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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : **B21D 5/02**	**A1**	**(11) International Publication Number:** **WO 98/56518** **(43) International Publication Date:** 17 December 1998 (17.12.98)

(21) International Application Number: PCT/IT98/00148

(22) International Filing Date: 2 June 1998 (02.06.98)

(30) Priority Data:
TV97A000079 13 June 1997 (13.06.97) IT

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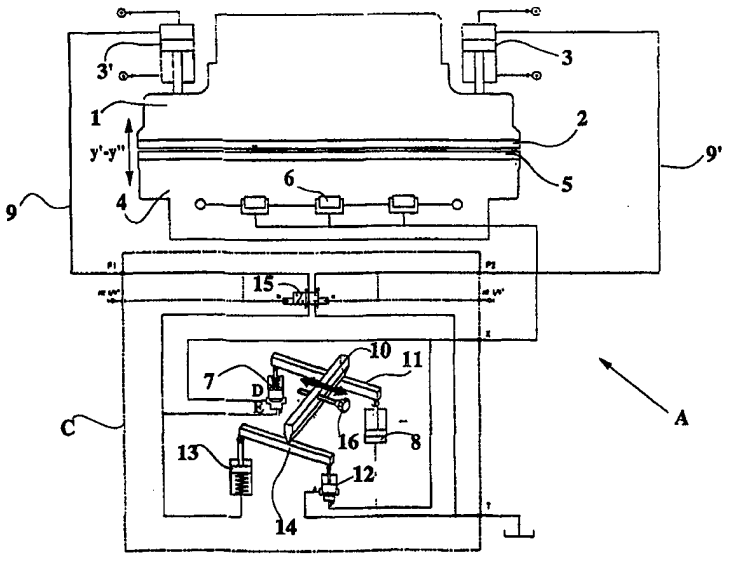
(81) Designated States: BR, CN, CZ, JP, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: DEVICE TO AUTOMATICALLY ADAPT THE BENDING PRESSURE, PROPORTIONALLY TO THE WORKING PRESSURE OF THE CYLINDERS OF THE UPPER CROSS–PIECE, PARTICULARLY IN A PRESS–BENDING MACHINE AND A MACHINE SO OBTAINED



(57) Abstract

Device to automatically adapt the bending pressure, proportionally to the working pressure of the cylinders of the upper cross–piece, particularly in a press–bending machine and a machine so obtained characterised in that it consists essentially in the interaction of at least two parts, respectively a first of proportional division of the pressure and in particular for the adjustment of the cylinder pressure (6) proportional to the cylinder pressure (3, 3') chosen by a switching means (15), said switching means being suitable for intercepting a lower pressure than that of the cylinder (3, 3') of the upper cross–piece (1) and a second one for the evacuation of the exceeding pressure, re–establishing the machine (A) to its original conditions for a subsequent press–bending cycle.

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DESCRIPTION

DEVICE TO AUTOMATICALLY ADAPT THE BENDING PRESSURE, PROPORTIONALLY TO THE WORKING PRESSURE OF THE CYLINDERS OF THE UPPER CROSS-PIECE, PARTICULARLY IN A PRESS-BENDING MACHINE AND A MACHINE SO OBTAINED

Technical Field

This invention deals with a device for the automatic adjustment of the bending pressure, proportionally to the working pressure of the cylinders of the upper cross-piece particularly in a bending press machine, and so-obtained machine.

The innovation finds particular, though not exclusive, application in processes and relative systems of metal processing and in general in the field of sheet deformation.

Background Art

Bending presses are known. They are often used in metallurgical industry, and in particular in the processing of metal sheets, to obtain, e.g. longitudinal sections in different forms, sometimes with the possibility of being taken up and each one of them again being subjected to a press-bending cycle.

Broadly speaking, it is possible to notice that a so-called bending cycle consists essentially in the vertical descent of a tool up to touching the lower sheet metal resting on the bench, in the execution of the bending, and therefore at the end, in proceeding with the ascent, up to reaching a starting position. In order to effect the previous phases, the machine is made up of two parts, respectively a first dynamic one which generally constitutes the upper part, and a static part which constitutes the underside of the machine and is placed on the perpendicular of the dynamic part. Concerning the dynamic part, in the execution of a

bending cycle, the tool, made up of a differently formed sheet also interchangeable, completes exclusively a vertical to-and-fro movement, ensured by at least two oleodynamic end cylinders which determine the descent, the eventual stop, and the ascent of an upper cross-piece which supports the tool longitudinally.

