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(54) **Metal strip casting apparatus and method**

Metallbandgiessanlage und Verfahren

Installation de coulée directe de bandes minces métalliques et méthode

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Description

BACKGROUND OF THE INVENTION

[0001] This invention relates to the casting of metal strip. It has particular application to the casting of metal strip by continuous casting in a twin roll caster.

[0002] In a twin roll caster molten metal is introduced between a pair of contra-rotated horizontal casting rolls which are cooled so that metal shells solidify on the moving roll surfaces and are brought together at the nip between them to produce a solidified strip product delivered downwardly from the nip between the rolls. The term "nip" is used herein to refer to the general region at which the rolls are closest together. The molten metal may be poured from a ladle into a smaller vessel or series of vessels from which it flows through a metal delivery nozzle located above the nip so as to direct it into the nip between the rolls, so forming a casting pool of molten metal supported on the casting surfaces of the rolls immediately above the nip and extending along the length of the nip. This casting pool is usually confined between side plates or dams held in sliding engagement with end surfaces of the rolls so as to dam the two ends of the casting pool against outflow, although alternative means such as electromagnetic barriers have also been proposed.

[0003] The change-over of the casting rolls in a twin roll caster is a significant problem. The rolls may need to be changed between casts so as to allow a different width of strip to be cast and the rolls must be replaced if the casting surfaces are in any way damaged or deteriorate during casting. If the rolls have to be changed in situ, a significant amount of potential casting time is lost waiting for the casting components and the area surrounding them to cool. The new set of rolls, once in place, has to be calibrated prior to casting so that the nip width can be pre-set.

[0004] When casting ferrous metals, it is necessary to preheat the refractory components of the metal delivery and pool confinement means to very high temperatures before casting commences. For these reasons it has been proposed to build twin roll casters with demountable components so that the rolls and preheated refractory components can be rapidly brought together into an operative assembly and casting started before the preheated components cool significantly. One example of a caster with moveable rolls and refractory components is disclosed in our Australian Patents 631728 and 637548 and corresponding United States Patents 5,184,668 and 5,277,243.

[0005] The present invention enables a twin roll strip caster to be built with a modular construction in which the casting rolls are installed in a moveable module readily moveable into and out of the machine. A previous proposal for mounting the rolls on a moveable module is described in Japanese Patent Publication JP-B93-9185 of Mitsubishi Heavy Industries Ltd. In that proposal the rolls and the pool confining side plates are mounted together on a frame which is carried on a wheeled car moveable horizontally into and out of the machine along rails. The present invention provides a different arrangement in which a roll module is moved horizontally into an intermediate position beneath the final casting position and is then lifted into the casting position. This enables the rolls to be quickly manoeuvred into the casting position without requiring movement of any ancillary equipment or components. In a preferred embodiment of the invention the rolls can be lifted into position between a pair of pool confinement side plates without the need to move the side plates.

SUMMARY OF THE INVENTION

[0006] According to the present invention there is provided an apparatus for continuously casting metal strip which includes: a pair of parallel casting rolls forming a nip between them; metal delivery means to deliver molten metal into the nip between the rolls to form a casting pool of molten metal supported on casting roll surfaces immediately above the nip; pool confining means at the ends of the rolls confining the pool against outflow from the ends of the nip; and roll drive means to drive the casting rolls in counter-rotational directions to produce a solidified strip of metal delivered downwardly from the nip; wherein the casting rolls are mounted on a roll module installable in a casting position and removable from said apparatus as a unit, and wherein the roll module is movable horizontally and longitudinally of the rolls from a stand-by position displaced below and to one side of the casting position into an intermediate position beneath the casting position and the apparatus includes a lifting means for lifting the roll module from the intermediate position into the casting position.

[0007] Preferably the lifting means includes a fluid cylinder actuated hoist.

[0008] Preferably the apparatus includes drive coupling means which automatically couple the roll drive means to the casting rolls when the roll module is in the intermediate position.

[0009] Preferably the apparatus includes water coupling means which automatically couple a water cooling means to the rolls when the roll module is in the intermediate position.

[0010] Preferably the roll module further includes a module frame and roll carriers moveable on the module frame to permit bodily movement of the rolls toward and away from one another to vary the nip between them.

[0011] Preferably the apparatus further includes a roll biasing means operable when the roll module is in the casting position to move the casting rolls from an open position towards each other to vary the width of the nip.

[0012] Preferably the pool confining means is in the casting position prior to moving the roll module from stand-by position to the intermediate position and thereafter to the casting position. Moving the roll module to

the intermediate position beneath the casting position and holding the casting rolls in the open position ensures that there is no contact between the rolls and the pool confining means during the installation of the rolls.

[0013] Preferably the roll biasing means is operable to move the casting rolls away from each other.

[0014] Preferably the roll module further includes an adjustable stop means disposed beneath the nip and between the roll carriers to serve as a spacer stop for engagement with the roll carriers to pre-set the minimum width of the nip between the rolls and adjustable in width to vary the minimum width of the nip.

[0015] Preferably the roll biasing means is operable to move the casting rolls from an open position to the stop means and thereafter to bias the rolls against the stop means.

[0016] Preferably, the roll module further includes a means for holding the roll carriers in the open position.

[0017] Preferably the holding means includes a locking pin assembly having locking pins carried by the module frame that can be received in openings in the roll carriers.

[0018] Preferably the locking pins are fixed relative to the roll carriers so that when the roll carriers and the rolls thereon are lifted from the intermediate position to the casting position the roll carriers are moved clear of and therefore are not retained by the locking pins.

[0019] The roll carriers may comprise a pair of roll end support structures for each of the rolls disposed generally beneath the ends of the respective roll.

[0020] Each pair of roll end support structures may carry journal bearings mounting the respective roll ends for rotation about a central roll axis.

[0021] The roll end support structures may be mounted on the module frame for generally horizontal movement of the rolls toward and away from one another.

[0022] The module frame may be moveable horizontally on linear bearings into and out of the intermediate position in the caster.

[0023] The roll module may be firmly clamped vertically by operation of the fluid cylinder actuated hoist described above lifting the roll module so that stop surfaces on the roll module contact fixed stop surfaces on the caster.

[0024] Appropriate indexing means may be provided for indexing of the module frame with the main machine frame when the module frame is hoisted so as to provide for accurate positioning of the module frame longitudinally of the rolls.

[0025] The roll biasing means may include a pair of biasing units for each roll and the biasing units being connectable to the roll carriers.

[0026] The biasing units may be carried on moveable mountings on the caster so that they can be readily moved into and out of operative inter-engagement with the roll carriers.

[0027] According to the present invention there is also provided a method of positioning casting rolls in a continuous strip casting which includes the steps of: moving a roll module carrying a pair of parallel caster rolls horizontallyand longitudinally of the rolls from a stand-by position, which is spaced below and to one side of a casting position, to an intermediate position below said casting position; coupling the rolls to a roll drive means and a water cooling unit at the intermediate position; and lifting the roll module to said casting position.

[0028] Preferably, the roll drive means and the water cooling unit are automatically coupled to the rolls when the roll module is moved to the intermediate position.

[0029] Preferably, after lifting the roll module to the casting position, the method further includes moving the rolls inwardly to a pre-set nip position.

[0030] Preferably, the rolls are held apart prior to being lifted to the casting position and the lifting movement releases the rolls for inward movement.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] In order that the invention may be fully explained one particular embodiment will be described in some detail with reference to the accompanying drawings in which:

Figure 1 is a vertical cross section through a strip caster constructed in accordance with the present invention;

Figure 2 is a side elevation of the caster shown in Figure 1 with the tundish and distributor removed for clarity and with the casting roll module in an intermediate position and the casting rolls in an open position;

Figure 3 is the same side elevation as shown in Figure 2 but with the roll module/casting rolls separated from the caster for clarity;

Figure 4 is a further side elevation of the caster with the roll module in a raised casting position and the rolls in an open position;

Figure 5 is a further side elevation of the caster with the roll module in the raised casting position and the rolls at a pre-set nip spacing.

Figure 6 is a top plan view of the caster;

Figure 7 is a top plan view illustrating in detail an end section of the roll module/casting rolls and the coupling of the rolls to water supply hoses and roll drive spindles; and

Figure 8 is a side elevation of the section of the caster shown in Figure 7.

DESCRIPTION OF PREFERRED EMBODIMENT

[0032] The illustrated caster comprises a main machine frame 11 which supports a casting roll module in the form of a roll cassette 13 which can be moved into an operative position in the caster as a unit but can readily be removed when the rolls are to be replaced. Cassette 13 carries a pair of parallel casting rolls 16 to which

molten metal is supplied during a casting operation from a ladle (not shown) via a ladle outlet nozzle 46, a tundish 17, a distributor 18 and a delivery nozzle 19 to create a casting pool 30 which is confined by the rolls 16 and by a pair of side closure plates 21. Casting rolls 16 are water cooled so that shells solidify on the moving roll surfaces and are brought together at the nip between them to produce a solidified strip product 20 at the roll outlet. This product may be fed to a standard coiler.

