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(54) Improvement in a copying distributor spool in hydraulic circuits for controlling hammer motion in punching machines

(57) Improvement in a spool of a copying distributor in a hydraulic circuit (3) for controlling the motion of a cylinder for a hammer (4) in a punching machine, including a pressurized fluid source (24a) in communication with said hydraulic circuit (3), a distributor body (5) which is connected to said hydraulic circuit through pipe fittings and is formed with pressurised-fluid supply lights (6, 33) and discharge light (7) communicating with said pipe fittings, at least one valve means (9) arranged in said hydraulic circuit to control the said distributor body (5), a spool (1) slidably mounted in said body (5) and arranged cyclically to open and close the said lights (6, 33, 7), one operating end (11) of said spool (1) extending outside said distributor body (5) through a calibrated aperture (12) and being arranged to abut against a reference member (13) designed to move rigid with said hammer (4). The improvement provides for a recess (14) formed in said operating end (11) and having one end (15) thereof blind and its other end (16) open, a pin (17) slidably mounted in said open end (16) and arranged to be displaced therein by pressurised fluid flows controlled by said valve means (9), and at least one duct (18) formed in said distributor body (5) and arranged to feed pressurised fluid from said fluid source (24a) to said recess (14).

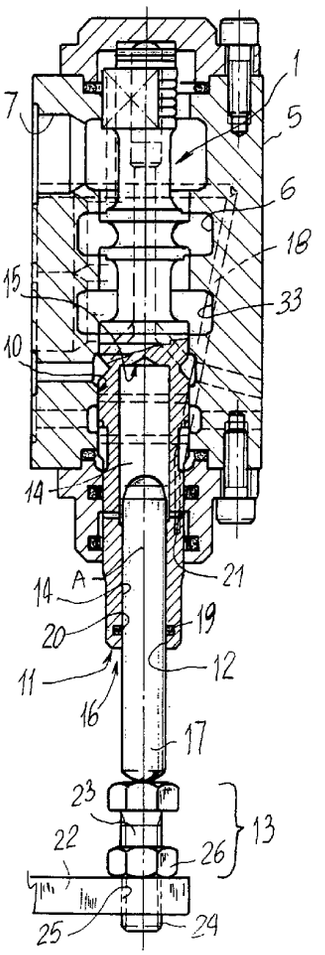

FIG. 5

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Description

[0001] The present invention regards improvements in a copying distributor spool in hydraulic circuits for controlling hammer movements in punching machines.

[0002] Fluid distributors, e.g. oil distributors, are known from long time and used in hydraulic circuits that control the movements of hammers, i.e. the cylinders loading the tools mounted each time in the tool heads of punching machines, such oil distributors being equipped with calibrated-stroke reciprocating drivers and designed to control parameters relating to the movements of the said hammers.

[0003] More particularly, among such parameters, those governing the speed of the hammer descent and ascent strokes and those adjusting upper and lower dead points of the hammer strokes and setting the start point of the punching stroke depending upon the thickness of the metal sheets to be worked, the so-called copying, are of special importance.

[0004] Setting the lower and upper dead points and adjusting the level of the start point of the hammer stroke depending upon the thickness of the metal sheet to be machined are controlled by the spool of a distributor, which is provided as a standard component in a hydraulic circuit driving a punching machine, and comprises a fixed body having multiple connections to the various sections of the hydraulic circuit and a slider or spool arranged to move axially in a respective seat by being urged by pressure variations of the fluid, and to control opening and closing of apertures that set the distributor in communication with the various sections of the hydraulic circuit.

[0005] According to a known hydraulic circuit described in the U.K. Patent Application n° 7800.6, filed on 2nd November 2001 each movement of the spool in one direction corresponds to a proportional movement in the opposite direction of the hammer inside its own receiving chamber, i. e. when the spool moves downwards the hammer moves upwards and vice-versa.

[0006] The useful stroke of the hammer is limited by the upper and lower dead points. The lower dead point is determined by using a pre-settable measuring member comprising an index normally fixed to the hammer rod and a graduated reference or scale which is fixed to the structure of the punching machine and along which the said index slides together with the hammer rod. The lower level the said index can reach is electronically monitored so that, when the same is reached and red on the graduated reference, the downwards stroke of the hammer is stopped.

