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(54) Method of the fluidised bed type for the shaping of sheet metal.

(57) The method comprises a first stage during which a blank holder (1) is brought into contact with the sheet (2), a second stage in which a pressurised fluid is fed by means of a first hydraulic circuit to the cavity (4) in a die (3) below the sheet and a third stage in which a punch (7) is displaced towards the sheet to deform it plastically through the combined action of the pressures generated by the punch and the fluid. In accordance with the invention the second pressurised fluid delivered from a second hydraulic circuit is caused to act on the upper surface (9) of at least a portion (10) of the sheet so as to balance out the pressures acting on the undersurface (11) of the said portion while the former is displaced towards the sheet.

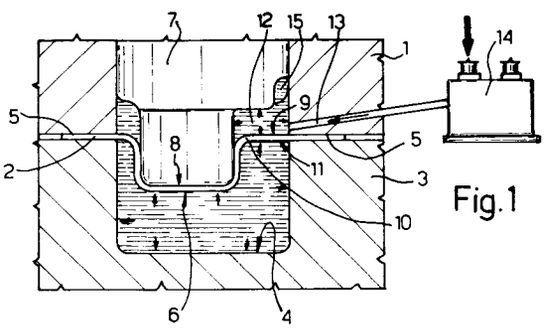

Fig.1

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The invention relates to a method of the fluidised bed type for the shaping of sheet metal.

As is known, a method of this type substantially comprises a first stage in which a blank holder is brought into contact with the sheet supported on a forming die provided with a cavity, a second stage in which a pressurised fluid is delivered to the aforesaid cavity beneath the sheet by means of a hydraulic circuit and finally a third stage during which a punch is displaced towards the sheet in order to deform it plastically. Deformation of the sheet takes place in this third stage due to the combined action of the pressures which are generated by the punch on the upper surface of the sheet and by the pressure generated by the aforesaid fluid which acts on the undersurface of the said sheet.

A method of this type has the disadvantage that relatively complex forms cannot be pressed in a single forming operation, or that they require a plurality of successive shaping operations carried out using different presses and dies.

In fact, when the shape of the punch which is required to effect the forming is such that it does not immediately come into contact with the upper surface of the sheet during the first part of the punches stroke, spaces or chambers whose dimensions decrease as the punch continues its stroke are produced between parts of the outside surfaces of the punch, the inside of the blank holder and the sheet itself. The pressure of the aforesaid fluid acts on the undersurface of the sheet and is not balanced by any other pressure acting on the upper surface, and therefore deformation of the sheet bounding these spaces proceeds in an uncontrolled way and fractures resulting from the high stresses which can be induced in the sheet through the effect of the fluid pressure can easily occur in the course of the piston's stroke.

In practice shaping has to be performed by means of a large number of passes through different machines and presses in order to avoid the occurrence of this problem.

The object of this invention is to provide a method of the fluidised bed type for the shaping of sheet metal which does not have the disadvantage which has been described and is therefore capable of carrying out extensive shaping of complex shapes in a single shaping operation.

This object is accomplished with a method of the fluidised bed type for the shaping of sheet metal substantially comprising a first stage in which a blank holder is brought into contact with the sheet supported on a shaping die provided with a cavity, a second stage in which a pressurised fluid is delivered to the said cavity below the said sheet by means of a first hydraulic circuit and a third stage during which a punch is displaced towards the said sheet to deform it elastically through the combined effect of the pressures generated by the said punch on the upper surface of the sheet and the pressures generated on the underside of the sheet by the said fluid, characterised in that a second pressurised fluid delivered by a second hydraulic circuit is caused to act on at least one portion of the upper surface of the said sheet so as to balance out the pressures acting against the underside of the said portion while the said punch is moved towards the sheet in the course of the said third stage.

For a better understanding of the stages in the method according to the invention a more detailed description will now be provided with reference to the figures in the appended drawings, in which:

Figures 1, 2 and 3 show successive configurations of the punch and the sheet in the course of the shaping of the said sheet.

The method according to the invention substantially comprises a first stage in which a blank holder 1 is brought into contact with the sheet 2 supported on a forming die 3, which is provided with a cavity 4 of suitable shape. During this first stage of the method the blank holder exerts a predetermined pressure against the edges 5 of the sheet so as substantially to provide a hydraulic seal for cavity 4.

During a second stage of the method a pressurised fluid is delivered to cavity 4 below undersurface 5 of the sheet through a first hydraulic circuit, which is not illustrated. In the course of a third stage a punch 7 of suitable shape is moved towards cavity 4 in order to deform sheet 2, as is clearly shown in Figure 1. During this stage the sheet is plastically deformed through the combined action of the pressures which punch 7 exerts against the upper surface 8 of the sheet and the pressures which are generated against the underside 6 of the said sheet by the fluid filling cavity 4. This is obviously held at a predetermined pressure within cavity 4 through suitable means which are not shown.

