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(12) (19) (CA) **Brevet-Patent**

(11) (21) (C) **2,067,732**
(86) 1990/08/30
(87) 1991/04/27
(45) 2000/02/15

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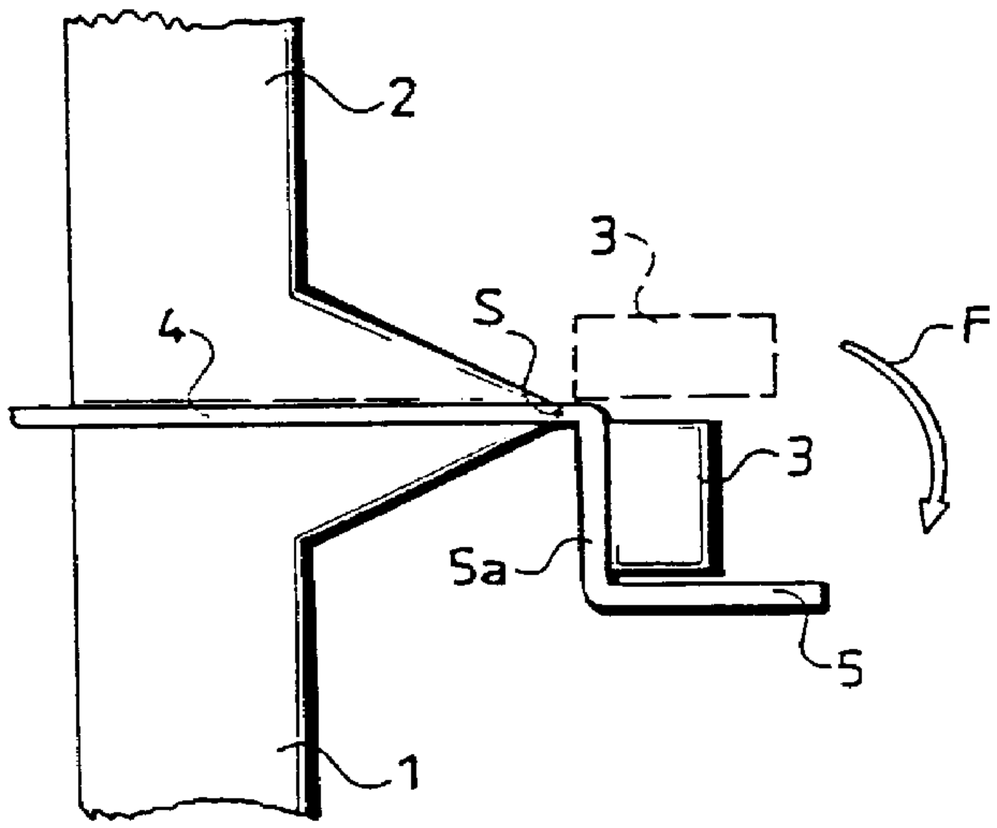
(51) Int.Cl.[5] B21D 5/04
(30) 1989/10/26 (P 39 35 658.2) DE

(54) **PROCEDE DE CINTRAGE BIDIRECTIONNEL DE LA TOLE**

(54) **PROCESS FOR THE TWO-DIRECTIONAL BENDING OF SHEET METAL**



(57) Un procédé de cintrage opposé d'une tôle comprend les opérations suivantes: on applique la joue de pliage d'une machine à cintrer oscillante sur une première face d'un tronçon de tôle et l'on plie celui-ci, selon un angle prédéterminé, dans un premier sens de rotation; on retire ensuite du tronçon de tôle replié, la joue de pliage dans un premier sens de déplacement, perpendiculairement à son axe de pivotement et l'on continue de l'incliner, dans le premier sens de rotation, jusqu'à ce qu'elle soit tournée vers la deuxième face de la tôle opposée à la première face; on déplace la joue de pliage dans un deuxième sens de déplacement perpendiculaire au premier; on applique la joue de pliage, après déplacement correspondant de la tôle repliée entre la joue inférieure et la joue supérieure de la machine à cintrer, sur la deuxième face de la tôle et l'on plie celle-ci selon un angle prédéterminé, par pivotement de la joue de pliage dans un deuxième sens de rotation opposé au premier. Dans la machine à cintrer pour la mise en oeuvre de ce procédé, la joue de pliage est montée de manière à pouvoir exécuter deux mouvements perpendiculaires entre eux dans les premier et deuxième sens de déplacement.

(57) A process for the two-directional bending of sheet metal comprises the following stages: The bending cheek of a swivel press is laid on a first side of a sheet metal section which is bent about a predetermined angle in a first direction of rotation; the bending cheek is then withdrawn from the bent sheet in a first direction of movement prependicularly to its pivoting axis and pivoted further in the first direction of rotation until it lies against the second side of the sheet opposite the first; the bending cheek is shifted in a second direction perpendicularly to the first; after the bent sheet has been suitably moved between the lower and upper cheeks of the bending machine, the bending cheek is laid against the second side of the sheet, which is bent about a predetermined angle by pivoting the bending cheek in a second direction of rotation opposite that of the first. In the bending machine for implementing this process, the bending cheek is fitted so that it can perform both mutually perpendicular movements in the first and second directions of travel.