[0007] The upper dead point, instead, is defined each time by the level of the abutment between the lower head of the distributor spool and the opposite upper head of a so-called plunger cylinder, which is also carried rigid with the hammer rod, with the interposition of a support suitable for locating it substantially coaxially below the said spool.

[0008] The piston of the said plunger cylinder is adjustable in position inside its own jacket or liner and setting thereof is effected by means of a valve provided in the hydraulic circuit, which is arranged either to feed or close or discharge the said jacket, whereby modifying the position of the piston and hence the abutment level between the piston and the distributor spool and thus the level of the upper dead point or start point of the active punching stroke, which depends upon the thickness of the metal sheet to be machined and is hence subject to numerous modifications during a working day.

[0009] The above-described state of the art, although providing substantially satisfactory results, is susceptible to further improvements in view of the fact that it has at least two major disadvantages.

[0010] The first drawback is due to the fact that the feed line of the plunger cylinder currently comprises a simple fluctuating hose which connects the oil feeding circuit to the cylinder jacket and is outside the control group, and thus bends to follow the movements of the control group.

[0011] The walls of such flexible hose experience resilient expansion phenomena, which in turn affect the oil pressure inside thereof and ultimately the setting of the upper dead point and thus the accuracy of the hammer movements and, in general, the punching machine operation.

[0012] A second disadvantage is due to the fact that the plunger cylinder is supported by the hammer rod by means of metal structural support, which is thus not calibrated in this application to the standards required by thousandth tolerances at which punching machines operate.

[0013] Such substantially imprecise working results in a notable axial misalignment between the spool and the opposite piston of the plunger cylinder. Misalignment, in turn, is responsible, in the course of the movements in contact at respective abutment ends, for irregular transverse thrust components which are transmitted to the spool and result in friction being generated between the spool and the distributor body.

[0014] Friction affects the sliding smoothness of the spool and the length of its actual stroke and thus ultimately the hammer stroke, whereby affecting the working accuracy also in this case.

[0015] The main object of the present invention is to eliminate the above-specified drawbacks faced with the state of the art solutions by providing improvements in copying distributor spool in hydraulic circuits designed to control the hammer motion in punching machines, which makes it possible to eliminate undesired resilient deformation phenomena of the plunger cylinder feed hoses and to ensure perfect axial alignment between the spool and the plunger cylinder piston, thus eliminating any potential source of working error.

These and other objects that will better appear beow are achieved by the improvements according to the present invention in a copying distributor spool for hydraulic cir-

cuits arranged to control the motions of the hammer cylinder in punching machines, comprising a distributor body connected to the hydraulic circuits through pipe fittings and equipped with pressured fluid supply and discharge openings to which the said pipe fittings are connected,
controlled by at least one valve unit mounted to the said circuits, inside which is mounted the spool in a mobile manner, for the purpose of opening and closing the said openings cyclically ,the active extremity of which communicates with the exterior of the said manifold body via a calibrated aperture, which is co-axially seated against a reference whose movement is integral with the movement of the hammer itself, characterised by the fact that at the said active extremity is machined an axial chamber of which one extremity is blind while the opposing extremity is open, inside which is mounted in a precisely mobile manner a pin driven by the flow of pressurised fluid controlled by the said valve unit, at least one duct being machined in the said manifold body, to feed the pressurised fluid to the axial chamber, which is fitted between it and a supply.

[0016] Further advantages and features of the present invention will better appear from the following detailed description of a preferred, but not exclusive, embodiment of an improvement in the copying distributor spool in hydraulic circuits arranged to control the motion of the hammer cylinder in punching machines illustrated by way of example, but not limited thereto, in the accompanying drawings, in which:

Figure 1 shows a hydraulic circuit for controlling the hammer in punching machines according to the improvement of the present invention in standard operation step;
Figure 2 illustrates the hydraulic circuit of Figure 1 in a phase of downwards modification of the position of the upper dead point of the useful stroke of the hammer in a punching machine;
Figure 3 shows the hydraulic circuit of Figure 1 in a phase of upwards modification of the position of the upper dead point of the useful stroke of the hammer in a punching machine;
Figure 4 is a detailed view on an enlarged scale of a copying distributor spool in a punching machine incorporating the improvement according to the present invention, in a configuration of high upper dead point; and
Figure 5 is a detailed view on an enlarged scale of a copying distributor spool in a punching machine incorporating the improvement according to the present invention, in a configuration the low upper dead point.

