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(11) **EP 0 979 691 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**16.02.2000 Bulletin 2000/07**

(51) Int. Cl.<sup>7</sup>: **B21D 37/18**

(21) Application number: **98830307.9**

(22) Date of filing: **20.05.1998**

(84) Designated Contracting States:  
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU  
MC NL PT SE**

Designated Extension States:  
**AL LT LV MK RO SI**

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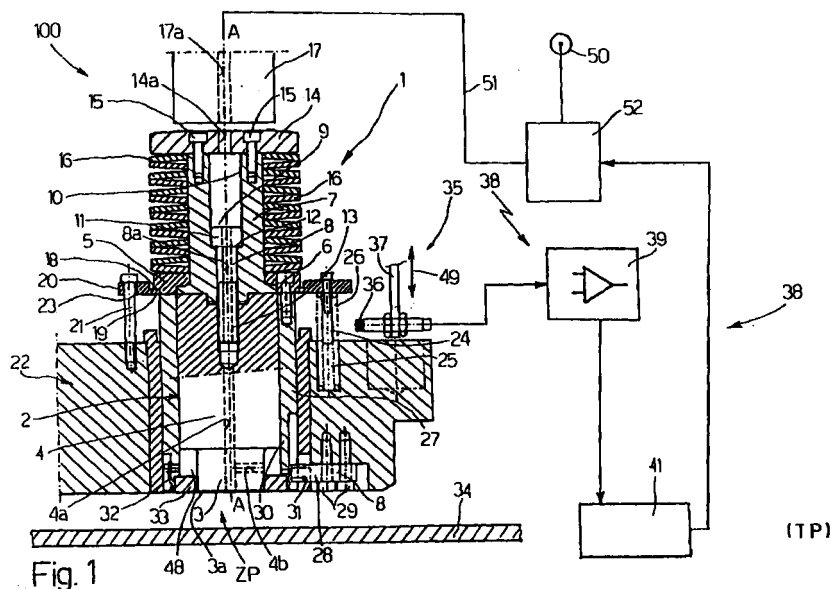
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(54) **Punching machine with a device for lubricating the punching region**

(57) A punching machine (100) having: at least one punchholder (2) in turn having a channel (14a, 10, 8a, 4a, 4b) for feeding a lubricant/compressed air mixture to a punching region (ZP) on a metal sheet (34); piping means (51) for connecting the channel (14a, 10, 8a, 4a, 4b) to a source (50) of atomized lubricant; and on/off valve means (52) for selectively permitting or preventing supply of the atomized lubricant to the piping means

(51) and the channel (14a, 10, 8a, 4a, 4b); the valve means (52) being controlled, via a device (41), by the position in space of an element (2), which position in space is detected by means of a probe (36); and the punching machine (100) being characterized in that the probe (36) detects the vertical position of the punchholder (2).



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## Description

**[0001]** The present invention relates to a punching machine comprising at least one punch assembly and a device for lubricating the punching region with a lubricant/compressed air mixture (atomized lubricant).

**[0002]** As is known, during operation of the punch assembly of a punching machine, it is common practice to lubricate the punching region with a lubricant/compressed air mixture to improve punching precision and, as far as possible, prevent the punch from jamming in the sheet metal. On currently used machines, to minimize dispersion of the atomized lubricant, most of the lubricant particles are removed immediately after the punching operation by means of a suction device on the die side.

**[0003]** Such a machine is described in US Patent US-A-4 977 804 (Amada).

**[0004]** The punching machine described and claimed in the above patent comprises at least one punch assembly, in turn comprising means for feeding a lubricant/compressed air mixture onto the punching region; and a ram, in turn comprising a channel, which communicates with a corresponding channel in the punch assembly when the ram contacts the top of the punch assembly to perform the punching operation. Once continuous flow of the lubricant/compressed air mixture along the two channels is established, appropriate means control supply of the atomized lubricant, which comes out on the front surface of the punch. The position of the ram is detected by a sensor, which supplies position data to an electronic central control unit, which, in turn, by known means, opens and closes a solenoid valve controlling the instant in which the atomized lubricant is sprayed onto the punching region. The above machine, however, provides for control on the basis of the vertical position of the ram; and the solenoid valve, which must be opened just before the cutting surface of the punch contacts the top surface of the sheet, is opened by a combination of the signal from the ram position sensor and a signal supplied to the electronic central control unit by a device for detecting the hydraulic pressure of a hydraulic circuit controlling vertical travel of the ram, so that a particularly complex, high-cost electronic central control unit is required to integrate the two signals. Moreover, the exact instant in which to spray the atomized lubricant onto the punching region is difficult to establish, so that the solenoid valve controlling flow of the atomized lubricant is invariably opened either too soon - i.e. long before the annular blankholder body contacts the top surface of the sheet, thus resulting in harmful dispersion of the atomized lubricant, through failure of the annular blankholder body to adhere to the sheet and so outwardly close off the punching region - or too late, i.e. after the punching operation has been performed, in which case, spraying the punching region with atomized lubricant is by then superfluous.