In accordance with the invention, a second pressurised fluid which is delivered by a second hydraulic circuit (not shown) is caused to act against the upper surface 9 of at least a portion 10 of sheet 2 in order to balance out the pressures acting on the undersurface 11 of portion 10.

As can be seen clearly from Figure 1, the second hydraulic fluid is delivered substantially to a chamber 12, which is defined partly by the lower surface of the punch itself, partly by the surface of blank holder 1 and the upper surface 9 of portion 10 of the sheet. The second pressurised fluid is delivered to chamber 12 when punch 7 has reached a predetermined point in its stroke and has already begun to deform sheet 2. Conveniently

the hydraulic fluid can be fed to a chamber 12 via a conduit 13 provided in blank holder 1. This conduit includes a stop valve 14 which can be switched from a first position in which the conduit is in communication with a source (not illustrated) of the second pressurized fluid and a second position in which this allows the said fluid to be discharged, thus maintaining a predetermined fluid pressure within the chamber. Conveniently valve 14 is provided with means to effect a desired resistance to the passage of fluid, so as to maintain the aforesaid predetermined pressure within chamber 12 while punch 7 completes its stroke to deform sheet 2 plastically.

As punch 7 completes its stroke for further deformation of the sheet, as shown in Figure 2, its deformation increases and it tends to adhere to the surface of the punch. During this deformation of the sheet the pressure of the second hydraulic fluid filling chamber 12 and the pressure of the first hydraulic fluid filling chamber 4 act on upper surfaces 9 and lower surfaces 11 of portion 10 of the sheet which has not yet come into contact with the punch respectively. When these pressures are substantially equal, portion 10 is perfectly balanced and therefore no force tends to deform it. As a result the forming deformation produced by punch 7 can continue even though the depth of forming is very great and the shape of the punch is rather complex.

As punch 7 proceeds with its stroke the second fluid is discharged from chamber 12 through valve 14 while the pressure within chamber 12 is maintained constant through the action of valve 14. When punch 7 reaches the end of its forming stroke, as shown in Figure 3, upper surfaces 8 and 9 of sheet 2 are completely in contact with the corresponding surface of punch 7. In this configuration the second hydraulic fluid which fills chamber 12 has been completely discharged through conduit 13.

To aid completion of the forming stoke of punch 7 it may be appropriate to provide an additional cavity 15, of small size, in e.g. punch 7, as shown in the figures. In this way, when punch 7 is at its end stop position shown in Figure 3, additional chamber 15 is still in communication with conduit 13 and excess pressure in the second hydraulic fluid resulting from closure of conduit 13 by punch 7 is thus avoided. Also the small volume of additional chamber 15 does not have any effect on the geometry and shape characteristics of the semi-finished product obtained by forming the sheet.

It is clear that modifications and variants may be made to the method which has been described without going beyond the scope of the invention.

Claims

1. A method of the fluidised bed type for forming sheet metal substantially comprising a first stage in which a blank holder (1) is brought into contact with the sheet (2) supported on the forming die (3) provided with a cavity (4), a second stage in which a pressurised fluid is delivered to the said cavity (4) underneath the sheet by means of a first hydraulic circuit and a third stage during which a punch (7) is moved towards the said sheet to deform it plastically through the combined action of the pressures generated by the said pressure on the undersurface (8) of the sheet and the pressures generated by the said fluid on the upper side (6) of the sheet, characterised in that a second pressurised fluid delivered by a second hydraulic circuit is caused to act on the upper surface (9) of at least one portion (10) of the said sheet (2) so as to balance out the pressures acting on the underside (11) of the said portion while the said punch (7) is moved to deform the said sheet in the course of the said third stage.

2. A method according to claim 1, characterised in that the said second hydraulic fluid is delivered to a chamber (12) defined partly by the surfaces of the said punch (7), the said blank holder (1) and the upper surface (9) of the said portion of sheet (10).

3. A method according to either of claims 1 or 2, characterised in that the said second pressured fluid is delivered to the said chamber (12) when the said punch (7) has reached a predetermined point in its stroke and is brought into contact with the said sheet (2) and is then gradually discharged from the said chamber during the remaining part of the punches stroke maintaining a predetermined pressure in the chamber while its volume decreases.

4. A method according to any one of the foregoing claims, characterised in that the said second hydraulic fluid is delivered to the said chamber (12) through a conduit (13) provided in the said blank holder (1) the course of which includes a stop valve (14) which can be switched from a first position in which the conduit is in communication with a source of the said second pressurised fluid and a second position in which it allows the said second pressurised fluid to be discharged while maintaining a predetermined fluid pressure in the said chamber.

