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(71)(72) Applicant and Inventor: CODATTO, Antonio [IT/IT]; Via Enrico Fermi, 17, I–36045 Lonigo (IT).

(74) Agents: SACONNEY, Piero et al.; Jacobacci & Perani S.p.A., Corso Regio Parco, 27, I–10152 Torino (IT).

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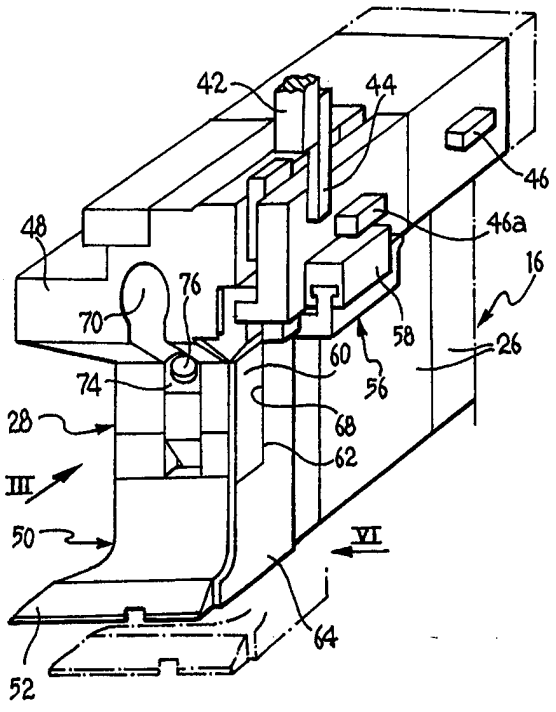
(54) Title: A BENDING PRESS FOR FORMING CHANNEL–SHAPED BENDS IN THE EDGES OF A METAL SHEET

(57) Abstract

The movable blank–holder (16) of a bending press comprises a series of segments (26, 28) and a pair of motor–driven carriages (42) each of which has an entraining member (44) which can selectively engage and release the segments (26, 28) in order to move them for re–arrangement purposes. Each of two segments (28) situated at opposite ends of the series comprises a shoe–holder body (48) which supports a respective shoe (50) by means of inclined guides. Each shoe–holder body (48) carries a respective slide (56) having a driving portion (60) and each shoe (50) has a driven portion (64). These driving and driven portions have facing cooperating pressure and sliding faces (62, 68) arranged in a manner such that a movement of the slide (56) towards the centre of the press is converted into an oblique movement of the respective shoe (50) such that is is released from a lateral channel–shaped bend already formed in a metal sheet, without sliding on the sheet. Each carriage (42) comprises an entraining member (44) and each slide (56) comprises an entrained member (58) which can be engaged by the entraining member (44) in order to move the slide (56) selectively towards the centre of the press. The two carriages (42) are movable simultaneously in opposite directions upon command in order to simultaneously bring about the aforementioned movements of the shoes (50), by means of the slides (56), in directions such as to release them from the respective lateral bends. The shoes (50) have respective resilient means for biasing them in directions such as to return each shoe (50) to a working position to which it is moved away from the centre of the press and from the movable blank–holder.



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A bending press for forming channel-shaped bends in the edges of a metal sheet

The present invention relates to a bending press for forming channel-shaped bends in the edges of a metal sheet, according to the preamble to Claim 1.

A bending press according to the preamble to Claim 1 is known from the document WO 96/13346.

A bending press according to one embodiment described and illustrated in the document WO 96/13346 comprises a pair of carriages which can be moved along its movable blank-holder in order to rearrange its segments. Each of these carriages comprises a first set of teeth fixed to the carriage, an input shaft housed in the shoe-holder body and connected to the first set of teeth by a toothed sprocket, a second set of teeth fixed to the shoe, and gearing for transmitting the drive of the input shaft to the second set of teeth.

This known mechanism enables the movements of the two shoes to be coordinated with the movements of the movable blank-holder, preferably by numerical control, in a manner such that, for movements of the movable blank-holder away from the fixed blank-holder there are corresponding simultaneous movements of the two shoes towards the centre of the press and towards the fixed blank-holder, without sliding of the shoes on the sheet. The two shoes are returned to the position in which they are moved away from the centre of the press by means of respective spiral springs or equivalent

means incorporated in the shoe-holder body and interposed between it and the input shaft of the mechanism.

The mechanism according to document WO 96/13346 represented considerable progress in comparison with the prior art but has the disadvantage of being expensive because of the precision required in the manufacture and assembly of its components, particularly of its sets of teeth and its toothed sprockets.

The object of the invention is to provide a bending press of the type in question in which the function of controlling the movements of the shoes is performed by much simpler and more inexpensive means.

According to the invention, this object is achieved by means of a bending press as claimed.

In a press according to the invention, the devices which transmit the movement of the carriages to the shoes in order to move them towards the centre of the press and towards the fixed blank-holder, that is, in order to release them from the channel-shaped bends without sliding on the sheet, do not comprise toothed members requiring very precise manufacture. As will be understood better from a reading of the detailed description given with reference to the drawings, according to the invention, these devices comprise very simple elements which operate by pressure and by relative sliding; even though the cooperating surfaces of these elements require a certain precision of manufacture, this precision does not involve such high costs as the manufacture of teeth.