**[0005]** It is therefore proposed to simplify the signal processing devices by providing a sensor for controlling the instant in which the atomized lubricant is sprayed on the basis of the vertical position of the punchholder, as opposed to the position of the ram. As opposed to a complex electronic central control unit for integrating and processing two signals, the present invention, among other things, employs a straightforward electro-mechanical device, such as a static relay, for opening and closing the solenoid valve.

**[0006]** This therefore provides for better controlling the instant in which the solenoid valve controlling flow of the atomized lubricant to the punching region is opened; for reducing dispersion of the atomized lubricant in conformance with current health regulations; and for ensuring correct performance of the punching operation by spraying the punching region with atomized lubricant at the precise instant the punch needs lubricating.

**[0007]** According to the present invention, therefore, there is provided a punching machine comprising:

- (a) at least one punchholder for punching a metal sheet;
  - (b) said punchholder comprising a first channel for feeding a lubricant/compressed air mixture to a punching region on the sheet;
  - (c) a ram for striking the punchholder, and comprising a second channel for selectively feeding the lubricant/compressed air mixture to the first channel upon the bottom surface of the ram contacting the top surface of the punchholder;
  - (d) piping means for connecting the first and second channels to a lubricant/compressed air mixture source; and
  - (e) on/off valve means for selectively permitting or preventing supply of the lubricant/compressed air mixture to the pipe means and to the series defined by the first and second channels;
- said valve means being controlled, by means of a control unit, by the position in space of a member on the punching machine; said position being detected by detecting means;
- and the punching machine being characterized in that said detecting means detect the vertical position of the punchholder.

**[0008]** In the present context, the term "top position" (TP) refers to a first position in which the ram occupies any position involving no contact between the bottom surface of the ram and the top surface of a flange integral with the punch; the term "top dead center position" (PMSP) refers to the position in which the cutting surface of the punch is about to contact the top surface of the underlying sheet; and the term "bottom dead center position" (PMIP) refers to the punch position in which the sheet has been punched and the ram is inverted.

**[0009]** A number of preferred, non-limiting embodiments of the present invention will be described by way

of example with reference to the accompanying drawings, in which:

Figure 1 shows a first embodiment of the punching machine according to the present invention, with the system in the top position (TP);

Figure 2 shows the first embodiment of the punching machine in Figure 1 with the system in the top dead center position (PMSP);

Figure 3 shows the Figure 1 and 2 embodiment with the system in the bottom dead center position (PMIP);

Figure 4 shows a second embodiment of the punching machine according to the present invention, with the system in the top position (TP);

Figure 5 shows the second embodiment of the punching machine in Figure 4 with the system in the top dead center position (PMSP);

Figure 6 shows the Figure 4 and 5 embodiment with the system in the bottom dead center position (PMIP).

**[0010]** The accompanying drawings show, by way of non-limiting examples, a number of embodiments of the present invention, as applied to a particular type of punch assembly. It is understood, however, that the considerations made herein with reference to the type of punch assembly shown in the accompanying drawings also apply to any other type of sheet metal punch assembly.

**[0011]** Figure 1 shows a punch assembly 1 forming part of a punching machine 100. Punch assembly 1 substantially comprises a punchholder 2, and a punch 3 housed inside punchholder 2; and punchholder 2 comprises a substantially cylindrical element 4, and a first annular flange 5 connected to element 4 by a number of screws 6 (only one shown in Figure 1).

**[0012]** As shown in Figure 1, punch 3 is connected to a cylindrical central body 7 by means of a threaded element 8 housed inside a seat 9 formed in a channel 10 along the central longitudinal axis A-A of cylindrical central body 7. The bottom horizontal surface of a head 11 of threaded element 8 rests on a shoulder 12 forming part of seat 9 formed in channel 10, while a shank 13 of threaded element 8 is screwed to punch 3 to connect punch 3 to cylindrical central body 7 and enable punch 3 to be changed rapidly. The top of cylindrical central body 7 is fitted with a ring nut 14 by means of a number of screws 15; and ring nut 14 is stressed by one end of an elastic element 16 (a Belleville washer in Figure 1), the opposite end of which rests on the top surface of first annular flange 5, so that cylindrical central body 7 and punch 3 - which, as stated, is connected to cylindrical central body 7 by threaded element 8 - are both stressed elastically by elastic element 16.

