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(54) Rolling mill.

(57) A rolling mill having at least a pair of work rolls (12, 13) each supported by a back-up roll (14, 15) has at least one roll (16) of hollow construction to give the mill compliance. The hollow roll (16) may contain an arbor (20) to give local stiffness to the roll as required by the shape of the material (17) entering the mill.

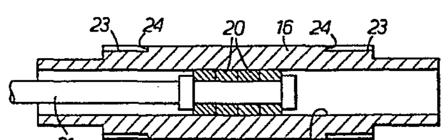


FIG.2A.

EP 0 044 715 A1

ROLLING MILL

This invention relates to rolling mills particularly for rolling elongate metallic strip, such as steel strip.

Rolling mills for rolling down steel strip as supplied by a roughing mill, are usually designed for maximum stiffness, and to that end have solid work rolls and massive back-up rolls intended to prevent bowing of the work rolls under the rolling load. One consequence of that arrangement is that, when the entering strip has a non-uniform profile across its width, those parts having a greater thickness are subject to greater reduction than those parts of lesser thickness and are elongated in the length dimension of the strip to a greater degree. The result is bad shape, usually in the form of strip with "a full centre" or "full edges" and the strip is no longer flat.

Strip with good shape is generally preferred to strip with a good, or uniform profile, even if the former is associated with a slightly non-uniform profile. Ideally, the strip finally emerging from the rolling process should have both good shape and good profile.

In the present invention, compliance is introduced into a mill by having a roll or rolls, of hollow construction. The compliant nature of the hollow roll or rolls is then such that the strip is subject to substantially uniform reduction across its width, regardless of its entering shape and its flatness does not deteriorate.

It is an advantage if the stiffness or compliance of the hollow roll or rolls can be made to vary along the axial length of the roll or each roll so that bad shape in the incoming strip may be improved. For that purpose, there may be means within the hollow roll for increasing its stiffness over some parts of its length relative to the remainder. That may be done by introducing support discs at selected points along the roll length, or by inserting a closely fitting plunger for a given length of the roll.

It is thought desirable that a mill should be stiff only over the width of the material being rolled; outside the confines of the strip width, the mill should be relatively compliant. A mill having such a stiffness profile is believed to avoid the over-rolling of the edges of the material being rolled and to facilitate work roll bending designed to control cross-sectional shape of the rolled material. By using a hollow roll in accordance with the present invention as, for example, the intermediate roll of a five-high mill or each of the intermediate rolls of a six-high mill, the aforementioned stiffness profile may be achieved.

Thus, the invention may be applied to a four-high mill, a five-high mill or a six-high mill. In the first case, one or both of the rolls can be hollow. In a five-high mill, a hollow intermediate roll is interposed between one of the work rolls, and its back-up roll, while in a six-high mill having an intermediate roll between each work roll and its back-up roll one or both of the intermediate rolls may be hollow.

The invention will be more readily understood by way of example from the following description of rolling mills in accordance therewith, reference being made to the accompanying drawings, in which

Figure 1 illustrates a five-high mill with a hollow intermediate roll,

Figures 2A and 2B show a variable stiffness hollow roll in two different arrangements,

Figures 3 and 4 illustrate respectively a six-high and a four-high mill with stiffened hollow rolls,

Figures 5 to 9 show mills with a hollow roll or rolls containing a central arbor or arbors,

Figures 10 and 11 show in schematic vertical section a five-high mill having a composite intermediate roll which in Figure 10 is arranged to roll wide strip and in Figure 11 narrow strip,

Figures 12A and 12B are together an axial section of a sleeved roll, illustrating one mode of roll construction, and

Figure 13 shows in axial section another construction of sleeved roll.

The mill of Figure 1 is represented by its rolls only, the mill housings and the drive being of well known form. The mill is shown as having two work rolls 12 and 13, two back-up rolls 14 and 15, and an intermediate roll 16 between work roll 12 and its back-up roll 14. Intermediate roll 16 is hollow as shown in order to introduce transverse compliance into the mill. In other words, the softness of the roll allows the roll to comply with variations of rolling load along its length due for example to variations in thickness of the incoming work 17 across its width. As a consequence the work is reduced evenly across its width and the flatness of the work is not detrimentally affected.

If desired, the mill may have a second intermediate roll between the rolls 13 and 15; the second intermediate roll may be hollow, like roll 16, or solid.

The hollow roll 16 may have means causing the roll to have a compliance which varies along its length. A roll with such means is illustrated in Figure 2A and 2B, where the means are constituted by a number of support discs 20 which are threaded on an arbor 21 and which are a close fit within the bore 22 of the roll 16; advantageously the discs 20 have an interference fit within the bore 22, but can be moved axially along the roll by expanding the roll by liquid under pressure.

The discs 20 are axially located according to the shape or flatness of the incoming work 17. Thus, if the incoming strip has wavy edges due to a greater reduction of the edge portions having taken place in a previous rolling operation, relative to the centre part of the strip, the support discs 20 are located centrally as shown in Figure 2A, so that the mill is stiffer in the centre than at the edges, the strip is given a greater reduction in the centre than at the edge parts, and the flatness is improved. Similarly, if the incoming strip 17 exhibits centre buckle, i.e. the strip has been subject to a greater reduction at the centre than at the edges, the discs are arranged as shown in Figure 2B to give the roll 16 a greater stiffness at the edges than at the centre; in Figure 2B, the discs 20 are separated so as to line up with the edges of the strip, the central part of the roll being free of stiffening discs.