Regarding the underside of the bending press machine, it includes a lower correspondent cross-piece on the perpendicular of the upper cross-piece, which is substantially intended to hold up a matrix and for possible measuring devices and control of the bending. From the structural point of view, it is interesting to stress that such precision machines are launched onto and required by the market with a lower dynamic cross-piece, which allows one to obtain a high quality product, unlike those which, being static, offer in general a product of lower quality. The necessity of resorting to those machines which are provided with a lower dynamic cross-piece always affects more the sector companies because the costs of planning this specific function, inter alia optional, affects somewhat marginally with respect to the total costs of the basic machine. One reason that induces the same companies to orientate themselves in this direction, is due to the fact that the lower cross-piece, if dynamic, can work on correcting as much as possible those notable imprecisions, that determine a curvature deflection of the press-bending working of the metal sheet.

In fact, it is certainly true that the press-bending of the metal sheet is a somewhat delicate process because it is very difficult to obtain completely identical results to the parameters for the planned working, in this case, allowing a rather wide margin of other metal working processes. This happens because of the concomitance of different factors, e.g. the inconstancy of thickness and material quality where the

incidence of a few hundredths also negatively influences the working, or owing to the phenomena of the elastic return of the material, but also because of the natural deformation of the two cross-pieces during the process, all these phenomena actually are corrected by predetermined and supplied programmes, a previous series of preventive tests by the software company.

In this reasoning, a negative and more or less common aspect in the pre-existing solutions relates to the deformation to which the machine framework is submitted in working condition. The drawback in more detail consists in the transversal determination to the metal sheet, a certain convexity or concavity in the product submitted to the working cycle, a fact which also can be attributed to the irregular distribution of the force on the punch. As already noticed, some of these deficiencies can be corrected by appropriate bending devices or by recovering the flexures that make the lower cross-piece dynamic, suitable for contacting a data process unit, which at present still are not sufficiently able to be modulated and easy. The problem is due to the fact that such process corrections cannot be repeated because of the variable working conditions and of the structural diversities of the used material, requiring constant and particular adjustments. Said variable working conditions include the length of the piece to bend, the thickness, the breaking load of the material and finally the position, lengthwise of the press, in which the bending operation is carried out. Quoting these circumstances, the bending or curving is aimed at recovering the curvature deflection caused by the bending effort on both cross-pieces, upper and lower, whose deformations are proportional to said bending effort.

The hydraulic bending systems, presently used, include a series of

jacks which work contextually along an intermediate part of the lower cross-piece, and in more detail, on the base of a part of same, better known as an action cross-piece with two corresponding reaction cross-pieces on the outside.

The main drawback of the known systems is that they present limits in the control of the bending pressure which, at present, is automatically defined by the numerical control provided together with the bending machines. The charging technique of the determination and calculation parameters for the intervention in the lower cross-piece deformation requires preliminarily the execution of a test series, which technically only count the sheet pieces, bent in the centre with respect to the machine. However, from a practical point of view, when the pieces to bend vary regarding the optimal conditions for which the machine has been programmed initially, and in particular when approximating the maximum and minimum working pressures of the bending machine, often due to the unsatisfactory result, a further manual adjustment of the pressure is considered to be necessary which works manually on the parameters of the data process unit.

A second important limiting factor can be noticed when it is necessary to proceed with a particular, likewise frequent, working in which for reasons of productive demands, one proceeds to the bending on the sides of the press. In this hypothesis, it is achieved that only one of the two pushing cylinders of the upper cross-piece carry out the necessary pressure to which corresponds the positioning side of the piece to bend, while the second cylinder, in contrast to the pushing one, usually only has the function of accompanying the cross-piece in the descent. Because of the effect of the non-optimal interaction between the bending device and the major pressure exerted by a cylinder, it is very

difficult to intervene in order to correct the eventual curvature deflection. Compared to such situations, consequently one has to act again on the numerical control, carrying out numerous tests with a considerable waste of time by the operators and a considerable amount of waste material.

Some recent solutions of a technical nature, in order to resolve the above-mentioned problems, have considered an application of a proportional valve supplied by an autonomous pump which, contacting the pushing cylinders of the upper cross-piece with the bending device of the lower cross-piece, has allowed a slight recovery of the margin of error notable by the unsuitable intervention of said bending device. However, such application still involves limiting factors, first of all, it may be only applicable after a convenient parametric phase for the processing in which the metal sheets are placed centrally to the machine. In fact, when the operator moves from the central axis of the machine, the defined parameters are unsuitable because the bending cylinders maintain the preceding pressure instead of reducing it according to the displacement of the piece against the ends. In these conditions, if the parameters of the machine are not settled according to the displacement, the bending angle will vary remarkably along the fold line. Additionally, since the operator cannot know precisely the mechanical characteristics of the specific material, he consequently cannot programme correctly the numerical control, which leads to consequent disapprovals and errors.