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WELTORGANISATION FÜR GEISTIGES EIGENTUM
Internationales Büro

PCT
INTERNATIONALE ANMELDUNG VERÖFFENTLICHT NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT)

(51) Internationale Patentklassifikation 5 :		(11) Internationale Veröffentlichungsnummer:
B21D 5/04	A1	WO 91/06383
		(43) Internationales Veröffentlichungsdatum: 16. Mai 1991 (16.05.91)

(21) Internationales Aktenzeichen: PCT/EP90/01446

(22) Internationales Anmeldedatum: 30. August 1990 (30.08.90)

(30) Prioritätsdaten:
P 39 35 658.2 26. Oktober 1989 (26.10.89) DE

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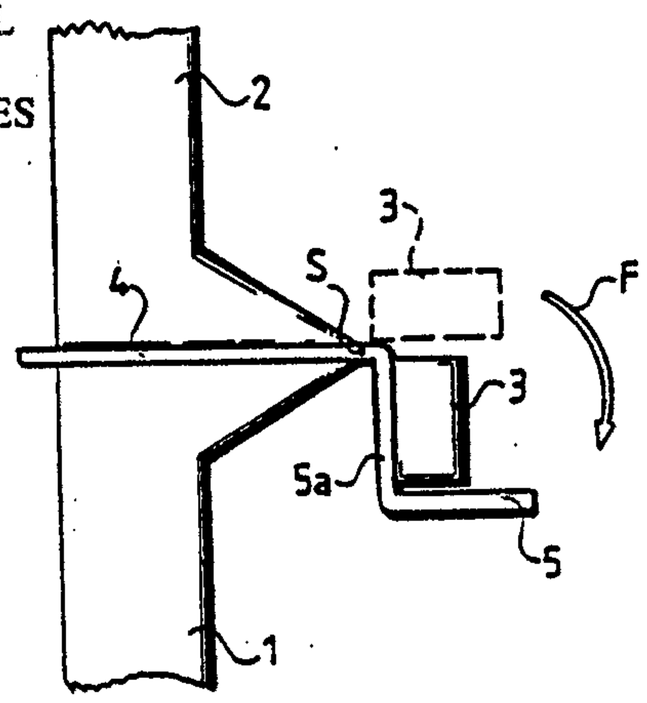
(81) Bestimmungsstaaten: AT (europäisches Patent), BE (europäisches Patent), CA, CH (europäisches Patent), DE (europäisches Patent)*, DK (europäisches Patent), ES (europäisches Patent), FR (europäisches Patent), GB (europäisches Patent), IT (europäisches Patent), JP, LU (europäisches Patent), NL (europäisches Patent), SE (europäisches Patent), US.

Veröffentlicht
Mit internationalem Recherchenbericht.
Mit geänderten Ansprüchen und Erklärung.

(54) Title: PROCESS FOR THE TWO-DIRECTIONAL BENDING OF SHEET METAL

(54) Bezeichnung: VERFAHREN ZUM GEGENLÄUFIGEN BIEGEN EINES BLECHES



(57) Abstract

A process for the two-directional bending of sheet metal comprises the following stages: The bending cheek of a swivel press is laid on a first side of a sheet metal section which is bent about a predetermined angle in a first direction of rotation; the bending cheek is then withdrawn from the bent sheet in a first direction of movement prependicularly to its pivoting axis and pivoted further in the first direction of rotation until it lies against the second side of the sheet opposite the first; the bending cheek is shifted in a second direction perpendicularly to the first; after the bent sheet has been suitably moved between the lower and upper cheeks of the bending machine, the bending cheek is laid against the second side of the sheet, which is bent about a predetermined angle by pivoting the bending cheek in a second direction of rotation opposite that of the first. In the bending machine for implementing this process, the bending cheek is fitted so that it can perform both mutually perpendicular movements in the first and second directions of travel.

(57) Zusammenfassung

Ein Verfahren zum gegenläufigen Biegen eines Bleches umfaßt folgende Schritte: Man legt die Biegewange einer Schwenkbiegemaschine an eine erste Seite eines Blechabschnittes an und biegt diesen um einen vorgegebenen Winkel in einer ersten Drehrichtung ab; man zieht hierauf die Biegewange in einer ersten Verstellrichtung senkrecht zu ihrer Schwenkachse vom abgebogenen Blechabschnitt zurück und verschwenkt sie in der ersten Drehrichtung weiter, bis sie der zweiten Seite des Bleches zugekehrt ist, die der ersten Blechseite gegenüberliegt; man verstellt die Biegewange in einer zweiten Verstellrichtung senkrecht zur ersten Verstellrichtung; man legt die Biegewange nach entsprechender Verschiebung des abgebogenen Bleches zwischen Unter- und Oberwange der Schwenkbiegemaschine an die zweite Seite des Bleches an und biegt dieses um einen vorgegebenen Winkel durch Verschwenken der Biegewange in einer zur ersten Drehrichtung entgegengesetzten, zweiten Drehrichtung ab. Bei der Schwenkbiegemaschine zur Durchführung diese Verfahrens ist die Biegewange so gelagert, daß sie die beiden senkrecht zueinander verlaufenden Bewegungen in den ersten und zweiten Verstellrichtungen ausführen kann.

* Siehe Rückseite

PROCESS FOR THE TWO-DIRECTIONAL BENDING OF SHEET METAL

The invention relates to a process and apparatus for two-directional bending of metal sheet clamped between two clamping cheeks and bent by a bending cheek. With the known sheet metal bending machines which have hitherto been used to perform such a process, the bending jaw is only usable in one working direction, i.e., for example, during swivel movement from the bottom upwards in the clockwise direction. Consequently, for sheet metal bending in opposite directions, i.e., when a first sheet metal section is to be bent, for example, in the clockwise direction and subsequently a further sheet metal section in the counter-clockwise direction, the metal sheet has to be turned between the individual bending operations. However, particularly when large metal sheets of several meters length have to be turned so that their top side becomes the bottom side, this is an inconvenient and time-consuming operation which is often also impeded by automatic handling devices provided on the sheet metal bending machine.

The object of the invention is to so improve a generic process that turning of the metal sheet between two two-directional bending operations can be avoided.

According to the invention, a process is provided for two-directional bending of sheet metal having a first side and an opposed second side, by a bending press, said process comprising the steps of

(a) clamping the sheet metal by a clamping force between a lower cheek and an upper cheek, leaving a projecting length of the sheet metal project beyond the upper and lower cheeks;

(b) applying a bending face of a bending cheek to the first side of the sheet metal at the projecting length and bending said projecting length through a specified angle by pivoting the bending cheek in a first direction of rotation about a pivot axis to provide a bent length of the sheet metal;

(c) displacing the bending cheek away from said bent length of the sheet metal in a first displacement direction

extending in radial direction to said pivotal axis and being arranged in a coordinate system rotating with said bending cheek;

(d) following the withdrawal of the bending cheek from the bent length of the sheet metal, moving the bending cheek further in said first direction of rotation until, after a movement over 180° in total, said bending face of the bending cheek faces the second side of the sheet metal;

(e) within a period of time displacing the bending cheek in a second displacement direction transverse to said first displacement direction, releasing the clamping force and moving the sheet metal a predetermined distance in said first displacement direction to expose a further projecting length of the sheet metal, and reapplying the clamping force, whereby at the end of said period of time said bending face faces the second side of the sheet metal at said further projecting length thereof; and

(f) applying said bending face to the second side of the sheet metal at said further projecting length, by displacement of the bending cheek in said first displacement direction and bending the further projecting length of the sheet metal through a specified angle by pivoting the bending cheek in a second direction of rotation opposite to said first direction of rotation.