[0017] With reference to the above listed Figures, reference numeral 1 indicates a spool of a copying distributor 2 provided in a hydraulic circuit 3 for controlling the movements of the cylinder for a hammer 4 in punching machines.

[0018] The distributor 2 comprises a body 5 which is connected to the hydraulic circuit 3 by means of pipe fittings, not shown in the drawings, and equipped with feed lights or spaces 6 and discharge apertures 7 for a pressurised fluid, e. g. oil, to which the said pipe fittings are connected.

[0019] The spool 1 is controlled by valve means, e.g. at least one pair of on-off valves 8 and 9 both connected to the hydraulic circuit 3, is also slidably mounted in a suitable seat 10 formed in the body 5, and is arranged cyclically to control opening and closing of lights or spaces 6, 7 and 33.

[0020] An active end 11 of the spool (1) communicates with the exterior of the body 5 via a suitable calibrated aperture 12 and is designed to engage by resting in a substantially co-axial way on an opposite locating or reference tip 13 which is integral with the hammer 4 and is thus moved with it.

[0021] At the active end 11 of the spool 1 an axial recess or chamber 14 is formed which has a blind end 15 and an open opposite end 16. A pin 17 is slidably mounted in the axial chamber 14 and is displaceable therein by the pressurised oil flow controlled by the valves 8 and 9.

[0022] The said chamber 14 is in communication with at least one duct 18 which is formed in the body 5 and designed to supply pressurized oil thereto.

[0023] The opposite open end 16 of the said axial chamber 14 is fitted with sealing means to ensure sealing with the pin 17, e.g. at least one O-ring 19 of resilient material which is mounted in a respective hollow seat 20 formed in the inner side wall of the open end 16.

[0024] Duct (18) has its connection end 21 opening into the intermediate portion of the said axial chamber 14.

[0025] Reference tip 13 rigidly moving with hammer 4, includes at least one cross-member 22 having one end thereof rigid with the hammer rod of hammer 4 and which features, and its other end carrying at least one stud 23 extending perpendicular to the cross-member 22 and in coaxial alignement with the longitudinal axis "A" of pin 17.

[0026] For a better operation, micrometric setting means is provided between stud 23 and cross-member 22 to set the axial position of the stud 23 with respect to cross-member 22, and comprises a threaded portion of at least the foot 24 of the said stud 23, a respective threaded bore 25 formed in the other end of cross-member 22 for screw coupling with the said foot 24, and at least one safety locknut 26 arranged to prevent rotation of the stud 23 in the bore 25 after setting.

[0027] Besides valves 8 and 9 the hydraulic circuit 3 also comprises a feed pump 24a, a pump delivery duct section 27, a branch 28 leading first to valve 8 and then to valve 9 and chamber 14, and a discharge or outlet 29.

[0028] A second branch 30 is leading to distributor 2 in which spool 1 is slidably mounted.

[0029] An electronic means 31 monitors the useful stoke of hammer 4 and the position of the lower dead point is settable in it, such a position in combination with the upper dead point, defining the absolute value of the said useful stroke.

[0030] The operation of the invention is as follows: hammer 4 of the punching machine effects its stroke between the upper and the lower dead points (see Figure 1) in order to punch the (or execute another operation on) metal sheets, the amplitude or length of the hammer stroke being previously defined.

[0031] Should the stroke amplitude be modified in order to carry out various working operations on metal sheets, the position of the upper dead point can be adjusted by moving it either downwards or upwards.

[0032] In the first case (see Figure 2), valve 8 is set in such a way as to supply pressurised oil coming from the delivery of pump 24 to valve 9. Valve 9 is set in such a way as to deliver pressurized oil to the axial chamber 14 of the distributor 2 via duct 18 directly formed in the body 5 of the distributor 2 and opening into chamber 14 at outlet 21.

[0033] Pressure in the axial chamber 14 progressively increases and is applied against the head of pin 17, thus creating a thrust that urge the pin 17 to move outwards; such a movement, however, is prevented by the reference pin 13 which is constantly abuts against pin 17.

[0034] By reaction spool (1) moves upwards thus setting into communication light 6 arranged to feed upper chamber (34), in which the cylinder of hammer 4 is slidingly arranged, with light 33 which is supplied with pressurised oil from the pump 24. As a consequence the said upper chamber 34 is pressurised and the hammer 4 moves downwards and takes with it the reference tip 13 which thus frees pin 17 that is caused to extend out of the axial chamber 14.