[0033] The illustrated twin roll caster as thus far described is of the kind which is illustrated and described in some detail in Australian Patent 664670 and United States Patent 5,488,988 and reference may be made to those patents for appropriate constructional details which form no part of the present invention.

[0034] Casting rolls 16 are contra-rotated through drive shafts 41 from an electric motor and transmission which includes drive spindles 128 mounted on the main machine frame. The drive shafts 41 can be disconnected from the transmission when the cassette 13 is to be removed from the caster. Rolls 16 have copper peripheral walls formed with a series of longitudinally extending and circumferentially spaced water cooling passages (not shown) supplied with cooling water through the roll ends from water supply ducts (not shown) in the roll drive shafts 41 which are connected to water supply hoses 42 through rotary glands 43. The rolls may typically be about 500 mm diameter and up to 2000 mm long in order to produce strip product approximately the width of the rolls.

[0035] The ladle is of entirely conventional construction and is supported on a rotating turret (not shown) whence it can be brought into position over the tundish 17 to fill the tundish. The tundish may be fitted with a sliding gate valve 47 actuable by a servo cylinder to allow molten metal to flow from the tundish 17 through the valve 47 and the refractory shroud 48 into the distributor 18.

[0036] The distributor 18 is formed as a wide dish made of a refractory material such as magnesium oxide (MgO). One side of the distributor 18 receives molten metal from the tundish 17 and the other side of the distributor 18 is provided with a series of longitudinally spaced metal outlet openings (not shown). The lower part of the distributor 18 carries mounting brackets (not shown) for mounting the distributor onto the main caster frame when the cassette is installed in its casting position.

[0037] Delivery nozzle 19 is formed as an elongate body made of a refractory material such as alumina graphite. Its lower part is tapered so as to converge inwardly and downwardly so that it can project into the nip between the casting rolls 16. Its upper part is formed with outwardly projecting side flanges (not shown) which locate on a mounting bracket (not shown) which forms part of the main frame.

[0038] Nozzle 19 may have a series of horizontally spaced generally vertically extending flow passages (not shown) to produce a suitably low velocity discharge of metal throughout the width of the rolls 16 and to deliver the molten metal into the nip between the rolls without direct impingement on the roll surfaces at which initial solidification occurs. Alternatively, the nozzle 19 may have a single continuous slot outlet (not shown) to deliver a low velocity curtain of molten metal directly into the nip between the rolls 16 and/or it may be immersed in the molten metal pool.

[0039] Side closure plates 21 are made of a strong refractory material, for example boron nitride, and have scalloped side edges to match the curvature of stepped ends of the rolls.

[0040] During a casting operation the sliding gate valve 47 is actuated to allow molten metal to pour from the tundish 17 to the distributor 18 and through the metal delivery nozzle 19 whence it flows onto the casting rolls. The head end of the strip product 20 is guided to the jaws of a coiler (not shown).

[0041] In accordance with the invention, the roll cassette 13 is movable:

(i) horizontally in a direction that is transverse to the casting direction of the caster (in the casting direction is denoted by the arrow A in the Figures) from a stand-by position located on one side of the caster to an intermediate position beneath a casting position; and thereafter

(ii) vertically to the casting position.

[0042] Figure 2 shows the roll cassette 13 at the intermediate position and Figures 4 and 5 show the roll cassette 13 at the raised casting position.

[0043] Movement of the roll cassette 13 to the intermediate position bring the casting rolls 16 into contact with and automatically couples the rolls 16 to the drive spindles 128 and the water supply hoses 42.

[0044] The roll cassette 13 is constructed so that the casting rolls 16 can be set up and the nip between them pre-set at the stand-by position before the cassette is installed in position in the caster.

[0045] Roll cassette 13 includes a large frame 102 supported on four wheels 121 which carries the rolls 16 and upper part (not shown) of the refractory enclosure for enclosing the cast strip below the nip. The caster includes a pair of rails 89 for guiding the wheels 121 between the stand-by position and the intermediate position. Rolls 16 are mounted on roll supports 104 which carry roll end bearings (not shown) by which the rolls are mounted for rotation about their longitudinal axes in parallel relationship with one another. The two pairs of roll supports 104 are mounted on the roll cassette frame 102 by means of linear bearings 106 whereby they can slide laterally of the cassette frame to provide for bodily movement of the rolls 16 toward and away from one another thus permitting separation and closing movement of the two parallel rolls between an open position shown

in Figure 4 and a pre-set nip position shown in Figure 5.

[0046] The caster includes a lifting means in the form of four fluid cylinder actuated hoists 71 supported by the machine frame 11 and located to underlie the corner regions of the roll cassette frame 102 when the roll cassette 13 is at the intermediate position - as can best be seen in Figures 2, 4 and 5. Actuation of the hoists 71 lifts the roll cassette 13 to the casting position. The upward movement of the roll cassette 13 is limited by inwardly extending flanges 75 on the guide rails 89 which are contacted by outwardly extending flanges 77 on the roll cassette frame 102.

[0047] The rolls 16 are retained at the open position shown in Figure 4 by four locking pin assemblies housed in vertical openings in the base of roll cassette frame 102. Each pin assembly includes a locking pin 83 which is biased upwardly by means of a spring 85. In the open position of the rolls 16 shown in Figure 4 the locking pins 83 extend into openings 87 in the base of roll supports 104. Upward movement of the roll cassette frame 102 relative to the locking pins 83 moves the roll cassette frame 102 clear of the pins and thereby releases the rolls 16 for movement inwardly by the action of roll biasing units 51 described hereinafter to bring the rolls 16 to the pre-set nip position shown in Figure 5.

[0048] Roll cassette frame 102 also carries two adjustable spacers 107 (shown only in Figures 2 and 3) in the form of a worm or screw driven jack disposed beneath the rolls 16 about a central vertical plane between the rolls 16 and located between the two pairs of roll supports 104 so as to serve as stops limiting inward movement of the two roll supports thereby to define the pre-set nip position, ie the minimum width of the nip between the rolls. The roll biasing units 51 act continuously to bias the roll supports 104 inwardly toward these central stops to permit outward springing movement of the rolls against preset biasing forces.

[0049] There are four roll biasing units 51 disposed in two pairs acting one pair on the supports 104 of each roll 16. Each roll biasing unit 51 includes a spring housing 111 containing a biasing spring 112 acting on a thrust rod 113 which is connected at its forward end to the respective roll support 104 The forward end of each thrust rod 113 has an enlarged head 115 located in a keyhole opening 117 in a side of one of the roll supports 104. The heads 115 of the thrust rods 113 are positioned in the keyholes 117 as the roll cassette 13 moves from the stand-by position to the intermediate position. The vertical dimension of the keyholes 117 is larger than the diameter of the enlarged heads 115 to accommodate vertical movement of the roll cassette 13 relative to the roll biasing units 51 as the roll cassette 13 is lifted from the intermediate position to the casting position. Each unit 51 is supported at its forward end on the main machine frame 11 by a linear bearing 116. When the roll cassette 13 is in the casting position shown in Figure 4 the thruster rods 113 can be translated inwardly by operation of hydraulic cylinder units so that the units 51 can move the rolls 16 to the preset nip position shown in Figure 5 and then provide a biasing action against the rolls. The spring biasing force of each roll biasing unit 51 can be adjusted by operation of a motor 119 which actuates a screw thread on spring plunger 118 to move the plunger and thereby adjust the compression in the spring 112.

[0050] The illustrated caster construction enables the rolls to be accurately set up out of the machine or offline and rapidly installed when required. Accordingly it is possible to set up rolls between casts in replacement cassettes and to accurately preset the nip spacing. Because the spacing between the rolls is accurately set by the centralised stops and the roll biasing forces bias the rolls inwardly against the stops, it is also possible to preload the rolls with appropriate biasing forces as soon as the cassette is installed and it is not necessary as in previous casters to wait for metal to pass through the rolls to develop reactive forces resisting roll separation. The direct coupling of the roll biasing units between the cassette frame and the roll supports also virtually eliminates friction in the spring control mechanism.

[0051] The illustrated caster construction also enables change-over of rolls quickly and effectively without interference with pre-positioned pool confining end plates.

[0052] The illustrated caster has been advanced by way of example only and it could be modified considerably. For example it is not essential that the roll supports be mounted on linear bearings for strict linear movement. They could alternatively be supported from the cassette frame on pivot arms to allow arcuate movement providing the necessary lateral movement of the rolls to permit appropriate springing movement. This arrangement would enable further reduction of the effective friction on roll movement. Similarly the roll biasing units 51 could be mounted on pivot arms and brought into position for connection with the installed cassette by actuation of hydraulic or pneumatic cylinder units acting on the supporting pivot arms. The precise manner in which the cassette is transported into and out of the casting machine could also be varied.

[0053] Moreover, the spring biasing units could be incorporated into the moveable cassette. However, this would require more moveable components and since each change of cassette would also involve a change of load cells, the cells would need to be recalibrated at each change. It is therefore preferred to mount a single set of biasing units and load cells on the main frame and to connect them to the roll supports when the cassette is moved into its operative position.

