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(54) **ROLL FORMING MACHINE, IN PARTICULAR FOR MAKING A VARIABLE-SECTION PROFILE**

(57) The present invention relates to a roll forming machine, in particular for making a variable-section profile, wherein said roll forming machine comprises at least one roll forming station (1) comprising a pair of rotary shafts (10) positioned vertically one over the other and substantially parallel to each other, in particular the ends of each shaft (10) being supported by a pair of uprights (11) through the interposition of a shoulder (12) that provides the coupling between the ends of the shaft (10) and the respective upright (11), wherein each shaft (10) comprises a roll forming tool (20) associated with the shaft (10), which cannot rotate relative to said shaft (10), wherein each roll forming tool (20) is divided transversally, with reference to an axis of rotation of the shaft (10), into a pair of forming rolls (21), and wherein said roll forming station (1) comprises at least one adjuster device (30) for adjusting the width of at least one roll forming tool (20) by moving at least one roll (21) axially on the shaft (10).

The peculiar feature of the present invention lies in the fact that said at least one adjuster device (30) comprises a double-acting cylinder, in particular of hydraulic or pneumatic type, comprising a piston (31) connected to said at least one roll (21), wherein said piston (31) has a hole (31F) extending along a longitudinal axis (31A) of said piston (31), and wherein the shaft (10) passes through said hole (31F).

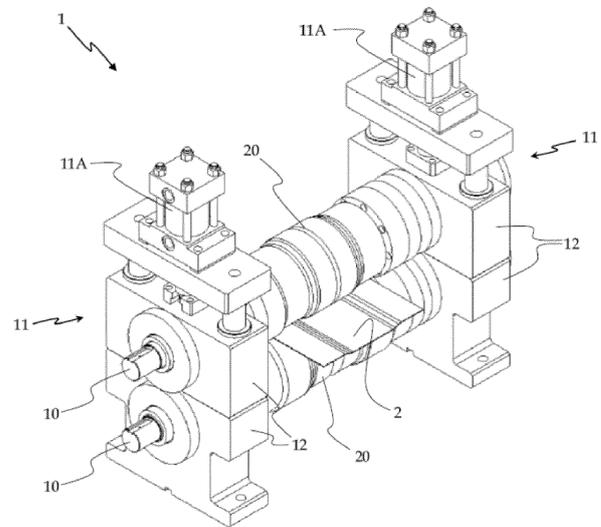


Fig. 1

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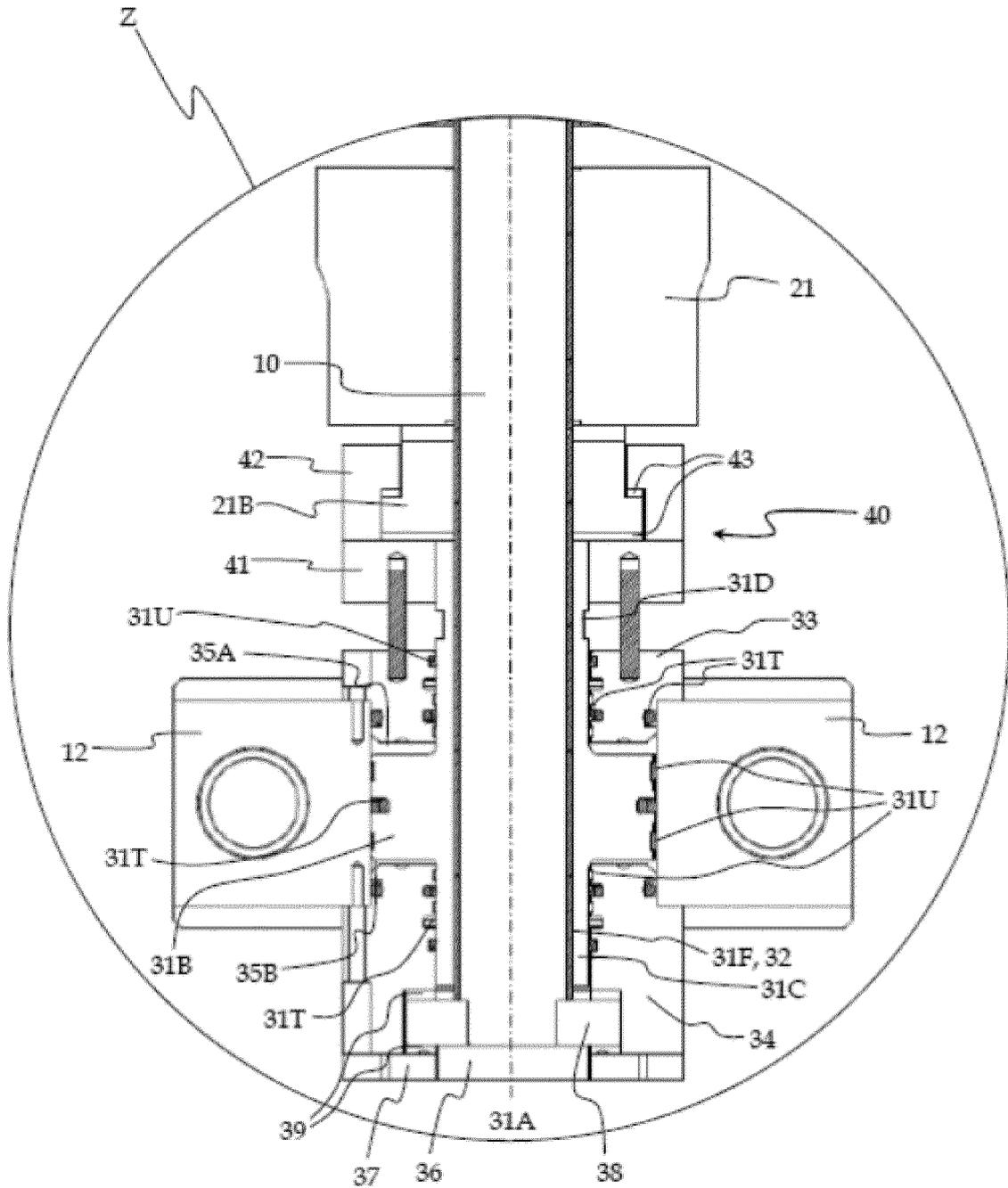


