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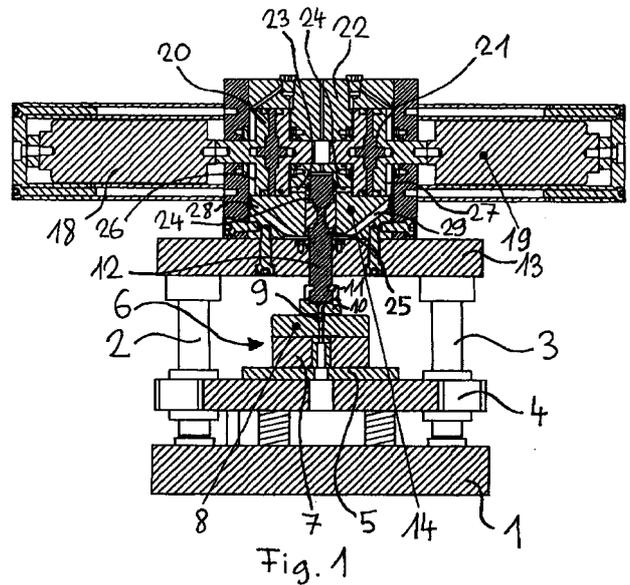
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(54) **Piezoelectric press drive with hydraulic transmission device**

(57) The invention relates to a press, more particularly for cutting and moulding miniature components, with a reciprocating die (9).

In order to provide a small and compact press, which can be economically manufactured, the drive of the die (9) is effected by at least one piezoactor (18, 19).

In addition, a more particularly hydraulic transmission device (14) is arranged between the piezoactor (18, 19) and the die (9).



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Description

[0001] The invention relates to a press, more particularly for cutting and moulding miniature components, with a reciprocating die.

[0002] On account of the large moving masses, conventional mechanical presses are unsuitable for the precision processing of small parts in the electronics field or are very expensive to manufacture.

[0003] It is the object of the invention to provide a small and compact press which can be economically manufactured. In particular, precision processing in the micrometer range is to be possible.

[0004] This object is attained in a press, more particularly for cutting and moulding miniature components, with a reciprocating die in that the drive of the die is effected by at least one piezoactor and in that a more particularly hydraulic transmission device is arranged between the piezoactor and the die. The piezoactor offers the advantage that it has practically no moving mass as compared with a mechanical drive. Consequently, it is possible to attain very high velocities and accelerations using the press according to the invention. Using conventional presses, it is possible to manufacture approximately 2000 parts per unit of time. Using the press according to the invention, markedly increased frequencies and therefore quantities can be realised. In addition, the use of the piezoactor allows for the representation of any chosen force/displacement profile. In contrast, it is only possible to represent a sinusoidal force/displacement profile using conventional mechanical presses with crank drives.

[0005] Whilst it is possible using the piezoactor to realise relatively large forces, it is only possible to realise relative small displacement distances. The transmission device is used in order to allow for larger displacement distances of the die. The transmission device is preferably a hydraulic transmission device, since mechanical transmissions usually have a clearance which is too great for precision processing in the micrometer range.

[0006] A particular embodiment of the invention is characterised in that the transmission device comprises a double-action transmission piston, which is arranged between the piezoactor and the die. In the double-action principle, both the forward and the backward movement (pressure and traction) of the piezoactor is transmitted to the transmission piston. This offers the advantage that no restoring device is required for the transmission piston.

[0007] A further particular embodiment of the invention is characterised in that the die is accommodated with clearance in a first coupling half, which is pre-stressed with a second coupling half. In this manner, a so-called floating die guidance is realised. The coupling serves to compensate any possible displacement which may occur during the assembly of the press according to the invention. This offers the advantage that larger

tolerances can be allowed in the case of the tool, which has a favourable effect on manufacturing costs.

[0008] A further particular embodiment of the invention is characterised in that a plurality of piezoactors actuated in parallel, more particular in modular form, is coupled with the transmission device. This offers the advantage that it is also possible to realise large displacement distances using the press according to the invention. Furthermore, the modular construction of the press allows for rapid adaptation of the press to different product settings.

[0009] A further particular embodiment of the invention is characterised in that a force sensor is connected to the piezoactor, which force sensor is connected to a control, which is connected to the voltage supply of the piezoactor. Using the force sensor, it is possible to continuously measure the force required for the processing operation. If the force increases during operation, this may mean that the tool is worn and needs to be replaced. Using the press according to the invention, it is possible to monitor tool wear. In this manner, undesirable die breakage can be prevented. Furthermore, it is possible using the press according to the invention to vary the die force in a controlled manner via the voltage supply of the piezoactor. It is therefore possible to intervene in a controlled manner in the pressing procedure. It is thereby possible, for example, to process different materials or material thicknesses using the same tool.

