

⑫

EUROPEAN PATENT APPLICATION

⑳ Application number: **80303412.3**

㉑ Int. Cl.³: **B 21 J 9/20**

㉒ Date of filing: **29.09.80**

㉓ Date of publication of application: **07.04.82**
Bulletin 82/14

㉔ Applicant: **mitsubishi JUKOGYO KABUSHIKI KAISHA,**
5-1, Marunouchi 2-chome Chiyoda-ku, Tokyo (JP)

㉕ Inventor: **Kushibe, Yuki, 1-97, Akatsukidai 2-chome,**
Yokkaichi-shi Aichi-ken (JP)
Inventor: **Kishigami, Hisao, 3008-32, Tsumagi-cho,**
Toki-shi Gifu-ken (JP)

㉖ Designated Contracting States: **DE FR GB IT**

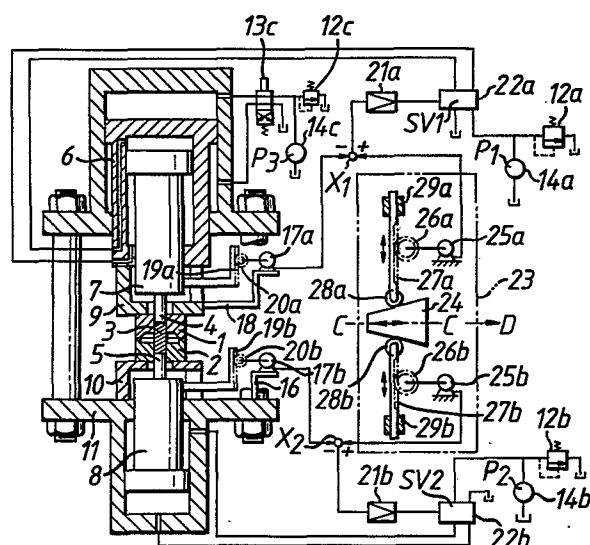
㉗ Representative: **Sommerville, John Henry et al,**
Sommerville & Rushton 89, St. Peters Street, St. Albans
Herts. AL1 3EN (GB)

㉘ **Precision forging press.**

㉙ The invention concerns precision forging presses comprising a plurality of punches (4, 5) adapted to be driven by respective drive means for forging a workpiece.

An object of the invention is to provide a press in which high precision in dimensions as well as in quality of the forged product is assured.

The invention is characterised by the press including means (17, 14, 20) by which the positions of the upper and lower punches can be continuously controlled as desired from the beginning of deformation of a workpiece (3) up to the termination of deformation. Said means enable positional information relating to the respective punches to be converted into voltages, the converted voltages to be compared with programmed reference voltages, and the movements of the respective punches to be continuously controlled in accordance with the comparison results.



PRECISION FORGING PRESS

The present invention relates to improvements in precision forging presses.

Heretofore, precision forging presses of the type in which a workpiece is forged within a space defined by upper and lower dies by means of hydraulically operable upper and lower punches which slidably penetrate the upper and lower dies, respectively, have been known and generally used. In order to assure precision in dimensions as well as in quality of the forged product, it is essentially necessary to control continuously the positions of the upper and lower punches as desired from the beginning of deformation of the workpiece up to the end of deformation. However, none of the precision forging presses of the prior art has been provided with means for completely satisfying such requirements.

It is, therefore, an object of the present invention to provide a novel precision forging press in which the positions of the upper and lower punches can be controlled continuously as desired during deformation of a workpiece.

According to the present invention, there is provided a precision forging press comprising a plurality of punches adapted to be driven by respective drive means for forging a workpiece, characterised by means for converting positional information relating to the respective punches into voltages, a reference voltage generator for generating a plurality of

programmed reference voltages, comparator means for comparing said respective converted voltages with the corresponding ones of said programmed reference voltages, and control means for controlling said respective drive means in accordance with comparison results from said comparator means.