[0054] It is accordingly to be understood that the invention is in no way limited to the constructional details of the illustrated apparatus and that many modifications and variations may be made without departing from the scope of the appended claims.

Claims

1. Apparatus for continuously casting metal strip which includes:

   a pair of parallel casting rolls (16) forming a nip between them; metal delivery means (46, 17, 18, 19) to delivery molten metal into the nip between the rolls to form a casting pool (30) of molten metal supported on casting roll surfaces immediately above the nip; pool confining means (21) at the ends of the rolls (16) confining the pool (30) against outflow from the ends of the nip; and roll drive means (128) to drive the casting rolls in counter-rotational directions to produce a solidified strip of metal (20) delivered downwardly from the nip; wherein the casting rolls (16) are mounted on a roll module (13) installable in a casting position and removable from said apparatus as a unit; **characterised in that** the roll module (13) is moveable horizontally and longitudinally of the rolls from a stand-by position displaced below and to one side of the casting position into an intermediate position beneath the casting position and the apparatus includes a lifting means for lifting the roll module (13) from the intermediate position into the casting position.

2. Apparatus as claimed in claim 1, further **characterised in that** the pool confinement means (21) comprises a pair of pool confinement plates (21) supported independently of the roll module one to either side of the space occupied by the rolls when the roll module is in the casting position, the casting rolls are disposed below the confinement plates when the roll module is in the intermediate position and are raised between those plates by operation of the lifting means

3. Apparatus as claimed in claim 1 or claim 2, further **characterised in that** the lifting means (71) includes a fluid cylinder actuated hoist.

4. Apparatus as claimed in any one of claims 1 to 3, further **characterised in that** the apparatus includes drive coupling means (41) engageable by said movement of the roll module longitudinally of the rolls to automatically couple the roll drive means (128) to the casting rolls (16) when the roll module is moved to the intermediate position.

5. Apparatus as claimed in any one of claims 1 to 4, further **characterised in that** the apparatus includes water coupling means (42) engageable by said movement of the roll module longitudinally of the rolls to automatically couple a water cooling means to the rolls when the roll module is moved to the intermediate position.

6. Apparatus as claimed in any one of claims 1 to 5, further **characterised in that** the roll module (13) further includes a module frame (102) and roll carriers (104) moveable on the module frame (102) to permit bodily movement of the rolls (16) toward and away from one another to vary the nip between them.

7. Apparatus as claimed in claim 6, further **characterised in that** the roll module (13) further includes an adjustable stop means (107) disposed beneath the nip and between the roll carriers (104) to serve as a spacer stop for engagement with the roll carriers to preset the minimum width of the nip between the rolls (16) and adjustable in width to vary the minimum width of the nip.

8. Apparatus as claimed in claim 7, further **characterised in that** the apparatus further includes roll biasing means (51) operable to move the casting rolls from an open position to the stop means (107) and thereafter to bias the rolls against the stop means.

9. Apparatus as claimed in any one of claims 6 to 8, further **characterised in that** the roll module (13) further includes a means (83, 85) for holding the roll carriers (104) in the open position.

10. Apparatus as claimed in claim 9, further **characterised in that** the holding means includes a locking pin assembly having locking pins (83) carried by the module frame that can be received in openings in the roll carriers.

11. Apparatus as claimed in claim 10, further **characterised in that** the locking pins (83) are fixed relative to the roll carriers so that when the roll carriers (104) and the rolls thereon are lifted from the intermediate position to the casting position the roll carriers are moved clear of and therefore are not retained by the locking pins (83).

12. Apparatus as claimed in any one of claims 6 to 10, further **characterised in that** the roll carriers (104) comprise a pair of roll end support structures for each of the rolls disposed generally beneath the ends of the respective roll.

13. Apparatus as claimed in claim 12, further **characterised in that** each pair of roll end support structures (104) carries journal bearings mounting the respective roll ends for rotation about a central roll axis.

14. Apparatus as claimed in claim 13, further **characterised in that** the roll end support structures (104)

are mounted on the module frame (102) for generally horizontal movement of the rolls toward and away from one another.

15. Apparatus as claimed in any one of claims 6 to 14, further **characterised in that** the module frame (102) is moveable horizontally on linear bearings (89, 121) into and out of the intermediate position in the caster.

16. Apparatus as claimed in any one of claims 1 to 15, further **characterised in that** the roll module (13) is firmly clamped vertically by operation of the lifting means (71) lifting the roll module so that stop surfaces (77) on the roll module contact fixed stop surfaces (75) on the caster.

17. Apparatus as claimed in claim 16, further **characterised in that** indexing means is provided for indexing of the module frame with the main machine frame when the module frame is hoisted so as to provide for accurate positioning of the module frame longitudinally of the rolls.

18. Apparatus as claimed in anyone of claims 1 to 17, further **characterised in that** the apparatus further includes a roll biasing means (51) operable when the roll module is in the casting position to move the casting rolls from an open position towards each other to vary the width of the nip.

19. Apparatus as claimed in claim 18, further **characterised in that** the roll biasing means (51) comprises a pair of biasing units for each roll, each biasing unit (51) being connectable to the module (13) to provide spring biasing of the respective roll (16) when the module is in its operative position but releasable from the module to enable the module to be removed from the caster.

20. Apparatus as claimed in claim 22, further **characterised in that** the spring biasing units (51) are carried on moveable mountings on the caster so that they can be moved into and out of operative interengagement with the module.

21. A method of positioning casting rolls in a twin roll continuous strip caster **characterised by** the steps of:

moving a roll module (13) carrying a pair of parallel casting rolls (16) horizontally and longitudinally of the rolls from a stand-by position, which is displaced below and to one side of a casting position, to an intermediate position below said casting position;
coupling the rolls (16) to a roll drive means (128) and a water cooling water unit (42) at the intermediate position; and
lifting the roll module (13) to said casting position.

22. A method as claimed in claim 21, further **characterised in that** a pair of casting pool confinement plates (21) are positioned one to either side of the space to be occupied by the casting rolls when in the casting position and the casting rolls (16) move upwardly between the pool confinement plates (21) when the roll module (13) is lifted to the casting position.

23. A method as claimed in claim 21 or claim 22, further **characterised in that** the roll drive means (128) and the water cooling unit (42) are automatically coupled to the rolls by the movement of the roll module from the stand-by position to the intermediate position.

24. A method as claimed in any one of claims 21 to 23, further **characterised in that** after lifting the roll module to the casting position, the method further includes moving the rolls inwardly to a pre-set nip position.

25. A method as claimed in claim 24, further **characterised in that** the rolls are held apart prior to being lifted to the casting position and the lifting movement releases the rolls for inward movement.

Patentansprüche

1. Anlage für Stranggießen von Metallband, die umfasst:

ein Paar paralleler Gießwalzen (16), die einen Walzenspalt zwischen denselben ausbilden; Metallausgabevorrichtungen (46, 17, 18, 19) zur Ausgabe schmelzflüssigen Metalls in den Spalt zwischen den Walzen zur Ausbildung eines Schmelzbades (30) aus schmelzflüssigem Metall, gelagert auf Gießwalzenflächen unmittelbar oberhalb des Spaltes; Begrenzungsvorrichtungen (30) gegen Ausfließen von den Enden des Spaltes; und Walzenantriebsvorrichtungen (128) zum Antreiben der Gießwalzen in gegeneinanderlaufenden Richtungen zur Erzeugung eines verfestigten Metallbandes (20), das von dem Spalt nach unten abgegeben wird; wobei die Gießwalzen (16) auf einem Walzenmodul (13) montiert sind, das in eine Gießstellung eingebaut werden kann und das als Einheit aus der Anlage ausgebaut werden kann; **dadurch gekennzeichnet, dass** das Walzenmodul (13) horizontal und in Längsrichtung der Walzen aus einer Bereitschaftsstellung unter-

halb und zu einer Seite der Gießstellung in eine Zwischenstellung unterhalb der Gießstellung verfahren werden kann und dass die Anlage eine Hebevorrichtung zum Anheben des Walzenmoduls (13) aus der Zwischenstellung in die Gießstellung umfasst.

2. Anlage nach Anspruch 1, weiterhin **dadurch gekennzeichnet, dass** die Schmelz bad-Begrenzungsvorrichtungen (21) ein Paar Schmelzbad-Begrenzungsplatten (21) umfassen, die unabhängig von dem Walzenmodul jeweils eine auf jeder Seite des Raumes, der von den Walzen eingenommen wird, wenn sich das Walzenmodul in der Gießstellung befindet, gelagert sind, wobei die Gießwalzen unterhalb der Begrenzungsplatten angeordnet sind, wenn sich das Walzenmodul in der Zwischenstellung befindet, und wobei sie durch Betreiben der Hebevorrichtung zwischen die genannten Platten angehoben werden.

3. Anlage nach Anspruch 1 oder Anspruch 2, weiterhin **dadurch gekennzeichnet, dass** die Hebevorrichtung (71) ein durch Fluidzylinder betätigtes Hebezeug umfasst.