When rolling to improve flatness as described above, the second intermediate roll (not shown) need not have the same hollow construction as shown in Figures 2A and 2B, but if the rolls are similarly constructed the discs are similarly arranged when rolling strip with wavy edges or with a wavy centre. However to improve quarter buckle, both intermediate rolls should be hollow and provided with the support discs 20. Then, if the incoming strip has suffered greater elongation at the quarter points between the edges and the centre of the strip than elsewhere, the discs of one intermedite roll are positioned as in Figure 2A while those of the other intermediate roll are positioned as in Figure 2B. If the strip has been elongated less at the quarter points than elsewhere, the disc arrangement is the same, except that fewer discs are provided in the Figure 2A roll, with the consequence that the quarter points are given a smaller reduction than elsewhere.

The barrel of the intermediate roll or of each intermediate roll 16 has usually the same diameter over its length. On the other hand, the barrel may be relieved as shown at 23 in Figures 2A and 2B, forming steps 24 aligned with the edges of the work. Stepped intermediate rolls reduce the over-rolling of the strip edges, particularly where work-roll bending is employed.

In Figure 3, there are two intermediate rolls 30 and 31 each of which is hollow and each of which is stiffened by an adjustable, close fitting, arbor 32 having tapered ends 33. The arbors 32 are positioned so that the end of one lines up respectively with one edge of the strip 17, while the opposite end of the other arbor lines up with the other strip edge, as shown. The mill is then relatively stiff over the width of the strip 17 and relatively soft outside the strip width. Over-rolling of the strip-edges is thus reduced and work-roll bending is facilitated. Figure 4 shows a four-high mill with work rolls 35 and back-up rolls 36 and with each work roll constructed similarly to the intermediate rolls 30, 31 of Figure 3. Profile of the rolled strip is again controlled by work roll bending.

In a further variant which is illustrated in Figure 5, each of the work roll 40, 41 of a four-high mill is hollow and contains an arbor 42. The arbor 42 is an interference fit with the bore of its roll and extends over the central third of the length of the roll 40, 41. The arbors are integral with shafts 43 of lesser diameter extending beyond the ends of the roll. Hydraulic piston and cylinder assemblies are connected to the ends of the shafts 43 as represented by the forces $F_4 - F_7$, to bend the arbors 42 and hence the centre parts of the rolls 40, 41. That bending equipment can replace or supplement the conventional work roll bending represented by the forces $F_1 - F_3$ and has the same function; however, the roll bending is concentrated at the roll centres which are normally subject to little bending when the bending forces are applied to the roll ends.

By selecting what bending forces are applied to the rolls 40, 41 and to the ends of the shafts 43, transverse rolling of the strip 17 can be varied as required. Thus,

1. applying the bending forces F_1 and F_4 would result in a large centre crown in the strip and in the strip edges being rolled i.e. a loose edge.

2. applying the bending forces F_4 and F_2 would result in a smaller centre crown but in relieving the edges i.e. a tight edge.

3. applying the bending forces F_2 and F_5 results in a heavy roll crown i.e. the strip has a rolled centre and a tight edge, and

4. applying the bending forces F_1 and F_5 results in rolling the strip centre and easing the tight strip edge.

The concept of a hollow roll with a central arbor can be applied to the intermediate roll 45 of a five-high mill (Figure 6) or to each of the intermediate rolls of a six-high mill (Figure 7) or to one or each of the back-up rolls (Figures 8 and 9). In these cases, the axial length of the arbor 42 is less than the effective length of the roll barrel and may be less than the width of the strip 17. Roll bending systems represented by the bending forces F_1 - F_7 are applied to the work rolls and to the intermediate roll 45 or intermediate rolls 46 and extends the influence of roll bending control across the full width of the strip.

In the roll configurations of Figure 8 and 9, each back-up roll 14, 15 is shown as consisting of a sleeve 50 which is centrally stiffened by an arbor 51. Arbor 51 has integral stub shafts 52 carried in bearings in the windows of the mill housing; the sleeves 50 themselves are unrestrained at their ends and remain isolated from much of the bending effect of the rolling load on the arbors 51. As the width of the strip 17 increases, the sleeves 50 tend to deflect in the opposite sense to the back-up rolls of normal four high mills, i.e. the outer ends of the upper sleeve 50 tend to deflect downwardly and the outer ends of lower sleeve 50 upwardly. Thereby, the total roll stack deflects or bowing is reduced relative to that of the rolls of a normal mill having solid back-up rolls.

In Figure 9, the central arbor 51 is supplemented by adjustable spacer rings 55 carried on the shafts 52 and providing further local support for the sleeves 50. The positions of rings 55 can be adjusted axially to influence the transverse deflections of the sleeves 50. It will be appreciated that this technique employs only the rolling load reaction force on the back-up bearing plates and does not require additional external forces, such as those applied in back-up roll bending, in order to influence the back-up bending deflections.

Figures 10 and 11 illustrate another form of stiffened hollow roll which, when used as the intermediate roll of a five-high mill has the properties of the six-high mill of Figure 3. In Figures 10 and 11, the work rolls of the mill are indicated at 112 and 113, the back-up rolls at 114 and 115, the intermediate roll at 116 between the upper work roll 112 and the upper back-up roll 114, and the metal strip to be rolled at 117. The work rolls 112 and 113 have as before conventional roll bending equipment to control shape with, if required, a strip shape sensor downstream of the mill to control the work roll bending equipment. Instead of, or in addition to, the work roll bending equipment other means for control strip shape may be provided, such as thermal cambering of the rolls by the control of the cooling sprays along the length of the rolls.