In another aspect, the invention provides a swivel bending machine comprising machine frame, lower jaw, upper jaw and bending jaw for performing the process according to the invention is characterized in that there is provided on each of the two end faces of the bending jaw a first swing arm which can be swivelled about the swivel axis of the bending jaw, in that there is movably mounted on the first swing arm a second swing arm, and in that there is provided on the second swing arm a guide means which permits an essentially straightline movement of the bending jaw extending perpendicular to the swivel axis, the bending arm itself

extending essentially perpendicular to the direction of movement of the second swing arm.

The following description of preferred embodiments serves in conjunction with the appended drawings to explain the invention in further detail. The drawings show:

Figures 1 to 8 — several subsequent steps in the two-directional bending of a metal sheet and

Figure 9 — a device for performing two-directional sheet metal bending according to Figures 1 to 8.

Figure 1 to 8 each show schematically the main parts of a swivel bending machine, namely a lower jaw 1, also referred to as "lower cheek", an upper jaw 2, also referred to as "upper cheek 2", and a bending jaw or bending cheek 3. The bending jaw 3 is mounted for rotation on the machine frame (not illustrated) and can be swivelled about a swivel axis S extending perpendicular to the drawing plane in Figures 1 to 8.

A sheet metal 4 is clamped between lower jaw 1 and upper jaw 2 by lowering the upper jaw 2 in the direction of the arrow A and protrudes with a sheet metal length 5 beyond the cheeks 1, 2. The bending cheek 3 engages with its upper or bending surface the underside of the metal sheet length 5. This side is also referred to hereinafter as the first side of the metal sheet 4; it lies opposite the top or second side of the metal sheet 4.

Figure 1 represents the initial state of the bending process. In a first bending step, the bending jaw 3 - cf. Figure 2 - is bent by pivoting the bending cheek upwards, in a first direction of rotation B through 90° in the counter-clockwise direction, whereby the sheet metal section 5 is likewise bent upwards in the counter-clockwise direction. The bending jaw 3 - cf. Figure 3 - is now withdrawn in a first displacement direction of adjustment (arrow C), also referred to as "a

first displacement direction" perpendicular to its swivel axis S from the bent sheet metal section 5 so that - cf. Figure 4 - it can be swivelled further upwards (arrow D) in an unimpeded manner around this bent sheet metal section 5 until after swivelling through a total of approximately 180° it faces the second or top side of the metal sheet 4. The swivelling of the bending jaw 3 according to Figure 4 again takes place about its swivel axis S. As is further evident from Figure 4, the bending jaw 3 is now located above the upper jaw 2 clamping the metal sheet 4 so that upon perpendicular lowering from this position, the bending jaw 3 would come into contact with the upper jaw 2 and not the metal sheet 4. Proceeding from the position according to Figure 4, the bending jaw 3 - cf. Figure 5 - is then moved in a second displacement direction of adjustment along the arrow E until it is outside of the range of the upper jaw 2 and can be lowered onto a protruding sheet metal section which projects between lower jaw 1 and upper jaw 2.

The directions of adjustment of the bending jaw 3 in accordance with the arrows C and E in Figures 3 and 5, respectively, now seem to extend parallel to one another. In actual fact, the arrow C always runs parallel to the small side and the arrow E always parallel to the large side of the rectangle schematically representing the bending jaw 3 in the drawings. Hence the two directions of adjustment according to the arrows C and E always stand perpendicular on one another, and in the transition from Figure 3 to Figures 4 and 5, the arrow C has likewise swivelled through 90°, as indicated in dashed lines in Figure 5.

In order to define the spatial position of the second direction of adjustment in accordance with arrow E, one can also say that this direction of adjustment (arrow E) extends perpendicular to the plane containing the first direction of adjustment (arrow C) and the swivel axis S. This plane extends in Figure 5 perpendicular to the drawing plane and parallel to the arrow C.

When the bending jaw 3 has reached the position illustrated in Figure 5, the upper jaw 2 is raised accordingly (arrow A_1) - cf. Figure 6 - and the metal sheet 4 is advanced to the right so that there is again a protruding sheet metal section 5a adjacent to the sheet metal section 5 which has already been bent. When the metal sheet 4 has been pushed forward into the position according to Figure 6, the upper jaw 2 is lowered again (arrow A) and the metal sheet 4 clamped between lower jaw 1 and upper jaw 2. Thereupon - cf. Figure 7 - the bending jaw 3 is placed against the top or second side of the metal sheet by displacement in the direction of arrow C_1. The direction of adjustment corresponding to the arrow C_1 is parallel to the arrow C but runs in the opposite direction.

Finally, as shown in Figure 8, by swivelling the bending jaw 3 through 90° in the second direction of rotation shown by the arrow F downwards or in the clockwise direction, the sheet metal section 5a is bent in the opposite direction to the sheet metal section 5. The metal sheet 4 thus bent in the opposite direction at its rim can now be removed from the swivel bending machine. By corresponding adjustment of the bending jaw 3 along arrows E and F, the swivel bending machine is brought back into its initial position according to Figure 1.

