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Description

The present invention relates to apparatus for and a method of bending metal profiles such as 'I' section beams and 'U' section beams or other formed sections.

In order to bend such sections it is conventional to provide three rolls which straddle the feed path of the material to be bent. The first roll normally has a fixed axis on one side of the path, the next or second along the path is on the other side, whilst the third roll is on the same side of the path as the first, the second and third rolls have axes which are adjustable with respect to the bending path. Bending is gradual, that is the position of the second and third rolls is initially only slightly away from the straight feed line of the material. In order to progress the bend, the material is passed through the rolls several times. Each time the positions of the second and third rolls are adjusted to increase the bend. As the bend increases the tendency for the material to twist increases. To prevent twisting the rolls are provided with flanges which should be in contact with the material on both edges. The flanges are normally adjustable to provide for different material widths. In the conventional bending method after each pass of the material, the material expands on the inside of the curvature and contracts on the outside so that to maintain contact on both edges the flanges have to be reset. This is manually done by tightening a nut on the roll shaft. The necessity for repassing the material with manual readjustment of the flanges after each pass is time-consuming and is very much an ad hoc procedure which relies considerably on the operator's skill to achieve an accurately formed finished article which does not have a twist in it.

FR-A-348680 describes a bending machine comprising three rollers, one fixed in position and two movable in an arcuate path. Each roller comprises a round block with a shoulder at one end. A cap is fitted over the other end of the block and biased towards the shoulder by a spring. A screw is provided for adjusting the tension in the spring. The web of a bar to be bent can be nipped between the cap and shoulder to hold it in place. Nip is provided from one side only and no provision is made for continuous adjustment to accommodate shrinkage or swelling of the web.

A bending machine for bending metal profiles having for example an "I" section or a "U" section according to the invention comprises a plurality of rolls arranged to act on a profile along a curvilinear roll path so as to bend the profile, at least a first one of the rolls being provided with a pair of restraining means, each restraining means being located either side of the roll path so that the profile is enclosed at a bending point between the restraining means and a contact surface of said first roll, said restraining means acting on the profile in a direction substantially at right angles to the direction of action of said contact surface of said first roll, means for enabling continuous adjustment of the relative position of the pair of restraining means during rolling and control means for setting the value of the total restraining force provided by the pair of restraining means characterised in that the adjustment means links the pair of restraining means and is arranged to adjust the relative position thereof by automatically moving them in unison towards or away from each other to maintain the total restraining force provided thereby constant.

A method of bending metal profiles having for example, an "I" section or a "U" section according to the invention comprises passing a profile along a curvilinear roll path between a plurality of rolls at least one of which is provided with a pair of restraining means acting in a first direction substantially at right angles to a second direction being the direction of bending action of said one roll on said profile and controlling the value of the total restraining force provided by the restraining means, characterised in that the relative position of the pair of restraining means is continuously automatically adjusted by moving them in unison towards or away from each other to maintain the total restraining force provided thereby constant.

Preferably the restraining means are flanges.

By reason of the provision of continuous adjustment of the restraining means it is possible to bend the material in a single pass especially if the amount of the bend is continually monitored. Furthermore it is also possible to ensure that the control means is operated so as to ensure an even and correct restraining pressure on the material so as to ensure accurate bending without any twisting being evident. A further advantage is that in a repetitive operation where material guage differs slightly from section to section the restraining means can he immediately reset to the correct restraining pressure normally about 10% of the roll pressure.

In a preferred embodiment the pair of restraining means comprises a pair of flanges on one of the rolls interconnected by one or more counter threaded or cammed shafts, each flange has a threaded or cammed portion counter to the other so that rotation of the or each counter threaded or cammed shaft relative the roll causes the flanges to move in unison towards or away from each other. In the case of a roll positioned on the inside of the bend the flanges should be controlled to move apart from each other as the bend increases whilst a roll on the outside of the bend is provided with

similar flanges which are controlled to move towards each other as the bend increases. In such a case it will be appreciated that the roll axes are continuously moved to achieve the bending.

An embodiment of the inventon will now be described by way of example with references to the accompanying drawings in which:-

Figure 1 is an axial view of a typical three roll bending machine layout incorporating the invention, and showing an 'I' section beam being rolled to form a colliery arch,

Figure 2 is a cross section taken along the line Z-Z in Figure 1 showing flange movement between two opposed rolls with the 'I' section beam in between,

Figure 3 is a diagrammatic cross section of one of the rolls of Figure 1 showing flange control arrangements,

Figure 4 is a diagram of part of the flange control arrangements taken at D-D in figure 3, and

Figure 5 is a diagram of an alternative arrangement for roll flange control according to the invention.