The intermediate roll 116 has a barrel length greater than that of the other rolls of the mill. The roll 116 is hollow having a bore 118 which has a uniform diameter over the greater part of its length from one end, but which has an enlarged diameter at 120 over the remainder of its length, a step 121 being formed where the diameter changes. An arbor 122 having a length rather less than that of the work rolls is a close fit in that part of the bore 118 of smaller diameter, but is axially adjustable therein; thus the arbor may be an interference fit in the bore, adjustment being made possible by expanding the roll by liquid under pressure. The arbor has a shank 123 by which it can be moved axially in the roll.

Intermediate roll 116 is itself axially adjustable relative to the other rolls, being mounted and driven for that purpose as described in British patent specification No. 1351074. Alternatively the arbor 122 may have shanks or spindles similar to 123 at both ends with those spindles carried in bearings which are mounted for axial adjustment. In the latter case, the intermediate roll itself is not supported in bearings but is adjustable relative to its arbor.

The mill may be used for rolling strip of any width up to the maximum for which the mill is designed, the roll 116 and the arbor 122 being adjustable axially according to the width of the strip to be rolled. As shown in both Figure 8 and Figure 9, roll 116 is adjusted to bring the step 121 into the same vertical plane as one edge of strip 117 and the arbor 122 is adjusted in roll 116 so that its shank end is in the same vertical plane as the other strip edge, the arbor 122 then overlying the strip width. The result is that the mill has the required stiffness over only the strip width, but has greater compliance outside the strip width. As the left hand side, the greater compliance is achieved by termination of the stiffening arbor at the left hand strip edge and, at the right hand side, by the enlarged bore 120 which prevents the arbor stiffening the roll beyond the right hand strip edge.

If desired, the arbor 122 may be extended with a slight tapering at the left hand end to give a progressive increase in compliance. Similarly the step 121 may be tapered.

The mill illustrated in Figures 10 and 11 has the advantage that only a single adjustable intermediate roll is required in order to adapt the mill to any strip width. Further, because the intermediate roll is longer than the other rolls, and is therefore in contact with work rolls 112 over the entire length of the latter, regardless of the axial position of the intermediate roll, marking of the work roll is avoided.

The arrangement of Figures 2A and 2B, entailing an arbor formed by a number of discs chosen according to the required support length, has the disadvantage that, to change the support length to comply with a change in width of the strip to be rolled, the roll is required to be removed from the mill and discs added or removed. The roll construction shown in Figures 12A and 12B enables the stiffened length of the roll to be adjusted with the roll in situ.

In Figures 12A and 12B, only that part above the roll axis and to the left of the median line is shown, and it is to be understood that the roll is symmetrical about its axis and that the right hand and left hand halves of the roll are mirror images of one another.

The roll has an arbor 212 formed at each end with a roll neck by which the roll is journalled in bearings in the roll housings (not shown). Over a central part 212A, the arbor has a constant diameter, but over each effective end of the arbor the diameter is reduced in small steps from the part 212A, as shown at 212B - 212G.

A sleeve 213 is carried on the arbor 212 and extends over the effective length of the latter. The central part 213A of the sleeve is an interference fit with the central part of the arbor so that that part is permanently stiffly supported by the arbor. On each side of the central part 213A, the bore of the sleeve is rebated as shown at 214, the diameter of the rebated bore increasing in steps 214B - 214G from the central part 213A, to correspond approximately with the stepped parts 212B - 212G of the arbor. A divergent, stepped, annular space is thus formed between the sleeve and the arbor at each end of the sleeve.

At each end of the sleeve, a number of annular wedge elements 215B - 215G are inserted between the rebated bore of the sleeve 213 and the stepped part of the arbor 215. In its initial form, each wedge element 215 has an axial length corresponding to the length of an arbor step and a radial width slightly smaller than the spacing between the steps 212B and 214B. When the elements 215 are in that condition they provide no support for the sleeve, with the result that the roll is relatively stiff over the length of the central part 212A of the arbor, and relatively compliant over the ends.

The stiffened length of the roll is increased by means of an actuator 216 at each end of the arbor. When hydraulically operated, the actuator 216 applies axial forces to the end element 215G, and through it to the other elements 215F - 215B. The effect of the application of the forces is to expand the wedge elements successively, starting with the element 215B which is restrained from axial movement; the number of elements so expanded depends on the magnitude of the forces applied by the actuator 216. When an element 215 is expanded against the contiguous faces of the arbor and sleeve, it provides stiffening support for the sleeve, with the consequence that the stiffened length of roll can be increased by a given axial length dependent on the force of the actuator 216.

The elements 215 may have any desired form capable of producing the necessary radial expansion when subject to axial forces. For example, the element may consist of two rings, one within the other and with tapered faces in contact with one another. It is however preferred to employ elements made and sold under the trade name "RINGFEDER", comprising three concentric rings of which the central ring is actuated directly or indirectly by the actuator 216 and has wedge faces engaging complementary faces on the other rings.

The central stiffened part of the sleeve 213A may have a length slightly less than the minimum width of strip to be rolled, while the overall axial length of the sleeve 213 is slightly greater than the maximum width of strip that can be rolled on the mill. The forces applied by the two actuators 216, and hence the stiffened length of the roll, are chosen according to the strip width to be rolled.

A roll as described may be employed for one or each of the rolls of a four-high mill; as the intermediate roll of a five-high mill; or as one or each of the intermediate rolls of a six-high mill.

Each of the hollow rolls so far described, the roll has a central bore in which is located an axially adjustable arbor.