[0010] A further particular embodiment of the invention is characterised in that a motion pickup is connected to the die, which motion pickup is connected to a control, which is connected to the voltage supply of the piezoactor. Using the motion pickup, it is possible on the one hand to monitor the movement of the transmission piston or the die. On the other hand, it is possible to intervene in a controlled manner in the pressing procedure via the control and the voltage supply of the piezoactor.

[0011] A further particular embodiment of the invention is characterised in that the control and the voltage supply of the piezoactor are connected to a function generator. As a result of the function generator, it is possible to influence the voltage supply of the piezoactor in a controlled manner. Consequently, it is possible to pre-set any chosen force/displacement profile.

[0012] Further advantages, features and details of the invention will be clear from the following description, in which an embodiment of the invention is described in detail with reference to the drawings. In this respect, the features mentioned in the claims and the description can be fundamental to the invention either individually or in any chosen combination. In the drawings:

Figure 1 is a section through a press according to the invention; and

Figure 2 is a block diagram for the control of a press according to the invention.

[0013] The press shown in section in Figure 1 comprises a base plate 1. Fitted to the base plate 1 is a plurality of columns 2, 3. The columns 2, 3 are used for securing a displaceable tool receiving plate 4.

[0014] Arranged on the tool receiving plate 4 is a pressure plate 5. A tool unit 6 is disposed on the pressure plate 5. The tool unit 6 is formed by a lower tool half 7 and an upper tool half 8. A die 9 is axially displaceably guided in the upper tool half 8.

[0015] The end of the die 9 remote from the lower tool half 7 is accommodated with clearance in a lower coupling half 10. The lower coupling half 10 cooperates with an upper coupling half 11, in order to couple the die 9 with a push rod 12. The push rod 12 is displaceably guided in a base plate 13 and projects with its end remote from the die 9 into a hydraulic transmission device 14. The base plate 13 belongs to the hydraulic transmission device 14 and is supported by the columns 2, 3.

[0016] The hydraulic transmission device 14 is used to transmit the movement of two piezoactors 18, 19 via two transmission pistons 20, 21 and a suitable hydraulic fluid to the push rod 12. The transmission pistons 20, 21 are constructed in three parts in order to allow for the securing of sealing rings in their centre. The pistons 20 and 21 are accommodated in cylinder chambers 26, 27 in a housing base element 22 so as to reciprocate and are coupled with the piezoactors 18, 19. A hydraulic fluid duct 23 provides a connection between the end face of the pistons 20, 21 remote from the piezoactors and the push rod 12. Constructed on the push rod 12 is a first collar 24, which is acted upon by the hydraulic pressure on the side remote from the tool. In addition, a second collar 25 is constructed on the push rod 12. On the side remote from the first collar 24, the second collar 25 communicates via ducts 28, 29 with the end faces of the pistons 20, 21 facing the piezoactors. Hydraulic fluid is disposed in the cylinder chambers 26, 27.

[0017] In Figure 1, the piezoactors 18 and 19 are in their displaced state. The transmission pistons 20 and 21 have moved towards one another. Consequently, the push rod 12 and the die 9 have been moved towards the pressure plate 5.