In Figure 1 the typical three roll bending machine layout is shown but it should be clear that the invention is in no way restricted to such a layout. The rolls in the direction of movement of the metal profile - in this case an 'I' section beam 4 - are first roll 1 on the outside of the beam path, second roll 2 on the inside of the bend, and third roll 3 on the outside of the bend path. For the purpose of this explanation roll 1 has a fixed axis, though it can of course be made to be movable if required. The axes of rolls 2 and 3 are movable relative each other and roll 1 whilst setting up the bend and during the bending operation. Their movement is controlled by a computer numerical control device (CNC) which is not the particular subject of the present invention though it may be associated with the control arrangements of the embodiments of the invention. Detectors 5 and 6 suitably monitor the position of the material being bent and these are linked to the CNC device.

As the material of beam 4 enters the bend between rolls 2 and 3 the inner flange 8 begins to deform in the x axis (see Figure 2). In order to contain this x axis deformation sufficiently to prevent beam twisting, flanges 14 and 16 of roll 2 are allowed to move outwardly under control as will be described. At the same time the out flange 10 of the beam tends to retract in the x axis so that flanges 18 and 20 of roll 3 must be moved inwardly under control.

In Figure 3 and 4 the control arrangements for 2 (similar to those for roll 3 and even those for roll 1 if required) are shown. Flanges 14 and 16 made of hardened steel are screwed to plates 22 and 24 respectively. Plate 22 has three (or there may be more) holes 26 axially parallel to the axis of the main roll drive shaft 30. Holes 26 are threaded with a left hand thread. Plate 24 has holes 28 axially aligned with holes 26 and are threaded with a right hand thread. Between plates 22 and 24 is a main roll member 32 having a hardened steel tyre 34 which in use abutts the material to be bent. Member 32 is bolted to an end flange 36 of shaft 30 by bolts 38. A capping plate 40 is bolted to the opposite side of members 32. Between the capping plate 40 and member 32 are located a sun wheel 42 and coacting planet gears 43. Wheel 42 is fixed to a shaft 44 born in suitable bearings in the member 32 and plate 40 and extending through plate 40 and plate 22 to a brake disc 46. Gears 43 have suitable bearings in member 32 and plate 40 and shafts 48 extend therefrom, the shafts 48 terminating in left handed and right handed threaded portions 50 and 52 corresponding to those in holes 26 and 28 respectively. Rotation of shaft 44 relative to shaft 30 causes rotation of wheel 42 and gears 43 causing the rotation of shafts 48 in plates 22 and 24 to close or open flanges 14 and 16 on workpiece 4.

To control the relative movement of shafts 44 and 30 it is merely necessary to apply a braking torque by means of brake pads 54 and disc 46. The threads in holes and shafts 26, 28, 48 are such that counterclockwise movement of roll 2 as seen in Figure 1 with braking torque tends to open the flanges 14 and 16 whilst a similar arrangement with clockwise movement of roll 3 tends to close flanges 18 and 20. To open the flanges it is merely necessary to apply the brake hard and reverse the rolls.

The torque can be applied to shaft 44 by an alternative arrangement i.e. a torque motor mounted to plate 22, or a torque motor mounted on a bracket 67 with belt drive or the like to shaft 44.

It will be appreciated that the braking force applicable to disc 46 will be proportioned to the restraining force of flanges 14 and 16 on the workpiece and this can be easily controlled by suitable servo mechanisms controlled in turn by the main control means 55 which may be the main CNC device.

In the mechanically most advantageous arrangement the main roll member 32 requires to be as near as possible centrally located with respect to flange 36. For simplicity they are shown distanced by distance W. When W = O the couple between 36 and 32 is reduced to zero.

A slot 56 is provided in member 32 (Figure 4) to enable easy cutting away of tyre 34. A new tyre can then be shrunk on.

An alternative arrangement is shown in Figure 5 where the main shaft 30′ has a rolling flange 36′

on which is heat shrunk a tyre 34′. Threaded portions 58 and 60 with left handed and right handed threads are provided either ride on the main shaft. Screwed on the threaded portions are flange plate 22′ and 24′ with flanges 14′ and 16′. Screwing toward or away from each other is controlled by a pair of shoe or band brakes 62 and 64 controlled by a common servo system 66. The operation in similar to the previous embodiment.

