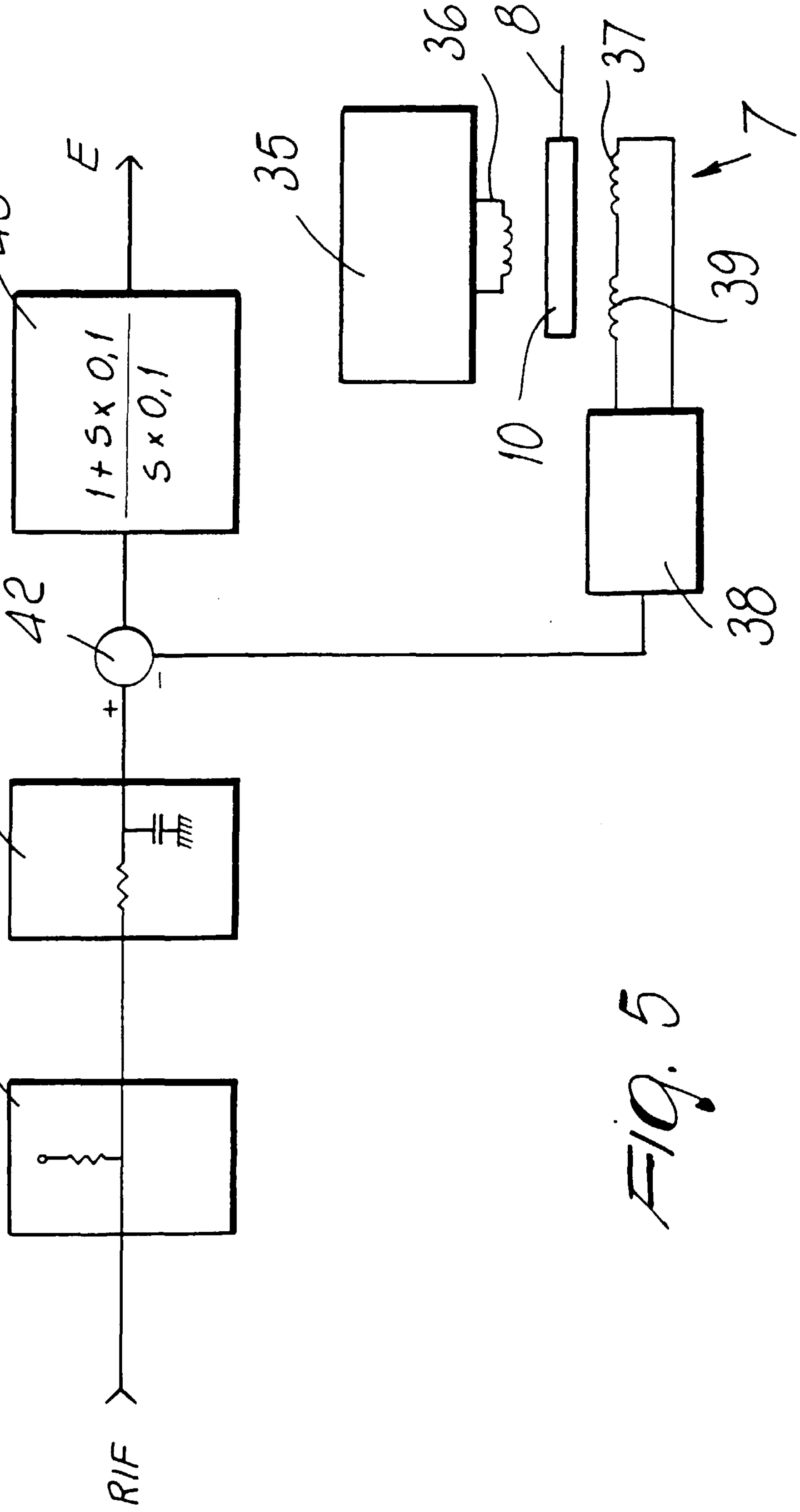

Fig. 5