**[0013]** Ring nut 14 is acted on directly by a ram 17, which, during the punching operation, travels downwards in the direction defined by longitudinal axis A-A of

cylindrical central body 7.

**[0014]** An outer shoulder 18 of first annular flange 5 mates with a mating surface 19 of a second annular flange 20, which travels vertically along a first number of threaded guide pins 21 (only one shown in Figure 1) screwed to a turret 22 and extending through holes 23 formed for the purpose in second annular flange 20.

**[0015]** In the first embodiment of the present invention shown in Figure 1, second annular flange 20 also comprises a second number of threaded pins 24 (only one shown in Figure 1) integral with flange 20 and corresponding with a number of cavities 25 (only one shown in Figure 1) formed in turret 22; and each cavity 25 houses elastic means 26, e.g. a coil spring, for elastically stressing the bottom surface of second annular flange 20.

**[0016]** A bush 27, integral with turret 22, provides for guiding the up and down movement of punchholder 2.

**[0017]** To prevent punchholder 2 and punch 3 from rotating during the punching operation, a key 28 is fitted to turret 22 by means of screws 29, and projects through an opening 31 in bush 27 into a groove 30 provided for the purpose on punchholder 2.

**[0018]** By means of conventional connecting means 32, punchholder 2 is fitted integrally with an annular blankholder body 33, which, at the work stage, rests on and provides for clamping a sheet 34.

**[0019]** Punch assembly 1 in Figure 1 operates as follows:

(a) Once the punchholder 2 and punch 3 are selected from those available on turret 22, ram 17 is moved vertically downwards from position TP (Figure 1) to rest on the top surface of ring nut 14.

(b) As it continues moving downwards, ram 17 pushes down cylindrical central body 7, punch 3 fitted to cylindrical central body 7, and punchholder 2 together with annular blankholder body 33; and just before (PMSP) the annular blankholder body contacts sheet 34, a signal is generated to open a solenoid valve 52 of a lubricant/compressed air mixture supply circuit (described later on). For elastic means 26 to deform before elastic means 16, the rigidity of elastic means 16 must be greater than that of elastic means 26, otherwise only punch 3 would be lowered first.

(c) Once annular blankholder body 33 comes to rest on sheet 34, the continued downward movement of ram 17 pushes punch 3 down into position PMIP to punch sheet 34 (Figure 3).

(d) At the return stage, i.e. when ram 17 completes the punching operation and moves back up, ring nut 14 and the elements integral with it, i.e. substantially cylindrical central body 7 and punch 3, are drawn elastically upwards. To ensure continuous contact between outer shoulder 18 of first annular flange 5 and mating surface 19 of second annular flange 20, elastic means 16 and 26 should be

precompressed.

**[0020]** Ring nut 14, ram 17, threaded element 8 and element 4 comprise respective longitudinal channels 14a, 17a, 8a, 4a extending along axis A-A, while element 4 also comprises a given number of channels 4b extending radially with respect to channel 4a.

**[0021]** The lubricant/compressed air mixture (atomized lubricant) supplied by a source 50 flows first along a conduit 51 and then out into channels 14a, 17a, 8a, 4a, 4b in series with one another.

**[0022]** The atomized lubricant supply from source 50 is controlled by solenoid valve 52, which is opened, as described later on, by electromechanical means.

**[0023]** In the first embodiment of the present invention shown in Figures 1-3, atomized lubricant flow is controlled and regulated by a unit 35 substantially comprising detecting means 36 integral with a supporting element 37, and which may comprise a magnetic proximity probe operating according to known electromagnetic principles.

**[0024]** As punchholder 2 is pushed down by the action of ram 17 on ring nut 14, an electric signal is generated when detecting means 36 face second annular flange 20, as shown in Figure 2; and the electric signal is supplied to a control unit 38 where it is appropriately amplified by an amplifier 39 and reprocessed by an electromechanical device 41, e.g. a static relay.

**[0025]** Electromechanical device 41 therefore provides for selectively opening or closing solenoid valve 52 to permit or prevent lubricant/compressed air mixture supply to the front cutting surface 3a of punch 3 where the atomized lubricant is sprayed onto the punching region ZP.