Fig. 3

## Description

**[0001]** The present invention relates to a roll forming machine, in particular for making a variable-section profile, according to claim 1.

**[0002]** It is known in the art to use a roll forming machine for bending (i.e. forming) a profile, wherein the piece being processed is usually received flat into the roll forming machine, and bends are progressively formed as the piece moves through the roll forming machine.

**[0003]** In fact, a roll forming machine of a known type typically comprises a plurality of roll forming stations arranged in succession, wherein each roll forming station comprises at least one shaft carrying a pair of forming rolls that cannot rotate relative to it. Usually the roll forming stations of the roll forming machines currently known in the art comprise a first shaft and a second shaft positioned vertically one over the other (so that they can also be defined as lower shaft and upper shaft), wherein a roll forming tool comprising a pair of forming rolls is associated with each shaft.

**[0004]** In order to make a variable-section profile, i.e. a profile having different widths along its longitudinal development, roll forming machines are known in the art wherein the forming rolls are divided into individual rolls or disks mounted on movable assemblies with a cantilevered bearing shaft.

**[0005]** However, such roll forming machines suffer from some drawbacks, in that said individual rolls or disks can only be moved by associating a suitable motor with each cantilevered bearing shaft; therefore, it is clear that such a type of roll forming machine is excessively complex and costly.

**[0006]** With a view to creating a roll forming machine which, in addition to producing shaped profiles or semi-finished products having a constant cross-section (e.g. cylindrical pipes, uprights for shelves, and so forth), can also make profiles having a variable cross-section in the longitudinal direction (e.g. variable-width profiles and/or variable-diameter pipes), Italian patent No. IT1138381 provides a solution wherein at least one roll forming tool is divided transversally to its axis of rotation into a pair of rolls mounted on a single shaft, wherein said rolls can be moved towards or away from each other during the roll forming process, so that the shaped profile or semi-finished product can be given a variable width in the longitudinal direction.

**[0007]** In this frame, the solution shown in document IT1138381 lies in the fact that the roll forming machine comprises a mechanical adjuster device for adjusting the width of the forming rolls.

**[0008]** In particular, in a first embodiment said adjuster device comprises a disk cam mounted on the working shaft, wherein the disk cam permits moving the rolls away from each other to widen the roll forming tool. In a second embodiment, said adjuster device comprises pistons associated with a central body interposed between two rollers mounted on the same shaft, wherein by actuating the

pistons it is possible to move said rolls away from each other and widen the roll forming tool. The first and second embodiments envisage the use of return springs for axially moving back the previously opened-out rolls. In a third embodiment, the adjuster device comprises control levers, the ends of which slidably engage into circumferential grooves on the movable rolls, and by moving the control levers it is possible to obtain a corresponding axial displacement of the rolls on the control shaft. The third embodiment may also include return springs for axially moving back (i.e. bringing closer again) the previously opened-out rolls.

**[0009]** However, the various embodiments of the adjuster device shown in document IT1138381 suffer from some drawbacks, in that the axial movement of the forming rolls can only be obtained by operating lever systems or mechanical systems, which act upon the peripheral part of the roll; in this regard, it should be noted that this type of actuation is the one normally employed in gear-type transmissions. In this context, it should also be noted that this type of action is only possible when no load is being applied to the toothed wheel or to the forming wheel (forming roll), i.e. when the wheels or rolls are idle; indeed, in under-load conditions the friction-induced strain would be such as to deform or break the control levers and the mechanical systems described in Italian patent No. IT1138381.

**[0010]** In this frame, it is the main object of the present invention to provide a roll forming machine for making a variable-section profile, wherein said roll forming machine has been so conceived as to overcome the drawbacks of prior-art solutions.

**[0011]** In particular, it is one object of the present invention to provide a roll forming machine, in particular for making a variable-section profile, wherein said roll forming machine has been so conceived as to comprise forming rolls that can be moved towards or away from each other during the roll forming process, wherein the rolls are mounted on a single shaft supported at its ends, as opposed to being mounted on independent shoulders with a cantilevered bearing shaft. As a result, it is one object of the present invention to provide a roll forming machine which has a simpler structure and is less costly than the solutions currently known in the art.

**[0012]** It is another object of the present invention to provide a roll forming machine, in particular for making a variable-section profile, wherein said roll forming machine is constructed in a manner such that the forming rolls can be moved to widen or narrow the roll forming tool, in particular wherein the rolls can be moved quickly and effectively even when a load is being applied to said rolls and without producing a strain that may deform or break the components that constitute the adjuster device adapted to provide such movement.