[0035] This movement occurs gradually owing to shutter 32that controls the useful light for the oil flow (e. g. a gigleur) arranged in the feeding branch or section 28 of the hydraulic circuit 3.

[0036] Once a new lower arranged upper dead point has been reached, valve 9 switches to shut off the oil delivery (see Figure 1) and valve 8 switches to deliver oil to chamber 34 in which the hammer 4 slides, thus resetting standard operation conditions of the punching machine.

[0037] When the need arises of modifying the position of the upper dead point, e.g. moving it to a higher level, valve 9 switches to its open position (see Figure 3) and valve 8 establishes communication between circuit section 28 and outlet 29, so that oil from axial chamber 14 of distributor 2 can be released.

[0038] The pressure reduction in the chamber 14 causes lowering of spool 1 inside the body 5 of the distributor 2. It should be noted, however, that, although this is not essential to the improvement of the present invention, one end of the said spool 1 is subjected to a constant hydraulic thrust, whereas on its other end a counterthrust due to pressurised oil from chamber (14) is applied, and thus when counterthrust is cut off spool 1 is urged it to move downwards.

[0039] The downwards movement of the spool 1 results in lights or spaces 6 and 7 to communicate with one another, so that upper chamber 34 is set in communication with outlet 29 and hammer 4 moves upwards together with reference tip 13, while progressively pushing pin 17 into the axial chamber 14 until valve 9 switches to its off position again.

[0040] While pin 17 returns and stops in the axial chamber 14, the contact and abutment point between the outer end of the pin and the reference tip 13 on the cross-member 22 is raised, thus raising the position of the upper dead point of the useful stroke of hammer 4.

[0041] On-off valves 8 and 9 are switched by a control press-button provided on a console 35 of the punching machine and manually operated when required.

[0042] The extent of the movements of the upper dead point is adjusted each time a control unit arranged to control the operation of the punching machine and to be accessed through controls provided on the said console 35.

[0043] Moreover, the function of the spool 1 remains unaltered, i.e. it alternately opens and closes the various lights (6, 7, 33) provided in the body 5 of the distributor 2 by moving in it upon the various operations to be executed by the punching machine.

[0044] The invention as described above is suitable for achieving the objects set forth above, i.e. it makes it possible, on the one hand, to guide the pin 17 inside the axial chamber 14 throughout the entire length of the pin stroke to prevent transverse thrust component to arise, and, on the other, to supply the said axial chamber 14 via the duct 18 which is directly formed in the body 5 of the distributor 2 rather being a loose flexible hose as in prior art distributors.

[0045] The invention as described above is susceptible to numerous modifications and variations within the scope of the claims. Details can be replaced by other technically equivalent details.

[0046] In practice the materials used, as well as the outer configuration and dimensions, can be various depending upon requirements.

[0047] The disclosure in Italian patent application no. MO2001A000211 from which priority is claimed is incorporated herein by reference.

[0048] Any reference sign following technical features in any claim has been provided to increase intelligibility of the claim and shall not be construe as limiting the scope of the claim.

Claims

1. Improvement in a spool of a copying distributor in a hydraulic circuit (3) for controlling the motion of a cylinder for a hammer (4) in a punching machine,

including a pressurized fluid source (24a) in communication with said hydraulic circuit (3), a distributor body (5) which is connected to said hydraulic circuit through pipe fittings and is formed with pressurised-fluid supply lights (6, 33) and discharge light (7) communicating with said pipe fittings, at least one valve means (9) arranged in said hydraulic circuit to control the said distributor body (5), a spool (1) slidably mounted in said body (5) and arranged cyclically to open and close the said lights (6, 33, 7), one operating end (11) of said spool (1) extending outside said distributor body (5) through a calibrated aperture (12) and being arranged to abut against a reference member (13) designed to move rigid with said hammer (4), ***characterised in that*** it comprises a recess (14) formed in said operating end (11) and having one end (15) thereof blind and its other end (16) open, a pin (17) slidably mounted in said open end (16) and arranged to be displaced therein by pressurised fluid flows controlled by said valve means (9), and at least one duct (18) formed in said distributor body (5) and arranged to feed pressurised fluid from said fluid source (24a) to said recess (14).

2. Improvement as claimed claim 1, **characterised in that** the said open end (16) of said recess (14) is equipped with sealing means (19) for tight sealing between recess (14) and said pin (17).