4. Anlage nach Ansprüchen 1 bis 3, weiterhin **dadurch gekennzeichnet, dass** die Anlage eine Antriebs-Kupplungsvorrichtung (41) umfasst, die in die Bewegung des Walzenmoduls in Längsrichtung der Walzen eingreifen kann, um die Walzenantriebsvorrichtung (128) automatisch an die Gießwalzen (16) zu kuppeln, wenn das Walzenmodul in die Zwischenstellung bewegt wird.

5. Anlage nach Ansprüchen 1 bis 4, weiterhin **dadurch gekennzeichnet, dass** die Anlage eine Wasserkühlungsvorrichtung (42) umfasst, die in die Bewegung des Walzenmoduls in Längsrichtung der Walzen eingreifen kann, um eine Wasserkühlungsvorrichtung automatisch an die Walzen zu kuppeln, wenn das Walzenmodul in die Zwischenstellung bewegt wird.

6. Anlage nach Ansprüchen 1 bis 5, weiterhin **dadurch gekennzeichnet, dass** das Walzenmodul (13) weiterhin einen Modulrahmen (102) und Walzenträger (104) umfasst, die auf dem Modulrahmen (102) beweglich sind, um physische Bewegung der Walzen (16) aufeinander zu und voneinander weg zu ermöglichen, um den Spalt zwischen denselben zu verändern.

7. Anlage nach Anspruch 6, weiterhin **dadurch gekennzeichnet, dass** das Walzenmodul (13) weiterhin eine einstellbare Anschlagvorrichtung (107) umfasst, die unterhalb des Walzenspaltes und zwischen den Walzenträgern (104) angeordnet ist, um als Anschlagvorrichtung für Eingriff in die Walzenträger zu dienen, um die kleinste Breite des Spaltes zwischen den Walzen (16) voreinzustellen, und die in der Breite einstellbar ist, um die kleinste Breite des Spaltes zu verändern.

8. Anlage nach Anspruch 7, weiterhin **dadurch gekennzeichnet, dass** die Anlage weiterhin Walzenvorspannvorrichtungen (51) umfasst, die betrieben werden können, um die Gießwalzen von der offenen Stellung zu der Anschlagvorrichtung (107) zu bewegen und um danach die Walzen gegen die Anschlagvorrichtung vorzuspannen.

9. Anlage nach Ansprüchen 6 bis 8, weiterhin **dadurch gekennzeichnet, dass** das Walzenmodul (13) weiterhin eine Vorrichtung (83, 85) zum Halten der Walzenträger (104) in der offenen Stellung umfasst.

10. Anlage nach Anspruch 9, weiterhin **dadurch gekennzeichnet, dass** die Haltevorrichtung eine Arretierstift-Baugruppe mit Arretierstiften (83) umfasst, die auf dem Modulrahmen gelagert ist und die in den Öffnungen in den Walzenträgern aufgenommen werden kann.

11. Anlage nach Anspruch 10, weiterhin **dadurch gekennzeichnet, dass** die Arretierstifte (83) in Bezug auf die Walzenträger befestigt sind, so dass wenn die Walzenträger (104) und die Walzen daran von der Zwischenstellung in die Gießstellung angehoben werden die Walzenträger davon weg bewegt werden und daher nicht von den Arretierstiften (83) gehalten werden.

12. Anlage nach Ansprüchen 6 bis 10, weiterhin **dadurch gekennzeichnet dass** die Walzenträger (104) ein Paar Walzenend-Tragkonstruktionen für jede der Walzen umfassen, die normalerweise unterhalb der Enden der jeweiligen Walzen angeordnet sind.

13. Anlage nach Anspruch 12, weiterhin **dadurch gekennzeichnet, dass** jedes Paar Walzenend-Tragkonstruktionen (104) Gleitzapfenlager trägt, mit denen die jeweiligen Walzenenden für Drehung um eine zentrale Walzenachse angebracht sind.

14. Anlage nach Anspruch 13, weiterhin **dadurch gekennzeichnet, dass** die Walzenend-Tragkonstruktionen (104) für normalerweise horizontale Bewegung der Walzen aufeinander zu und voneinander weg auf dem Modulrahmen (102) angebracht sind.

15. Anlage nach Ansprüchen 6 bis 14, weiterhin **dadurch gekennzeichnet, dass** der Modulrahmen (102) horizontal auf Linearlagern (89, 121) in die

und aus der Zwischenstellung in der Anlage verfahrbar ist.

16. Anlage nach Ansprüchen 1 bis 15, weiterhin **dadurch gekennzeichnet, dass** das Walzenmodul (13) vertikal durch Betrieb der Hebevorrichtung (71), die das Walzenmodul anhebt, so dass die Anschlagflächen (77) auf dem Walzenmodul in Berührung mit den festen Anschlagflächen (75) an der Gießanlage kommen, fest geklemmt wird.

17. Anlage nach Anspruch 16, weiterhin **dadurch gekennzeichnet, dass** Schaltvorrichtungen für Weiterschalten des Modulrahmens mit dem Hauptmaschinenrahmen, wenn der Modulrahmen angehoben wird, um genaue Positionierung des Modulrahmens in Längsrichtung der Walzen zu ermöglichen, bereitgestellt werden.

18. Anlage nach Ansprüchen 1 bis 17, weiterhin **dadurch gekennzeichnet, dass** die Anlage weiterhin eine Walzenvorspannvorrichtung (51) umfasst, die betriebsbereit ist, wenn sich das Walzenmodul in der Gießstellung befindet, um die Gießwalzen von einer offenen Stellung aufeinander zu zu bewegen, um die Breite des Walzenspaltes zu verändern.

19. Anlage nach Anspruch 18, weiterhin **dadurch gekennzeichnet, dass** die Walzenvorspannvorrichtung (51) ein Paar Vorspanneinheiten für jede Walze umfasst, wobei jede Vorspanneinrichtung (51) mit dem Modul (13) verbunden werden kann, um Federvorspannung der jeweiligen Walze (16) bereitzustellen, wenn sich das Modul in seiner Betriebsstellung befindet, und wobei es von dem Modul freigegeben werden kann, um zu ermöglichen, dass das Modul aus der Gießanlage ausgebaut werden kann.

20. Anlage nach Anspruch 22, weiterhin **dadurch gekennzeichnet, dass** die Federvorspannvorrichtungen (51) auf beweglichen Lagerungen an der Gießanlage gelagert sind, so dass sie in und aus betriebsbereitem Eingriff mit dem Modul bewegt werden können.

21. Verfahren der Positionierung von Gießwalzen in einer Doppelwalzen-Stranggießanlage, **gekennzeichnet durch** die folgenden Schritte:

Verfahren eines Walzenmoduls (13), das ein Paar paralleler Gießwalzen (16) trägt, horizontal und in Längsrichtung der Walzen aus einer Bereitschaftsstellung, die unterhalb und seitlich einer Gießstellung verschoben wird, in eine Zwischenstellung unterhalb der Gießstellung;
Ankoppeln der Walzen (16) an eine Walzenantriebsvorrichtung (128) und eine Wasserkühlungseinheit (42) an der Zwischenstellung; und
Anheben des Walzenmoduls (13) zu der Gießstellung.

22. Verfahren nach Anspruch 21, weiterhin **dadurch gekennzeichnet, dass** von einem Paar Schmelzbad-Begrenzungsplatten (21) jeweils eine zu jeder Seite des Raumes positioniert werden, der von den Gießwalzen eingenommen wird, wenn sie sich in der Gießstellung befinden und sich die Gießwalzen (16) nach oben zwischen die Schmelzbad-Begrenzungsplatten (21) bewegen, wenn das Walzenmodul (13) in die Gießstellung angehoben wird.

23. Verfahren nach Anspruch 21 oder Anspruch 22, weiterhin **dadurch gekennzeichnet, dass** die Walzenantriebsvorrichtung (128) und die Wasserkühlungsvorrichtung (42) durch Verfahren des Walzenmoduls von der Bereitschaftsstellung in die Zwischenstellung automatisch an die Walzen angekoppelt werden.

24. Verfahren nach Ansprüchen 21 bis 23, weiterhin **dadurch gekennzeichnet, dass** nach dem Anheben des Walzenmoduls in die Gießstellung das Verfahren Bewegen der Walzen nach innen in eine voreingestellte Walzenspaltposition umfasst.

25. Verfahren nach Anspruch 24, weiterhin **dadurch gekennzeichnet, dass** die Walzen, bevor sie in die Gießstellung angehoben werden, auseinander gehalten werden und dass die Hubbewegung die Walzen für Bewegung nach innen frei gibt.