**[0013]** It is a further object of the present invention to provide a roll forming machine, in particular for making a variable-section profile, wherein said roll forming machine is constructed in a manner such that it comprises

an adjuster device for axially moving the forming rolls which can be manufactured and installed easily, and which is also applicable to existing roll forming machines.

**[0014]** It is therefore an object of the present invention to permit the construction of roll carrier assemblies that can be used in standard roll forming machines, which are usually equipped with cardan transmissions, thus avoiding the need for manufacturing complex and costly roll forming machines with independent movable heads.

**[0015]** It is yet another object of the present invention to provide a roll forming machine for making a variable-section profile, wherein said roll forming machine is characterized by a broad range of applications.

**[0016]** Said objects are achieved by the present invention through a roll forming machine, in particular for making a variable-section profile, wherein said roll forming machine incorporates the features set out in the appended claims, which are an integral part of the present description.

**[0017]** Further objects, features and advantages of the present invention will become apparent in light of the following detailed description and of the annexed drawings, which are provided herein merely by way of non-limiting explanatory example, wherein:

- Fig. 1 shows a perspective view of a roll forming station of a roll forming machine, in particular for making a variable-section profile, according to the present invention;
- Fig. 2a shows a front view of the roll forming station of Fig. 1, whereas Fig. 2b shows a sectional view along one of planes B-B of Fig. 2a;
- Fig. 3 shows a sectional view of a detail Z of Fig. 2b.

**[0018]** The present invention concerns a roll forming machine, in particular for making a variable-section profile, wherein said roll forming machine comprises at least one roll forming station, designated as a whole by reference numeral 1 in Fig. 1 and Fig. 2a; it should be noted that

**[0019]** Fig. 1 shows also a portion of a profile, designated by reference numeral 2.

**[0020]** The roll forming machine of the present invention preferably comprises a plurality of roll forming stations 1 arranged in succession, wherein each roll forming station 1 executes part of the bending until the desired section of the profile 2 is obtained, as is known in the art; in addition, the roll forming machine according to the present invention may comprise a reel for continuously feeding material into the roll forming machine, and a cutting system for cutting the material to a predefined length prior to inserting it into the roll forming stations 1, said reel and cutting system not being shown in the annexed drawings.

**[0021]** Said at least one roll forming station 1 comprises a pair of rotary shafts 10 positioned vertically one over the other and substantially parallel to each other, in particular the ends of each shaft 10 being supported by a

pair of uprights (designated as a whole by reference numeral 11) through the interposition of a shoulder 12 that provides the coupling between the ends of the shaft 10 and the respective upright 11.

**[0022]** As is known in the art, each shaft 10 is rotated by means of at least one motor (not shown in the drawings); in particular, rotary motion transmission can be obtained by means of cardan joints (not shown) adapted to connect said motor to one end of each shaft 10.

**[0023]** Preferably, each upright 11 comprises at least one actuator element 11A for varying the distance between the shafts 10 for the purpose of adjusting the height of the bends of the profile 2; for example, said at least one actuator element 11A may consist of a cylinder, in particular of hydraulic or pneumatic type. Preferably, the actuator elements 11A of two uprights 11 of one roll forming station 1 operate synchronously to allow the upper shaft 10 to adequately move along a vertical axis, so as to change the distance of the upper shaft 10 from the lower shaft 10. Such height movements may occur simultaneously during the roll forming process, thus permitting a substantially continuous adjustment of the distance between the lower and upper shafts 10.

**[0024]** Each shaft 10 comprises a respective roll forming tool 20 associated with the shaft 10 in such a way that it cannot rotate relative to said shaft 10, wherein each roll forming tool 20 is divided transversally, with reference to an axis of rotation of the shaft 10, into a pair of forming rolls 21 (as shown in Fig. 2b) which can be moved axially along said shaft 10.

**[0025]** Basically, each roll 21 cannot rotate about the shaft 10, but each roll 21 can be moved axially along the respective shaft 10.

**[0026]** In this regard, it must be pointed out that the shaft 10 and the associated roll forming tool 20 (and hence the rolls 21 making up each roll forming tool 20) are equipped with coupling means that provide an integral (or not mobile) coupling in rotation and a mobile coupling in the axial direction between them; for example, said coupling means may comprise grooves (e.g. formed on the shaft 10) into which matching tabs (e.g. formed on the rolls 21 of the roll forming tool 20) can be inserted.

**[0027]** The roll forming station 1 comprises also at least one adjuster device (designated as a whole by reference numeral 30 in Fig. 2b) for adjusting the width of at least one roll forming tool 20 by moving at least one roll 21 axially on the shaft 10.

**[0028]** In accordance with the present invention, and as clearly shown in Fig. 3 (which shows a sectional view of a detail Z of Fig. 2b), said at least one adjuster device 30 (Fig. 2b) comprises a double-acting cylinder, in particular of hydraulic or pneumatic type, which comprises a piston 31 (Fig. 2b) connected to said at least one roll 21, wherein said piston 31 has a hole 31F extending along a longitudinal axis (represented in Fig. 3 as a dashed-dotted line and designated by reference numeral 31A) of said piston 31, and wherein the shaft 10 passes through said hole 31F.