For the performance of the inventive sheet metal bending process explained with reference to Figures 1 to 8, it is essential that the bending jaw 3 engage the first side of the metal sheet during the first bending operation and the second side of the metal sheet during the second bending operation, as is evident from Figures 1 and 7, respectively. To this end, adjustment of the bending jaw 3 in the first direction of adjustment (along arrow C; Figure 3) is necessary to enable transfer of the bending jaw 3 away from the bent sheet metal section 5 from the first to the second side of the metal sheet. However, since the bending jaw 3 (cf. Figure 4) thereby moves over the projecting part of the upper jaw 2, the bending jaw 3 has to be additionally adjusted (cf. Figure 5) in the second direction of adjustment in the direction of

arrow E so that it can again be position (cf. Figure 7) on a sheet metal section 5a protruding between lower jaw and upper jaw. These two reciprocating movements for adjustment of the bending jaw 3 which stand perpendicular on one another in accordance with arrows C, C_1 and E are thus essential to the inventive process and, in the end, ensure that two-directional sheet metal bending is possible without turning the metal sheet.

Figure 9 shows schematically a swivel bending machine 10 which is structurally designed such that the bending process explained with reference to Figures 1 to 8 can be performed on it. Figure 9 shows in a front view only the right side of such a swivel bending machine 10. The other side is of corresponding mirror-inverted design.

The upper jaw 2 and the bending jaw 3 which are mounted on a machine frame are illustrated in Figure 9. The bending jaw 3 which can be swivelled about the swivel axis S covers in Figure 9 the lower jaw 1 which is likewise mounted on the machine frame 11 and is visible in Figures 1 to 8. The upper jaw 2 is movable up and down in the direction of the arrow G which corresponds to the arrows A and A_1 in Figures 1 and 6, respectively, to clamp and release the metal sheet 4. To this end, the upper jaw 2 is connected to a hydraulic cylinder 12 attached to the machine frame 11. The swivel movement of the bending jaw 3 about the swivel axis S is indicated in Figure 9 by the arrows H which correspond to the arrows B, D, F in Figures 2, 4 and 8, respectively.

The swivelling of the bending jaw 3 is carried out with the aid of a motor 13 attached to the machine frame 11. The motor 13 engages a first swing arm or locker 14 mounted for swivel movement about the swivel axis S and can swivel it back and forth perpendicular to the drawing plane of Figure 9. A second swing arm 16 is mounted on the first swing arm 14 for rotation about an axis 15. The axis 15 lies below the swivel axis S. A piston-cylinder-unit 18 is provided between a protruding foot 17 of the second swing arm 16 and the bending

jaw 3. Its cylinder 19 is rigidly connected to the bending jaw 3 and its piston rod 21 to the foot 17. The cylinder 19 can be additionally guided in straight-line configuration along arrows I on the second swing arm 16. In this way, the piston-cylinder-unit 18 forms a guide means for the bending jaw 3 such that upon actuation of the unit 18, the bending jaw 3 can be displaced in a straight line relative to the second swing arm 16, away from the swivel axis S or towards this axis. This first adjusting movement of the bending jaw 3 is illustrated by the arrows I which correspond to the arrows C, C_1 in Figures 3 and 7, respectively.

The second adjusting movement mentioned hereinabove which takes place perpendicular to the plane containing the first direction of adjustment I and the swivel axis S (drawing plane of Figure 9) is implemented with the aid of the second swing arm 16. When the second swing arm 16 is swivelled about the axis 15 with the aid of a drive motor 22 indicated in dashed lines in Figure 9, the bending jaw 3 or at least its working surface engaging the metal sheet to be bent is adjusted perpendicular to the drawing plane of Figure 9 in accordance with arrow E in Figure 5.

It is possible for the straight-line guide means formed by the piston-cylinder-unit 18 in the embodiment according to Figure 9 to also be designed in a different way, for example, by a sliding guide means for the bending jaw 3, with a separate drive device, for example, an electric motor with a gear spindle, then being allocated to this jaw 3. The second swing arm 16 could - instead of being adapted to swivel about the axis 15 - also be slidably connected to the first swing arm 14 in a different way, for example, likewise by a straight-line guide means. In any case, the structural design of the swivel bending machine 10 must ensure that the adjustment of the bending jaw 3 in the first and second directions of adjustment (arrows C and E) explained in detail hereinabove is possible.

CLAIMS

1. Process for two-directional bending of sheet metal having a first side and an opposed second side, by a bending press, said process comprising the steps of

(a) clamping the sheet metal by a clamping force between a lower cheek and an upper cheek, leaving a projecting length of the sheet metal project beyond the upper and lower cheeks;

(b) applying a bending face of a bending cheek to the first side of the sheet metal at the projecting length and bending said projecting length through a specified angle by pivoting the bending cheek in a first direction of rotation about a pivot axis to provide a bent length of the sheet metal;

(c) displacing the bending cheek away from said bent length of the sheet metal in a first displacement direction extending in radial direction to said pivotal axis and being arranged in a coordinate system rotating with said bending cheek;

(d) following the withdrawal of the bending cheek from the bent length of the sheet metal, moving the bending cheek further in said first direction of rotation until, after a movement over 180° in total, said bending face of the bending cheek faces the second side of the sheet metal;

(e) within a period of time displacing the bending cheek in a second displacement direction transverse to said first displacement direction, releasing the clamping force and moving the sheet metal a predetermined distance in said first displacement direction to expose a further projecting length of the sheet metal, and reapplying the clamping force, whereby at the end of said period of time said bending face faces the second side of the sheet metal at said further projecting length thereof; and

(f) applying said bending face to the second side of the sheet metal at said further projecting length, by displacement of the bending cheek in said first displacement direction and bending the further projecting length of the sheet metal through a specified angle by

pivoting the bending cheek in a second direction of rotation opposite to said first direction of rotation.

2. A bending press for carrying out the process of claim 1, comprising

a lower cheek; an upper cheek and a bending cheek comprising two opposed ends;

a first rocker associated with each said ends of the bending cheek and pivotable about the pivotal axis of the bending cheek;

a second rocker movably mounted on said first rocker;

a guide provided on said second rocker said guide carrying said bending cheek and permitting a substantially rectilinear motion of the bending cheek with respect to said second rocker in a first displacement direction transverse to said pivotal axis of the bending cheek; and

said bending cheek being moveable in a second displacement direction extending transverse to said pivotal axis of the bending cheek and transverse to said first displacement direction by movement of the second rocker with respect to the first rocker.