**[0026]** As stated, it is important that the command to supply atomized lubricant to punching region ZP be given with the system in the top dead center position PMSP shown in Figure 2, i.e. just before annular blankholder body 33 contacts sheet 34 and punch 3 commences the punching operation of region ZP, so that, given the hysteresis of the system, lubricant is supplied to punching region ZP the instant annular blankholder body 33 contacts sheet 34. Control on the basis of the displacement of punchholder 2 therefore provides for accurately regulating the instant in which atomized lubricant is expelled from channels 4a, 4b, as shown in Figure 2.

**[0027]** Besides being expelled, as described, directly on the front cutting surface 3a of punch 3 from channel 4a, the atomized lubricant is also fed to a number of channels 4b (only one shown) extending radially with respect to axis A-A, and which come out inside an annular gap 48 defined laterally and at the top by punch 3 and bush 27, and at the bottom by annular blankholder body 33. Once inside annular gap 48, the atomized lubricant seeps into the gap between annular blankholder body 33 and the bottom end of punch 3 to also lubricate both and so provide for smooth slide of

one with respect to the other when the system moves from the Figure 2 to the Figure 3 position.

**[0028]** As shown by two-way arrow 49, element 37 supporting detecting means 36 is movable vertically in two directions to regulate the instant in which solenoid valve 52 is opened.

**[0029]** Any delay in the opening of solenoid valve 52 is obviously corrected by lowering element 37 supporting detecting means 36.

**[0030]** Figures 4-6 show a second embodiment of the present invention, which, as opposed to a magnetic proximity probe 36 as in Figures 1-3, employs a light source 36 for emitting a beam which is reflected by any moving element forming part of punchholder 2. In the example shown, the beam is reflected by annular flange 20 and is picked up and reprocessed by known electronic means (not shown in Figures 4-6), so that, by detecting the position of annular flange 20 of punchholder 2, solenoid valve 52 (Figure 1) is opened and closed, as described previously, to control supply of the atomized lubricant to punch 3 via conduit 51 and channels 17a, 14a, 10, 8a, 4a, 4b.

**[0031]** To a person skilled in the art, any system equivalent to those described may obviously be used to detect the downward travel of punchholder 2 of punch assembly 1 and so regulate supply of atomized lubricant to punch 3, without, however, departing from the scope of the present invention.

## Claims

### 1. A punching machine (100) comprising:

at least one punchholder (2) for punching a metal sheet (34);  
 said at least one punchholder (2) comprising a first channel (14a, 10, 8a, 4a, 4b) for feeding a lubricant/compressed air mixture (atomized lubricant) to a punching region (ZP) on said sheet (34);  
 a ram (17) for striking said punchholder (2), and comprising a second channel (17a) for selectively feeding said lubricant/compressed air mixture (atomized lubricant) to said first channel (14a, 10, 8a, 4a, 4b) upon the bottom surface of said ram (17) contacting the top surface of said punchholder (2);  
 piping means (51) for connecting said first (14a, 10, 8a, 4a, 4b) and second (17a) channels to a source (50) of said lubricant/compressed air mixture (atomized lubricant); and  
 on/off valve means (52) for selectively permitting or preventing supply of said lubricant/compressed air mixture (atomized lubricant) to said pipe means (51) and to said first (14a, 10, 8a, 4a, 4b) and second (17a) channels;  
 said valve means (52) being controlled, by means of a control unit (38), by the position in

space of a member (2) on said punching machine (100); said position in space being detected by detecting means (36);

and the punching machine (100) being characterized in that said detecting means (36) detect the vertical position of said at least one punchholder (2). 5

2. A punching machine (100) as claimed in Claim 1, wherein said detecting means (36) are defined by a magnetic proximity probe (36). 10
3. A punching machine (100) as claimed in any one of the foregoing Claims, wherein a supporting element (37) for supporting said detecting means (36) is movable vertically to regulate the instant in which said valve means (52) are opened. 15
4. A punching machine (100) as claimed in claim 1, wherein said detecting means (36) comprise a light source for producing a beam reflected by an element (20) forming part of said punchholder (2). 20
5. A punching machine (100) as claimed in any one of the foregoing Claims, wherein said valve means (52) are opened and closed by means of an electro-mechanical device (41). 25
6. A punching machine (100) as claimed in Claim 5, wherein said electromechanical device (41) is a static relay (41). 30