**[0029]** It should be noted that the longitudinal axis 31A of the piston 31 substantially coincides with a longitudinal axis of the shaft 10, which in turn coincides with an axis of movement of the roll 21 along the shaft 10.

**[0030]** In substance, the piston 31 according to the present invention comprises a hole 31F adapted to house a portion of the shaft 10; as a consequence, the piston 31 envelops or surrounds said at least one portion of the shaft 10.

**[0031]** Preferably, the piston 31 is a double-rod piston and comprises a head 31B, a first rod 31C and a second rod 31D, wherein said rods 31C, 31D develop in opposite direction from the head 31A (see Fig. 3); in this context, the hole 31F extends along a longitudinal axis 31A of said first rod 31C, head 31B and second rod 31D.

**[0032]** Preferably, the roll forming machine comprises at least one coupling element 32 positioned between the shaft 10 and the hole 31F, which permits attenuating or reducing the friction that may be caused by the shaft 10 rotating within said hole 31F.

**[0033]** In accordance with a preferred embodiment, said at least one coupling element 32 comprises at least one bushing, in particular a sliding bushing made of a self-lubricating compound.

**[0034]** Preferably, said bushing is made from processed sheet steel, externally protected by a layer of copper or tin a few microns thick; a porous bronze layer is then sintered on the sheet, whereon polyethylene tetrafluoride (PTFE), which is a plastic material having an extremely low coefficient of friction, and polyphenylsulphide (PPS), which is a polymer that gives the bearing high resistance to wear and specific pressure, are then fixed; for example, such a bushing is available from company M.B.I. Metal Bushing Italia S.p.A. It is however clear that said at least one coupling element 32 may also consist of another technically equivalent element.

**[0035]** Preferably, the double-acting cylinder of the present invention is provided with a body that comprises the shoulder 12 (which, as previously explained herein, provides the coupling between one end of the shaft 10 and the associated upright 11), a front cap 33 and a rear cap 34, such components being such as to define a first chamber 35A and a second chamber 35B for moving the piston 31 axially (in particular, for axially moving the head 31B of the piston 31, said head 31B being interposed between the first chamber 35A and the second chamber 35B) in two opposite directions (and hence for moving also the roll 21 in said two directions, for the purpose of adjusting the width of the roll forming tool 20).

**[0036]** The roll forming machine may comprise sealing elements 31T (e.g. gaskets, as shown in Fig. 3) positioned between the piston 31 and the elements 12, 33, 34 that constitute the body of the double-acting cylinder.

**[0037]** In addition, the roll forming machine according to the present invention preferably comprises at least one additional bushing 31U (in particular, a sliding bushing made of a self-lubricating compound and highly resistant to wear and specific pressure) positioned between the

piston 31 and the elements that constitute the body of the double-acting cylinder, said at least one additional bushing 31U being adapted to bear the load applied to the roll forming shaft 10.

**[0038]** The peculiar provisions of the double-acting cylinder and the piston 31 according to the present invention permit the generation of great axially balanced forces.

**[0039]** Moreover, the solution of the present invention is compact, extremely stiff, integrated into the roll forming station 1, and particularly accurate and fast in axially positioning the forming rolls 21.

**[0040]** It should be noted that in Fig. 2b each one of the two rolls 21 of a shaft 10 is associated with a respective adjuster device 30 made in accordance with the present invention; as a result, in a preferred embodiment, each roll 21 of the lower shaft 10 and each roll 21 of the upper shaft 10 is made in such a way as to be associated with a respective adjuster device 30. It is however clear that the present invention is also applicable to the case wherein only one roll 21 (in particular, only one roll 21 per shaft 10 of a roll forming station 1) is associated with an adjuster device 30 made in accordance with the principles of the present invention.

**[0041]** In a preferred embodiment, the roll forming machine of the present invention further comprises a closing element 36, optionally equipped with a cover 37, to allow the shaft 10 to be locked into the roll forming station 1; a positioning element 38 may also be provided, constrained to the shaft 10 and adapted to allow said shaft 10 to be adequately centred relative to the other components of the roll forming machine.

**[0042]** The roll forming machine of the present invention comprises at least one anti-friction element 39 (e.g. a washer, in particular made of bronze) positioned between the positioning element 38 and the rear cap 34 and/or between the positioning element 38 and the cover 37, and adapted to reduce the friction caused by the rotation of the shaft 10 and/or of the positioning element 38.

**[0043]** In accordance with the present invention, the roll forming machine comprises connecting means (designated as a whole by reference numeral 40 in Fig. 3), which allow the piston 31 to be connected to the roll 21.

**[0044]** According to a preferred embodiment (shown in Fig. 3), said connecting means 40 comprise a thruster 41 constrained to the piston 31, in particular said thruster 41 being screwed to the second rod 31D of the piston 31, wherein said thruster 41 comprises a thruster shoulder 42 that encloses or houses at least a portion of a base 21B of the roll 21. It must be pointed out that, in Fig. 3, the thruster 41 and the thruster shoulder 42 are represented as two separate elements; it is however clear that such components may also be made as one piece.

**[0045]** In this frame, the roll forming machine comprises at least one additional anti-friction element 43 (in this case as well, it may consist of at least one washer, in particular made of bronze) positioned between the thruster 41 and the base 21B of the roll 21 and/or between the thruster shoulder 42 and the base 21B of the roll 21, and

adapted to reduce the friction caused by the rotation of said base 21B of the roll 21.