3. Improvement as claimed in claim 2, **characterised in that** the said sealing means comprises at least one gasket (19) mounted in a seat (20) formed in the inner wall of said open end (16) of the said recess (14).

4. Improvement as claimed in claim 1, **characterised in that** the said duct (18) communicates with the said recess (14) and opens into it at an intermediate portion thereof.

5. Improvement as claimed in claim 1 **characterised in that** the said reference member (13), comprises at least one cross-member (22) having one end thereof rigid with a rod of said hammer (4) and its other end carrying at least one stud (23) in alignement with said pin (17).

6. Improvement as claimed in claim 5, **characterised in that** micrometric setting means are provided between said stud (23) and said cross-member (22) and arranged to adjust the position of said stud (23) with respect to said cross-member (22).

7. Improvement as claimed in claim 6, **characterised in that** the said setting means comprises a threaded portion of at least a section (24) of the said stud (23), a respective threaded bore (25) formed in said other end of the said cross-member (22) for screw coupling with the said section (24), and at least one locknut (26) preventing said stud (23) from rotating inside said threaded bore (25) after setting.

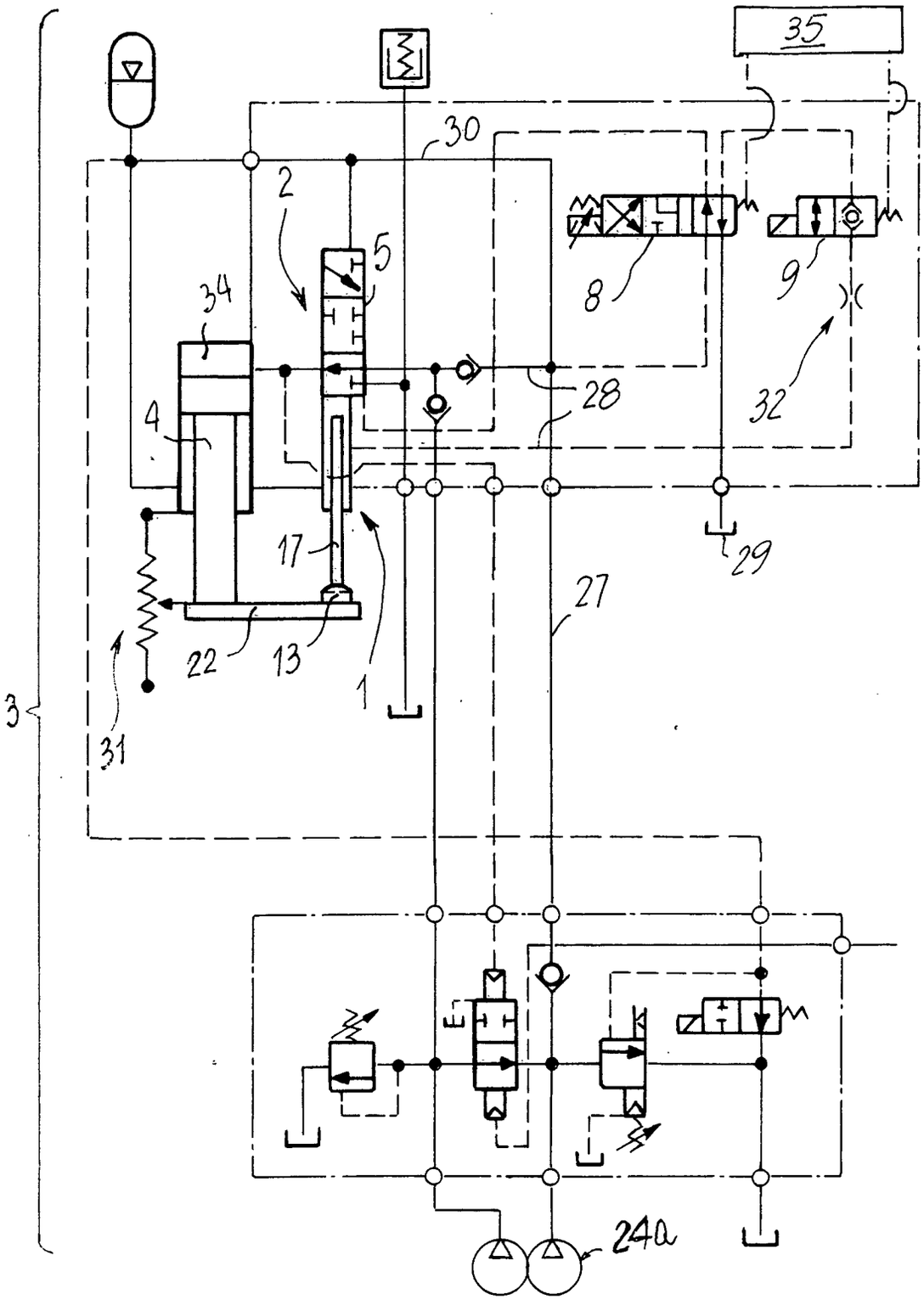
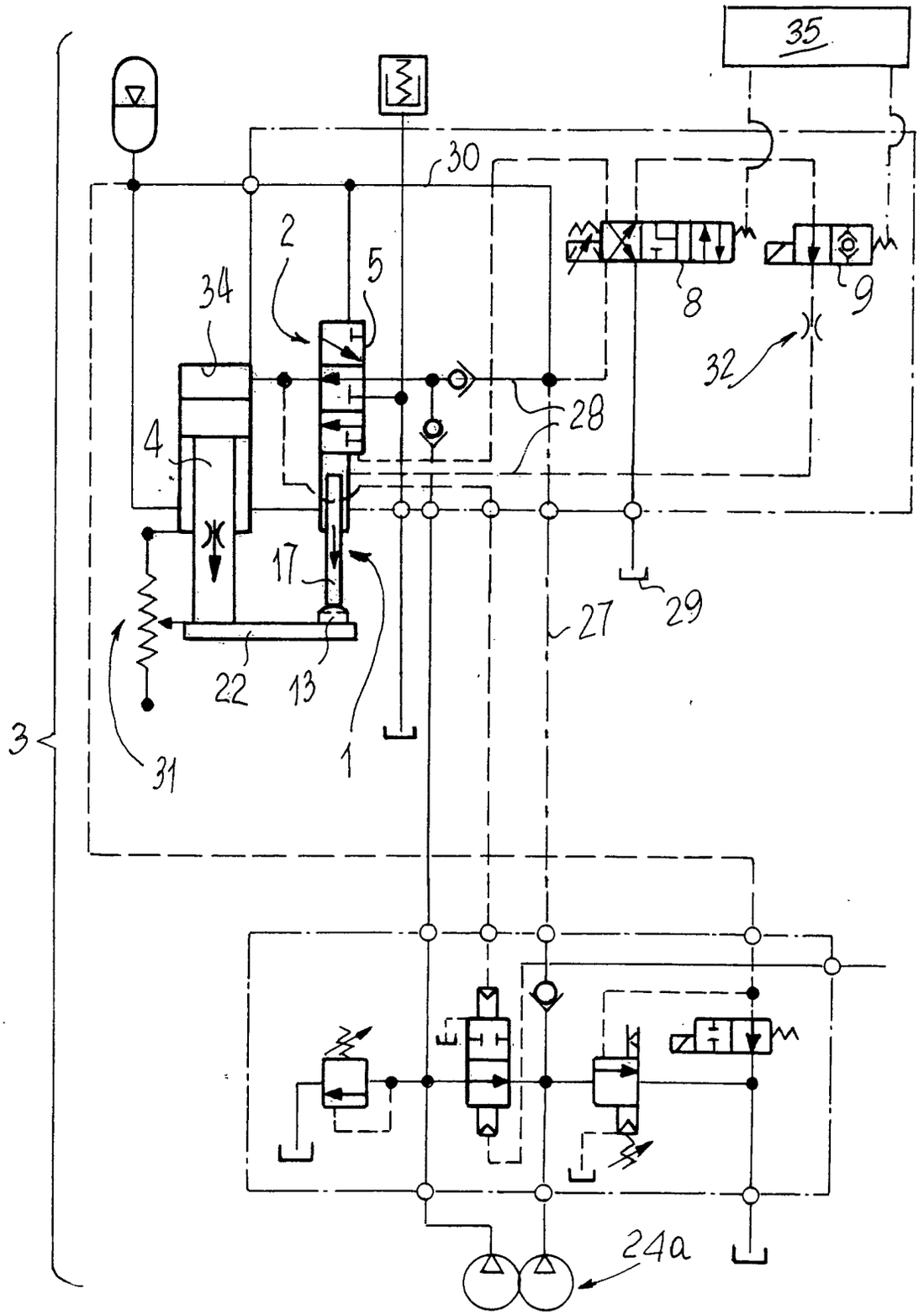