The invention will be understood better from a reading of the following detailed description, given by way of non-limiting example, with reference to the appended drawings, in which:

Figure 1 is a schematic, perspective view of a bending press to which the invention is applied,

Figure 2 is a perspective view of an end region of the movable blank-holder of the press of Figure 1, on an enlarged scale, including one of the two shoe/shoe-holder units (the left-hand one closer to the observer in Figure 1), it being understood that the other shoe/shoe-holder unit is formed as mirror image thereof,

Figure 3 is a side elevational view taken on the arrow III of Figure 2,

Figure 4 is a section taken in the plane indicated IV-IV in Figure 3,

Figure 5 is a section of a detail taken on the line V-V of Figure 4,

Figures 6 and 7 are front elevational views taken on the arrow VI of Figure 2 showing the shoe of the unit in the position to which it is moved away from the centre of the press and from the fixed blank-holder, and in the position to which it is moved towards the centre of the press and towards the fixed blank-holder, respectively, and

Figures 8, 9 and 10 are partial schematic front views taken on the arrow VIII of Figure 1 showing three successive stages of the release of the movable blank-holder of the press and of its shoes from a metal sheet two opposite edges of which already have channel-shaped bends.

The embodiment shown in the drawings relates to the most common case of a press in which the movable blank-holder is the upper one, the fixed blank-holder is the lower one, and the plane of the metal sheet subjected to bending is horizontal.

The invention is not limited to this arrangement, however, since, by virtue of the fact that the movements of the shoes are brought about positively, it can be applied to other arrangements such as, for example, an arrangement in which the movable blank-holder is the lower one, or an arrangement in which the plane of the metal sheet is vertical and the movable blank-holder moves horizontally.

With reference to Figure 1, a vertical bending press, generally indicated 10, comprises a strong channel-shaped frame, generally indicated 12.

A strong front plate 14 is slidable vertically on an upper front portion of the frame 12 and its lower portion carries an upper movable blank-holder, generally indicated 16, which will be referred to further below.

Upward and downward vertical movements of the front plate 14 and of the blank-holder 16 are brought about by one or more hydraulic actuators, not shown.

A lower front portion of the frame 12 carries a fixed blank-holder 18 with which the movable blank-holder 16 cooperates during bending operations.

A blade-holder 20 mounted in the cavity defined by the channel-shape of the frame 12 is also channel-shaped and carries a pair of bending blades, that is, a lower blade 22 and an upper blade 24.

The blade-holder 20 can be moved upwards and downwards and also advanced and retracted under the control of actuators which are preferably numerically controlled, in order selectively to cause its lower blade 22 to cooperate with the upper blank-holder 16 or its upper blade 24 with the lower blank-holder 18.

For further details relating to the blade-holder 20 and to its control actuators, reference should be made to an International patent application filed by the Applicant on the same date for "A sheet-metal bending press" and claiming priority of Italian patent application No. TO97A000314 of April 15, 1997.

The upper movable blank-holder 16 is of the sectional type formed by a series of segments 26, for example, as in the bending presses described and illustrated in the documents US-A-4 089 198 and WO 96/13346.

The series of segments 26 comprises two special segments, indicated 28, which are spaced apart so as to correspond to opposite lateral edges of a metal sheet. In Figures 1, 2 and 8 to 10, these segments 28 are arranged at the two ends of the series of segments, that is, in positions corresponding to the maximum useful width of the press.

As shown in Figure 1, on the front of the press 10 there is a table 30 for supporting metal sheets being bent. The table 30 is preferably served by a manipulator (not shown).

All of the movements of the press and of its manipulator are preferably controlled by a numerical control device, conventionally indicated by means of a suspended "console" 32 thereof.

A translation bar 34 extending along the movable blank-holder 16 comprises two portions 38 which are threaded in opposite directions.

The bar 34 can be rotated selectively by a numerically-controlled electric motor 40.

The two portions 38 of the bar 34 which are threaded in opposite directions carry respective carriages 42 coupled to these threaded portions by means of respective female threads, not shown. The two carriages 42 are provided for rearranging the segments 26 of the movable blank-holder 16 each time such rearrangement is necessary in order to adapt

the blank-holder 16 to the width of a specific sheet to be bent.

With reference to Figures 1, 2, 6, 7 and 8 to 10, in order to perform these operations to rearrange the segments 26, each carriage 42 has a respective entraining member 44, further details of which will be given below.

For the moment, it will suffice to state that an upper portion of each of the segments 26 has a respective entrained member constituted by a front projection 46 which can be engaged by a respective entraining member 44.

Further details of the entraining members 44, of the entrained members 46, and of their cooperation will be given below. For the moment it will suffice to state that the left-hand carriage 42 of Figures 1 and 8 to 10 is arranged for moving segments 26 situated to the left of the centre of the press and the right-hand carriage 42 with its entraining member 44 is arranged for simultaneously moving right-hand segments 26 in the opposite direction.

With reference to Figures 2 to 4 and 6 to 10, each end segment 28 comprises a shoe-holder body 48 which acts as the actual segment and has, for its rearrangement by the respective carriage 42, an entrained member 46a in the form of a front projection just like the projections 46 and aligned therewith.

Each body 48 supports a shoe 50 with a lower beak-like projection 52.

As can be seen, for example, in Figures 8 to 10, the projections 52 of each shoe 50 extend in opposite directions so that each can be inserted in a lateral channel-shaped bend, indicated B, already formed in a metal sheet P.

Each shoe 50 is supported by its body 48 by means of inclined guides 54, preferably oriented at 45° to the plane of the metal sheet P (Figures 8 to 10) to be bent.

The cross-section of the guides 54, which is similar to a dovetail, is visible in Figure 5.

Each shoe 50 can move along the guides 54 between a working or engagement position, shown in continuous outline in Figures 2 and 4 as well as in Figure 6, and a release position, shown in broken outline in Figures 2 and 4, as well as in Figure 7.

Means which, in accordance with a preferred embodiment of the invention, serve for converting the movements of the carriages 42 along the translation bar 34 from the working position to the release position, as well as returning them from the release position to the working position, will now be described with reference to Figures 2 to 7.