Claims

1. A bending machine for bending metal profiles having for example an "I" section or a "U" section comprising a plurality of rolls arranged to act on a profile along a curvilinear roll path so as to bend the profile, at least a first one of the rolls being provided with a pair of restraining means, each restraining means being located either side of the roll path so that the profile is enclosed at a bending point between the restraining means and a contact surface of said first roll, said restraining means acting on the profile in a direction substantially at right angles to the direction of action of said contact surface of said first roll, means for enabling continuous adjustment of the relative position of the pair of restraining means during rolling and control means for setting the value of the total restraining force provided by the pair of restraining means characterised in that the adjustment means (48, 30') links the pair of restraining means (14, 16) and is arranged to adjust the relative position thereof by automatically moving them in unison towards or away from each other to maintain the total restraining force provided thereby constant.

2. A machine as claimed in Claim 1 wherein said pair of restraining means comprises a pair of flanges (14, 16) on said first roll (2) interconnected by at least one counter threaded or cammed shaft (48), each flange (14, 16) having a threaded or cammed portion (26, 28) engaged with the counter threaded or cammed shaft (48), the threaded or cammed portion (26) of one flange (14) of a pair being counter threaded or cammed with respect to the threaded or cammed portion (28) of the other flange (16) of the pair so that rotation of the shaft (48) relative the roll causes the pair of flanges (14, 16) to move in unison towards or away from each other.

3. A machine as claimed in Claim 2 wherein the or each counter threaded or cammed shaft (48) is geared to a brake shaft (44) coaxial with a drive shaft (30) drivably connected to said roll (2), and braking means (46, 54) on said brake shaft (48) is controlled by said control means (55).

4. A machine as claimed in Claim 1 wherein said pair of restraining means comprises a pair of flanges (14', 16') on said first roll (2) threadingly or cammedly mounted on counter threaded or cammed portions (58, 60) of a drive shaft (30') drivably connected to said first roll (2), one threaded or cammed portion (58) being counter in direction to the other threaded or cammed portion (60), braking means (62,64) arranged to brake said flanges (14', 16') to cause differential motion between the flanges (14', 16') and the drive shaft (30') whereby rotation of the drive shaft (30') with braking on the flanges (14', 16') causes the flanges of the pair to move in unison towards or away from each other.

5. A machine according to any preceding Claim having at least a first (2) and a second roll (3) each provided with a pair of said restraining means (14, 16 and 18, 20), one said roll (3) being positioned adjacent the bending point on the outside of the roll path and the other said roll (2) being positioned adjacent the bending point on the inside of the roll path, said pairs of flanges being so controlled that the flanges (14, 16) of the roll (2) on the inside of the bend move apart from each other as the bend increases whilst the flanges (18, 20) of the roll (3) on the outside of the bend are controlled to move towards each other as the bend increases.

6. A machine according to any preceding Claim wherein detectors (5, 6) for detecting the angle of bend are provided either side of the contact surface of said roll (2, 3).

7. A method of bending metal profiles having for example, an "I" section or a "U" section comprising passing a profile along a curvilinear roll path between a plurality of rolls at least one of which is provided with a pair of restraining means acting in a first direction substantially at right angles to a second direction being the direction of bending action of said one roll on said profile and controlling the value of the total restraining force provided by the restraining means, characterised in that the relative position of the pair of restraining means is continuously automatically adjusted by moving them in unison towards or away from each other to maintain the total restraining force provided thereby constant.

8. A method of bending strip material as claimed in Claim 7 comprising moving a pair of said restraining means away from each other and from the profile on the inside of the curvilinear roll path as the bend increases whilst moving a pair of said restraining means towards each other onto the profile on the outside of the roll path as the bend increases.

Patentansprüche

1. Biegemaschine zum Biegen von Metallprofilen, welche beispielsweise ein "I"-Profil oder ein "U"-Profil aufweisen, mit einer Vielzahl von Walzen, die angeordnet sind, um auf ein Profil entlang einer gekrümmten Walzenbahn derart einzuwirken, daß das Profil gebogen wird, daß mindestens eine erste der Walzen mit einem Paar Feststellmitteln versehen ist, wobei jedes Feststellmittel an einer der Seiten der Walzenbahn angeordnet ist, so daß das Profil an einem Biegepunkt zwischen den Feststellmitteln und einer Kontaktoberfläche der ersten Walze umschlossen ist, daß die Feststellmittel auf das Profil in halbwegs rechtwinkeliger Richtung zur Richtung der Arbeitsweise der Kontaktoberfläche der ersten Walze wirken, Mitteln zur Befähigung zur kontinuierlichen Einstellung der relativen Position des Festellmittelpaars während des Walzens und Regulierungsmitteln zum Einstellen des Wertes der gesamten Feststellkraft, die durch das Feststellmittelpaar geliefert wird,
dadurch gekennzeichnet,
daß das Einstellmittel (48, 30') das Paar Feststellmittel (14, 16) verbindet und angeordnet ist, um dessen relative Position durch automatisches Bewegen im Gleichgang zueinander hin oder voneinander weg einzustellen, um die dabei gelieferte gesamte Feststellkraft konstant zu halten.