Problems can arise if a conventional solid roll is bored out to form a hollow roll. The greatest problem arises from the dichotomy between the need to have the bore sufficiently large for adequate roll compliance, and the need for the roll necks, through at least one of which the bore must extend to allow entry and adjustment of the arbor, to be sufficiently strong to transmit the rolling load and to withstand the drive torque, when the roll is driven; for the former, the bore needs a large diameter, while for the latter the bore needs to be of small diameter.

Secondly, for practical use in a rolling mill, the roll should have a life comparable with the life of a conventional solid roll. However, the possible turn-down of a hollow roll is clearly limited relative to that of a solid roll and furthermore a given turn-down of a hollow roll gives a larger change in roll compliance than in the case of a solid roll.

Thirdly, there is the problem of boring out the roll which, because of its intended duty, is made of hard, wear-resisting steel; attempts to bore out such a roll may result in catastrophic fracture of the roll.

The roll illustrated in Figure 13 avoids many of those difficulties. As shown in that Figure, the roll comprises a sleeve 262 which constitutes the roll barrel and an arbor 263 received within the sleeve with a clearance fit and having a length substantially less than that of the sleeve. The arbor 263 is secured to a relatively narrow actuating rod 264 extending beyond the sleeve end.

After the arbor has been positioned within the sleeve, end members 265 and 266 are secured in the sleeve ends, as by Bratt mounting, those members having spigot parts 265A and 266A for that purpose. Each end member is integral with a roll neck 267 or 268 by which the roll is journalled in the mill. The end member 266 with its integral roll neck 268 has a bore 270 to receive the rod 264. The bore within the roll neck 268 is enlarged at 271 and receives a piston 272, which is secured on a reduced part of 264A of the rod 264, and an end plug 273. The rod 264 has passages 274 by which liquid under pressure can be supplied to opposite ends of the enlarged bore 268 to cause the piston 272, and with it the arbor 263, to be moved in either direction. Further passages lead through the arbor to transverse ducts supplying lubricant between the arbor and the sleeve bore, while the end member 265 and roll neck 267 have a passge 275 for oil discharge.

The roll may be used in a four-high, a five-high, or a six-high mill configuration, for example in place of the hollow roll 16, 30, 35, 40, 45 or 46 of Figures 1 to 9. As the available axial adjustment of the arbor 13 within the sleeve 12 is limited, it is advantageous to use two rolls having arbors of different axial length. Between them, the two rolls are then able to be accommodated to all widths of strip or other workpiece likely to be encounterd in the operation of the mill.

With the use of a hollow, compliant, roll as described, roll bending equipment on the work rolls of the mill may be unnecessary because the compliance of the hollow roll provides shape control. To that end, a shape detector, preferably that known under the name VIDIMON, downstream of the mill may be used in conjunction with a closed loop control scheme to vary automatically the position of the arbor within the sleeve for shape control.

It is not essential that the arbor should be an interference fit within the sleeve and, indeed, such a fit should be avoided for ease of adjustment. Instead, there should be clearance between the arbor and the bore of the sleeve when the roll is not in use; under the rolling load, the barrel then deflects on to the arbor and the rolling load is taken in part by the sleeve and in part by the arbor.

The construction illustrated in Figure 13 reduces the difficulties referred to above. It not only removes the conflict between the desired compliance of the barrel and the need for strength in the roll necks, but obviates the necessity of boring out a hardened solid roll; the sleeve can be cast in hard, wear-resisting metal, or it can be formed by boring out a cylinder and subsequently hardened by heat-treatment.

Further, the life of the roll is no longer determined by the amount of turn-down that is available, since it is relatively cheap and easy to fit a new sleeve to the end members and roll necks when wear occurs. Excessive changes in compliance of the sleeve is thereby avoided.

CLAIMS

1. A rolling mill having at least two work rolls (12, 13, 112, 113) and two back-up rolls (14, 15, 114, 115), in which one at least of the rolls (16, 30, 31, 35, 40, 45, 46, 116), is of hollow construction.

2. A rolling mill according to claim 1, in which there are means (20, 32, 42, 122, 212, 263) within the hollow roll (16, 30, 31, 35, 45, 46, 116, 213, 262) for locally increasing the stiffness of the roll, whereby to give the mill a compliance which varies in the axial direction of the rolls.

3. A rolling mill according to claim 2, in which the means comprise support discs (20) which are a close fit within the bore of the hollow roll (16) and which are axially positioned where stiffness is required.

4. A rolling mill according to claim 2, in which the means comprise an arbor (32, 42, 122, 212, 263) which is a close fit within the bore of the hollow roll.

5. A rolling mill according to claim 4, in which the effective axial length of the arbor within the roll is

adjustable to suit the width of material (17, 117) being rolled.

6. A rolling mill according to claim 5, in which the arbor is axially adjustable within the roll.

7. A rolling mill according to claim 5, in which the arbor is constituted by a first part (212A) which is a close fit and is centrally located within the roll, and at least one other part (212B - 212G, 215B - 215G) located adjacent to, and on one side of, the first part, which is capable of being brought into engagement with the roll bore over an adjustable axial length, whereby the effective length of the arbor may be varied.

8. A rolling mill according to claim 7, in which the other part, or each other part, comprises a plurality of sequentially arranged annular wedge elements (215B - 215G), and there are means (216) for applying axial force to the other part, or to at least one of the other parts, to adjust the effective length of the arbor.

9. A rolling mill according to claim 6, in which the hollow roll comprises a sleeve (262) and removable end members (265, 266) carrying a roll neck (267, 268), and in which one of the roll necks has a bore (270) to receive an adjustment rod (264) secured to the arbor (263).