Each shoe-holder body 48 carries a respective slide 56 slidable on the body 48 in directions parallel to the directions of movement of the carriage 42.

An abutment in the form of a block 58, the function of which will be referred to further below, is fixed to the slide 56 so as to be adjustable in the same directions.

A driving portion 60 in the form of a vertically elongate plate-like portion is fixed to the slide 56. The plate-like portion 60 is fitted flat on a front face of the shoe-holder body 28 and is substantially coplanar with the front faces of the segments 26.

An edge of the plate-like portion 60, indicated 62, facing laterally inwardly relative to the press, extends vertically, that is, in the direction of movement of the movable blank-holder 16.

Each shoe 50 has a driven portion 64 fixed thereto. In the preferred embodiment shown in the drawings, the driven portion 64 is constituted by a plate fixed to the front of the shoe 50 by means of a series of screws 66, the heads of which are shown schematically in Figures 6 and 7.

A straight lateral edge of the plate 64, indicated 68, is parallel to and faces the straight edge 62.

As will be seen from the following, the two edges 62 and 68 constitute facing cooperating pressure and sliding surfaces arranged in a manner such that a movement of the slide 56 towards the centre of the press is converted by the cooperation of the facing surfaces 62, 68 with pressure and sliding into a movement of the shoe 50 from the working position of Figure 6 to the release position of Figure 7.

This movement is controlled positively by the respective carriage 42 in the manner which will be explained below.

A resilient biasing means, an embodiment of which is shown in Figure 4, is provided for returning the shoe 50 from the release position to the working position.

With reference to Figure 4, each shoe-holder body 48 has a recess 70 also visible in Figures 2, 3 and 5. This recess 70 extends parallel to the inclined guides 54 and contains, as resilient biasing means, at least one helical compression biasing spring 72.

The shoe 50 has an appendage 74, also visible in Figures 2, 3 and 5, which is slidable along a fixed rod 76 extending through the spring 70 for centring purposes.

The spring 70 reacts against an end wall 78 of the cavity 70 at one end and against the appendage 74 at the other end.

When the shoe 50 moves from the working position of Figure 6 to the release position of Figure 7, the spring 72 is compressed and biases the shoe in the opposite direction by virtue of the release of its compression energy.

Reference will now be made to Figures 2, 3, 6 and 7 to describe the details of the entraining member 44 of each carriage 42 and the way in which it serves to bring about the movement of the respective shoe 50 from the working position to the release position.

The entraining member 44 is in the form of a bar slidable vertically, that is, in the direction of movement of the movable blank-holder 16, in the respective carriage 42.

The top of the bar 44 is connected to the rod of a respective linear actuator 80 (Figure 1), which is preferably numerically controlled.

The actuator 80 can move the bar between a position in which it is raised, that is, retracted, relative to the fixed blank-holder 18, an intermediate position, and a position in which it is lowered, that is, advanced relative to the fixed blank-holder 18.

In Figure 6, the level of the lower end of the bar 44 in the retracted position is indicated L1, the level of this end in the intermediate position is indicated L2, and its level in the advanced position is indicated L3.

When the bar 44 is retracted, its end which is at the level L1 is above all of the projections or entrained members 46, 46a and any movements of the carriage 42 have no effect.

When the bar 44 is in the intermediate position, its end which is at the level L2 is in a position such that it interferes with the projections 46, 46a and the segments 26, 28 can be arranged by means of the movements of the carriage 42, by virtue of the engagement of the bar 44 with lateral pressure with the selected projection 46 or 46a.

In order to bring about the movements of the shoes from the working position of Figure 6 to the release position of Figure 7, the bars 44 of the two carriages 42 are brought to the advanced position corresponding to the level L3, as shown in Figure 6 in broken outline, and in Figure 7.

In this position, the bar 44 is so arranged as to interfere with the projection or abutment 58 of the slide 56 on its side facing outwardly relative to the press.

In these conditions, a movement of the carriage 42 towards the centre of the press in the direction of the arrow F of Figure 7 is converted into a corresponding movement of the slide 56 by virtue of the engagement of the bar 44 with the abutment or projection 58.

During this movement, the edge 62 of the driving member constituted by the plate-shaped portion 60 of the slide 56 engages the edge 68 of the plate 64 of the shoe 50.

By virtue of the inclined guides 54, the pressure of the edge 62 on the edge 68 is translated into a movement of the shoe 50 in the direction of the arrow G of Figure 7, during which movement the edge 68 moves downwardly along the edge 62.

The arrangement is such that, when the shoe 50 reaches the release position of Figure 7, the bar 44 strikes the projection 46a which constitutes a travel-limit stop.

This travel-limit position can be adjusted by adjustment of the position of the abutment or projection 58 along the slide 56.

Reference will now be made to Figures 8, 9 and 10 to describe the coordinated sequence of movements of the blank-holder 16 and of its end shoes 50, both of which movements are preferably controlled by the numerical-control device 32 of Figure 1.

In Figure 8, the metal sheet P is gripped between the upper blank-holder 16 and the lower blank-holder 18. The two shoes 50 are in the respective working positions of Figure 6 in which they are moved apart and away from the centre of the press and their beak-like projections 52 are fitted in the respective lateral bends B in the sheet P.

With reference to Figure 9, in order to be able to release the sheet P from the press, the numerical control device 32 (Figure 1) brings about upward movement of the movable blank-holder 16 and, at the same time, oblique movement of the two shoes 50 towards their release positions in the direction of the arrow G of Figure 7. The movements are coordinated in a manner such that, as soon as the movable blank-holder 16 is detached from the sheet P, the shoes 50 are also detached from the sheet P whilst starting to move in the direction of the arrow G of Figure 7, so that they never slide on the panel.