2. Maschine nach Anspruch 1, dadurch gekennzeichnet, daß das Paar Feststellmittel auf der ersten Walze (2) ein Paar Flansche (14, 16) umfaßt, welche durch mindestens eine gegengeschraubte oder -genockte Welle (48) untereinander verbunden sind, daß jeder Flansch (14, 16) einen geschraubten oder genockten Teilbereich (26, 28) aufweist, welcher mit der gegengeschraubten oder genockten Welle (48) verbunden ist, daß der geschraubte oder genockte Teilbereich (26) eines Flansches (14) eines Paars in Bezug auf den geschraubten oder genockten Teilbereich (28) des anderen Flansches (16) des Paars gegengeschraubt oder -genockt ist, so daß die Rotation der Welle (48) relativ zur Walze bewirkt, daß sich das Paar Flansche (14, 16) in Gleichgang zueinander hin oder voneinander weg bewegt.

3. Maschine nach Anspruch 2, dadurch gekennzeichnet, daß die oder jede gegengeschraubte oder -genockte Welle (48) in Eingriff mit einer Bremswelle (44) steht, die koaxial zu einer fahrbar an der Walze (2) befestigten Antriebswelle (30) liegt, und daß ein Bremsmittel (46, 54) auf der Bremswelle (48) durch das Regulierungsmittel (55) reguliert wird.

4. Maschine nach Anspruch 1, dadurch gekennzeichnet, daß das Paar Feststellmittel ein Paar Flansche (14', 16') auf der ersten Walze (2) umfaßt, die geschraubt oder genockt an den gegengeschraubten oder -genockten Teilbereichen (58, 60) einer Antriebswelle (30'), welche fahrbar an der erstzen Walze (2) befestigt ist, angeordnet sind, daß sich ein geschraubter oder genockter Teilbereich (58) in entgegengesetzter Richtung zum anderen geschraubten oder genockten Teilbereich (60) befindet, daß Bremsmittel (62, 64) zum Bremsen der Flansche (14', 16') angeordnet sind, um eine veränderliche Bewegung zwischen den Flanschen (14', 16') und der Antriebswelle (30') zu erzeugen, wobei die Rotation der Antriebswelle (30') mit dem Bremsen der Flansche (14', 16') bewirkt, daß sich die Flansche des Paars in Gleichgang zueinander hin oder voneinander weg bewegen.

5. Maschine nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß sie mindestens eine erste (2) und eine zweite (3) Walze aufweist, welche jeweils mit einem Paar Feststellmittel (14, 16 und 18, 20) versehen ist, daß die eine Walze (3) nahe dem Biegepunkt auf der Außenseite der Walzbahn und die andere Walze (2) nahe dem Biegepunkt auf der Innenseite der Walzbahn angeordnet ist, daß die Flanschpaare so geregelt werden, daß sich die Flansche (14, 16) der Walze (2) auf der Innenseite der Biegung voneinander weg bewegen, wenn die Biegung ansteigt, während die Flansche (18, 20) der Walze (3) auf der Außenseite der Biegung geregelt werden, um sich zueinander hin oder voneinander weg zu bewegen, wenn die Biegung ansteigt.

6. Maschine nach einem der der vorhergehenden Ansprüche, worin Detektoren (5, 6) zur Erfassung des Biegewinkels an jeder Seite der Kontaktoberfläche der Walze (2, 3) vorgesehen sind.

7. Verfahren zum Biegen von Metallprofilen, die

beispielsweise als "I"-Profil oder als "U"-Profil ausgebildet sind, welches umfaßt, daß ein Profil entlang einer gekrümmten Walzbahn zwischen einer Vielzahl von Walzen hindurchgeführt wird, daß mindestens eine der Walzen mit einem Paar Feststellmittel versehen ist, die in einer ersten Richtung , die halbwegs rechtwinkelig zu einer zweiten Richtung ist, die die Richtung des Biegevorganges der Walze auf das Profil ist, wirken und daß der Wert der gesamten Festellkraft, die durch die Feststellmittel geliefert wird, geregelt wird,
dadurch gekennzeichnet,
daß die relative Position der Feststellmittelpaare kontinuierlich automatisch eingestellt wird, indem sie in Gleichgang zueinander hin oder voneinander weg bewegt werden, um die dabei gelieferte gesamte Feststellkraft konstant zu halten.