In order that the invention may be readily understood, and other features and objects of the invention made more apparent, one preferred embodiment will now be described with reference to the accompanying drawings, in which :-

Figure 1 is a system diagram showing one example of prior art precision forging press, partly in cross-section,

Figure 2 is an enlarged cross-sectional view showing the dies of the press of Figure 1 at the start of a forging operation,

Figure 3 is a view similar to Figure 2 showing the dies at the termination of a forging operation when a workpiece has been shaped by the dies, and

Figure 4 is a system diagram showing said preferred embodiment of the present invention, partly in cross-section.

Before describing the preferred embodiment, the structure and operation of one example of prior art precision forging press will be explained with reference to Figure 1, in order to facilitate understanding of the present invention.

Referring to Figure 1, the press comprises an upper die 1 and a lower die 2, which define a forging space in which a workpiece 3 of raw material can be accommodated. An upper

punch 4 and a lower punch 5 are associated with respective upper and lower dies, the upper punch being connected to a main ram 5. The upper and lower punches 4 and 5 slidably project through the upper and lower dies 1 and 2 respectively, into the forging space upon actuation of an upper auxiliary ram 7 and a lower auxiliary ram 8. To the bottom of the main ram 6 is mounted an upper bolster 9 to which the upper die 1 is fixed. Similarly, a lower bolster 10 is provided to which the lower die 2 is fixed, the lower bolster 10 being mounted on a machine frame 11. Hydraulic circuits are provided for the upper auxiliary ram 7, lower auxiliary ram 8 and main ram 6, respectively, said circuits including pressure regulation valves 12a, 12b and 12c, switching valves 13a, 13b and 13c, hydraulic pumps 14a, 14b and 14c and flow rate regulation valves 15a and 15b.

For a forging operation, at first when the dies 1 and 2 are in an opened condition, the workpiece 3 of raw material is inserted between the dies 1 and 2. Then, the switching valve 13c is actuated to introduce pressurized oil into the upper chamber of the main ram 6 by the action of the hydraulic pump 14c, and thereby the main ram 6 is lowered to close the dies 1 and 2 together. Subsequently, the upper and lower punches 4 and 5 are set in motion to press into the dies 1 and 2 by the actuation of the upper and lower auxiliary rams 7 and 8, respectively, and thus the forging of the workpiece 3 of raw material is started.

In this operation, in order to assure precision in dimensions as well as in quality of the forged product 3a, the positions A and B of the upper and lower punches 4 and 5 at the start of deformation of the workpiece 3, as well as the positions A_1 and B_1 of the upper and lower punches 4 and 5 at the end of deformation (as shown in Figures 2 and 3 respectively) must always be kept constant. Moreover, in the case of a forged product having a complex shape, not only the punch positions A and B at the start and end of deformation of the workpiece, but also the successive punch positions during the deformation process must be continuously controlled. However, such requirements for the control of the upper and lower punch positions are not fulfilled in the prior art precision forging press described above, and, therefore, very high precision in dimensions together with excellent quality of the forged product cannot be obtained.

Turning now to the preferred embodiment of the present invention illustrated in Figure 4, component parts equivalent to those included in the prior art precision forging press shown in Figure 1 are given like reference numerals. Thus, the press comprises an upper die 1, and a lower die 2 defining a forging space for a workpiece 3, an upper punch 4, a lower punch 5, a main ram 6, upper and lower auxiliary rams 7, 8 respectively, upper and lower bolsters 9 and 10 respectively, a machine frame 11 and hydraulic

circuits including pressure regulation valves 12a, 12b and 12c, a switching valve 13c and hydraulic pumps 14a, 14b and 14c. The above-referred to components are identical to those included in the prior art press shown in Figure 1.