Revendications

1. Appareil pour la coulée en continu de bandes de métal, qui comprend :

une paire de rouleaux de coulée parallèles (16) formant une zone de pincement entre eux ; un dispositif d'amenée de métal (46, 17, 18, 19) pour amener du métal liquide dans la zone de pincement entre les rouleaux pour former un bain de coulée (30) de métal liquide supporté par les surfaces de coulée des rouleaux situées immédiatement au-dessus de la zone de pincement ; un dispositif (21) de confinement de bain aux extrémités des rouleaux (16) confinant le bain (30) et évitant un échappement aux extrémités de la zone de pincement ; et un dispositif (128) d'entraînement de rouleau pour entraîner les rouleaux de coulée dans des sens contrarotatifs pour produire une bande de métal solidifiée (20) distribuée depuis la zone de pincement vers le bas ; dans lequel les rouleaux de coulée (16) sont montés sur un modu-

le de rouleaux (13) pouvant être installé dans une position de coulée et retiré dudit appareil en une seule fois ; **caractérisé en ce que** le module de rouleaux (13) est déplaçable horizontalement et dans la direction longitudinale des rouleaux depuis une position d'attente, décalée en-dessous et sur un côté de la position de coulée, vers une position intermédiaire en-dessous de la position de coulée, et l'appareil comprend un dispositif de levage pour relever le module de rouleaux (13) depuis la position intermédiaire vers la position de coulée.

2. Appareil selon la revendication 1, **caractérisé en outre en ce que** le dispositif (21) de confinement de bain comprend une paire de plaques (21) de confinement de bain supportées indépendamment du module de rouleau, une sur chaque côté de l'espace occupé par les rouleaux quand le module de rouleaux est dans la position de coulée, les rouleaux de coulée étant disposés en-dessous des plaques de confinement quand le module de rouleaux est dans la position intermédiaire et relevés entre lesdites plaques par actionnement du dispositif de levage.

3. Appareil selon la revendication 1 ou la revendication 2, **caractérisé en outre en ce que** le dispositif de levage (71) comprend un appareil de levage avec actionneur à vérin hydraulique.

4. Appareil selon l'une quelconque des revendications 1 à 3, **caractérisé en outre en ce que** l'appareil comprend un dispositif d'accouplement (41) pouvant être mis en prise par ledit mouvement du module de rouleaux dans la direction longitudinale des rouleaux afin de coupler automatiquement le dispositif d'entraînement de rouleau (128) aux rouleaux de coulée (16) quand le module de rouleaux est déplacé vers la position intermédiaire.

5. Appareil selon l'une quelconque des revendications 1 à 4, **caractérisé en outre en ce que** l'appareil comprend un dispositif de connexion d'eau (42) pouvant être mis en prise par ledit mouvement du module de rouleaux dans la direction longitudinale des rouleaux afin de coupler automatiquement un dispositif de refroidissement à l'eau aux rouleaux quand le module de rouleaux est déplacé vers la position intermédiaire.

6. Appareil selon l'une quelconque des revendications 1 à 5, **caractérisé en outre en ce que** le module de rouleaux (13) comprend en outre un châssis de module (102) et des supports de rouleau (104) déplaçables sur le châssis du module (102) pour permettre un rapprochement et éloignement complet des rouleaux (16) afin de faire varier la zone de pincement entre eux.

7. Appareil selon la revendication 6, **caractérisé en outre en ce que** le module de rouleaux (13) comprend en outre un dispositif d'arrêt réglable (107) disposé en-dessous de la zone de pincement et entre les supports de rouleau (104) pour servir de butée d'espacement et venir en contact avec les porte-rouleaux de sorte à prérégler la largeur minimum de la zone de pincement entre les rouleaux (16) et réglables en largeur pour faire varier la largeur minimum de la zone de pincement.

8. Appareil selon la revendication 7, **caractérisé en outre en ce que** l'appareil comprend en outre un dispositif de rappel de rouleau (51) actionnable pour déplacer les rouleaux de coulée depuis une position ouverte vers le dispositif d'arrêt (107) puis pour rappeler les rouleaux contre le dispositif d'arrêt.

9. Appareil selon l'une quelconque des revendications 6 à 8, **caractérisé en outre en ce que** le module de rouleaux (13) comprend en outre un dispositif (83, 85) pour maintenir les porte-rouleaux (104) en position ouverte.

10. Appareil selon la revendication 9, **caractérisé en outre en ce que** le dispositif de maintien comprend un ensemble de goupilles de verrouillage comprenant des goupilles de verrouillage (83) portées par le châssis du module et pouvant se loger dans des trous ménagés dans les porte-rouleaux.

11. Appareil selon la revendication 10, **caractérisé en outre en ce que** les goupilles de verrouillage (83) sont fixées par rapport aux porte-rouleaux de sorte que lorsque les porte-rouleaux (104) et les rouleaux sur ces derniers sont relevés depuis la position intermédiaire vers la position de coulée, les porte-rouleaux sont détachés des goupilles de verrouillage (83) et ainsi ne sont pas retenus par ces dernières.

12. Appareil selon l'une quelconque des revendications 6 à 10, **caractérisé en outre en ce que** les porte-rouleaux (104) comprennent une paire de structures de support d'extrémité de rouleau pour chacun des rouleaux qui sont disposées en général en-dessous des extrémités du rouleau respectif.

13. Appareil selon la revendication 12, **caractérisé en outre en ce que** chaque paire de structures de support d'extrémité de rouleau (104) porte des paliers de bout d'arbre tenant les extrémités de rouleau respectives pour tourner autour d'un axe central de rouleau.

14. Appareil selon la revendication 13, **caractérisé en outre en ce que** les structures de support d'extrémité de rouleau (104) sont montées sur le châssis du module (102) pour un mouvement sensiblement horizontal d'éloignement et de rapprochement des rouleaux.

15. Appareil selon l'une quelconque des revendications 6 à 14, **caractérisé en outre en ce que** le châssis du module (102) est déplaçable horizontalement sur des portées linéaires (89, 121) vers et hors de la position intermédiaire dans la machine de coulée.

16. Appareil selon l'une quelconque des revendications 1 à 15, **caractérisé en outre en ce que** le module de rouleaux (13) est solidement fixé verticalement sous l'action du dispositif de levage (71) relevant le module de rouleaux de sorte que des surfaces d'arrêt (77) sur le module de rouleaux entrent en contact avec des surfaces d'arrêt fixes (75) sur la machine de coulée.

17. Appareil selon la revendication 16, **caractérisé en outre en ce qu'**un dispositif d'indexation est prévu pour repérer le châssis du module par rapport au châssis principal de la machine lorsque le châssis du module est levé de sorte à pouvoir positionner avec précision le châssis du module dans la direction longitudinale des rouleaux.

18. Appareil selon l'une quelconque des revendications 1 à 17, **caractérisé en outre en ce que** l'appareil comprend également un dispositif de rappel de rouleau (51) utilisable quand le rouleau est dans la position de coulée pour déplacer les rouleaux de coulée depuis une position ouverte l'un en direction de l'autre de sorte à faire varier la largeur de la zone de pincement.

19. Appareil selon la revendication 18, **caractérisé en outre en ce que** le dispositif de rappel de rouleau (51) comprend une paire d'éléments de rappel pour chaque rouleau, chaque élément de rappel (51) pouvant être connecté au module (13) pour assurer un rappel élastique du rouleau respectif (16) quand le module est dans la position de travail mais libérable du module pour permettre au module d'être retiré de la machine de coulée.

20. Appareil selon la revendication 22, **caractérisé en outre en ce que** les éléments de rappel à ressort (51) sont portés sur des support mobiles sur la machine de coulée de sorte à pouvoir être déplacés pour venir en prise et hors de prise fonctionnelle avec le module.

21. Procédé de positionnement de rouleaux de coulée dans une machine de coulée continue entre rouleaux, **caractérisé par** les étapes de :

déplacement d'un module de rouleaux (13) portant une paire de rouleaux de coulée parallèles (16) horizontalement et dans la direction longitudinale des rouleaux, depuis une position d'attente, décalée en-dessous et sur un côté d'une position de coulée, vers une position intermédiaire en-dessous de ladite position de coulée ;
couplage des rouleaux (16) à un dispositif d'entraînement de rouleau (128) et à un module d'alimentation en eau de refroidissement (42) à la position intermédiaire ; et
relevage du module de rouleaux (13) vers ladite position de coulée.

22. Procédé selon la revendication 21, **caractérisé en outre en ce qu'**une paire de plaques (21) de confinement de bain de coulée sont positionnées, une sur chaque côté de l'espace devant être occupé par les rouleaux de coulée quand ceux-ci sont dans la position de coulée, et les rouleaux de coulée (16) se déplacent vers le haut entre les plaques (21) de confinement de bain quand le module de rouleaux (13) est relevé en position de coulée.

23. Procédé selon la revendication 21 ou la revendication 22, **caractérisé en outre en ce que** le dispositif d'entraînement de rouleau (128) et le module d'alimentation en eau de refroidissement (42) sont automatiquement couplés aux rouleaux du fait du déplacement du module de rouleaux depuis la position d'attente vers la position intermédiaire.

24. Procédé selon l'une quelconque des revendications 21 à 23, **caractérisé en outre en ce qu'**après que le module de rouleaux ait été relevé en position de coulée, le procédé comprend également le déplacement des rouleaux vers l'intérieur vers une position de pincement préréglée.

25. Procédé selon la revendication 24, **caractérisé en outre en ce que** les rouleaux sont maintenus éloignés l'un de l'autre avant d'être relevés vers la position de coulée et **en ce que** le mouvement de relevage libère les rouleaux pour un déplacement vers l'intérieur.