FIG. 1

FIG. 2



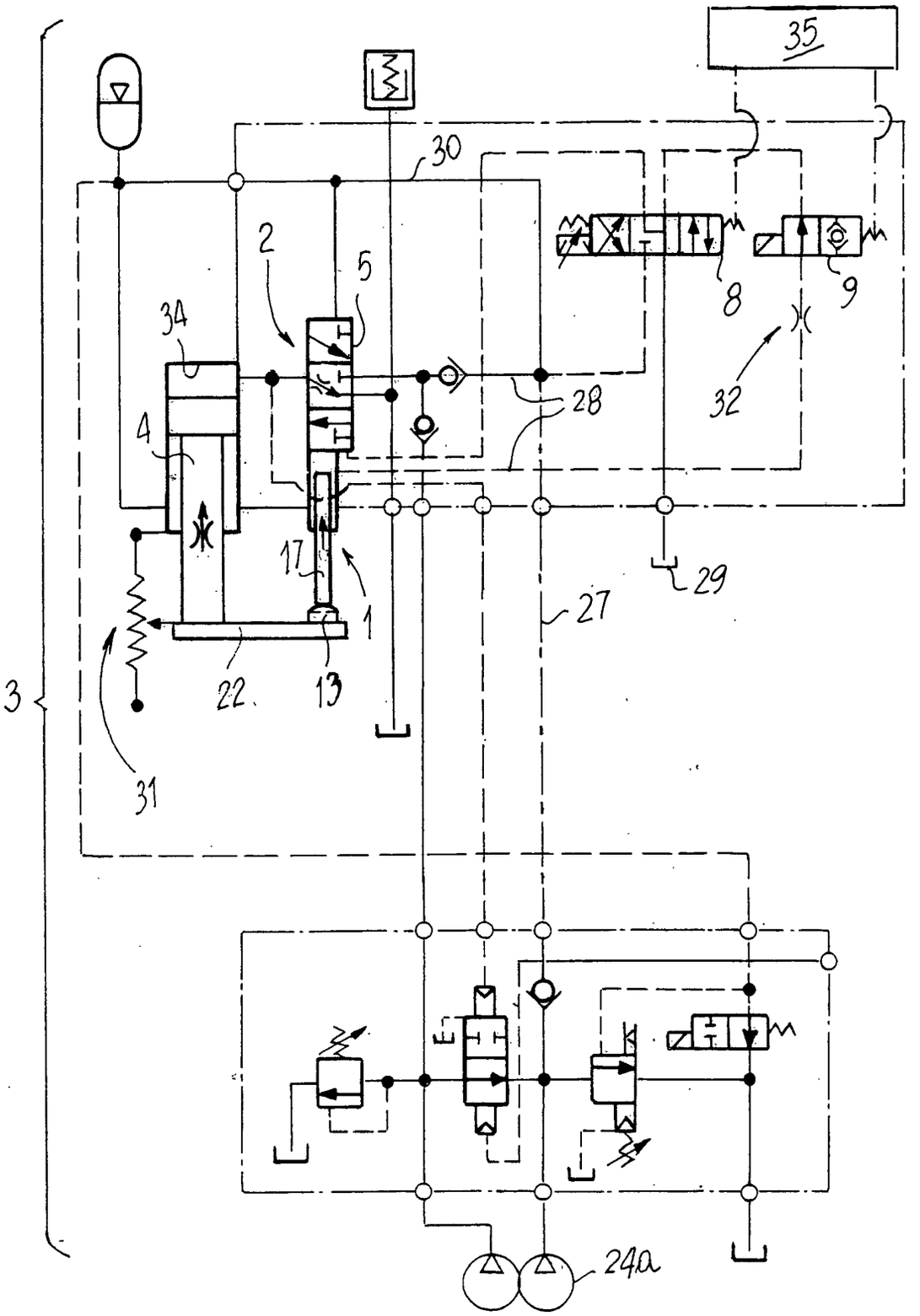


FIG. 3

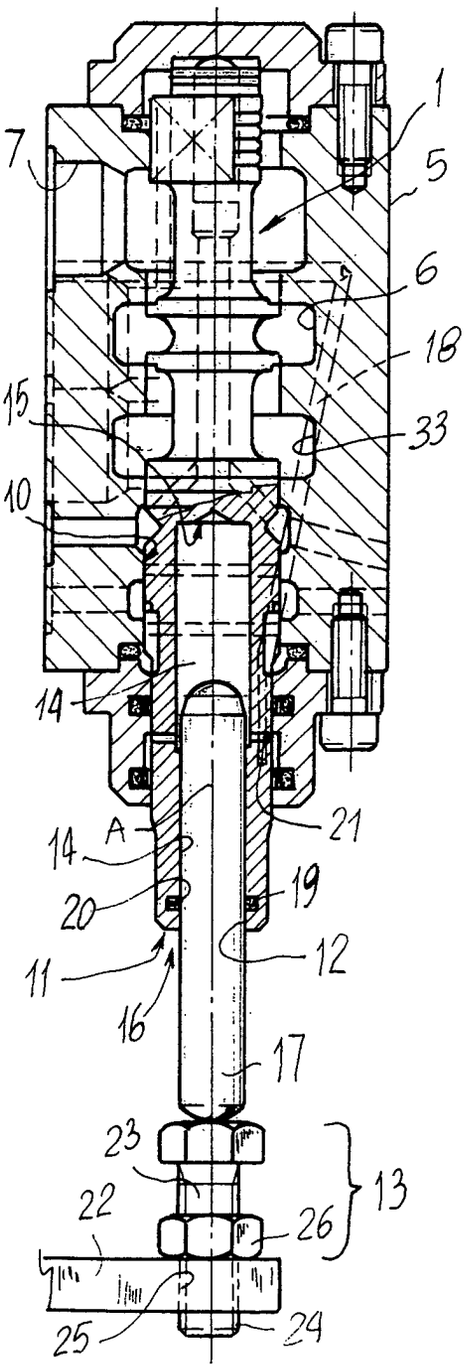