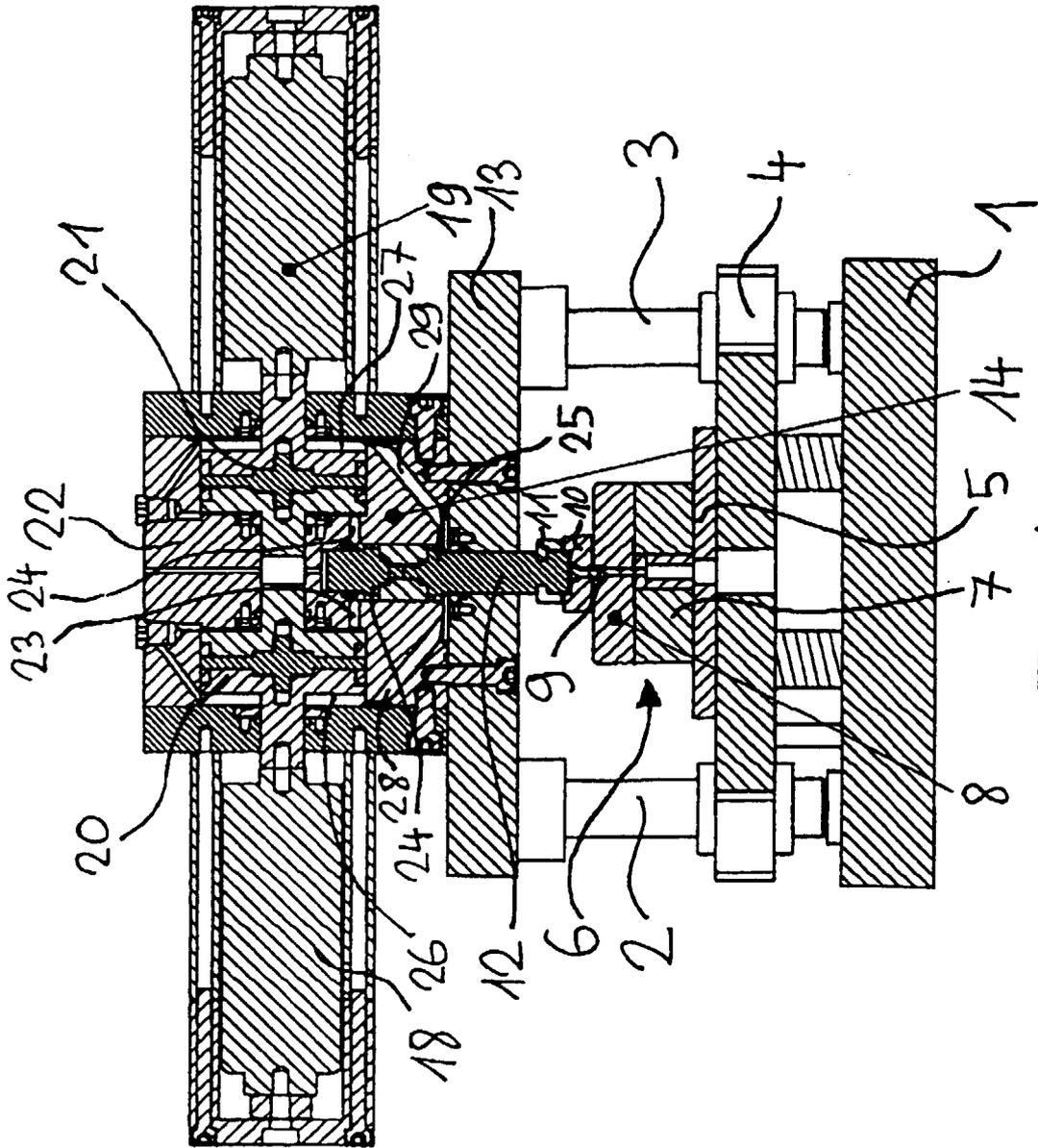
[0018] When the piezoactors 18, 19 move away from one another, this also results in the transmission pistons 20, 21 moving away from one another. Consequently, the hydraulic fluid disposed on the side of the pistons 20, 21 remote from the piezoactors is displaced. This displacement is transmitted via the ducts 28, 29 to the second collar 25 of the push rod 12. In this manner, the push rod 12 is moved back into its starting position.

[0019] The block diagram illustrated in Figure 2 shows how the press illustrated in Figure 1 is controlled during operation. On the one hand, the displacement movement of the die 9 is recorded with the aid of a motion pickup. In addition, the piezoactors 18, 19, which are also referred to as piezo operators, are equipped with force sensors. The motion pickup and the force

sensors supply their measurement values to a control, which communicates with a function generator and the voltage supply of the piezo operators.

5 Claims

1. A press, more particularly for cutting and moulding miniature components, with a reciprocating die (9), characterised in that the drive of the die (9) is effected by means of at least one piezoactor (18, 19), and a more particularly hydraulic transmission device (14) is arranged between the piezoactor (18, 19) and the die (9).
2. A press according to claim 1, characterised in that the transmission device (14) comprises a double-action transmission piston (20, 21), which is arranged between the piezoactor (18, 19) and the die (9).
3. A press according to one of the preceding claims, characterised in that the die (9) is accommodated with clearance in a first coupling half (10), which is prestressed with a second coupling half (11).
4. A press according to one of the preceding claims, characterised in that a plurality of piezoactors (18, 19) actuated in parallel, more particular in modular form, is coupled with the transmission device (14).
5. A press according to one of the preceding claims, characterised in that a force sensor is connected to the piezoactors (18, 19), which force sensor is connected to a control, which is connected to the voltage supply of the piezoactor (18, 19).
6. A press according to one of the preceding claims, characterised in that a motion pickup is connected to the die (9), which motion pickup is connected to a control, which is connected to the voltage supply of the piezoactor (18, 19).
7. A press according to claim 5 or 6, characterised in that the control and the voltage supply of the piezoactor (18, 19) are connected to a function generator.