**[0046]** The features of the present invention, as well as the advantages thereof, are apparent from the above description.

**[0047]** In particular, the provisions of the present invention make it possible to overcome the drawbacks of the solutions currently known in the art, and permit changing the width of the roll forming tools 20 and of the rolls 21 that make up each roll forming tool 20 without the necessity of building a complex and costly structure, since the rolls 21 are mounted on a single shaft 10 supported at its ends, as opposed to being mounted on independent shoulders with a cantilevered bearing shaft.

**[0048]** In this frame, the peculiar provisions of the present invention make it possible to provide a roll forming machine, in particular for making a variable-section profile, wherein said roll forming machine is constructed in a manner such that the forming rolls 21 can be moved quickly and effectively even when a load is being applied to said rolls 21 and without producing a strain that may deform or break the components that constitute the adjuster device 30 adapted to provide such movement. In fact, the peculiar provisions of the double-acting cylinder and piston 31 according to the present invention permit the generation of great axially balanced forces.

**[0049]** Moreover, the solution of the present invention is compact, extremely stiff, integrated into the roll forming station 1, and particularly accurate and fast in axially positioning the forming rolls 21 (i.e. moving each roll 21 axially on the shaft 10).

**[0050]** Another advantage lies in the fact that the roll forming machine made in accordance with the teachings of the present invention comprises an adjuster device 30 for axially moving the forming rolls 21 which is simple to manufacture and easy to install, even in existing roll forming machines. Indeed, the roll forming machine according to the present invention makes it possible to produce roll carrier assemblies that can be used in standard roll forming machines, which are usually equipped with cardan transmissions, thus avoiding the need for making complex and costly roll forming machines with independent mobile heads.

**[0051]** It is therefore apparent that the roll forming machine made in accordance with the teachings of the present invention is characterized by a broad range of applications.

**[0052]** The roll forming machine and the roll forming station 1 described herein by way of example may be subject to many possible variations without departing from the novelty spirit of the inventive idea; it is also clear that in the practical implementation of the invention the illustrated details may have different shapes or be replaced with other technically equivalent elements.

**[0053]** It can therefore be easily understood that the present invention is not limited to the above-described roll forming machine and roll forming station 1, but may be subject to many modifications, improvements or re-

placements of equivalent parts and elements without departing from the inventive idea, as clearly specified in the following claims.

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## Claims

1. Roll forming machine, in particular for making a variable-section profile, wherein said roll forming machine comprises at least one roll forming station (1) comprising a pair of rotary shafts (10) positioned vertically one over the other and substantially parallel to each other, in particular the ends of each shaft (10) being supported by a pair of uprights (11) through the interposition of a shoulder (12) that provides the coupling between the ends of the shaft (10) and the respective upright (11),

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wherein each shaft (10) comprises a roll forming tool (20) associated with the shaft (10), which cannot rotate relative to said shaft (10), wherein each roll forming tool (20) is divided transversally, with reference to an axis of rotation of the shaft (10), into a pair of forming rolls (21),

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and wherein said roll forming station (1) comprises at least one adjuster device (30) for adjusting the width of at least one roll forming tool (20) by moving at least one roll (21) axially on the shaft (10),

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said roll forming machine being **characterized in that**

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said at least one adjuster device (30) comprises a double-acting cylinder, in particular of hydraulic or pneumatic type, comprising a piston (31) connected to said at least one roll (21), wherein said piston (31) has a hole (31F) extending along a longitudinal axis (31A) of said piston (31), and wherein the shaft (10) passes through said hole (31F).

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2. Roll forming machine according to claim 1, **characterized in that** said piston (31) is a double-rod piston and comprises a head (31B), a first rod (31C) and a second rod (31D), wherein said rods (31C, 31D) develop in opposite directions from the head (31A), and wherein the hole (31F) extends along a longitudinal axis (31A) of said first rod (31C), head (31B) and second rod (31D).

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3. Roll forming machine according to one or more of the preceding claims, **characterized in that** it comprises at least one coupling element (32) positioned between the shaft (10) and the hole (31F), which permits attenuating or reducing the friction that may be caused by the shaft (10) rotating within said hole (31F).

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4. Roll forming machine according to claim 3, **characterized in that** said at least one coupling element (32) comprises at least one bushing, in particular a sliding bushing made of a self-lubricating compound. 5
5. Roll forming machine according to one or more of the preceding claims, **characterized in that** said double-acting cylinder is provided with a body that comprises the shoulder (12), a front cap (33) and a rear cap (34), such components being such as to define a first chamber (35A) and a second chamber (35B) for moving a head (31B) of the piston (31) axially in two opposite directions, in particular said head (31B) being interposed between said first chamber (35A) and second chamber (35B). 10 15
6. Roll forming machine according to claim 5, **characterized in that** it comprises at least one additional bushing (31U), in particular a sliding bushing made of a self-lubricating compound and highly resistant to wear and specific pressure, positioned between the piston (31) and said shoulder (12), front cap (33) and rear cap (34) that constitute the body of the double-acting cylinder, said at least one additional bushing (31U) being adapted to bear the load applied to the roll forming shaft (10). 20 25
7. Roll forming machine according to one or more of the preceding claims, **characterized in that** it comprises connecting means (40) that allow the piston (31) to be connected to the roll (21). 30
8. Roll forming machine according to claim 7, **characterized in that** said connecting means (40) comprise a thruster (41) constrained to a rod (31D) of the piston (31), wherein said thruster (41) comprises a thruster shoulder (42) that encloses or houses at least a portion of a base (21B) of the roll (21). 35
9. Roll forming machine according to one or more of the preceding claims, **characterized in that** each upright (11) comprises at least one actuator element (11A) that allows moving the upper shaft (10) adequately along a vertical axis in order to change the distance of the upper shaft (10) from the lower shaft (10). 40 45
10. Roll forming station (1) for a roll forming machine according to one or more of the preceding claims. 50
11. Adjuster device (30) for adjusting the width of at least one roll forming tool (20) by moving at least one roll (21) axially on at least one shaft (10) of a roll forming station (1) of a roll forming machine according to one or more of the preceding claims 1 to 9. 55