A second machine, clearly more complex than the preceding, has supplied the use of two transducers, one for each cylinder of the upper cross-piece, each of which transmits the pressure with a numerical control and contacts with a common proportional valve which elaborates

certain data regarding each sheet position, independently if it is placed on the centre or on the sides. If on the one hand such solution seems to be optimal, because it intervenes correctly as a function of the cylinder pressure, on the other hand it gives rise to an unsuitable determinant. It is caused by the electronic part of the machine which is particularly complex, onerous, and frequently requires maintenance interventions.

Another aim of this invention is to avoid the above-mentioned drawbacks.

This and other aims are reached by this innovation according to the characteristics of the enclosed claims, solving the exposed problems by a device to automatically adapt the bending pressure variation proportionally to the working pressure of the single cylinders of the upper cross-piece, particularly in a press-bending machine, essentially consisting of two parts, respectively a first part for the proportional distribution of the pressure and a second one for the surplus pressure recovery, re-establishing the machine in the original conditions for a subsequent press-bending cycle, in which the following is provided:

- regarding the first part, eventual selecting means suitable for intercepting the minor cylinder pressure of the upper cross-piece, allowing the opening of a turn circuit for stressing a downstream release valve which moves an end of a balance rod, said valve being suitable for supplying the bending device and intercommunicating with the adjusting means of the outgoing pressure, which moves the opposite end of said balance rod;
- and at least one second part, comprising a further balance rod, which provides on one side balancing means contacting with the supply circuit of the incoming pressure of the release valve, while the opposite end of said balance rod is contrasted by a second release valve, comprising a

receiving entry for the exceeding pressure taken along the outgoing circuit from the first release valve, and an exit to expel the possible exceeding oil flow;

and where still both balance rods can be adjusted by balanced calibration, by means of a common adjustable fulcrum.

Through the considerable creative contribution, the effect of which forms an immediate technical progress different advantages are achieved.

First of all, it is possible to realize that the present self-balanced bending system can adapt full-automatically the bending pressure proportionally to the working pressure of the single cylinders of the upper cross-piece of the press-bending machine, no matter the loading entity and position regarding the length of the bending machine. Therefore an adjustment by the final user is not required, allowing a fair reduction of the working time, with a lower dead time introducing evident benefits from an economical point of view, and at the same time, allowing the realization of practically perfect bends.

Additionally, it can be noticed that regarding the initial calibration phase, practicable in its origin by the subject manufacturer, it requires only a short intervention with minimal waste material for a subsequent tight closing.

Further, the adoption of such device allows a radical simplification of the press-bending machine, on the one hand, with an important reduction of the realization costs reducing the electronic component. As a consequence thereof, it does not require any maintenance by assigned personnel and no stops of the productive cycle.

These and other advantages will appear from the following specified description of a preferred solution with the aid of enclosed

schematic drawings, whose details are not to be considered as limitative but only illustrative.

Figure 1 represents a view of a press-bending machine in static state, and of a relative interaction circuit with an adjusting device for the bending pressure, proportionally to the working pressure of the single cylinders.

Figure 2 is a view in a dynamic state, always of a press-bending machine as in figure 1, and of a relative interaction circuit with an adjusting device for the bending pressure, proportionally to the working pressure of the cylinders, where a working cycle is provided with the central positioning of the sheet to press-bend.

Figure 3 is a view, always in dynamic state, of a press-bending machine as in the preceding figures and of a relative interaction circuit with an adjusting device for the bending pressure, proportionally to the working pressure of the cylinders, where a working cycle is provided on the right side with the positioning of the sheet to press-bend.

Finally, the figure 4 is a view, still in dynamic state, of a press-bending machine as in the preceding figures and of a relative interaction circuit with an adjusting device for the bending pressure, proportionally to the working pressure of the cylinders, in which one provides a working cycle with the positioning of the sheet to be press-bend, on the left side.

Referring also to the figures, it can be noticed that a press-bending machine (A), is essentially composed of an upper cross-piece (1), which can be moved vertically along the axis (Y'-Y") regarding the framework of the press-bending machine (A), on the upper end of which one provides associated longitudinally, an interchangeable tool, which forms the punch (2). Further, the machine (A), provides at the

ends, a cylinder group (3-3') per side, which determine the descending movement and vice versa along the axis (Y'-Y") of the upper cross-piece (1) towards the underlying lower cross-piece (4), which in its turn provides a matrix (5), it also being interchangeable.