5. A method according to any one of the foregoing claims, characterised in that a residual volume which is not zero is maintained in the said chamber when the punch (7) reaches the end of its stroke.

6. A method according to claim 5, characterised in that the said residual volume is contained within an additional chamber (15) in communication with the said chamber (12) provided by means of a cavity made in part of the said punch (7) which lies close to the outlet of the said conduit (13) at the end of the forming stroke.

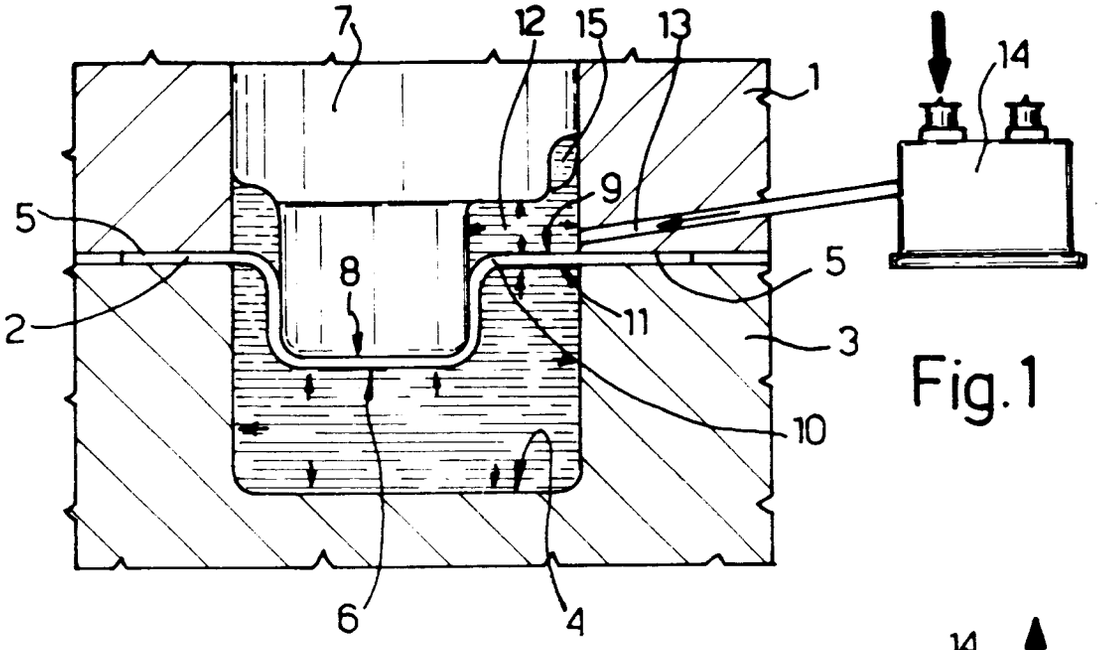

Fig.1

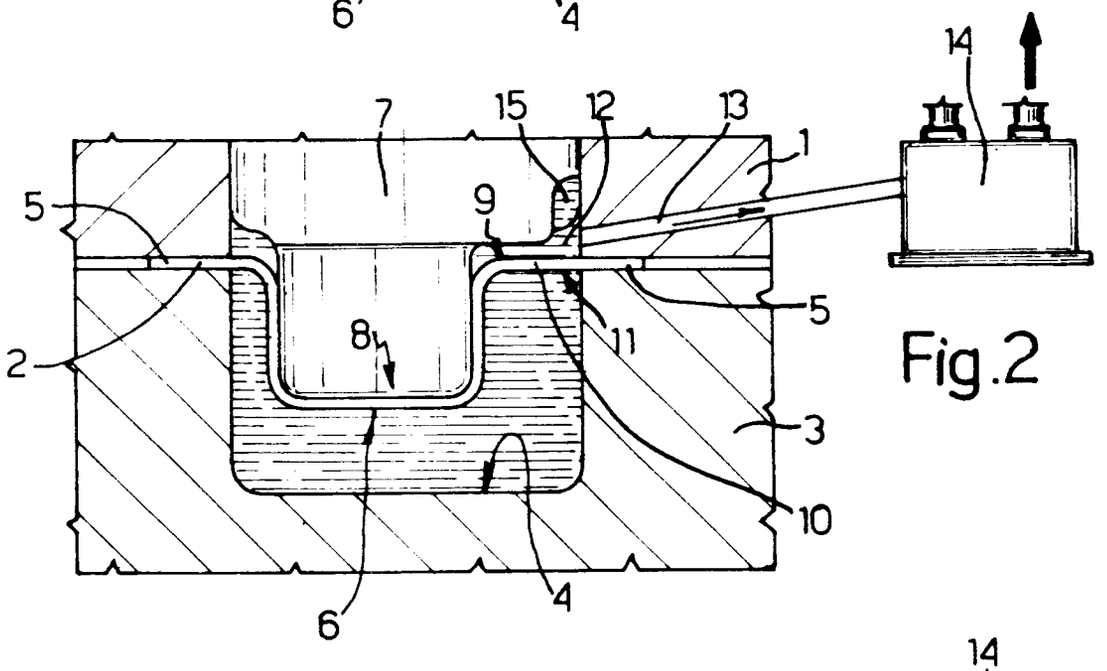

Fig.2

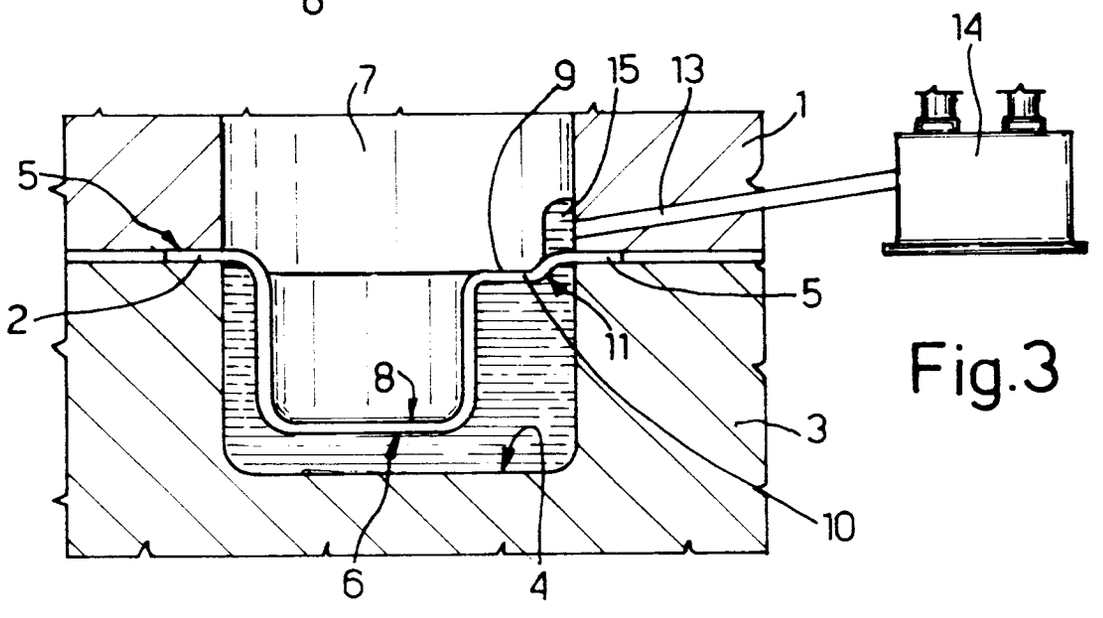

Fig.3

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EUROPEAN SEARCH REPORT

Application Number

EP 92 12 1405

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.5)
X	PATENT ABSTRACTS OF JAPAN vol. 8, no. 160 (M-312)(1597) 25 July 1984 & JP-A-59 056 926 (MATSUSHITA DENKO K.K.) 2 April 1984 * abstract *	1-4,7	B21D22/20
X	EP-A-0 092 253 (K.NAKAMURA) * page 9, line 5 - page 14, line 4; claims; figures 1-5 *	1,2,7	
A	PATENT ABSTRACTS OF JAPAN vol. 8, no. 270 (M-344)(1707) 11 December 1984 & JP-A-59 141 328 (MAZSUSHITA DENKO K.K.) 14 August 1984 * abstract *	1	
A	PATENT ABSTRACTS OF JAPAN vol. 6, no. 86 (M-131)(964) 25 May 1982 & JP-A-57 022 826 (HITACHI ZOSEN K.K.) 5 February 1982 * abstract *	3,4	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	PATENT ABSTRACTS OF JAPAN vol. 12, no. 404 (M-757)(3251) 26 October 1988 & JP-A-63 149 023 (HONDA MOTOR CO LTD) 21 June 1988 * abstract *	5,6	B21D
A	DE-C-951 807 (H.E. KRANENBERG) * page 2, line 56 - page 2, line 104; figures *	1	
A	DE-C-915 327 (H.E. KRANENBERG) * page 2, line 61 - page 2, line 126; figures 1-3 *	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	11 MARCH 1993	PEETERS L.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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