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FIG.1

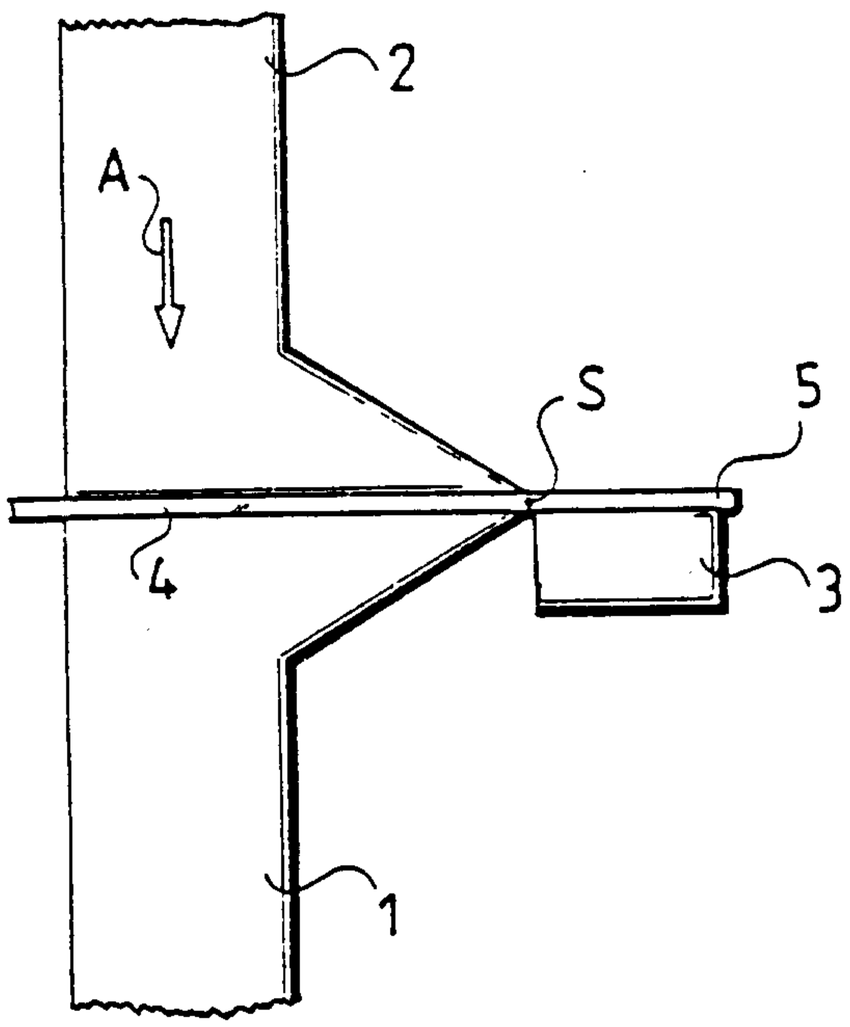

FIG.2

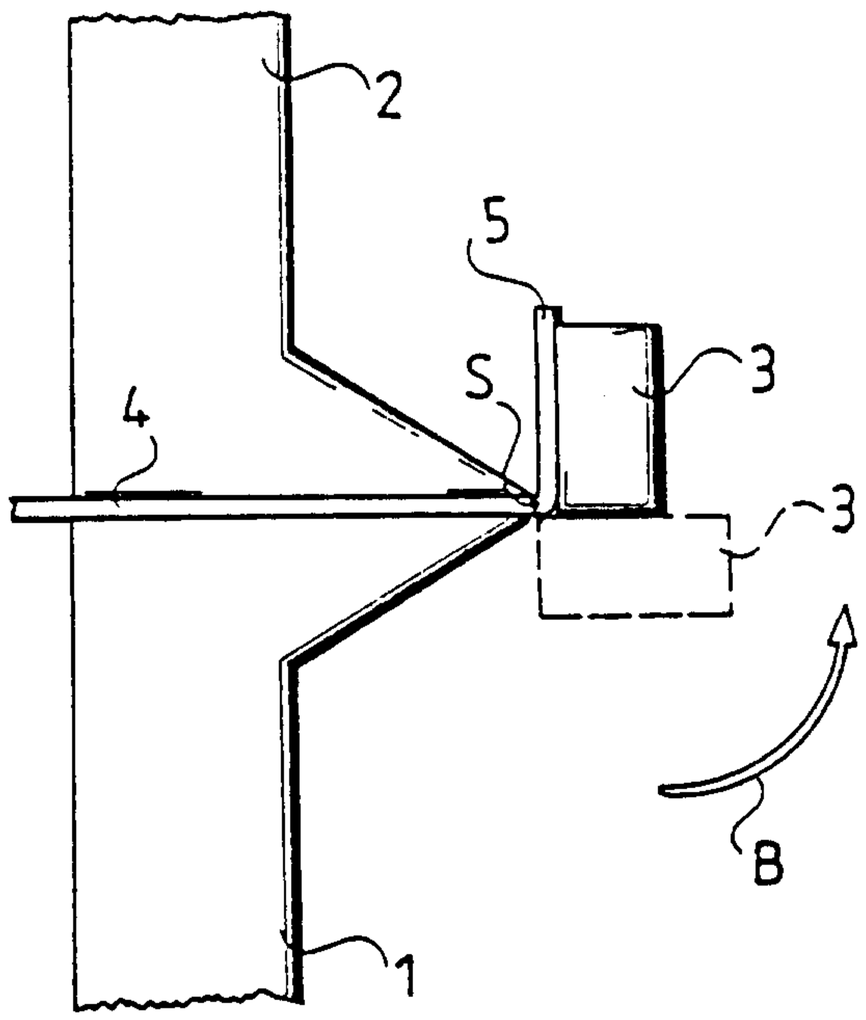