8. Verfahren zum Biegen von Bandmaterial nach Anspruch 7, welches umfaßt, daß ein Paar der Festellmittel voneinander und vom Profil auf der Innenseite der gekrümmten Walzbahn weg bewegt wird, wenn die Biegung anwächst, während ein Paar der Feststellmittel zueinander hin auf das Profil auf die Außenseite der Walze bewegt wird, wenn die Biegung anwächst.

Revendications

1. Machine à cintrer pour cintrer des profilés métalliques qui ont par exemple une section en "I" ou une section en "U" comprenant plusieurs rouleaux aménagés pour agir sur un profil le long d'un chemin de rouleau curviligne de façon à cintrer le profil, au moins un premier rouleau étant équipé d'une paire de moyens de retenue, chaque moyen de retenue étant situé des deux côtés de la courbe de cintrage de façon à ce que le profil soit enfermé en un point de cintrage entre les moyens de retenue et une surface de contact dudit premier rouleau, lesdits moyens de retenue agissant sur le profil dans une direction sensiblement à angle droit par rapport à la direction de l'action de ladite surface de contact dudit premier rouleau, des moyens pour permettre un réglage continu de la position relative de la paire de moyens de retenue pendant le cintrage et des moyens de commande pour fixer la valeur de la force totale de retenue produite par la paire de moyens de retenue, caractérisée en ce que les moyens de réglage (48, 30') sont liés à la paire de moyens de retenue (14, 16) et sont aménagés pour régler leur position relative par leur déplacement automatique à l'unisson en se rapprochant ou en s'écartant l'un de l'autre pour maintenir ainsi la constance de la force totale de retenue engendrée.

2. Machine selon la revendication 1, caractérisée en ce que ladite paire de moyens de retenue est réalisée sous la forme de collerettes (14, 16) associées au premier rouleau (2) et en liaison par au moins un arbre (48) fileté à pas contraires ou à cames inversées, chaque collerette (14, 16) ayant une partie filetée ou à rampe (26, 28) en prise avec l'arbre (48), la partie filetée (26) de l'une des collerettes (14) d'une paire étant filetée à pas contraire par rapport à la partie filetée (28) de l'autre collerette (16) de la paire ou les cames de l'une des collerettes étant en opposition par rapport aux rampes de l'autre, de sorte que la rotation de l'arbre (48) par rapport au rouleau provoque le déplacement à l'unisson en se rapprochant ou en s'écartant l'une de l'autre de la paire de collerettes (14, 16).

3. Machine selon la revendication 2, caractérisée en ce qu'au moins un arbre (48) engrenne avec un arbre de freinage (44) coaxial à un arbre de commande (30) connecté au rouleau (2), et en ce que des moyens de freinage (46, 54) prévus sur l'arbre de freinage (44) sont commandés par les moyens de commande (55).

4. Machine selon la revendication 1, caractérisée en ce que la paire de moyens de retenue comporte une paire de collerettes (14', 16') prévues sur le premier rouleau (2) coopérant par filetage à pas contraire (58, 60) d'un arbre de transmission (30') connecté audit premier rouleau (2), ou comportant des cames coopérant avec des rampes dudit arbre de commande, une partie filetée (58) étant de pas contraire à celui de l'autre partie filetée (60) ou une partie à cames (58) coopérant avec une rampe inversée de l'arbre de commande, des moyens de freinage (62, 64) aménagés pour freiner lesdites collerettes (14', 16') pour provoquer des mouvements différentiels entre les collerettes (14', 16') et l'arbre de commande (30'), de manière que la rotation de l'arbre (30') avec le freinage des collerettes (14', 16') entraîne le déplacement à l'unisson en se rapprochant ou en s'écartant l'une de l'autre des collerettes de la paire.

5. Machine selon l'une quelconque des revendications précédentes, caractérisée en ce qu'au moins un premier (2) et un second rouleaux (3) équipés chacun d'une paire desdits

moyens de retenue (14, 16 et 18, 20), l'un desdits rouleaux (3) étant adjacent au point de cintrage sur l'extérieur de la courbe de cintrage et l'autre dit rouleau (2) étant adjacent au point de cintrage sur l'extérieur de la courbe de cintrage, lesdites paires de collerettes étant commandées de façon que celles (14, 16) du rouleau (2) sur l'intérieur du cintrage s'éloignent l'une de l'autre au fur et à mesure que le cintrage augmente, tandis que les collerettes (18, 20) du rouleau (3) sur l'extérieur du cintrage sont commandées pour se déplacer l'une vers l'autre au fur et à mesure que le cintrage augmente.