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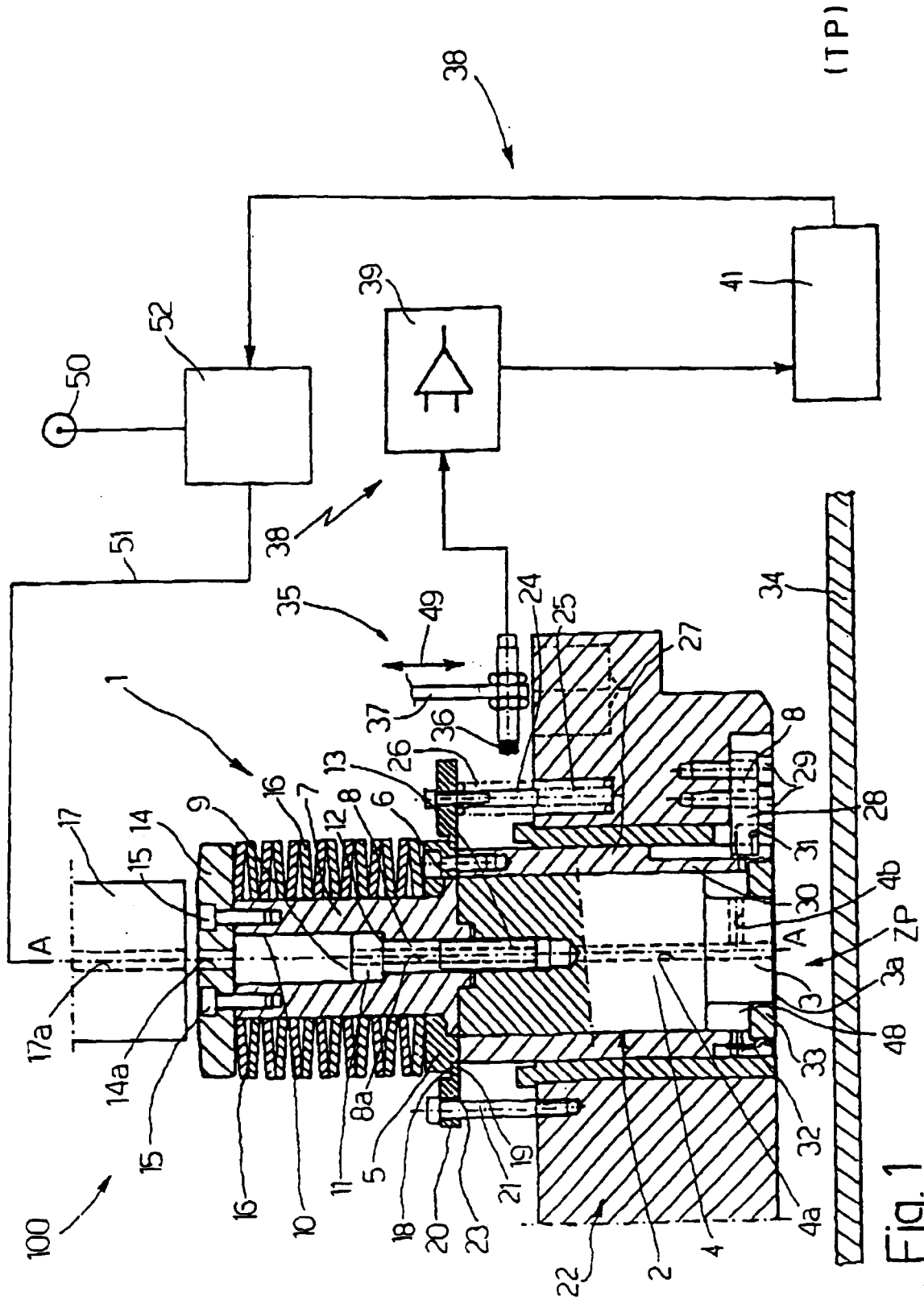