FIG.3

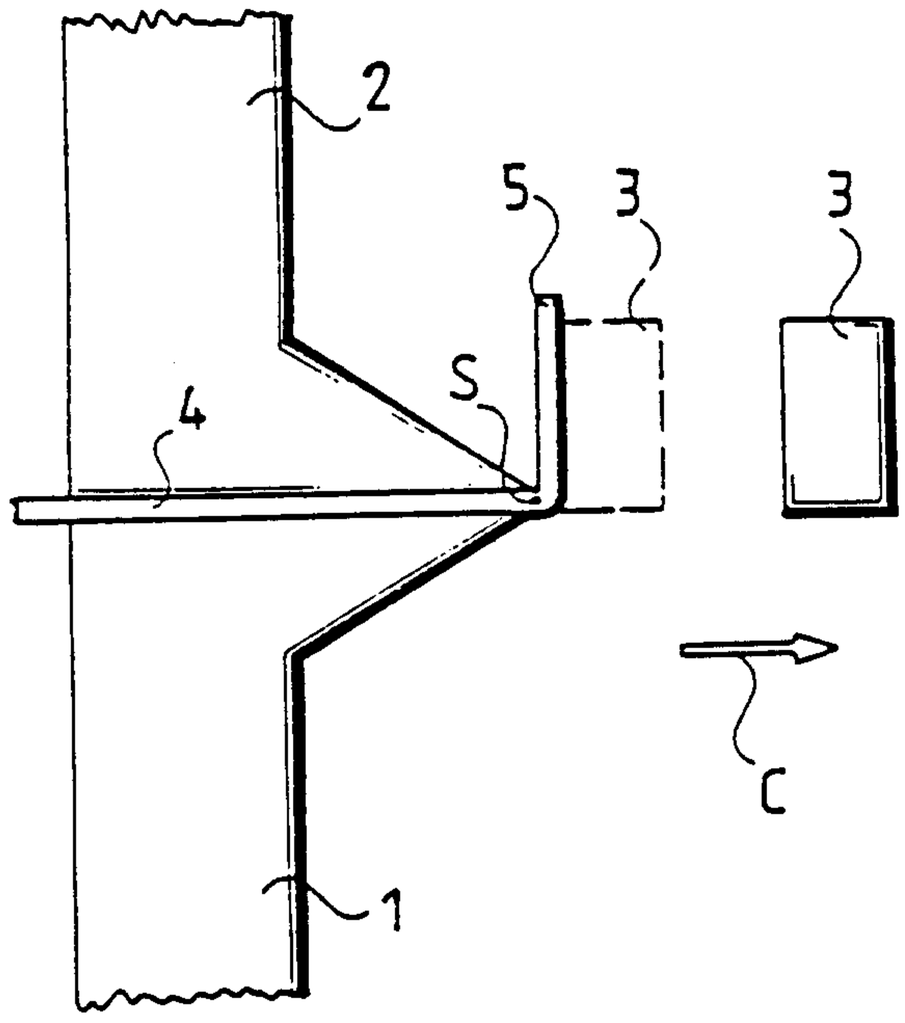

FIG.4

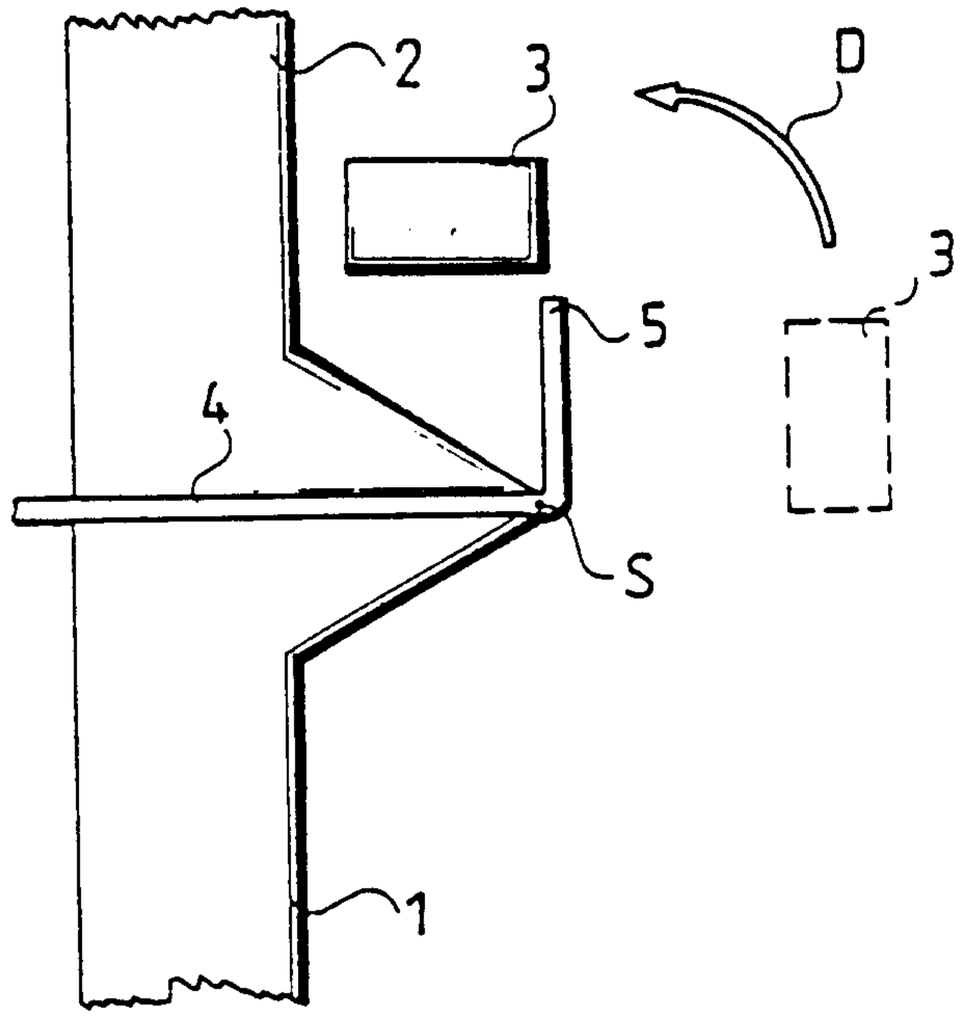

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