6. Machine selon l'une quelconque des revendications précédentes, caractérisée en ce que des détecteurs (5, 6) pour détecter l'angle de cintrage équipent chaque côté de la surface de contact desdits rouleaux (2, 3).

7. Procédé de cintrage de profilé métallique comportant par exemple une section en "I" ou en "U" comprenant le passage d'un profilé le long d'une courbe de cintrage entre plusieurs rouleaux, au moins l'un d'eux étant équipé d'une paire de moyens de retenue agissant dans une première direction sensiblement à angle droit par rapport à une seconde direction qui est la direction de l'action de cintrage dudit rouleau sur ledit profilé et commandant la valeur de la force totale de retenue produite par les moyens de retenue, caractérisé en ce qu'il consiste à provoquer le réglage de la paire de moyens de retenue en les déplaçant à l'unisson ou en les écartant l'un de l'autre pour maintenir constante par ce moyen la force totale de retenue fournie.

8. Procédé de cintrage de matière en bande selon la revendication 7, caractérisé en ce qu'il consiste à faire déplacer une paire desdits moyens de retenue en s'écartant l'un de l'autre par rapport au profilé sur l'intérieur de la courbe de cintrage au fur et à mesure que le cintrage augmente et à faire déplacer une paire de moyens de retenue l'un vers l'autre sur le profilé sur l'extérieur de la courbe de cintrage au fur et à mesure que le cintrage augmente.

Fig.1.

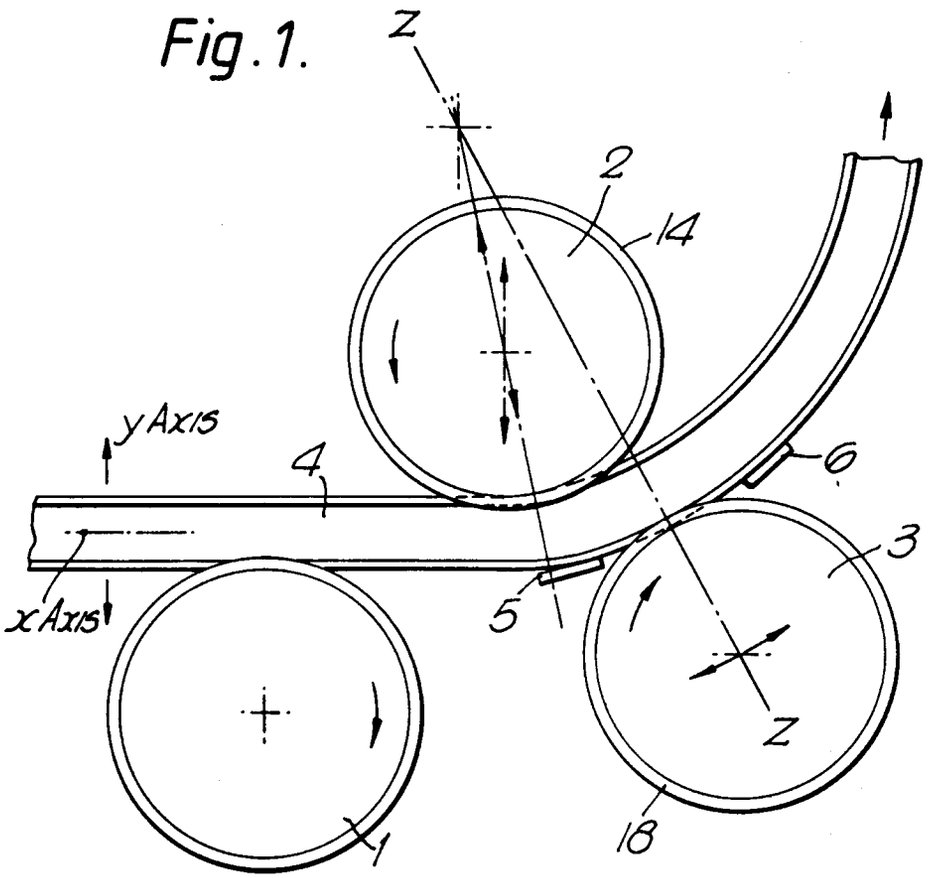
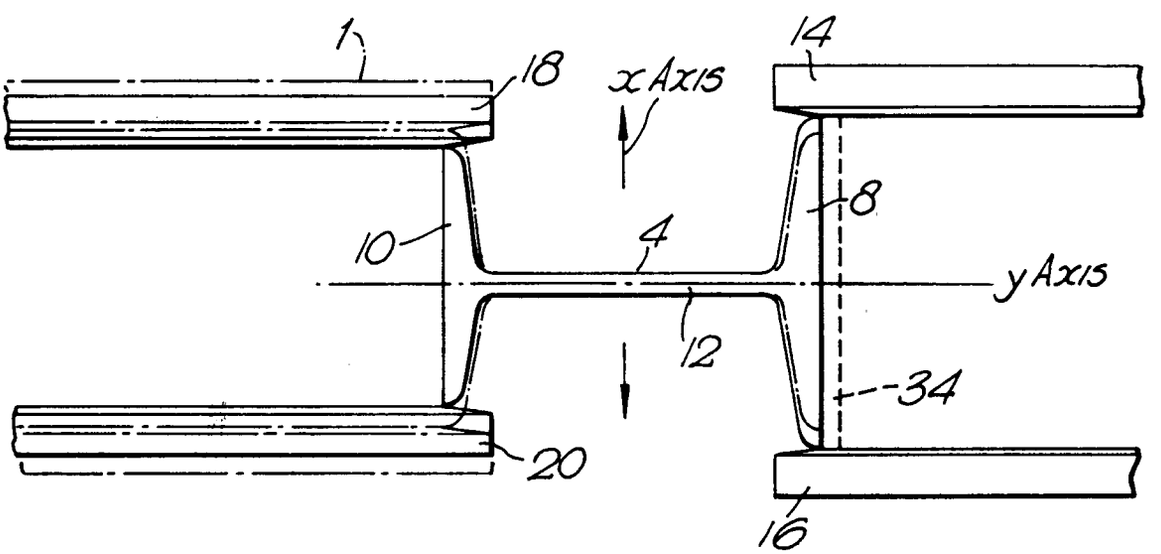