Fig. 1

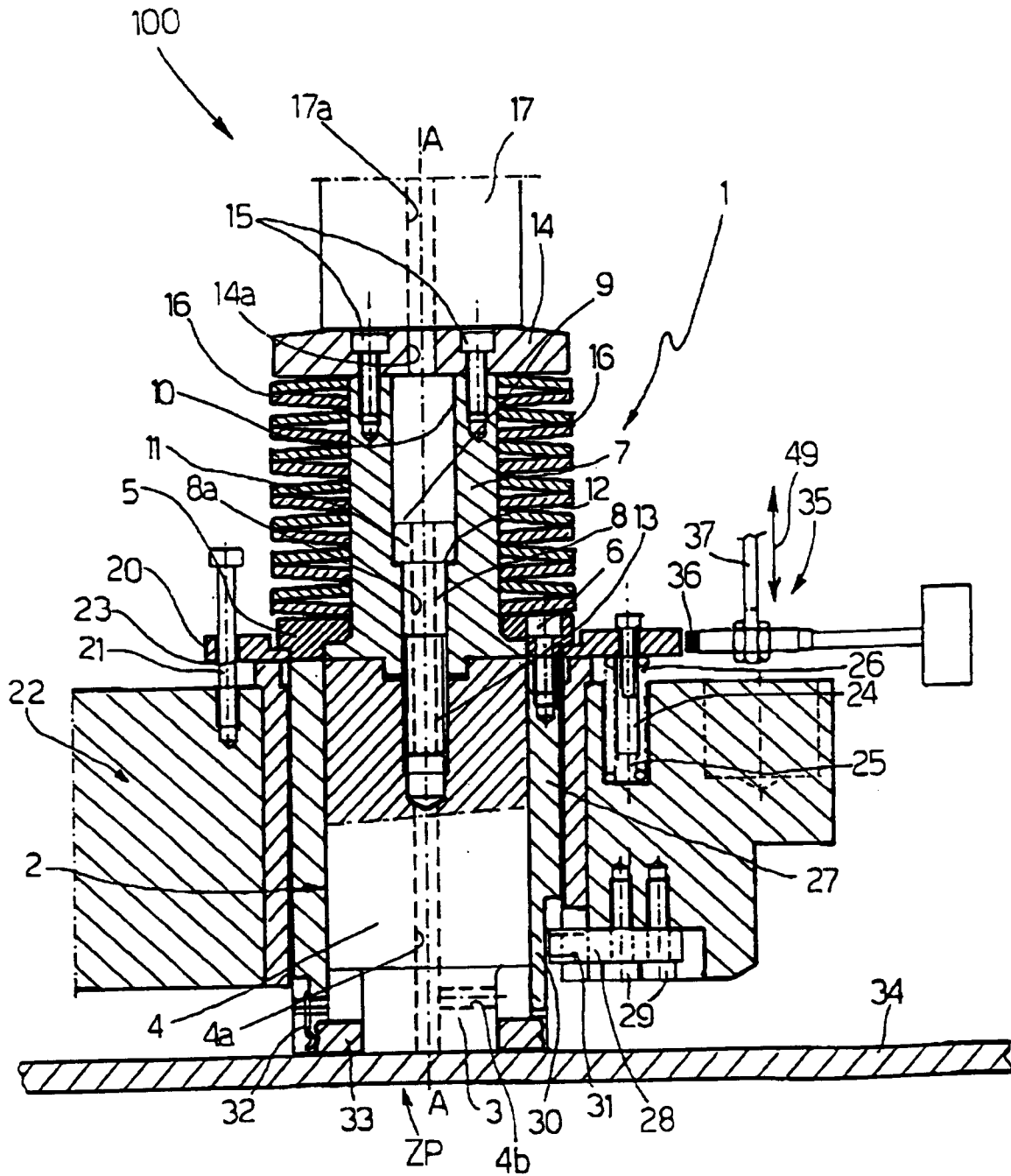


Fig. 2

(PMSP)