10. A four-high rolling mill (Figure 4), in which each of the work rolls (35) is according to any one of claims 4 to 9, and which is arranged so that the effective length of the arbor in each roll extends over the width of the material being rolled, with the effective ends of the arbors of the work rolls lying substantially at the opposite edges of the material.

11. A five-high rolling mill (Figures 8 and 9), which has an intermediate roll (16) between one work roll (112) and its back-up roll (114) and in which the intermediate roll is according to any one of claims 4 to 9 and is itself axially adjustable relative to the other rolls, the arrangement being such that the effective end (121) of the intermediate roll can be brought into substantial alignment with one edge of the material (117) being rolled with the end of the effective length of the arbor in substantial alignment with the other end, whereby the mill is relatively stiff over the width of the material and relatively compliant beyond the edges of the material.

12. A six-high rolling mill (Figure 3), which has an intermediate roll (30, 31) between each work roll (12, 13) and its back-up roll (14, 15) and in which each intermediate roll is according to any one of claims 4 to 9, the arrangement being such that the ends of the effective lengths of the arbors within the intermediate rolls can be brought into substantial alignment with the opposite edges

of the material (17) being rolled, whereby the mill is relatively stiff over the width of the material and relatively compliant beyond the edges of the material.

13. A rolling mill according to any one of claims 10 to 12, in which there are means for bending at least one of the work rolls for the control of the shape of the material being rolled.

14. A rolling mill according to any one of claims 10 to 13, in which there are means for applying bending forces to the arbor, or at least one arbor.

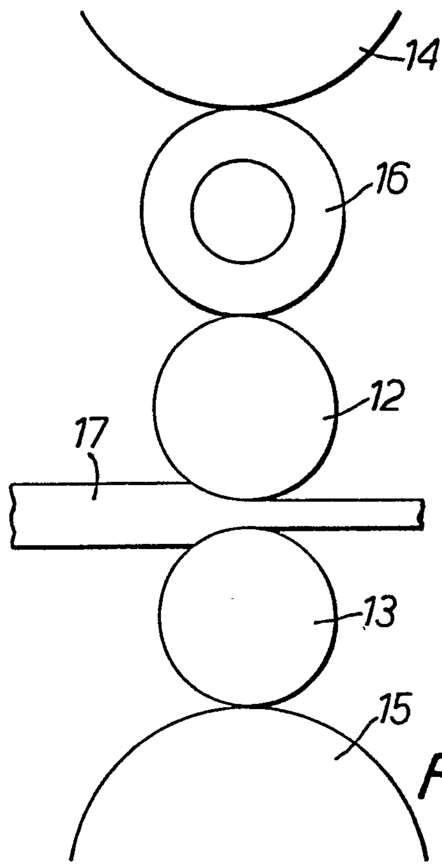


FIG. 1.

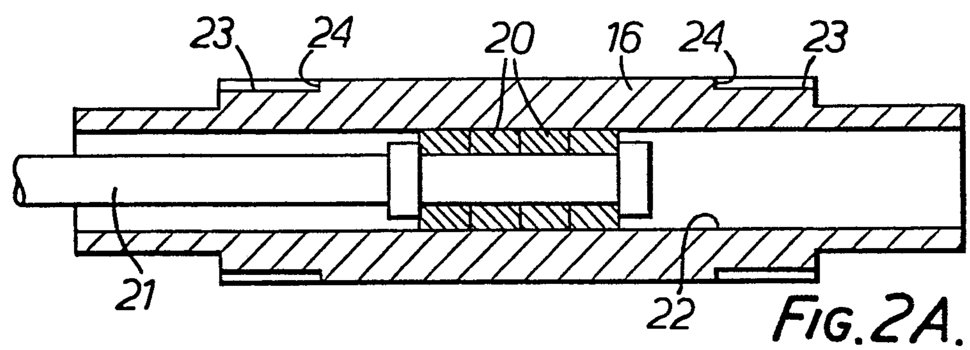


FIG. 2A.

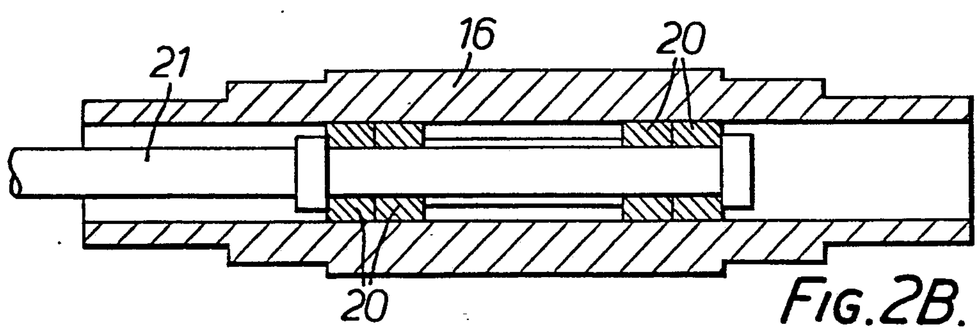


FIG. 2B.