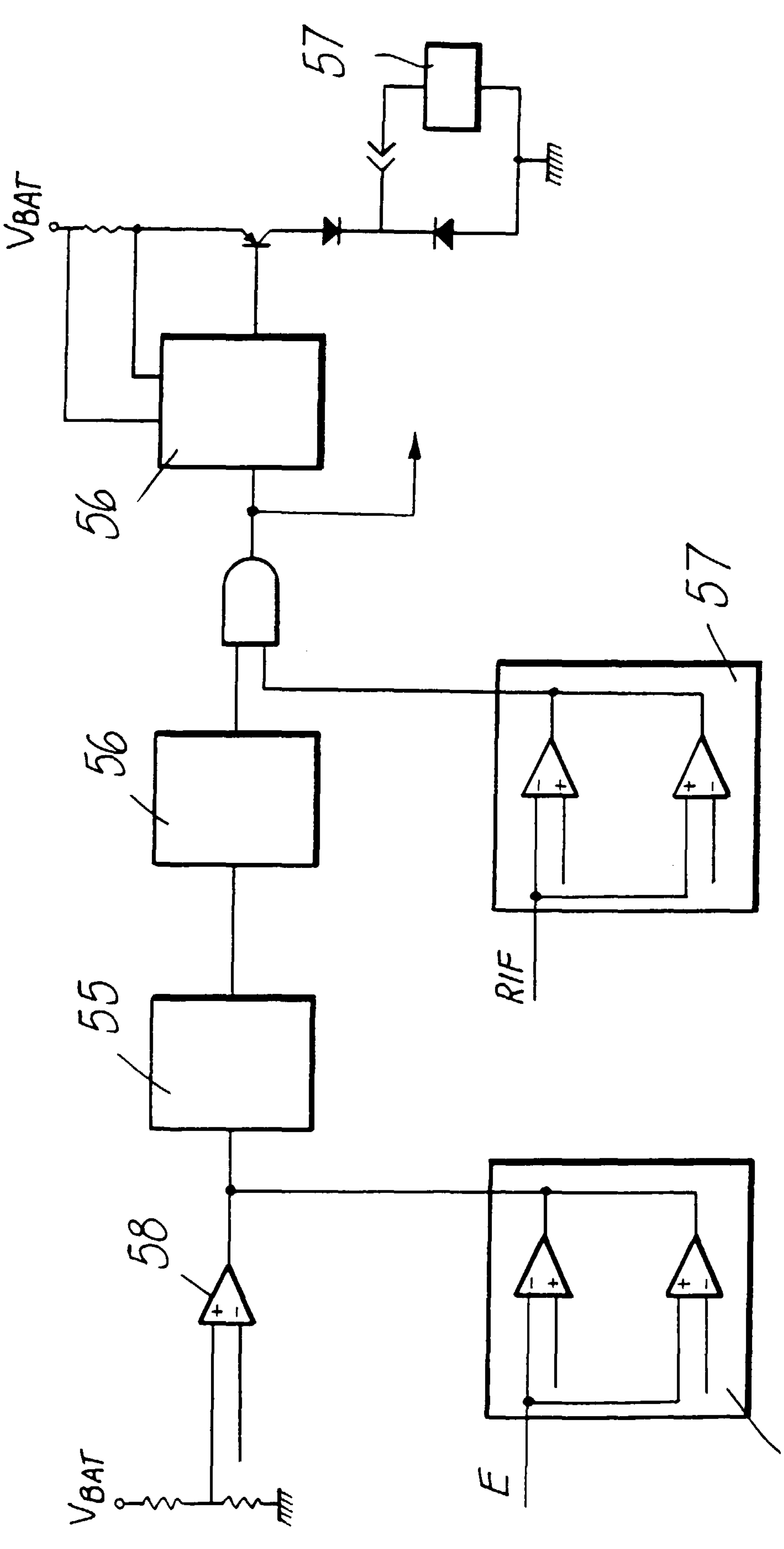

Fig. 6