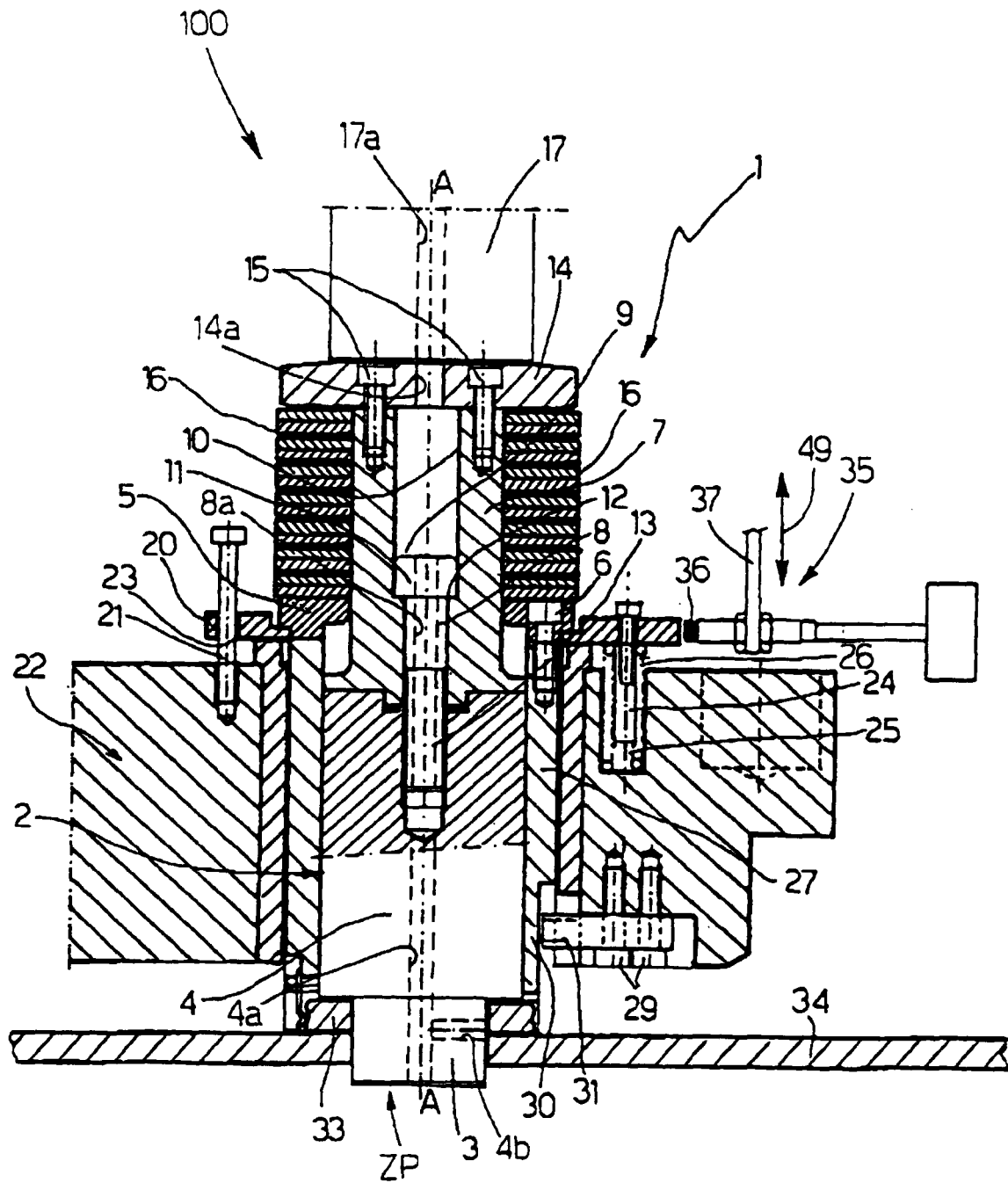
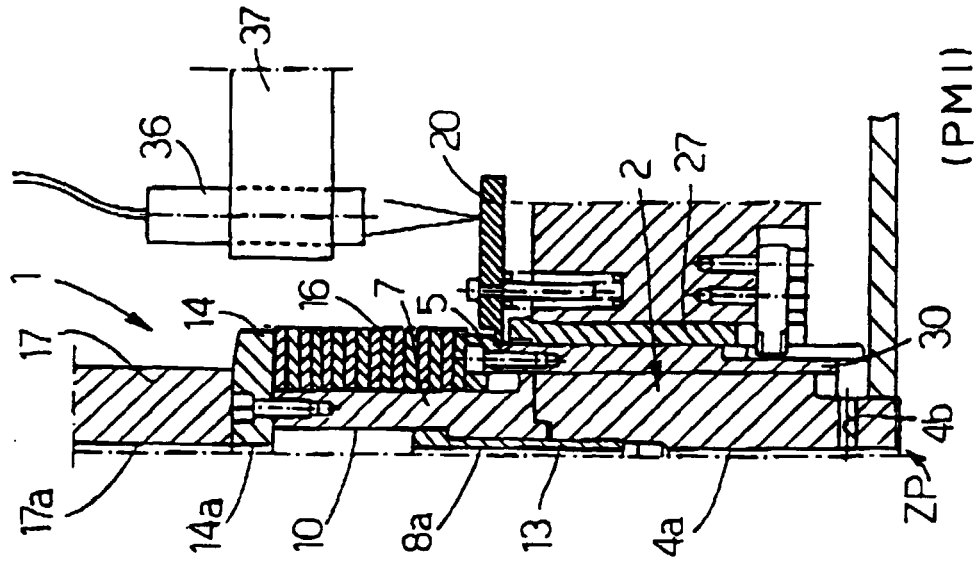
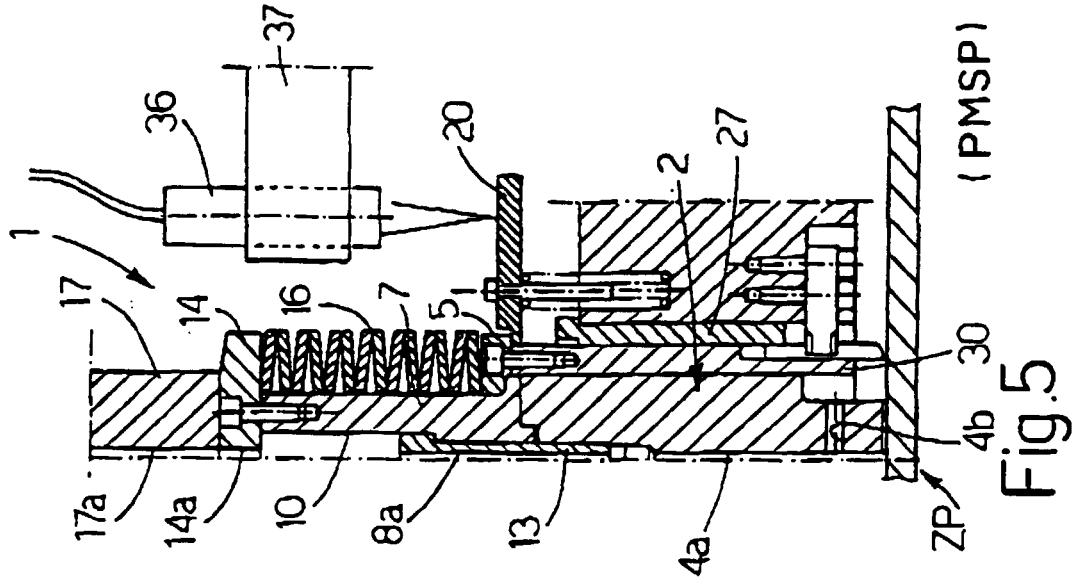
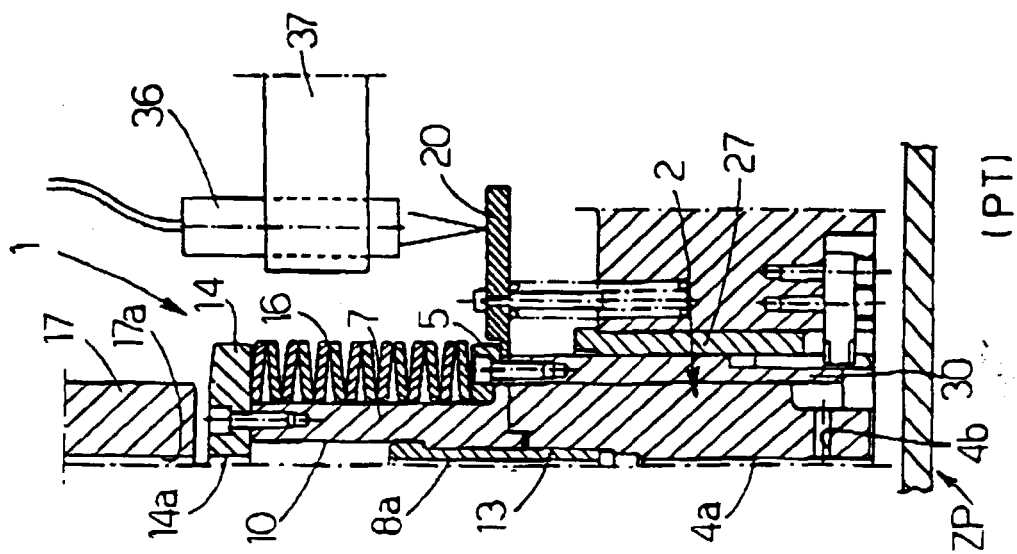


Fig. 3

(PMIP)







European Patent  
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# EUROPEAN SEARCH REPORT

Application Number  
EP 98 83 0307

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.6)
X	US 4 977 804 A (AMADA COMPANY) 18 December 1990 * column 6, line 58 - column 7, line 63; figure 5 *	1-6	B21D37/18
A	JP 55 033889 A (ANRITSU CORP) 10 March 1980 * abstract *	1	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B21D
Place of search		Date of completion of the search	Examiner
MUNICH		20 October 1998	Ash, R
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**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 98 83 0307

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
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20-10-1998

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