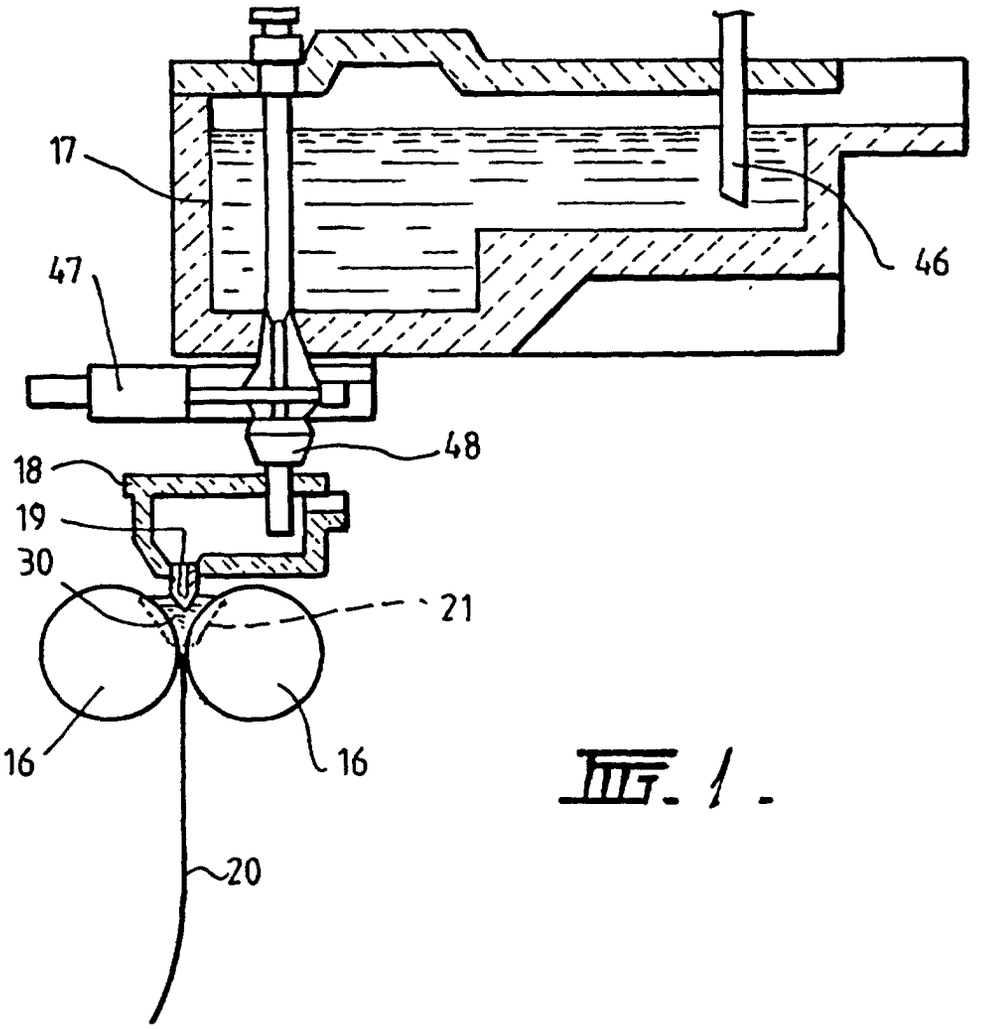

FIG. 1.

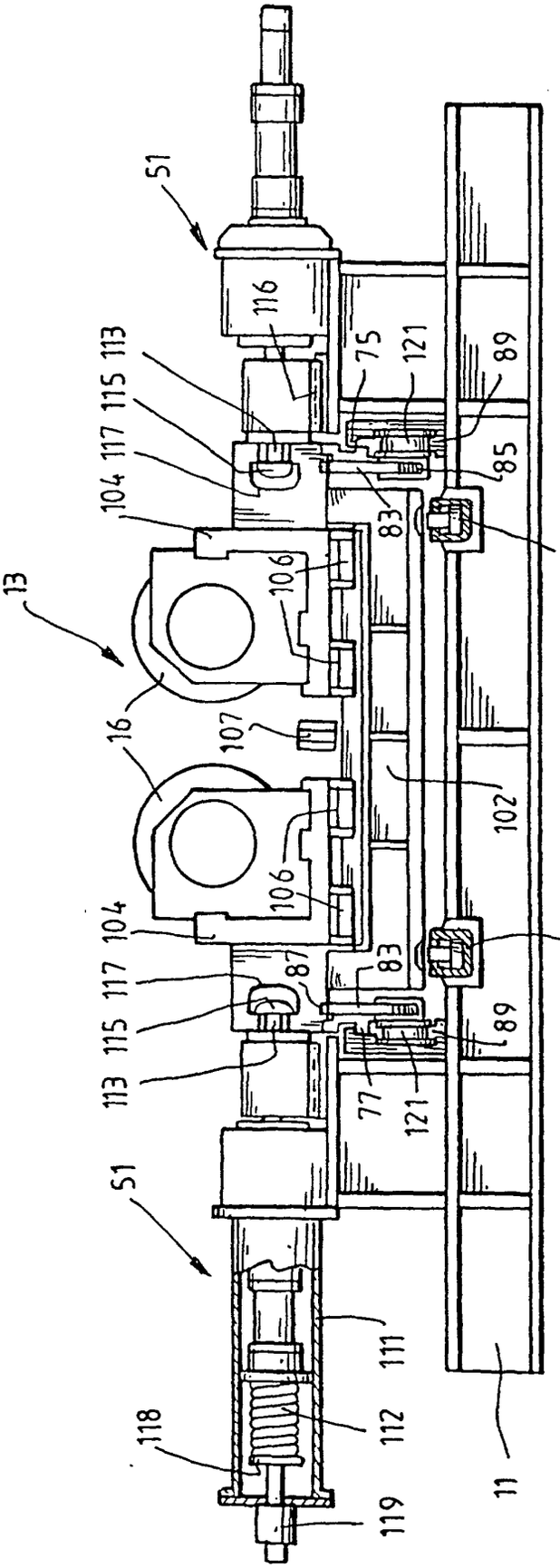
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Fig. 2.

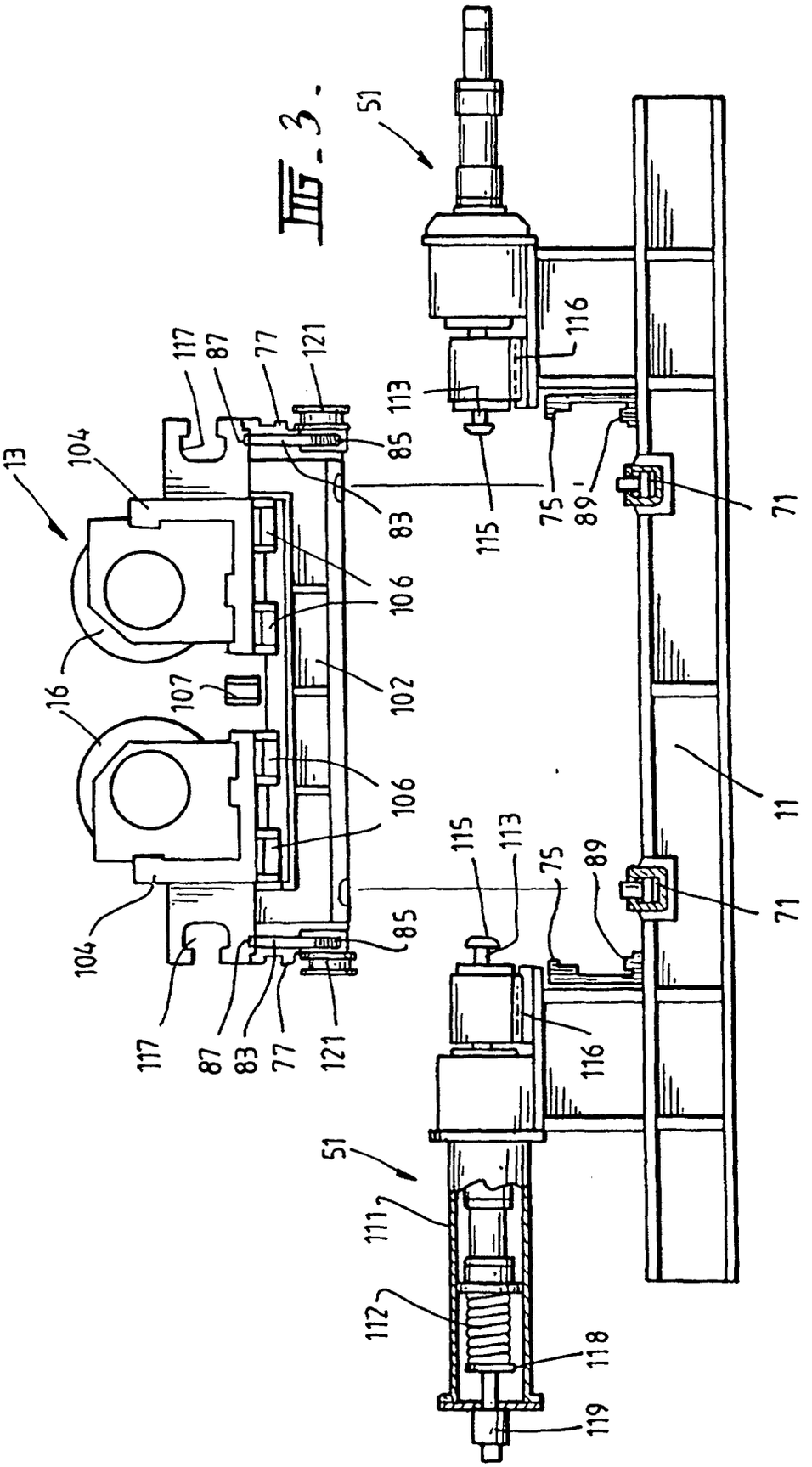
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Fig. 3.