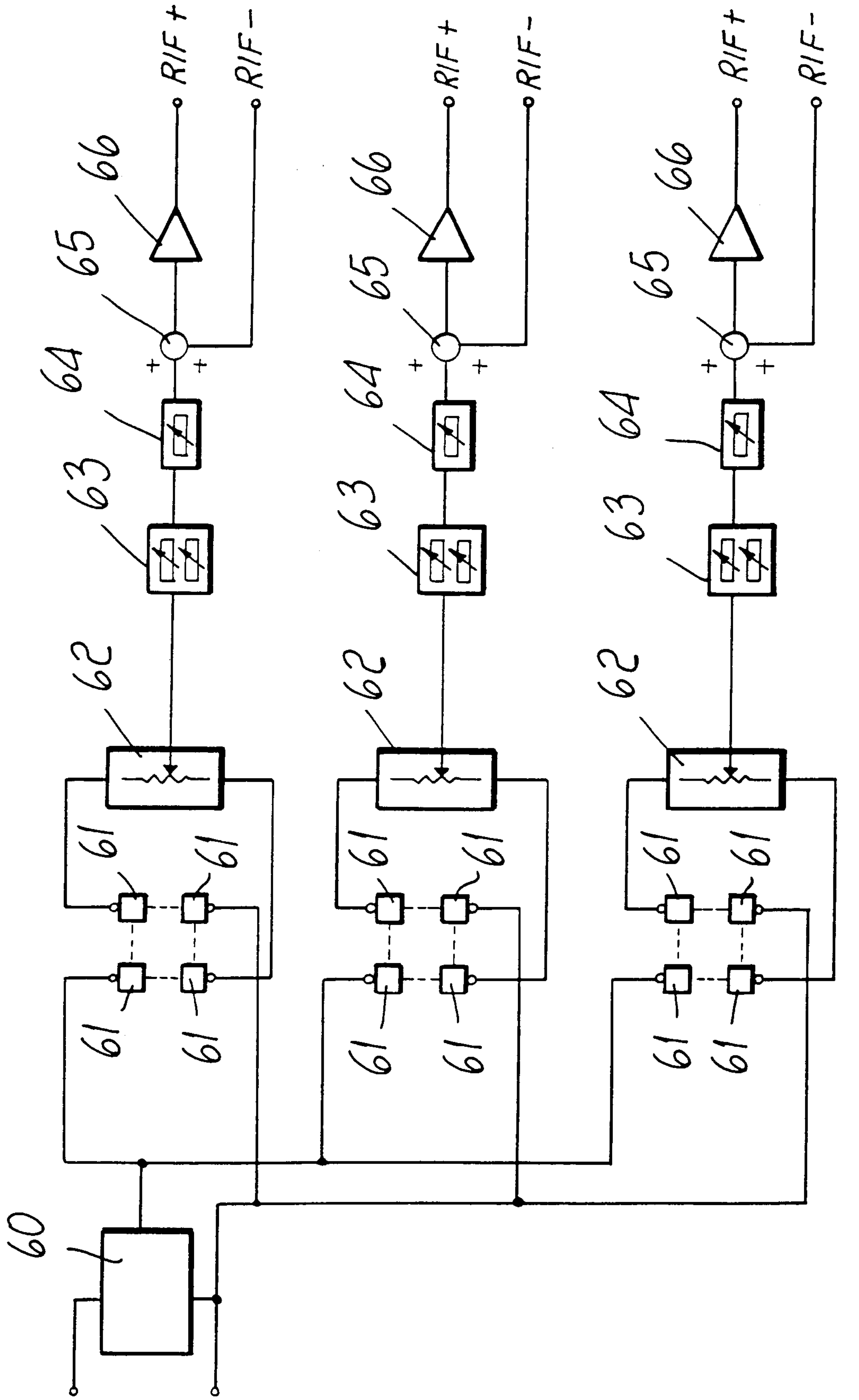

Fig. 7