In this embodiment the press has a mount table 16 for a potentiometer 17b provided on the machine frame 11, a mount table 18 for a potentiometer 17a provided on the upper bolster 9, and racks 19a and 19b mounted on the upper and lower auxiliary ram 7, 8 respectively, which racks are meshed with pinions 20a and 20b respectively, mounted on the ends of the shafts of the potentiometers 17a and 17b. The control circuit for the press includes amplifiers 21a and 21b, electromagnetically operable servo valves 22a and 22b, which are included in the hydraulic circuits for the upper and lower auxiliary rams 7 and 8, respectively, and a template 24 that is movable along an arrowed dash-dot line C-C and whose profile is designed according to a programme for the positional control of the punches 4 and 5. Reference numerals 25a and 25b designate potentiometers which are associated, at their shaft ends, with pinions 26a and 26b meshed with racks 27a and 27b respectively. At one end, each rack 27a and 27b has a roller 28a and 28b respectively serving as a cam follower, the other end of each rack being slidably supported by a rack guide 29a, 29b respectively. In

addition, the racks 27a and 27b are adapted to be urged against opposite, inclined side surfaces of the template 24 via their rollers 28a and 28b, respectively, by suitable resilient means not shown.

In operation, since the upper auxiliary ram 7 and the upper punch 4 are driven integrally, the potentiometer 17a which generates a voltage corresponding to the position of the upper auxiliary ram 7, can represent the extent of insertion of the upper punch 4 into the forging space defined by the dies 1 and 2. The same is also true with respect to the lower punch 5, and the voltage generated by the potentiometer 17b indicates the extent of insertion of the lower punch 5 into the space formed by the dies 1 and 2.

The voltages generated by the potentiometers 17a and 17b respectively, are compared in comparator circuits X_1 and X_2 with programmed reference voltages generated by a programmed reference voltage generator 23 consisting of the above-described template 24, potentiometers 25a and 25b, pinions 26a and 26b, racks 27a and 27b, rollers 28a and 28b and rack guides 29a and 29b, and the difference signals issued from the comparator circuits X_1 and X_2 are amplified by the amplifiers 21a and 21b and then applied to the signal inputs of the servo valves 22a and 22b, respectively. As a result, the servo valves 22a and 22b are actuated to drive the upper auxiliary ram 7 and the lower auxiliary ram 8 by means of the respective hydraulic pressure sources

12a-14a and 12b-14b so that the difference between the programmed reference voltages and the voltages generated by the potentiometers 17a and 17b may be nulled. Accordingly, the positions of the upper and lower punches 4 and 5 can be continuously controlled in accordance with the programmed reference voltages issued from the programmed reference voltage generator 23.

In the programmed reference voltage generator 23, the successive reference voltages corresponding to the desired positions of the upper and lower punches 4 and 5 are generated in accordance with the profile of the template 24. Therefore, if the profile of the template 24 is appropriately designed from the position for start of a forging operation up to the position for termination of the forging operation, and if the template 24 is moved in the direction of arrow D in Figure 4 during the forging operation from the forging start position up to the forging termination position, then it becomes possible to control continuously the positions of the upper and lower punches 4 and 5 during the entire forging process.

It is to be noted that while description has been made above in connection to a forging press provided only with vertically movable punches, obviously the same control method can be equally applied for a forging press in which not only vertically movable punches but also horizontally movable punches are provided, these punches being simultaneously actuated in their respective vertical and

horizontal directions. In addition , although a programmed reference voltage generator 23 of template type has been described above, it is possible to generate similar programmed reference voltages by substituting purely electrical means such as, for example, a function generator, an electronic computer, etc. for the template type generator.

As described in detail above, according to the present invention, since the movements or positions of the punches can be continuously controlled during the forging process from the forging start position up to the forging termination position, the mode of deformation flow of the work-piece is always kept constant, and as a result, excellent forged products having good quality and high precision in dimensions can be obtained.

Since many modifications can be made in the construction of the embodiment described above it will be appreciated that it is given by way of example only and many apparently widely different embodiments of this invention could be made without departing the scope thereof. It is, therefore, intended that all matter contained in the above description and shown in Figure 4 of the accompanying drawings shall be interpreted as illustrative and not as a limitation of the scope of the invention.