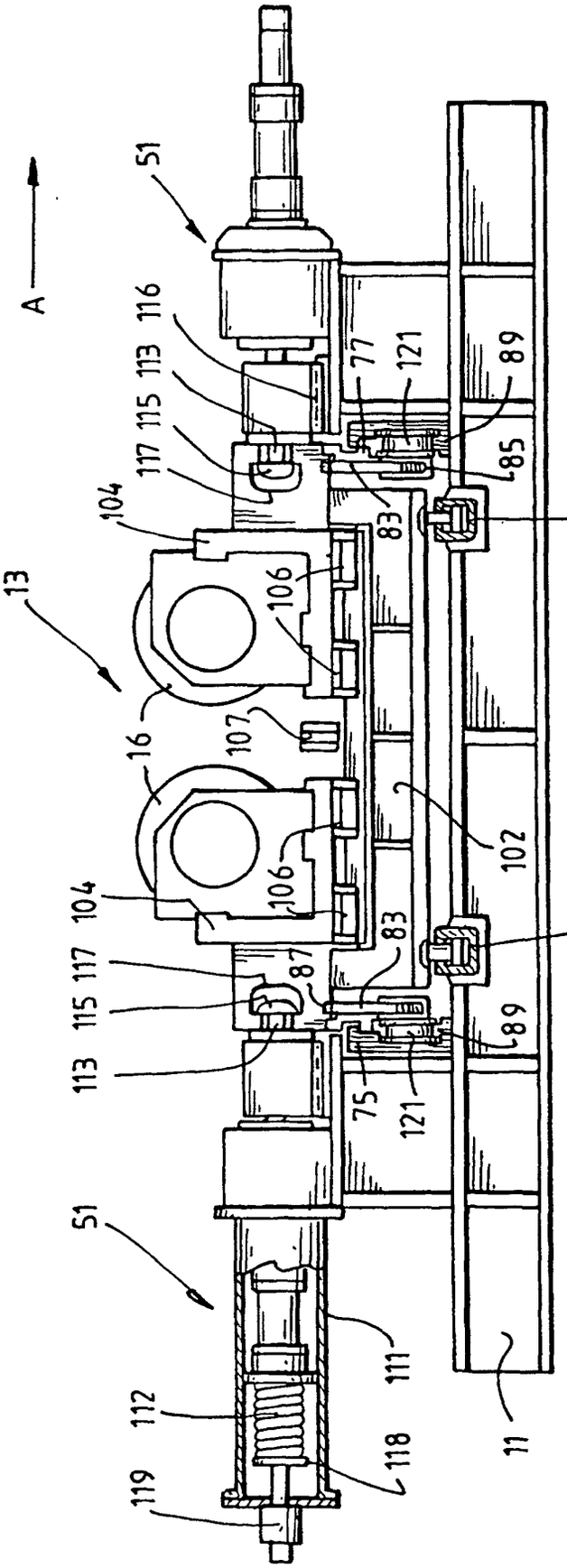
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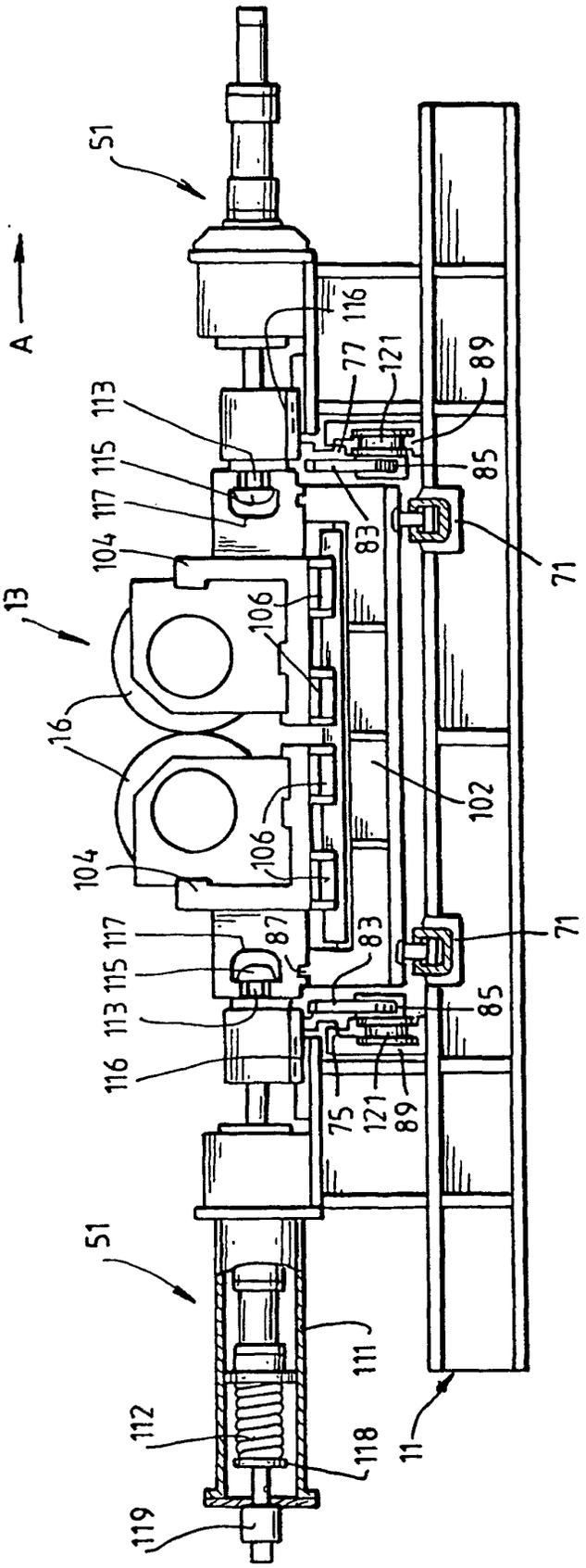
Fig. 4.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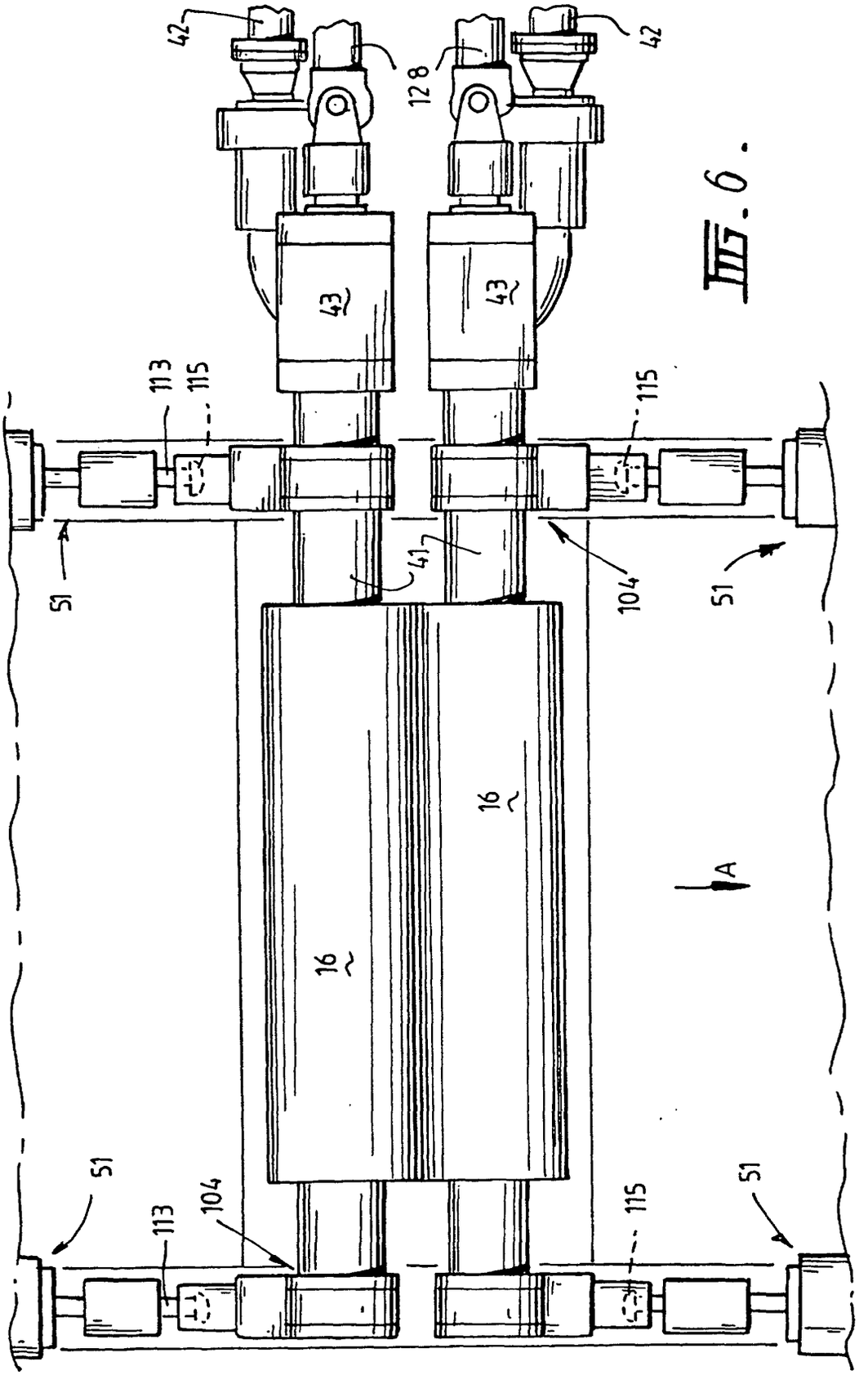
Фиг. 5.