Figure 10 shows the final condition in which the movable blank-holder 16 is raised and the shoes 50 are moved the

maximum distance towards one another and have reached the final release position of Figure 7. In this position, the projections 52 no longer interfere with the bends B.

When the upper blank-holder 16 is lowered against a sheet P for bending purposes, the movements of the blank-holder 16 and of the shoes 50, which are coordinated by the numerical-control device 32 of Figure 1, take place in the opposite directions by virtue of the biasing force of the springs 72 of Figure 4, again without sliding of the shoes 50 on the sheet P.

Figure 1 shows a bending press which comprises a pair of blades cooperating with respective opposed blades forming part of respective blank-holders.

The invention may, however, be applied to a press even having only one pair of bending tools (blade and opposed blade), in particular in order to form one or more bends in an edge of a metal sheet in a direction perpendicular to that of the opposed channel-shaped bends indicated B in Figures 8 to 10.

CLAIMS

1. A bending press for forming at least one bend in an edge of a metal sheet of which at least one lateral edge perpendicular to the edge to be bent has already been bent into a channel-shape, of the type comprising a pair of opposed blank-holders, that is, a movable blank-holder (16) and a fixed blank-holder (18), and at least one bending blade (22) cooperating with the movable blank-holder (16), in which:

- the movable blank-holder (16) comprises a series of segments (26, 28) movable along the blank-holder and equipped with a pair of motor-driven carriages (42) each of which has a entraining member (44) which can selectively engage and release the segments (26, 28) in order to move them for rearrangement purposes,

- each of two segments (28) situated at opposite ends of the series comprises a shoe-holder body (48) which supports a respective shoe (50) by means of inclined guides (54) converging towards the fixed blank-holder (18),

- the two shoes (50) have projections (52) extending in opposite directions for insertion in respective channel-shaped bends (B) which have already been formed,
- each carriage (42) can bring about a movement of a respective shoe (50) along its inclined guides (54) in a direction towards the centre of the press (10) and towards the fixed blank-holder (18) whilst the movable blank-holder

(16) is moving away from the fixed blank-holder (18) after the formation of the bend, and

- the shoes (50) have respective means (72) for resiliently biasing them away from the centre of the press (10) and from the movable blank-holder (16),

characterized in that

- each shoe-holder body (48) carries a respective slide (56) movable parallel to the direction of movement of the respective carriage (42),

- each slide (56) has a driving portion (60) and each shoe (50) has a driven portion (64), the driving and driven portions having facing, cooperating pressure and sliding surfaces (62, 68) arranged in a manner such that a movement of the slide (56) towards the centre of the press (10) is converted by the cooperation of the facing surfaces (62, 68) with pressure and sliding into an oblique movement of the respective shoe (50) along the respective inclined guide (54) towards the centre of the press (10) and towards the fixed blank-holder (18),

- each carriage (42) comprises an entraining member (44) and each slide (56) comprises an entrained member (58) which can be engaged by the entraining member (44) of the respective carriage (42) in order to move the slide (56) selectively towards the centre of the press (10), and

- the two carriages (42) are movable simultaneously in opposite directions upon command in order simultaneously to bring about the aforementioned movements of the shoes (50) by means of the slides (56).

2. A bending press according to Claim 1, characterized in that each carriage (42) comprises a single entraining member (44) for selectively moving the segments (26, 28) for rearrangement purposes and for engaging the entrained member (58) of a respective slide (56) in order to move it towards the centre of the press (10).

3. A bending press according to Claim 2, characterized in that the entraining member of each carriage (42) is constituted by a bar (44) extending in the direction of movement of the movable blank-holder (16) and movable by a respective actuator (80) in this direction between a position (L1) in which it is retracted relative to the fixed blank-holder (18), an intermediate position (L2), and a position (L3) in which it is advanced relative to the fixed blank-holder (18), in that each segment (26, 28) has a first front projection (46) which can be engaged laterally by the bar (44) for the purposes of rearrangement of the segments (26, 28), in that each slide (56) has a second front projection (58) which can be engaged laterally by the bar (44) of the respective carriage (42) for the purpose of moving the slide (56) in the direction corresponding to the inward movement of the shoe (50), and in that the arrangement of the bar (44) and of the projections (46, 46a, 58) is such that, in its intermediate position (L2), the bar (44) can engage only the projections (46, 46a) of the segments (26, 28), including the

projection (46a) of the respective shoe-holder body (28) and, in the advanced position (L3), the bar (44) can engage the projection (58) of the respective slide (56).

4. A bending press according to Claim 3, characterized in that, when the slide (56) is in the position farthest from the centre of the press (10), its projection (58) is farther from the centre than the projection (46a) of the shoe-holder body (28) and the projection (46a) of the shoe-holder body (28) is arranged in a manner such as to constitute, in the direction in which the movable blank-holder (16) extends, a lateral travel abutment for the bar (44) in the position of the slide (56) which corresponds to the position in which the shoe (50) is moved towards the fixed blank-holder (18) and towards the centre of the press (10).

5. A bending press according to any one of the preceding claims, characterized in that the said driven portion is constituted by a plate (64) fixed to the front of the respective shoe (50) and having, as a facing surface, a straight edge (68) extending in the direction of movement of the movable blank-holder (16), perpendicular to the direction of movement of the slide (56), and facing laterally outwardly relative to the press (10), and the respective driving portion is constituted by a plate-like portion (60) projecting from the carriage (42), coplanar with the plate (64) fixed to the shoe (50), and having, as a facing surface, a straight edge (62) parallel to the straight edge (68) of the plate (64), fixed to the shoe (50), and facing laterally inwardly relative to the press (10).