CLAIMS

1. A precision forging press comprising a plurality of punches adapted to be driven by respective drive means for forging a workpiece, characterized by means for converting the positional information relating to the respective punches into voltages, a reference voltage generator for generating a plurality of programmed reference voltages, comparator means for comparing said respective converted voltages with the corresponding ones of said programmed reference voltages, and control means for controlling said respective drive means in accordance with comparison results from said comparator means.
2. A precision forging press as claimed in Claim 1, in which said drive means consists of a hydraulic ram and a hydraulic pressure source, characterised in that said control means consists of an amplifier and a servo valve interposed between said hydraulic ram and said hydraulic pressure source.
3. A precision forging press as claimed in Claim 1 or Claim 2, characterised in that said reference voltage generator consists of a template having a programmed profile, a plurality of cams associated with said template, and potentiometers adapted to be rotated in response to movements of the corresponding cams for generating the respective reference voltages.

FIG. 1

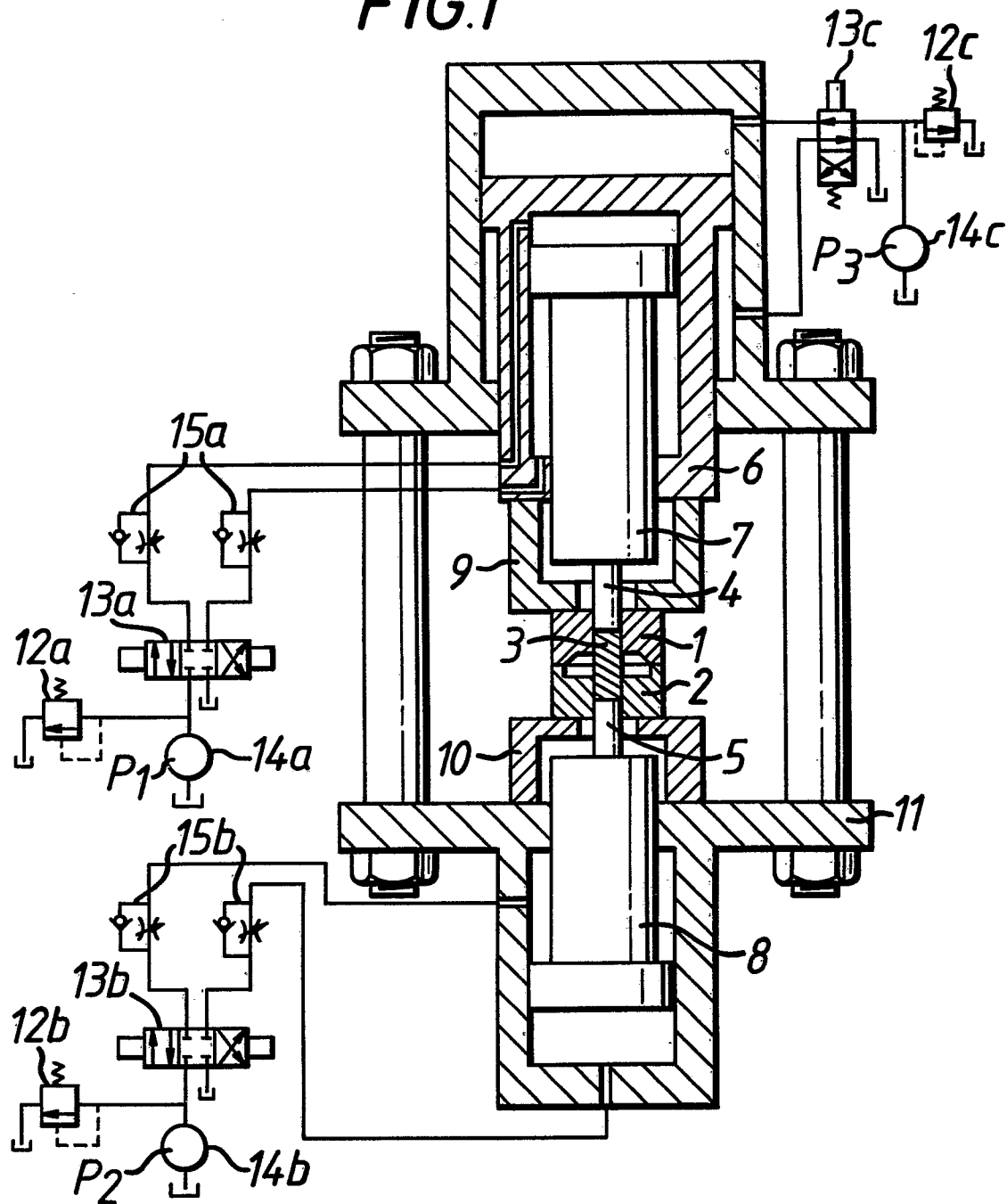


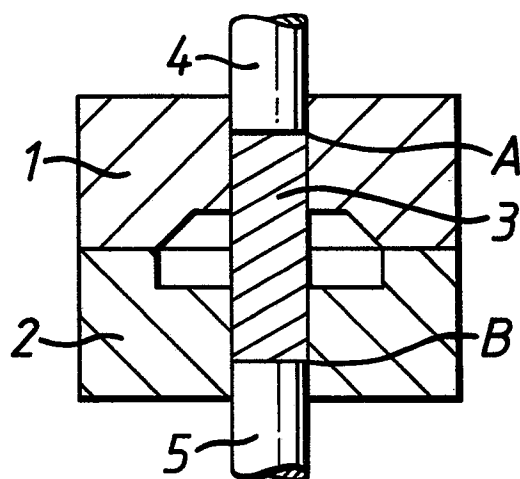
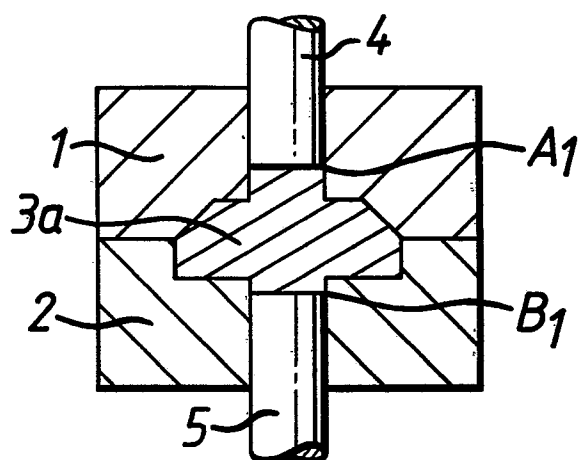
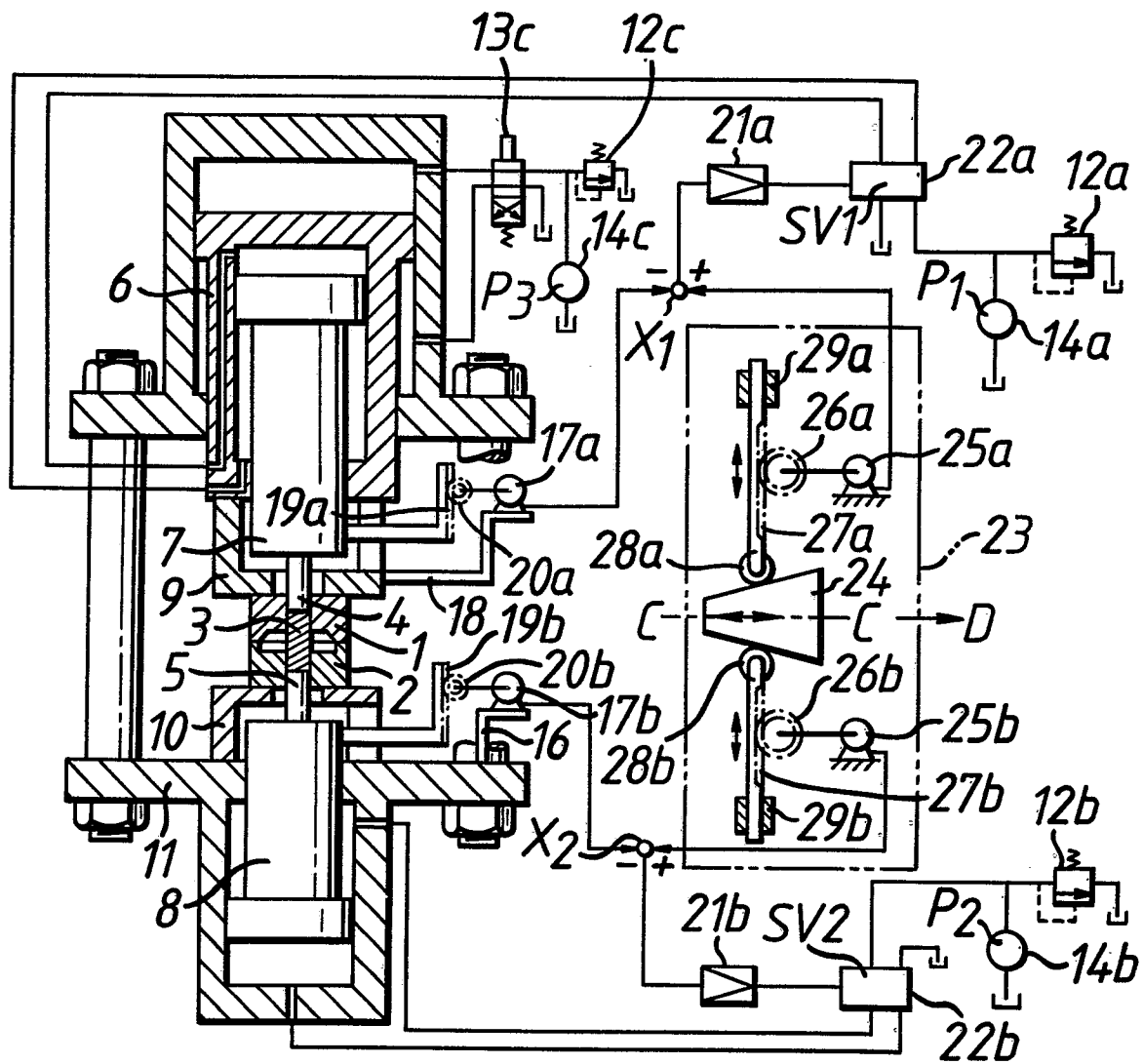
FIG. 2**FIG. 3**

FIG. 4





European Patent
Office

EUROPEAN SEARCH REPORT

0048776

Application number

EP 80 30 3412.3

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
X	<u>DE - B - 1 234 487</u> (SCHLOEMANN AG) * claims 1 to 4; fig. 1 * --- <u>GB - A - 843 394</u> (LOEWY & ENGINEERING) * claims 1 to 3 , page 1, lines 71 to 80 * --- <u>DE - B - 1 427 298</u> (BRITISH IRON) * claim 3 * --- <u>DE - B - 1 763 002</u> (LANGENSTEIN & SCHEMANN) * column 4, lines 27 to 40 * --- <u>DD - A - 124 279</u> (J. KRIEGER et al.) * claim 1 * ---	1,2 1,2 1 1 1	B 21 J 9/20 TECHNICAL FIELDS SEARCHED (Int. Cl.³) B 21 J 5/00 B 21 J 9/00 CATEGORY OF CITED DOCUMENTS X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons &: member of the same patent family, corresponding document
A	<u>DE - A - 2 819 167</u> (ET. SUPERVIS) ---		
A	<u>GB - A - 857 485</u> (SCHLOEMANN AG) -----		
X The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Berlin		13-05-1981	SCHLAITZ