Fig.2.



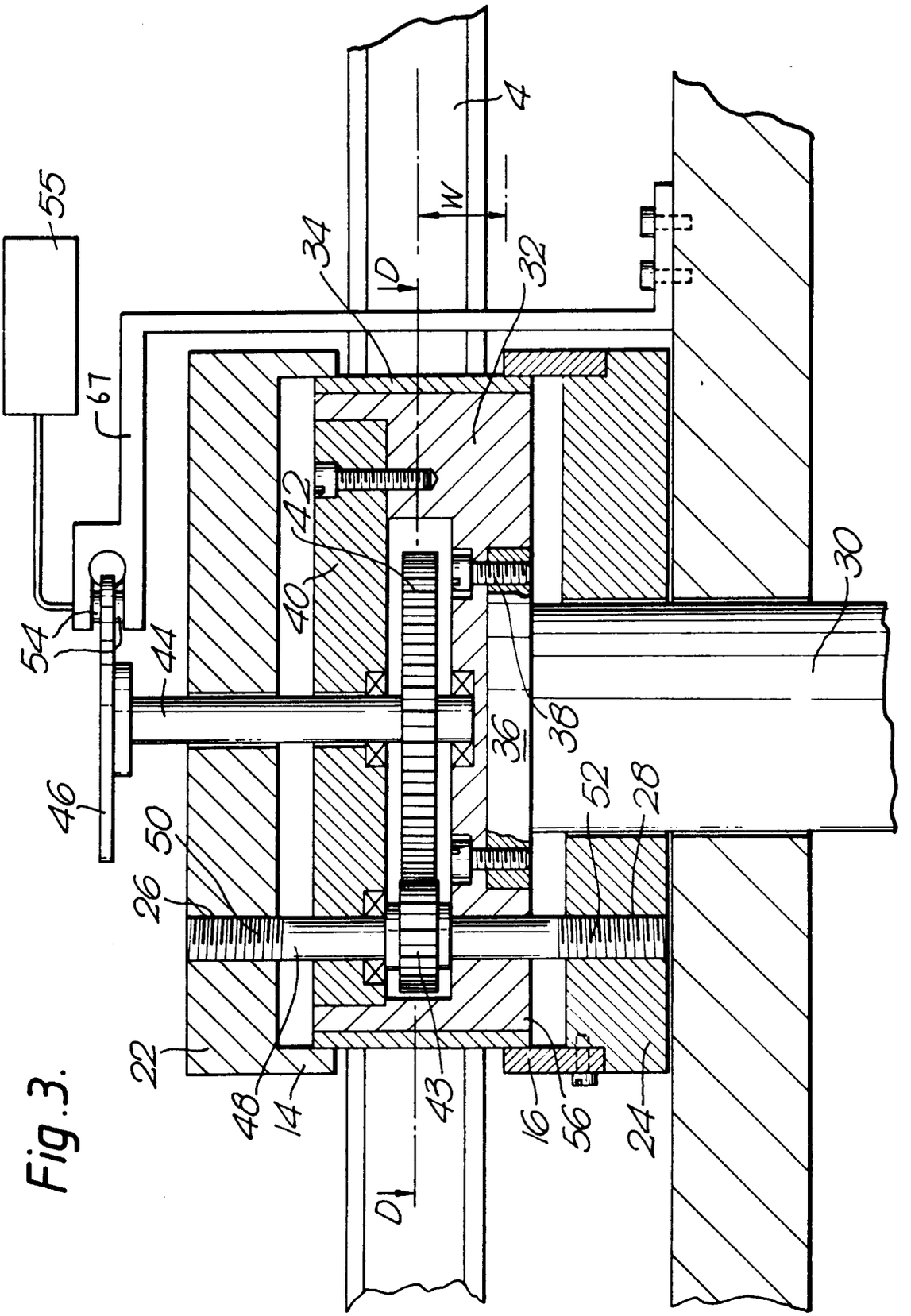

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