6. A bending press according to any one of the preceding claims, characterized in that each resilient biasing means comprises at least one helical compression biasing spring (72) which extends parallel to the inclined guide (54), is housed in a recess (70) in the shoe-holder body (48), and reacts against an end wall (78) of the recess (70) at one end and against an appendage (74) of the shoe (50) at the other end.

7. A bending press according to any one of Claims 3 to 6, characterized in that it comprises a threaded translation bar (34) extending along the movable blank-holder (16) and having two portions (38) threaded in opposite directions and coupled with respective female threads of the respective carriages (42), and a numerically-controlled electric motor (40) for rotating the threaded bar (44), in that each carriage (42) carries a numerically-controlled actuator (80) for moving the respective bar (44), and in that the bending press comprises a numerical-control unit (32) which controls the motor (40) and the actuators (80) in coordination with the means for controlling the movable blank-holder (16) in a manner such that, for movements of the movable blank-holder (16) away from and towards the fixed blank-holder (18), there are respective corresponding movements of the shoes (50) towards one another and apart, without sliding of the shoes on the metal sheet interposed between the two blank-holders (16, 18).

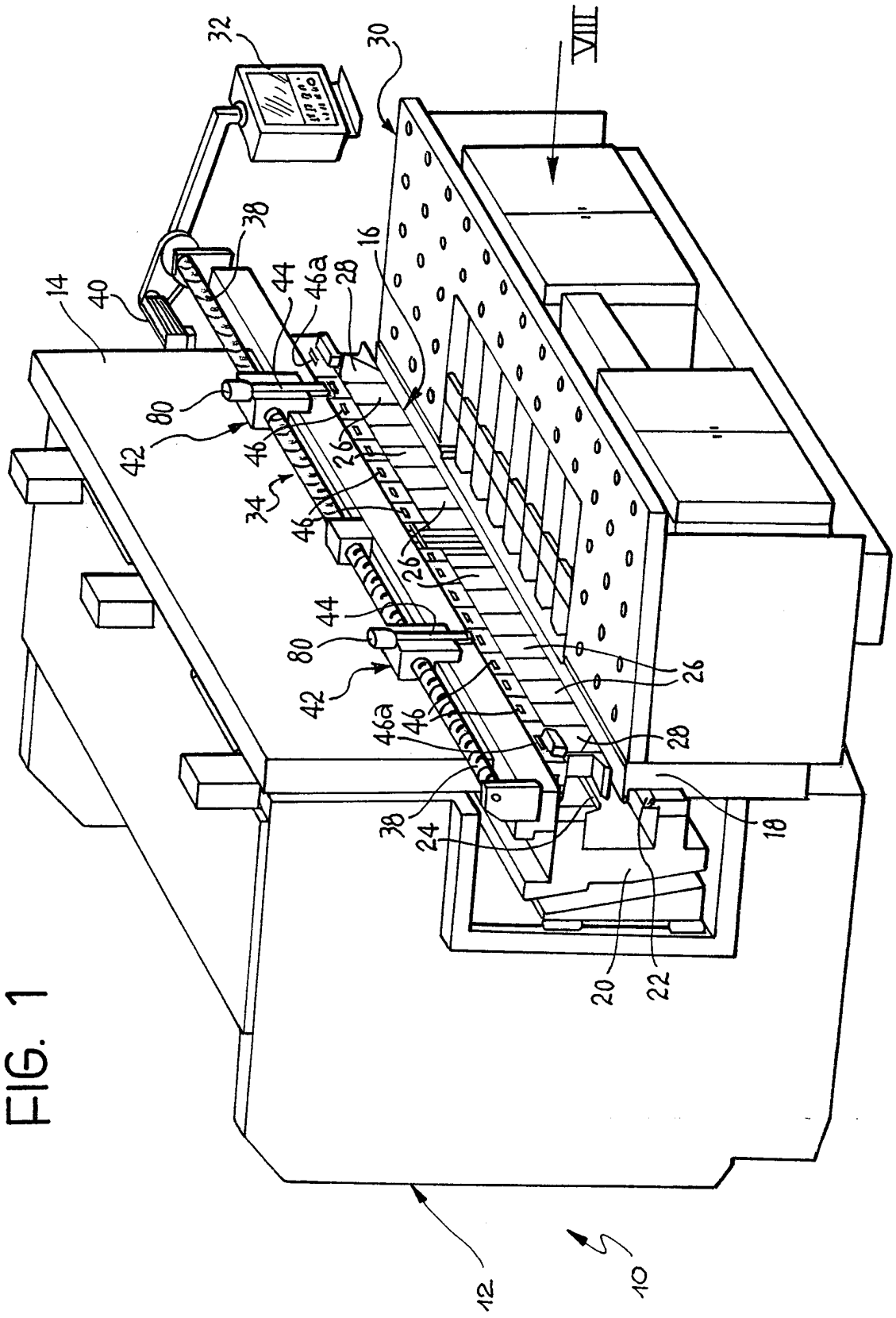
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FIG. 1