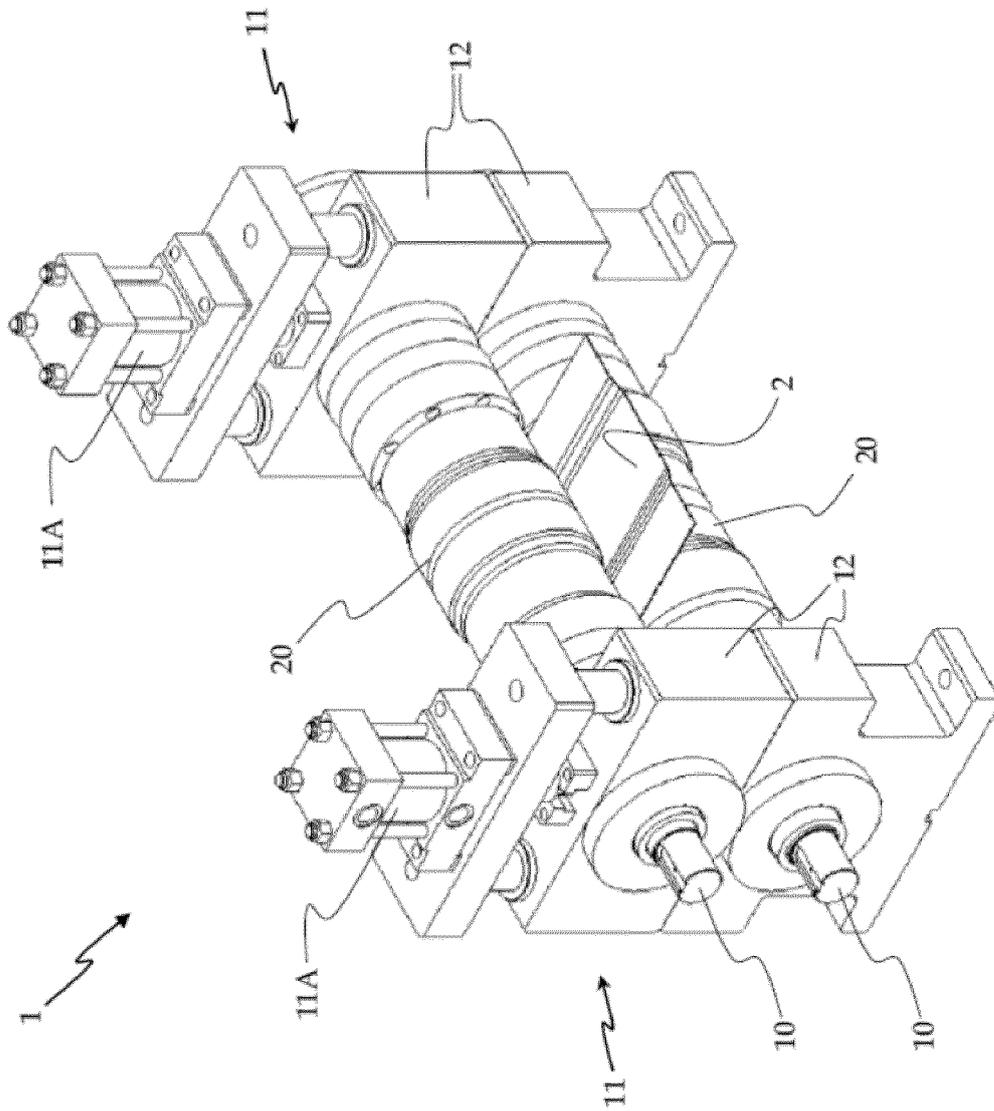


Fig. 1

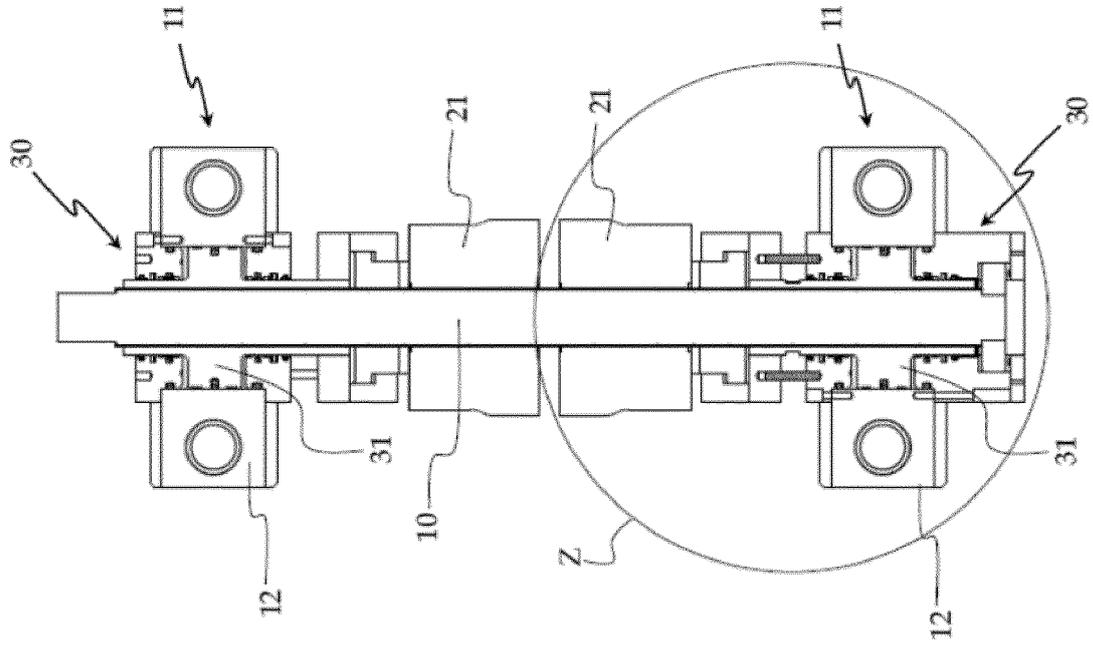


Fig. 2b

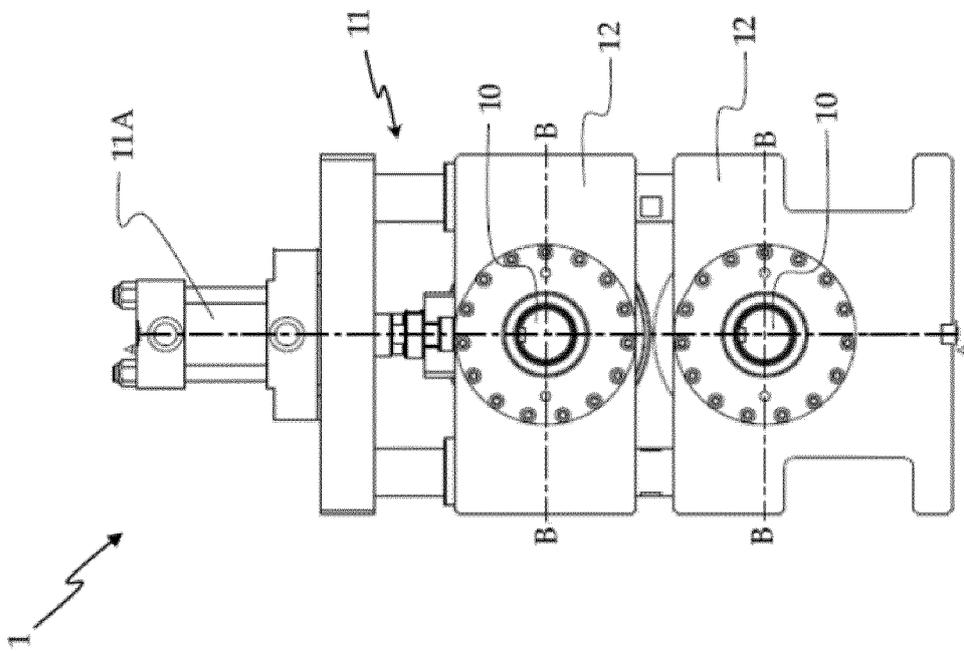


Fig. 2a

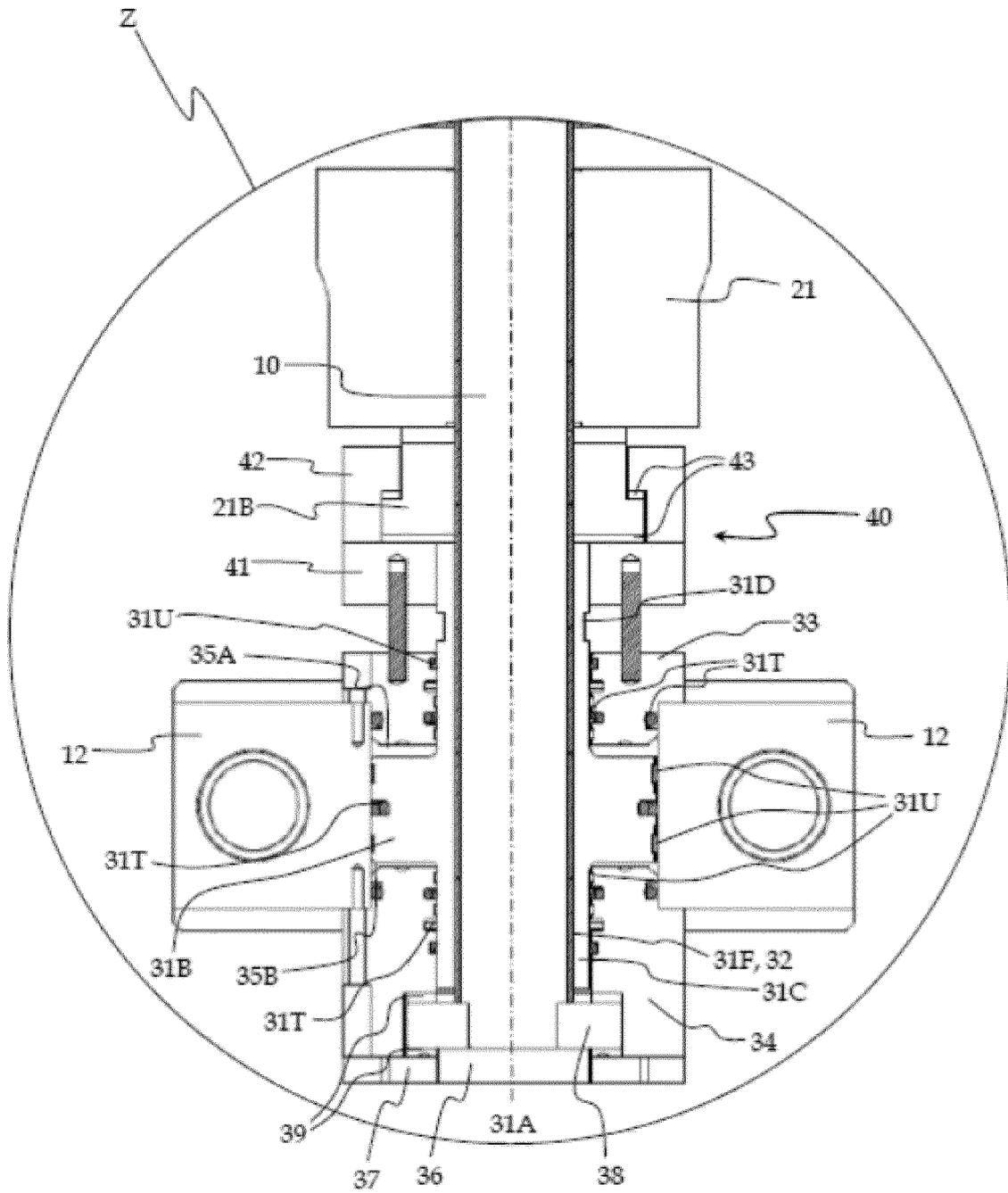


Fig. 3



EUROPEAN SEARCH REPORT

Application Number  
EP 23 18 6031

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| DOCUMENTS CONSIDERED TO BE RELEVANT  |  |  |   |  |
|--|--|--|---|--|
| Category   | Citation of document with indication, where appropriate, of relevant passages                      | Relevant to claim  | CLASSIFICATION OF THE APPLICATION (IPC)     |  |
| X  | US 4 006 617 A (FOSTER GENE B)<br>8 February 1977 (1977-02-08)<br>* figures 6, 7, 11 *             | 1-11   | INV.<br>B21D5/08                            |  |
| X  | FR 2 484 874 A1 (KRUECKELS GERHARD [DE])<br>24 December 1981 (1981-12-24)<br>* figures 4, 6, 15 *  | 10, 11   |   |  |
| A  | & IT 1 138 381 B (KRUECKELS GERHARD [DE])<br>17 September 1986 (1986-09-17)                        | 1-9  |   |  |
| X  | US 5 142 894 A (GUTOWSKI TIMOTHY A [US])<br>1 September 1992 (1992-09-01)<br>* figure 5 *          | 10, 11   |   |  |
| A  | * figure 5 *   | 1-9  |   |  |