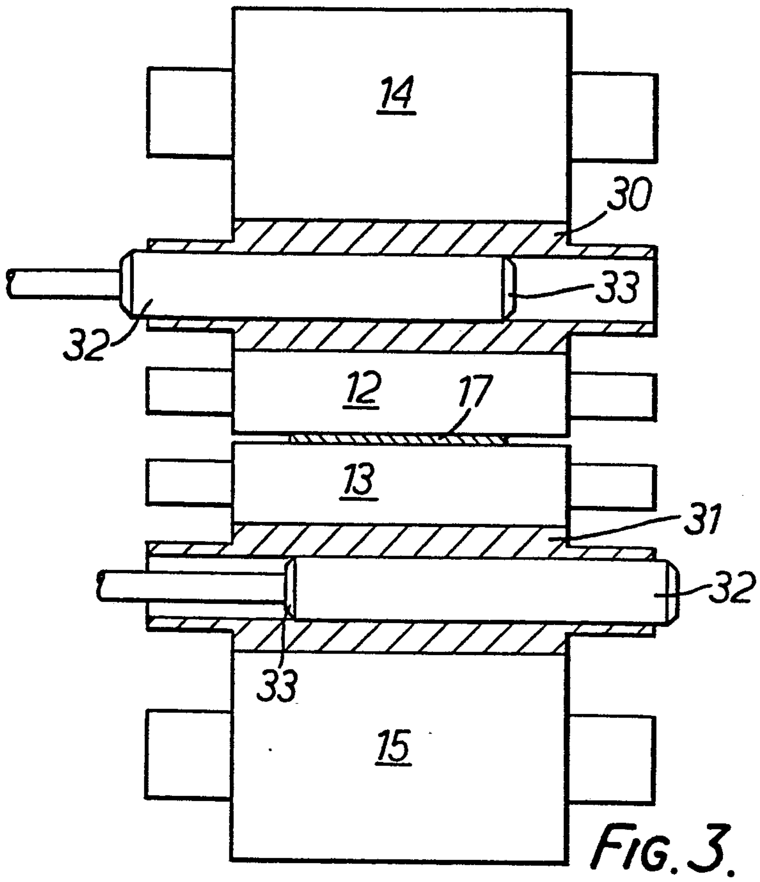


FIG. 3.

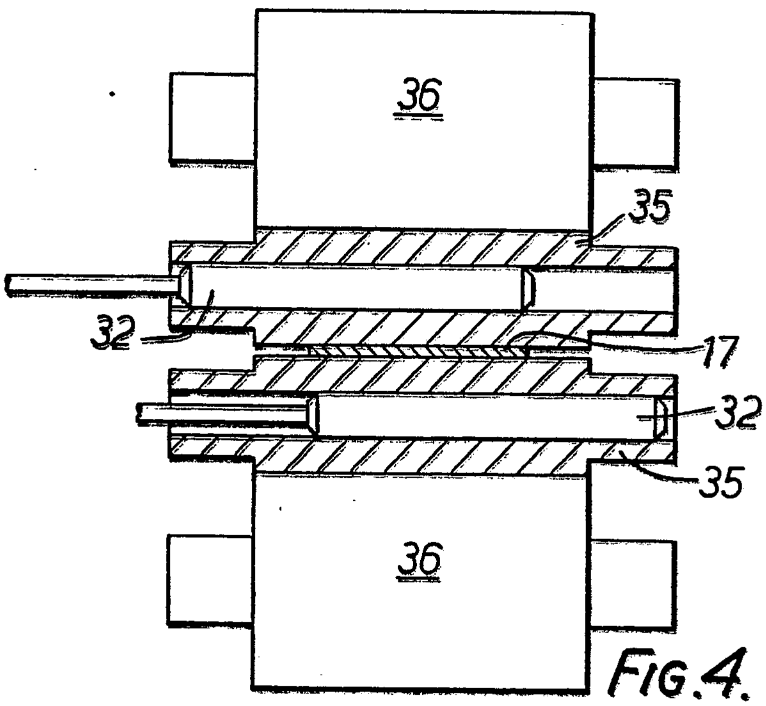
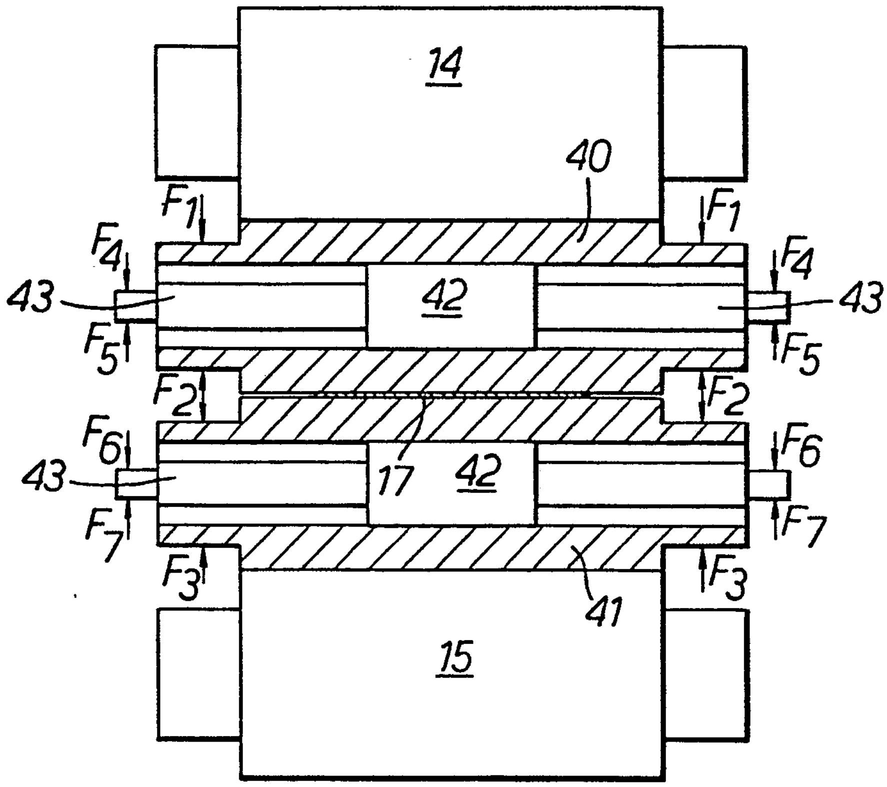


FIG. 4.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F4
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F5
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FIG. 5.