In order to recover the cross-piece deflections, an eventual necessity of resorting to the correction of the curvature deflections of the sheet (B) caused by the bending effort, being determined, a bending device is provided, working on the lower cross-piece (4) and made up of a series of lined-up hydraulic jacks (6), in this case three. Said jacks (6) load on the base of an action cross-piece, placed on the lower cross-piece (4) in an intermediate position regarding two reaction cross-pieces, with co-ordinated activities of the device (C) to adapt the bending pressure proportionally to the working pressure of the single cylinders (3, 3') of the upper cross-piece, said device (C) being interposed along a circuit contacting the same. In more detail, regarding the device (C) interposed along a connecting circuit (9, 9') contacting the cylinders (3, 3') of the upper cross-piece with the cylinders (6) of the bending device provided on the lower cross-piece (4), is based on a system essentially made up of a first release valve (7) and a balance cylinder (8) for the proportional control of the cylinder pressure (6) of said bending device. In this case, the release valve (7) is represented with a slightly smaller closing surface regarding the pushing surface of the balance cylinder (8), so ensuring the perfect closing of the release valve (7). Additionally, it is noticed that the release valve (7) proportionally controls the pressure of the bending cylinders on the basis of the fulcrum position (10). The outgoing pressure (side D) of the release valve (7) will always be lower than the incoming one (side E), but the relation rod-balance (11), subjected to adjustment (16) by the fulcrum (10), sees to it that the

balancing cylinder (8) always ensures the closing of the release valve (7).

A second part of the device (C) interacting with the first, is made up of a second release valve (12) and a relative contrast means given by a balancing cylinder (13). Both have a security and control function, so that the pressure of the bending cylinders does not exceed the one necessary for the good result of the bending. The closing of the first release valve (7) is commanded by the balancing cylinder (8) which acts mechanically by a balance (11). Analogously, the closing of the second release valve (12) is commanded by the second balancing cylinder (13) which acts mechanically by means of a second balance (14). Further, it is determined that the fulcrum position (10), on which the two rocker arms are rotating, respectively (11) and (14), is adjustable by handwheel means (16) to allow the balanced calibration between the pressure of the press cylinders (3, 3') and the cylinders (6) of the bending device. The field of the fulcrum adjustment (10) is limited in order to ensure that, with equal pressure, the force exerted by the balancing cylinder (8) always exceeds the one provoking the opening of the release valve (7). This calibration is originally developed in the factory, successively by bending tests, adjusting the handwheel screw (16), finding the precise fulcrum position (10), and so calibrating balances (11, 14) according to the real cylinder pressures (3, 3') and the real balancing pressures of the cylinders (6), obtaining this way a constant angularity of the bent piece be it over the total length of the machine, as well as the lateral bending to the various possible pressures of the machine. Once calibrated, the device (C) is adjusted.

In particular, on machine (A), a switching valve (15) is provided. This valve (15) is aimed at contacting the bending cylinders (6) with the

pressure of the press cylinder (3, 3') contacting the cylinder with the minor pressure. For example, if one carries out a bending on the right side of the press (A), (figure 3), the right-hand cylinder (3) will have the higher pressure; this pressure will displace the cursor of the switch valve or interception valve (15) so that it uses the pressure of the left-hand press cylinder (3'), in order to activate the bending contextual phase, which is lower than that of the right-hand press cylinder (3). This function is important, because on the lateral bending, the sole cylinder on the side of which one bends, exerts the necessary force for the bending, and the so-caused pressure can also be twice the pressure necessary for bending the same piece in the machine centre. Consequently, if this pressure were to work on the bending cylinders (6), the deformation of the lower cross-piece (4) should be very accentuated regarding how much will be necessary for a good bending result. From field tests, it has been noticed that the pressure present in the less stressed press cylinder (3, 3') is in any case suitable for commanding the bending through the described auto-balancing system. Once the switching valve (15) has individuated the cylinder (3, 3') of the bending machine (A), which has a lower pressure in the bending phase, in this hypothesis, the cylinder (3'), the oil flow coming from said intercepted cylinder (3') get through the release valve (7) in order to be guided towards the bending cylinders (6), and one part to the balancing cylinder (8). In that case, the release valve (7) controls proportionally the pressure of the bending cylinders (6) on the basis of the fulcrum position (10). So that the outgoing pressure (side D) of the valve (7) will always be lower than that the incoming one (side E), but the relation rod-balance (11), determined by the fulcrum adjustment (10), sees to it that the cylinder (8) always ensures the closing of the valve (7). The oil

flow coming from the intercepted cylinder (3') will continue to supply the bending cylinders (6), until its pressure will allow to leave the valve open (7), or until the pressure of this cylinder (3') and that of the bending cylinders (6) will be proportionally balanced. At this point, the force exerted by the balancing cylinder (8) will exceed that one allowing the opening of the release valve (7).

Supposing that, in the bending phase, the pressure of the bending cylinders (6) increases more than necessary for a good work result, a second release valve (12), normally still closed by the contrast cylinder (13), is opened slightly, unloading the excess pressure, consequently allowing a pressure that works on the bending cylinders (6) always proportionally to the working pressure of the press (A).