FIG.5

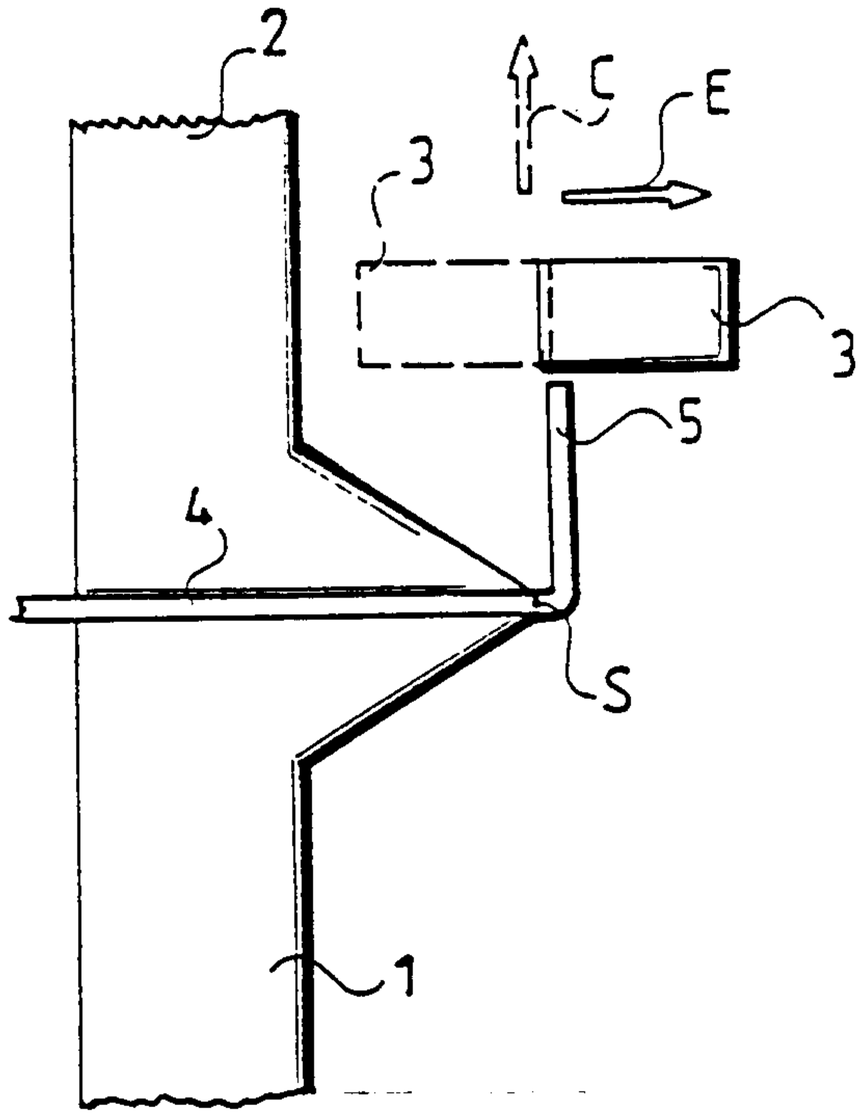

FIG.6

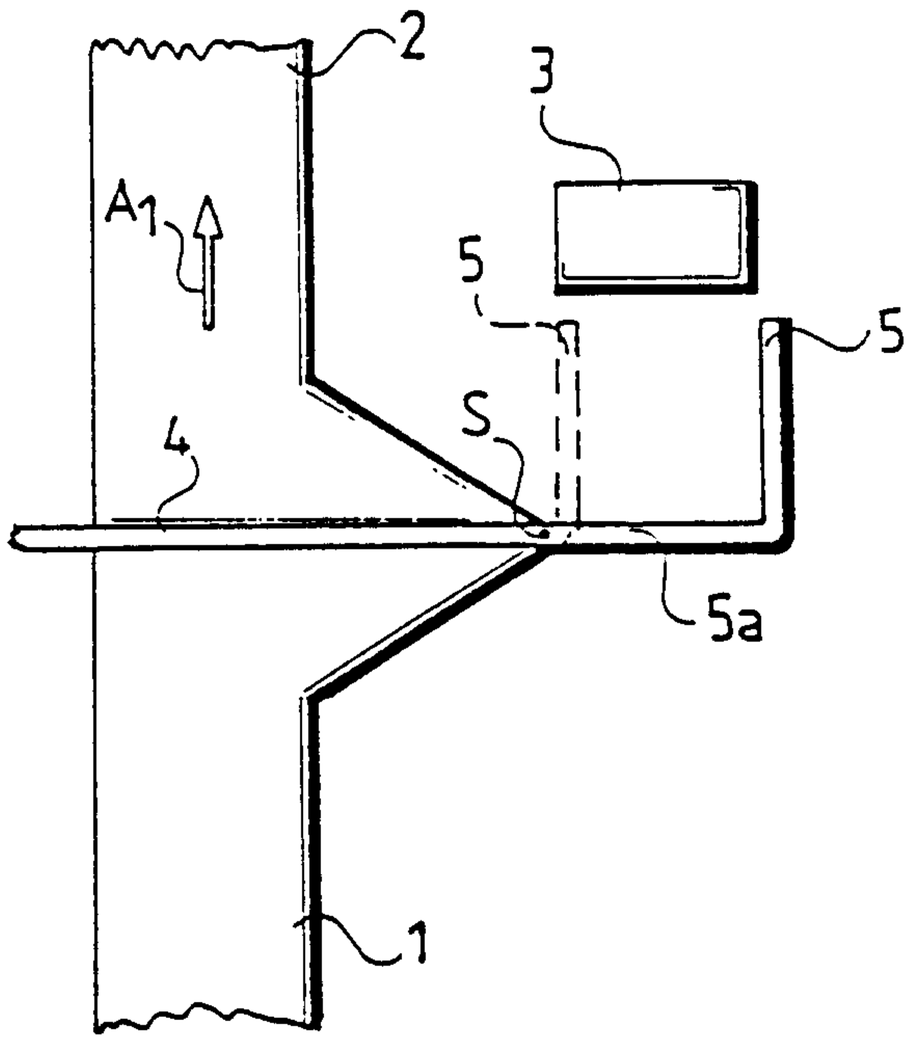

FIG.7