Фиг. 6.

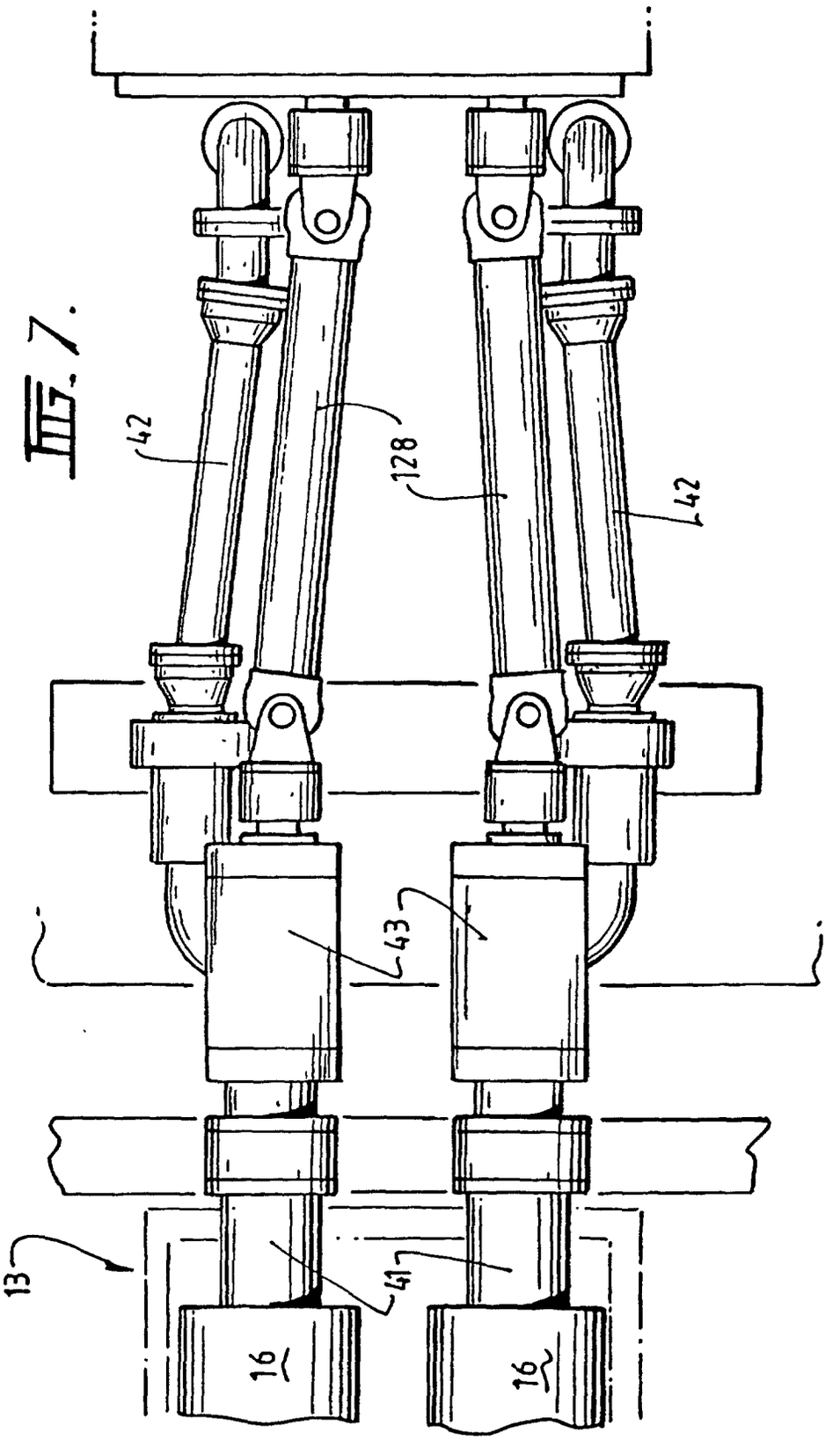


Fig. 7.

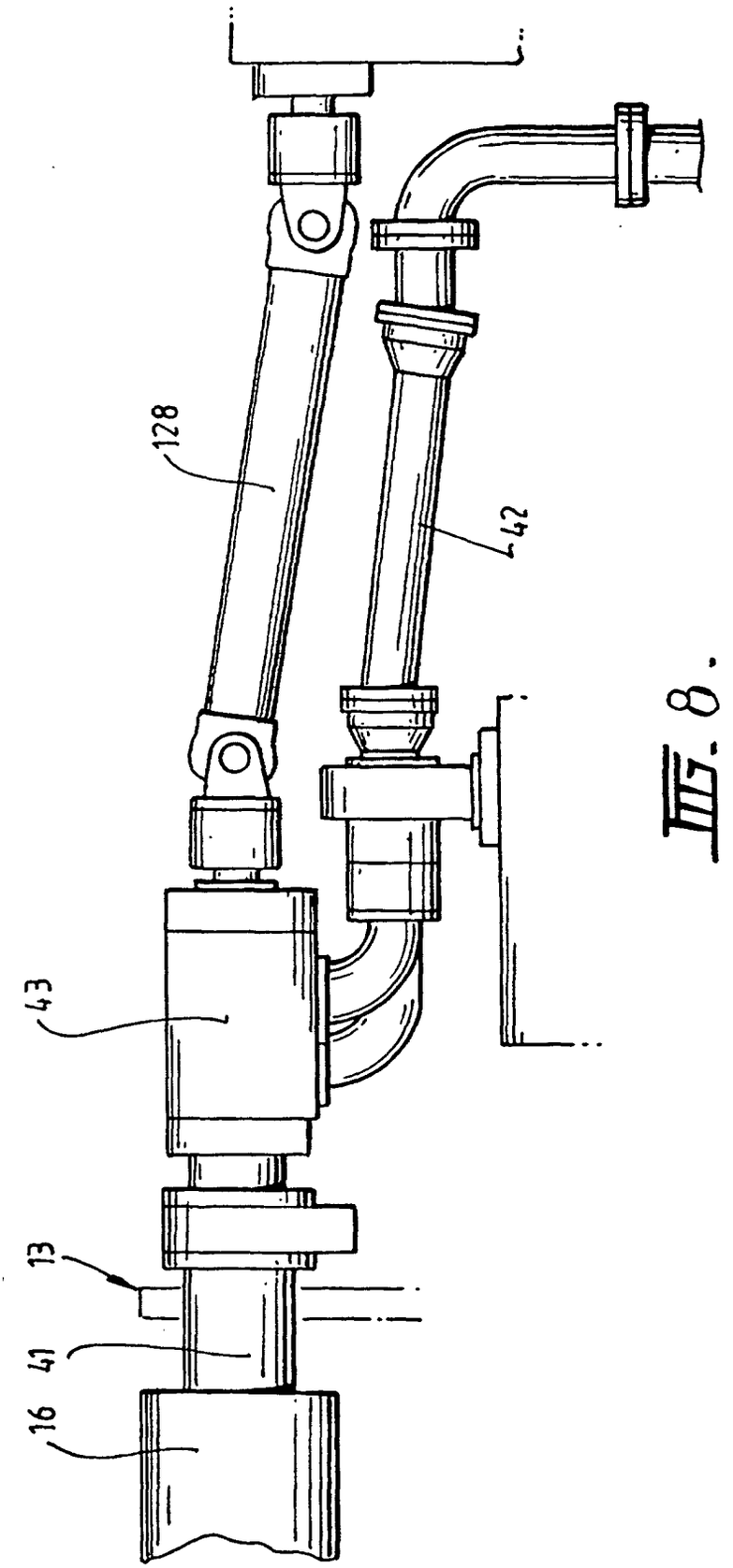


Fig. 8.