Claims

1. Device to automatically adapt the bending pressure, proportionally to the working pressure of the cylinders of the upper cross-piece, particularly in a press-bending machine and a machine so-obtained, characterised in that it consists essentially in the interaction of at least two parts, respectively a first of proportional division of the pressure and in particular for the adjustment of the cylinder pressure (6) proportional to the cylinder pressure (3, 3') chosen by a switching means (15), said switching means (15) being suitable for intercepting a lower pressure than that of the cylinders (3, 3') of the upper cross-piece (1) and a second one for the evacuation of the exceeding pressure, re-establishing the machine (A) to its original conditions for a subsequent press-bending cycle.

2. Device to adapt automatically the bending pressure, according to claim 1, characterised in that it provides:

- a first part including eventual switching means (15) suitable for intercepting a lower pressure than the cylinder (3, 3') of the upper cross-piece (1), allowing the opening of a circuit (9, 9') to stress a downstream release valve (7) which moves an end of a balance rod (11), said valve (7) being suitable for supplying the bending device and for intercommunicating with balancing means (8) of the outgoing pressure (side D) which moves the opposite end of said balance rod (11);
- and a second, including a further balance rod (14), which provides balancing means (13) on one side contacting with the supply circuit of the incoming pressure of the release valve (7), while the opposite end of said balance rod (14) is contrasted by a second release valve (12), including an entry that receives the determined exceeded pressure along the outgoing circuit from the first release valve (7), and an outgoing to

expel the possible exceeding oil flow.

3. Device to adapt automatically the bending pressure, according to claim 1 and 2, characterised in that both balance rods (11, 14) can be adjusted by balanced calibration, by at least one adjustable (16) fulcrum (10).

4. Device to adapt automatically the bending pressure, according to preceding claims characterised in that both balance rods (11, 14) are engaged with at least one fulcrum (10).

5. Device to automatically adapt the bending pressure, according to preceding claims characterised in that the release valve (7), represented with a closing surface slightly lower with respect to the pushing surface of the balancing cylinder (8).

6. Device to automatically adapt the bending pressure, according to preceding claims characterised in that the outgoing pressure (side D) of the release valve (7) is always lower than the incoming one (side E).

7. Device to automatically adapt the bending pressure, according to preceding claims characterised in that the relation rod-balance (11) determined by the adjusting means (16) of the fulcrum (10), sees to it that the balancing cylinder (8) always ensures the closing of the release valve (7).

8. Press-bending machine, according to preceding claims characterised in that it includes a device (C) to adapt automatically the bending pressure proportionally to the working pressure of the cylinders (3, 3') of the upper cross-piece (1).