| X  | US 4 558 577 A (TRISHEVSKY IGOR S [SU] ET AL)<br>17 December 1985 (1985-12-17)<br>* figures 4, 5 * | 10, 11   | TECHNICAL FIELDS SEARCHED (IPC)<br><br>B21D |  |
| A  | * figures 4, 5 *   | 1-9  |   |  |
| The present search report has been drawn up for all claims   |  |  |   |  |
| Place of search<br><b>Munich</b>   |  | Date of completion of the search<br><b>6 December 2023</b> |   | Examiner<br><b>Vassoille, Philippe</b> |
| CATEGORY OF CITED DOCUMENTS<br>X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document<br>T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>& : member of the same patent family, corresponding document |  |  |   |  |

1  
EPO FORM 1503 03:82 (F04C01)

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

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
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06-12-2023

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date                |
|--|------------------|-------------------------|---------------------------------|
| <b>US 4006617</b>                      | <b>A</b>         | <b>08-02-1977</b>       | <b>NONE</b>                     |
| -----                                  |                  |                         |                                 |
| <b>FR 2484874</b>                      | <b>A1</b>        | <b>24-12-1981</b>       | <b>AT 374123 B 26-03-1984</b>   |
|  |                  |                         | <b>DE 3022671 A1 14-01-1982</b> |
|  |                  |                         | <b>FR 2484874 A1 24-12-1981</b> |
|  |                  |                         | <b>IT 1138381 B 17-09-1986</b>  |
| -----                                  |                  |                         |                                 |
| <b>US 5142894</b>                      | <b>A</b>         | <b>01-09-1992</b>       | <b>NONE</b>                     |
| -----                                  |                  |                         |                                 |
| <b>US 4558577</b>                      | <b>A</b>         | <b>17-12-1985</b>       | <b>FR 2539339 A1 20-07-1984</b> |
|  |                  |                         | <b>US 4558577 A 17-12-1985</b>  |
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- IT 1138381 [0006] [0007] [0009]