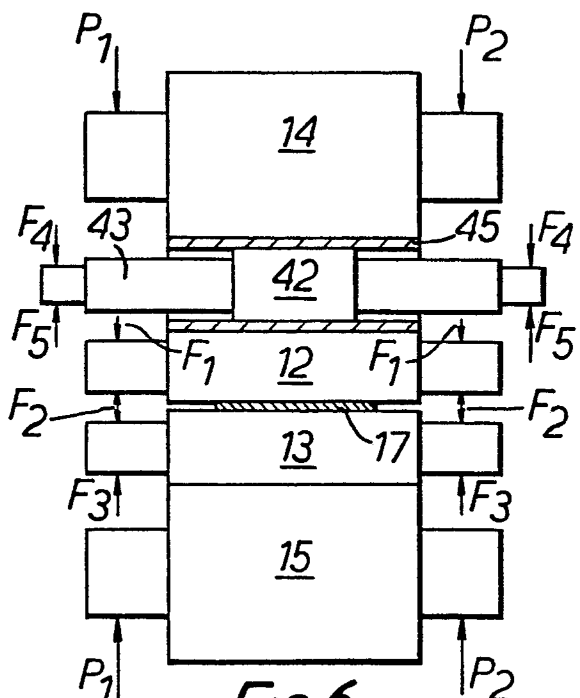
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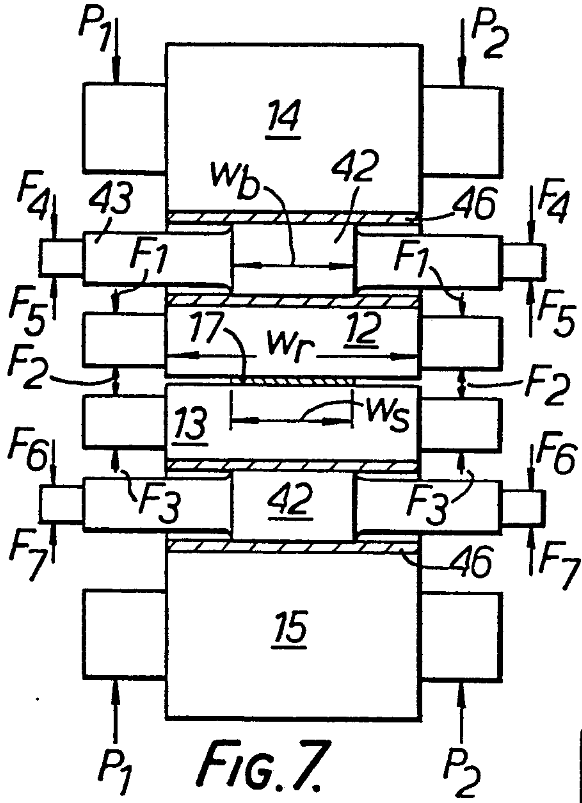
FIG. 6.



P_1
P_2
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w_b
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43
46
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F_1
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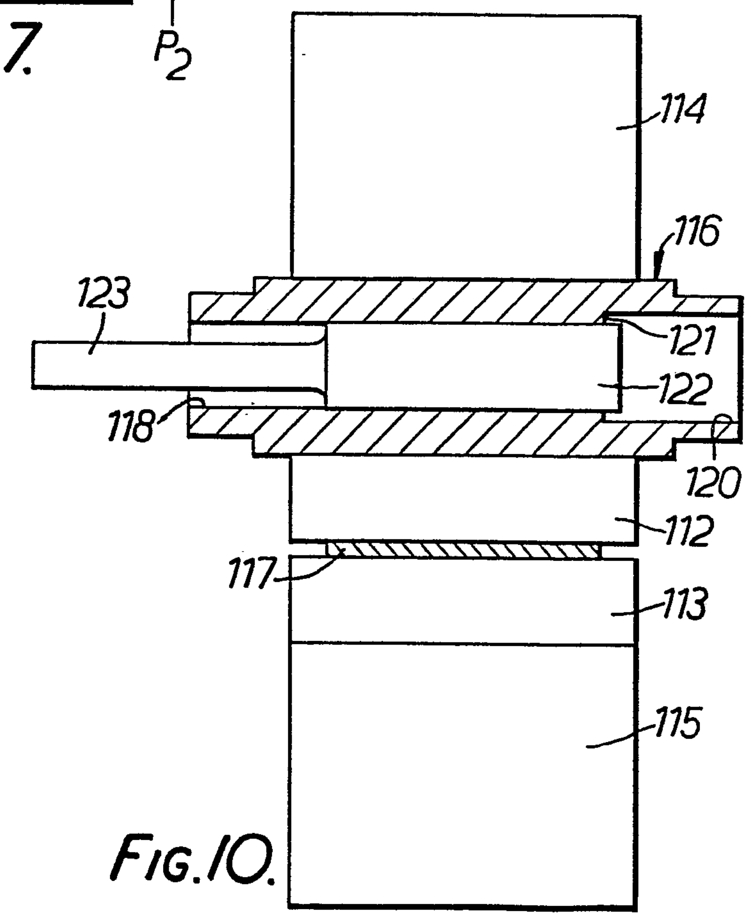
P_1
P_2

FIG. 7.