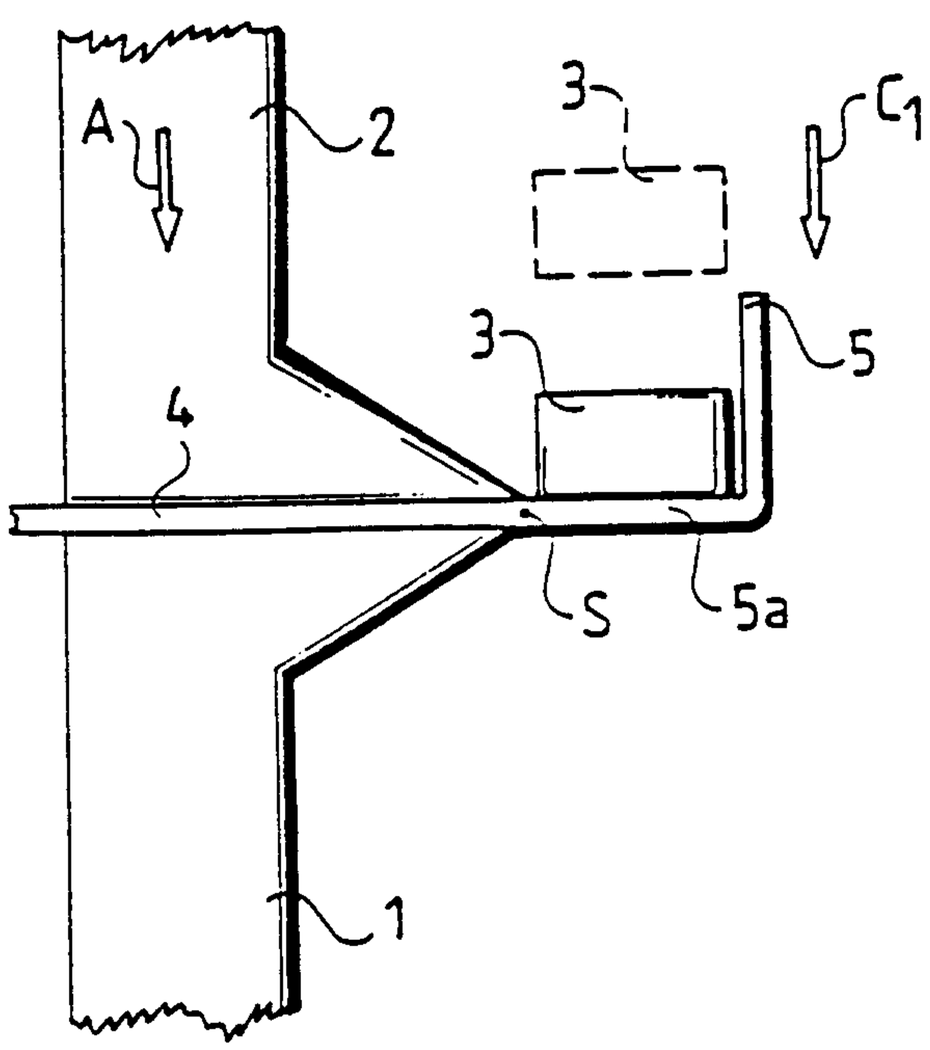

FIG.8

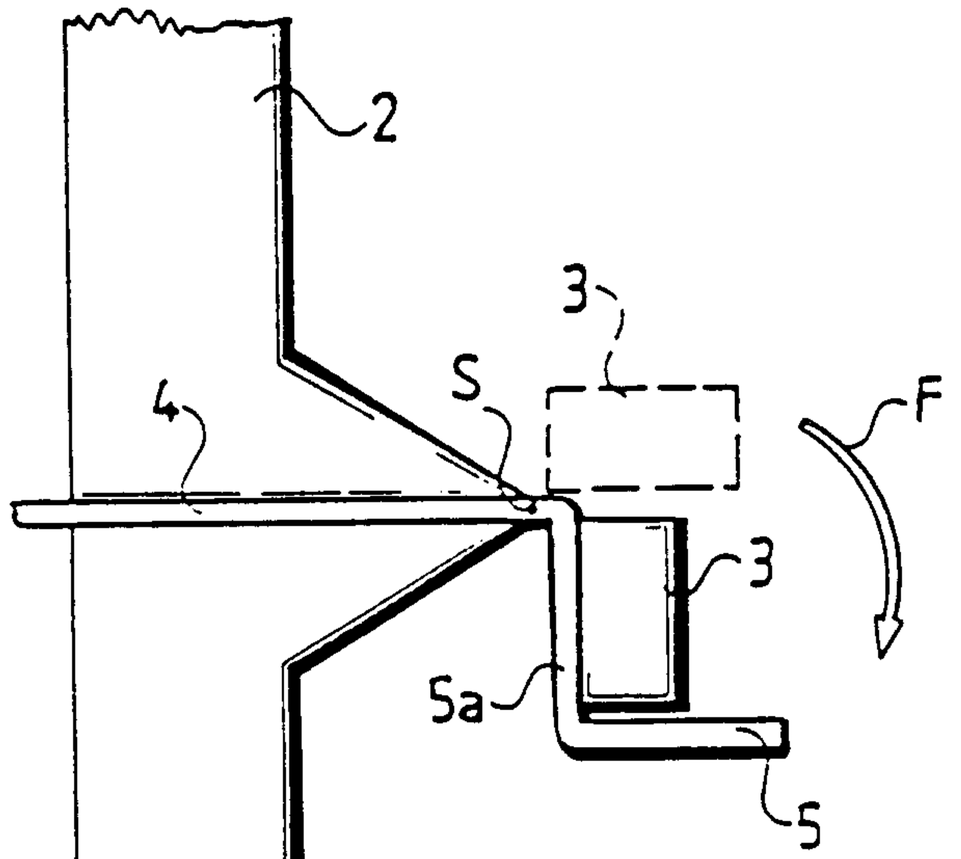

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FIG.9