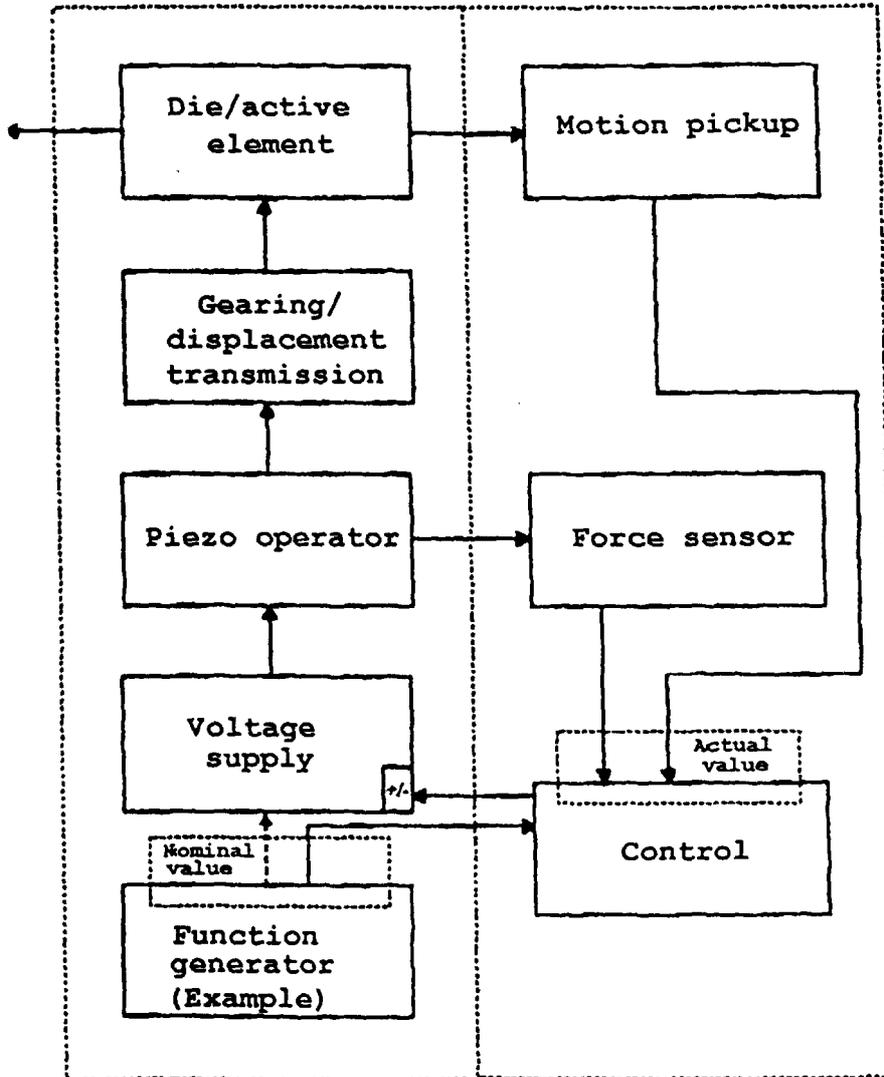


Fig. 2



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EUROPEAN SEARCH REPORT

Application Number
EP 00 12 3428

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.7)
X	JP 60 177897 A (NIPPON TELEGRAPH & TELEPHONE) 11 September 1985 (1985-09-11)	1	B30B1/00 H01L41/04
Y	* figures *	2-7	
Y	US 5 095 725 A (KAWAMURA YUKINORI ET AL) 17 March 1992 (1992-03-17) * abstract; figures *	2-7	
A	PATENT ABSTRACTS OF JAPAN vol. 1999, no. 12, 29 October 1999 (1999-10-29) & JP 11 179600 A (UHT CORP), 6 July 1999 (1999-07-06) * abstract *	1-7	
A	US 5 138 217 A (WADA TATUYA ET AL) 11 August 1992 (1992-08-11) * abstract; figures *	1-7	
A	CH 671 187 A (AUTOPHON ASCOM AG) 15 August 1989 (1989-08-15) * abstract; figures *	1	
A	PATENT ABSTRACTS OF JAPAN vol. 013, no. 094 (M-804), 6 March 1989 (1989-03-06) & JP 63 286299 A (KOMATSU LTD), 22 November 1988 (1988-11-22) * abstract *	1-7	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.7) B30B H01L
Place of search THE HAGUE		Date of completion of the search 6 February 2001	Examiner Bel1bel, C
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 00 12 3428

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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06-02-2001

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 60177897 A	11-09-1985	NONE	
US 5095725 A	17-03-1992	DE 4015196 A JP 3089873 A US 5205147 A	15-11-1990 15-04-1991 27-04-1993
JP 11179600 A	06-07-1999	NONE	
US 5138217 A	11-08-1992	JP 2114236 C JP 2297983 A JP 8031635 B DE 4011277 A	06-12-1996 10-12-1990 27-03-1996 15-11-1990
CH 671187 A	15-08-1989	NONE	
JP 63286299 A	22-11-1988	NONE	