Fig.3.

Fig. 4.

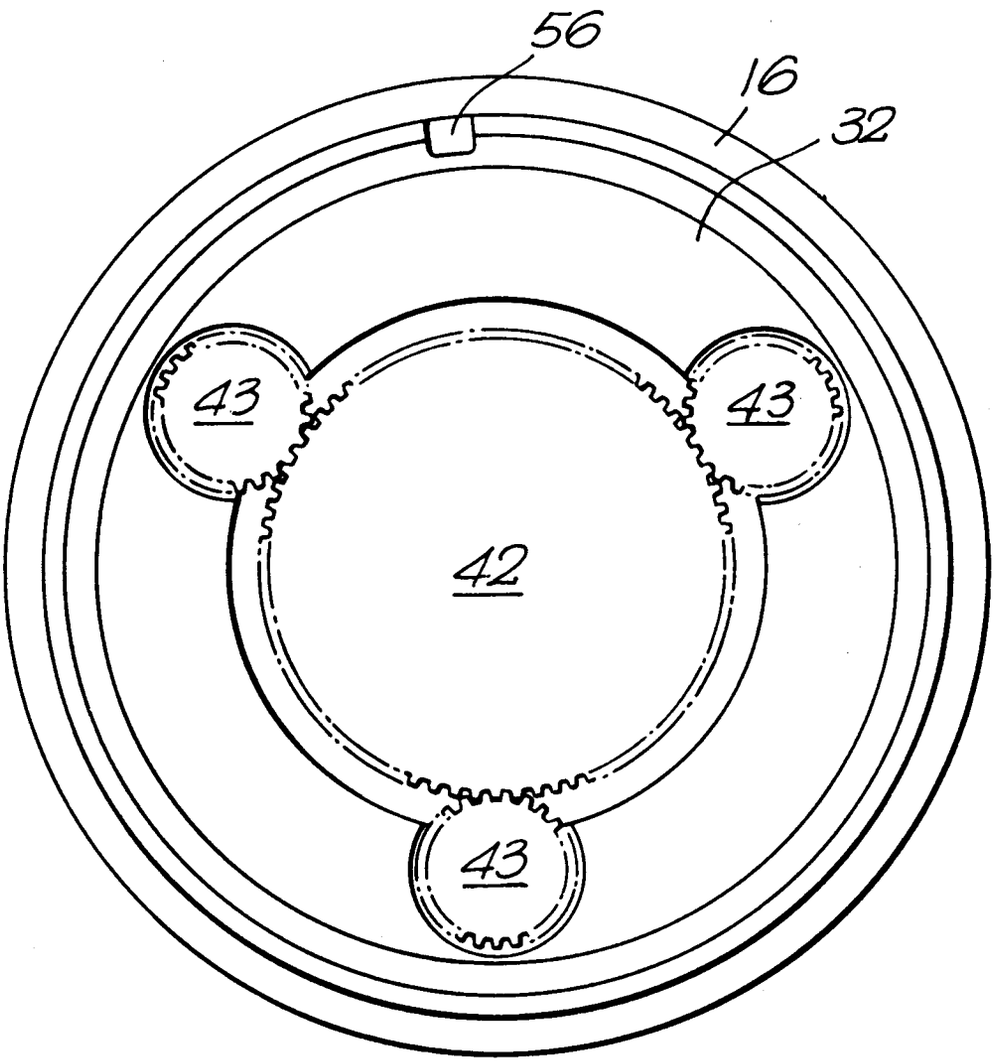

Fig.5.