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FIG. 5

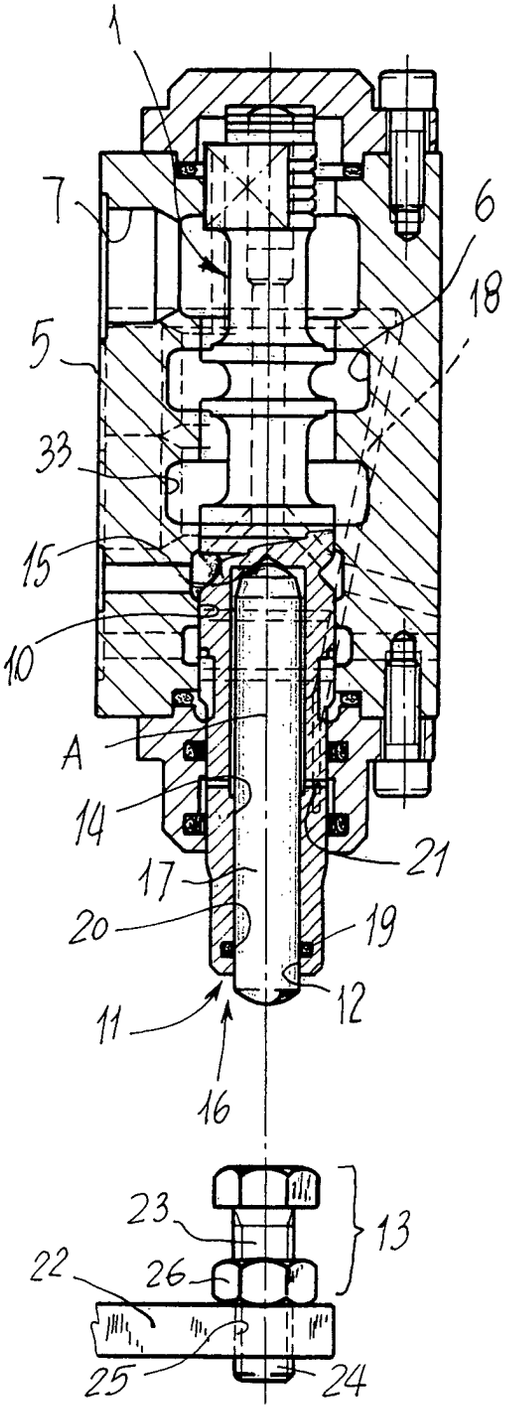
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FIG. 4