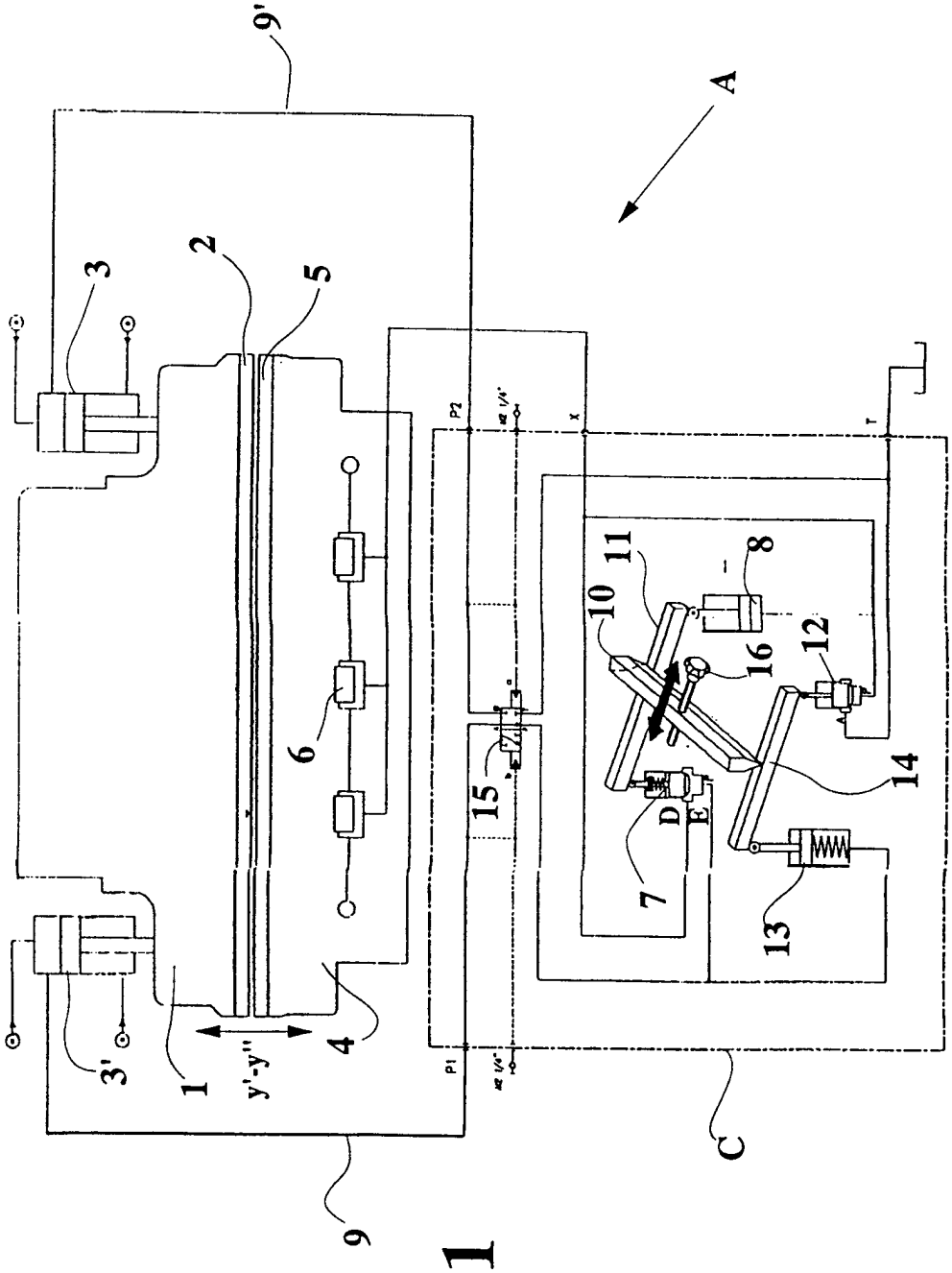

Fig. 1

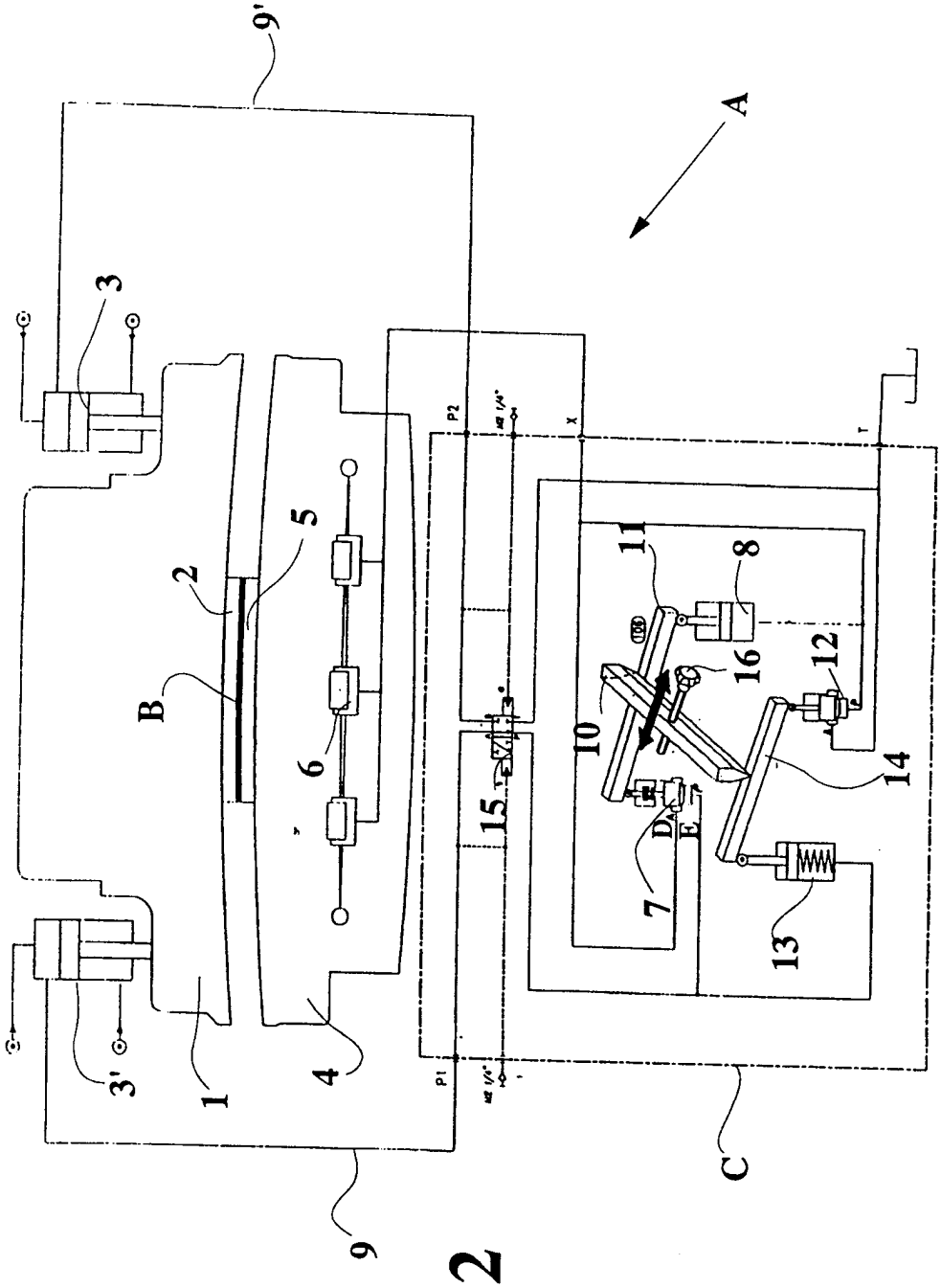

Fig. 2

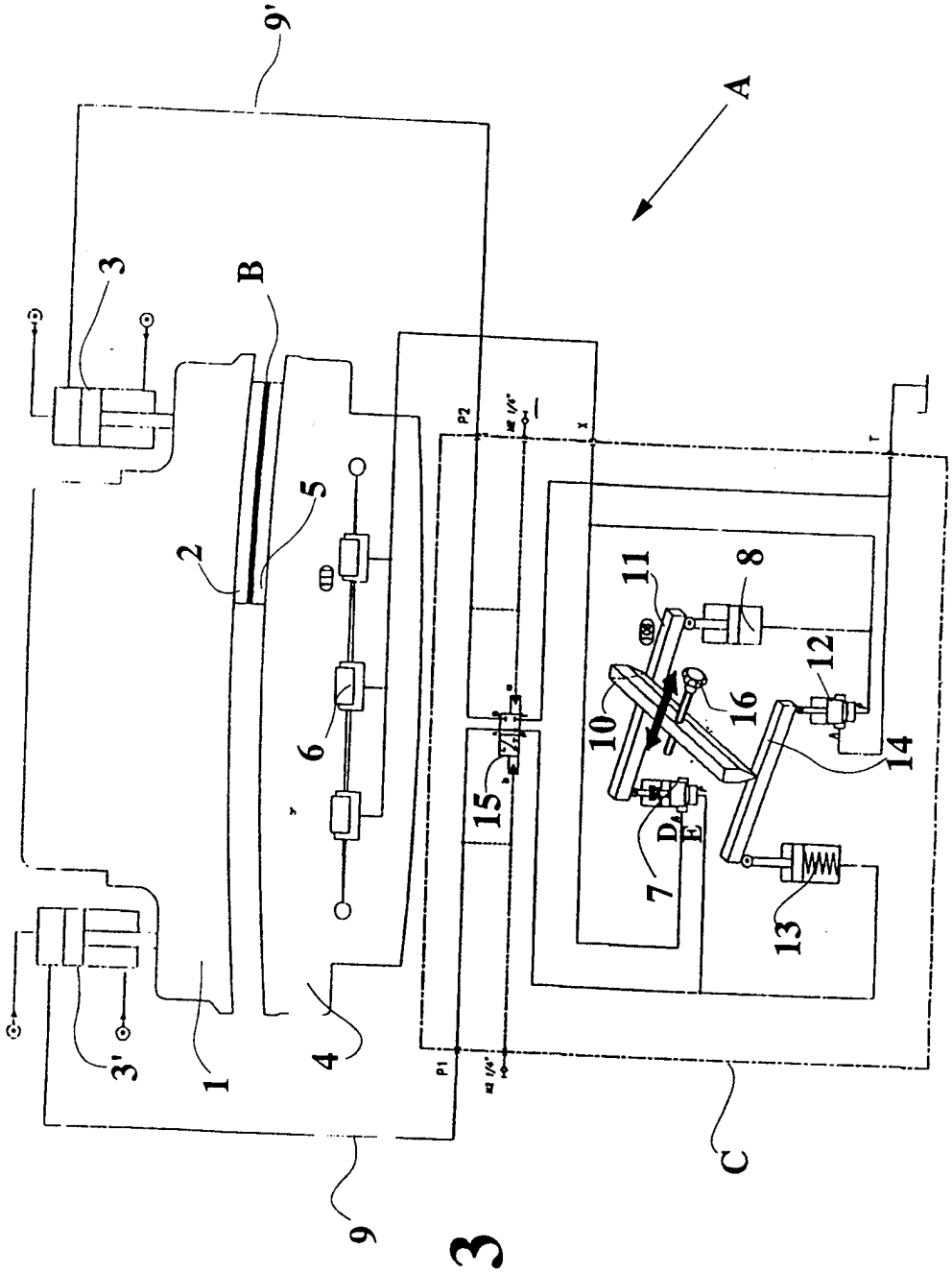

Fig. 3

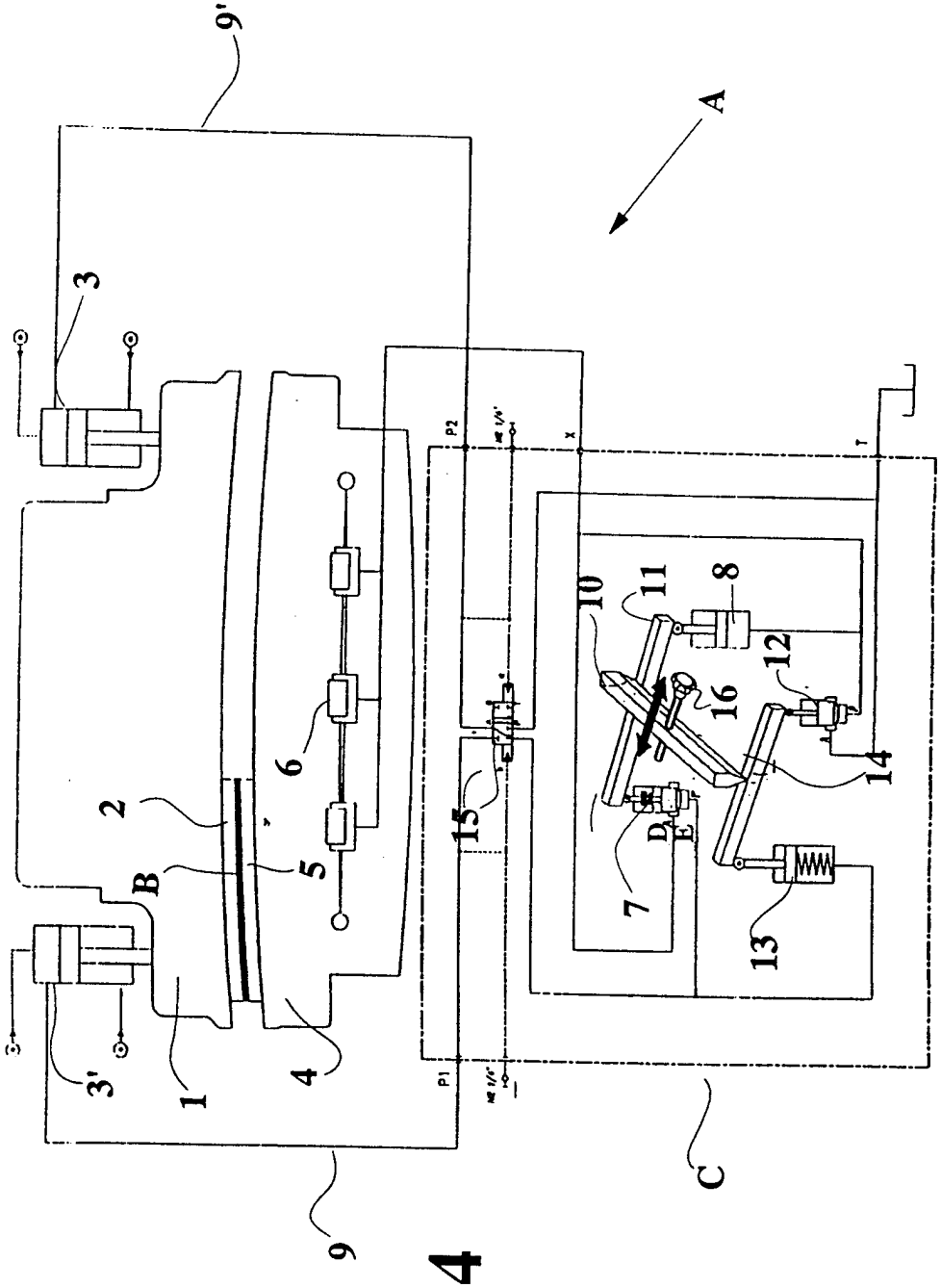

Fig. 4

INTERNATIONAL SEARCH REPORT

national Application No
PCT/IT 98/00148

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B21D5/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 155 228 A (BEYELER MACHINES SA) 18 September 1985 see the whole document -----	1,8

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
24 August 1998	09/09/1998

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

national Application No
PCT/IT 98/00148

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0155228 A	18-09-1985	CH 654761 A	14-03-1986
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