FIG. 3

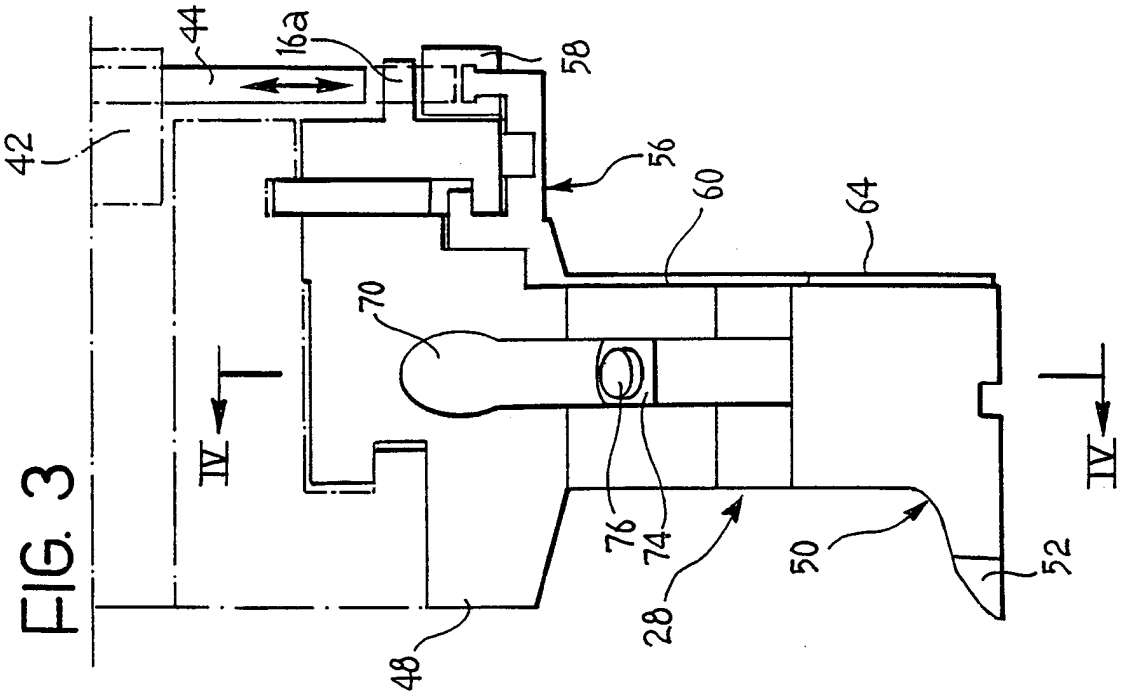


FIG. 5

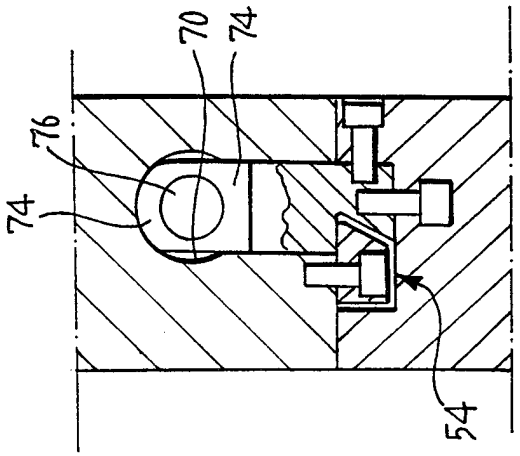


FIG. 2

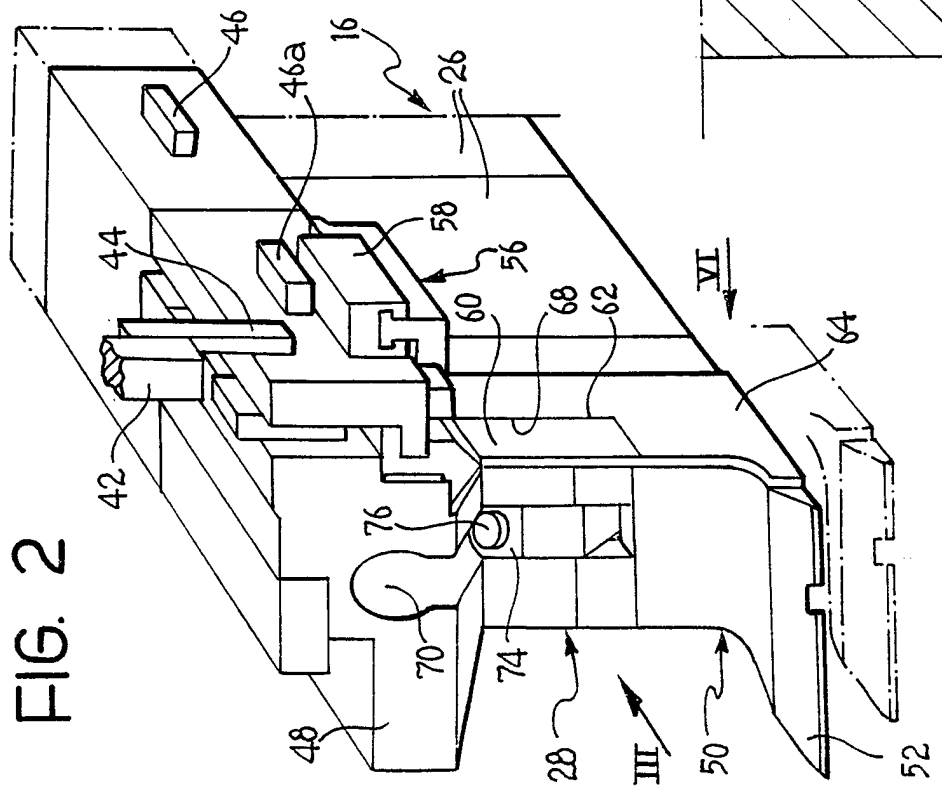


FIG. 4

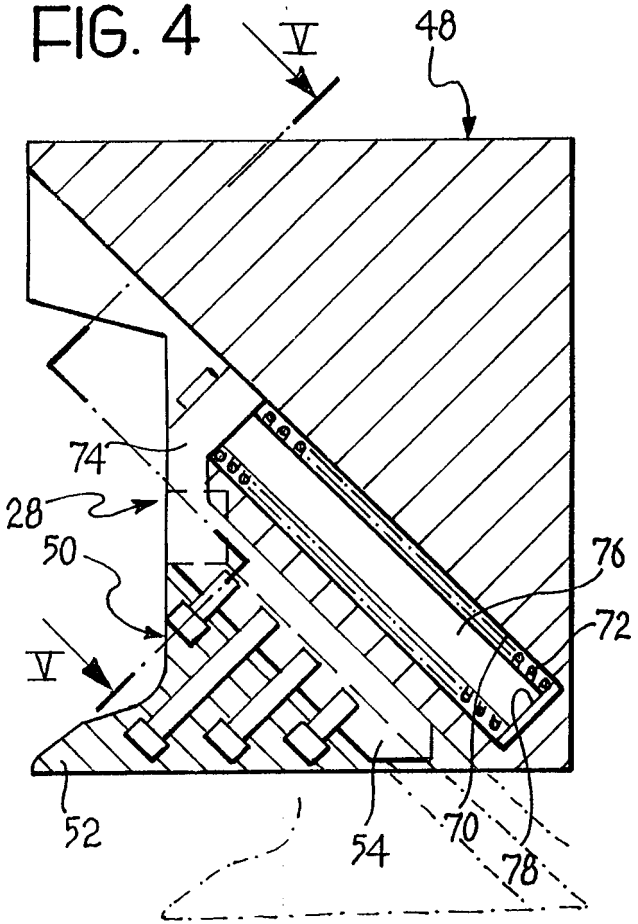


FIG. 6

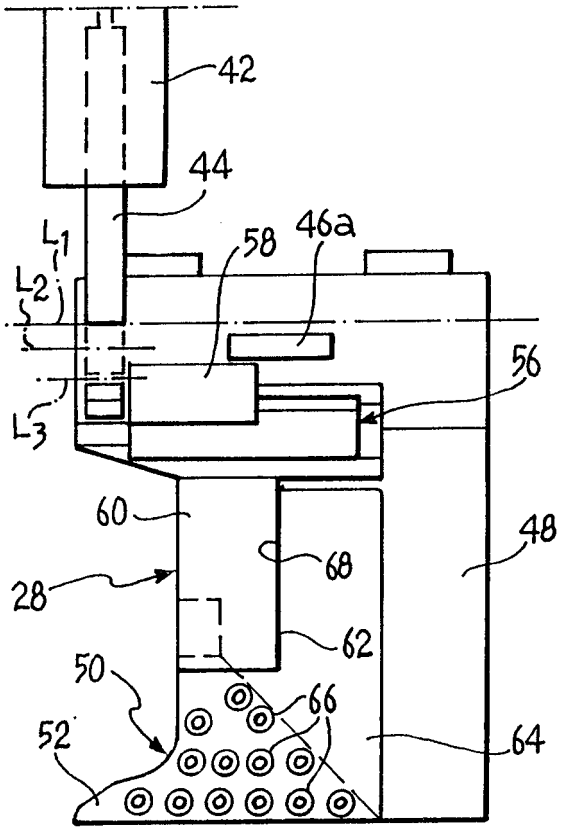


FIG. 7

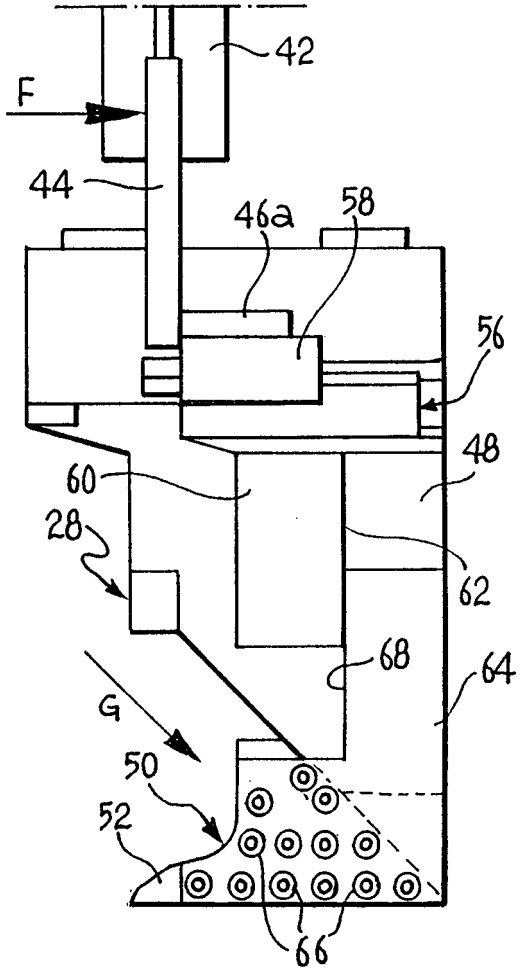


FIG. 8

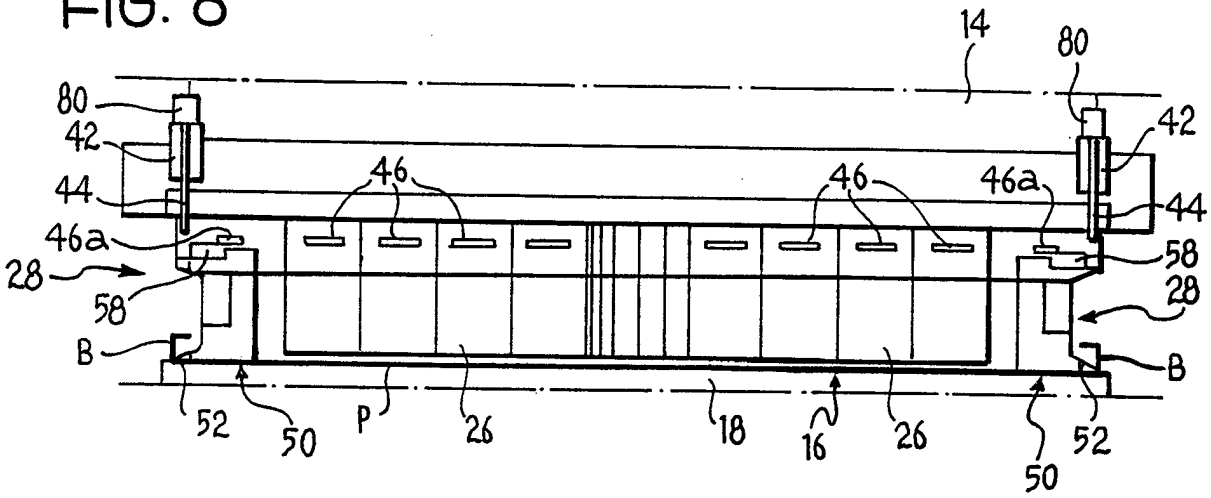


FIG. 9

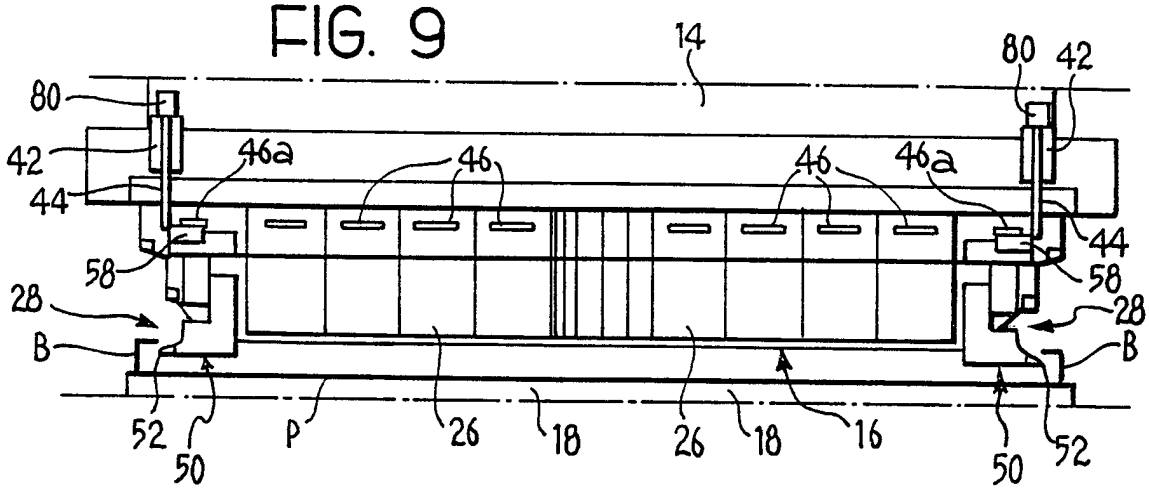
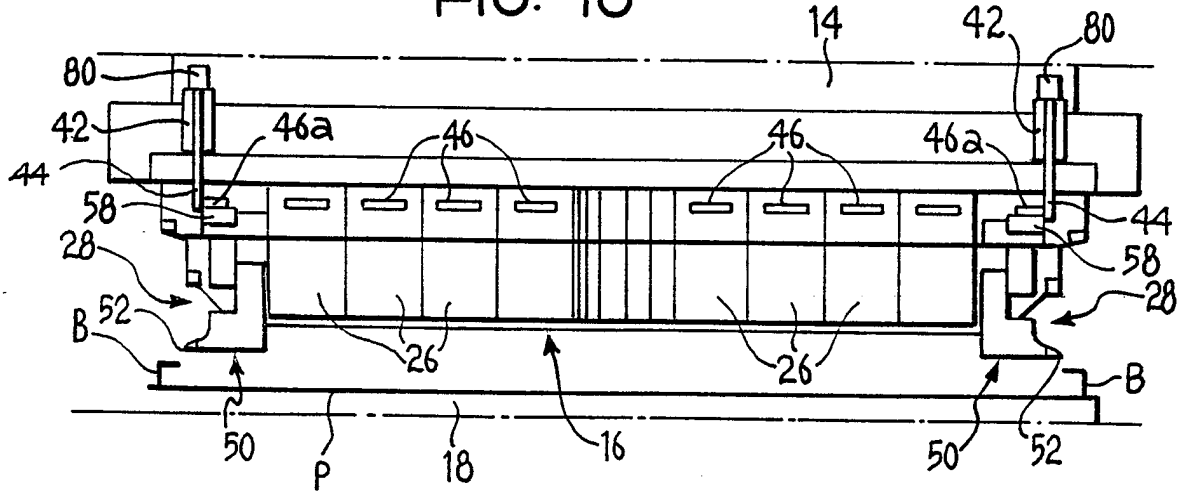


FIG. 10



INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/EP 98/02162

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B21D5/04

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 B30B

Documentation searched other than minimumdocumentation 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	WO 96 13346 A (SAPIM AMADA S.P.A) 9 May 1996 cited in the application see the whole document	1
A	US 5 313 814 A (KABUSHIKI KAISHA KOMATSU) 24 May 1994 see the whole document	1
A	US 4 660 402 A (MARU KIKAI KOGYO CO.) 28 April 1987 see the whole document	1

☐ 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 theinternational search	Date of mailing of the international search report
23 July 1998	07/08/1998

Name and mailing address of the ISA	Authorized officer
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1

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte ional Application No
PCT/EP 98/02162

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