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115

FIG. 10.

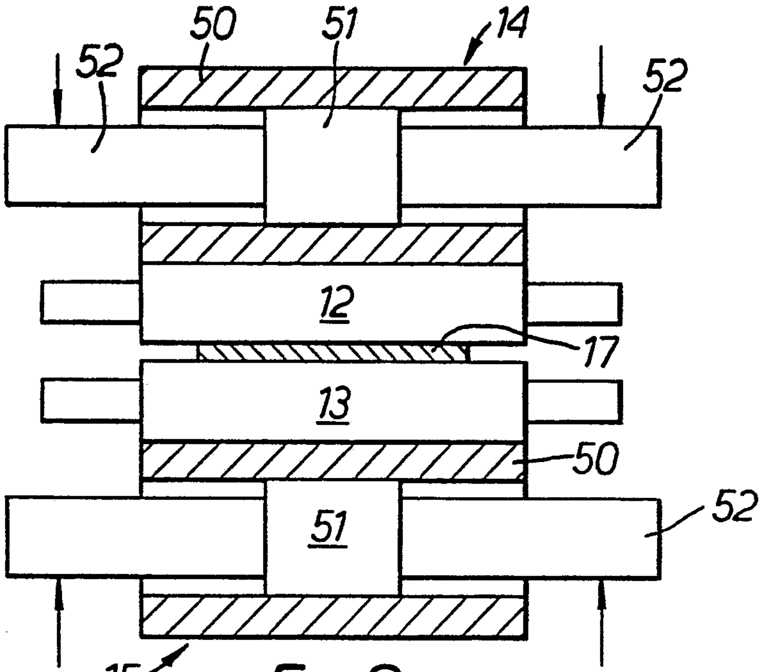
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FIG. 8.

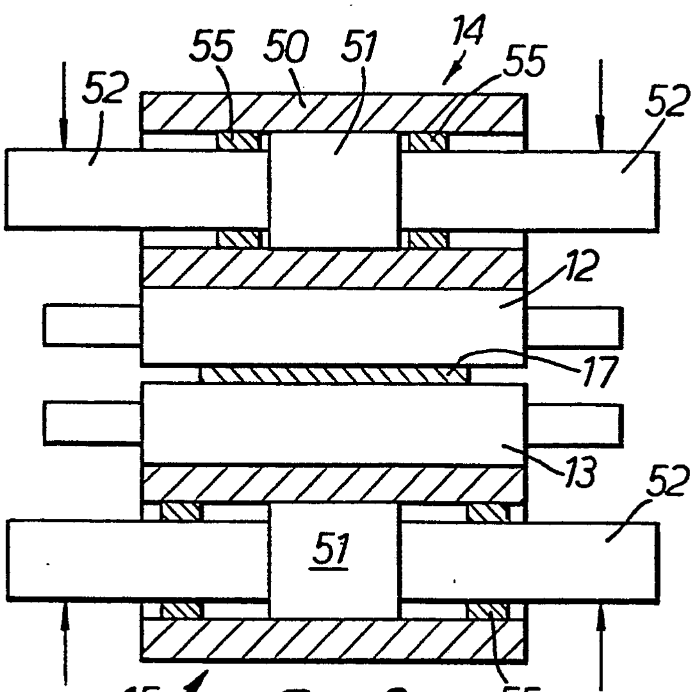
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FIG. 9.

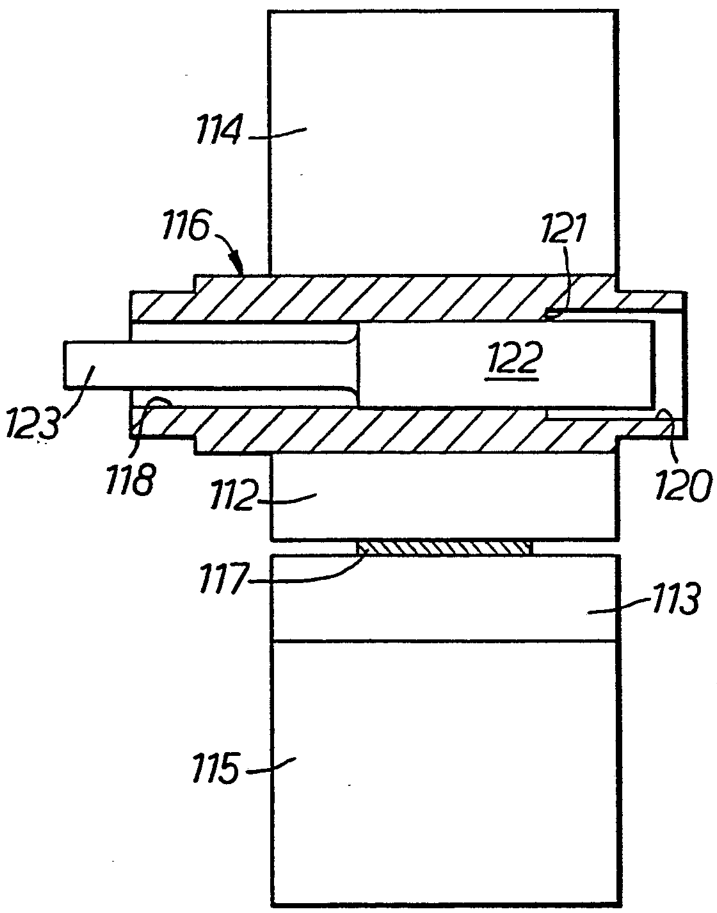

FIG. 11.

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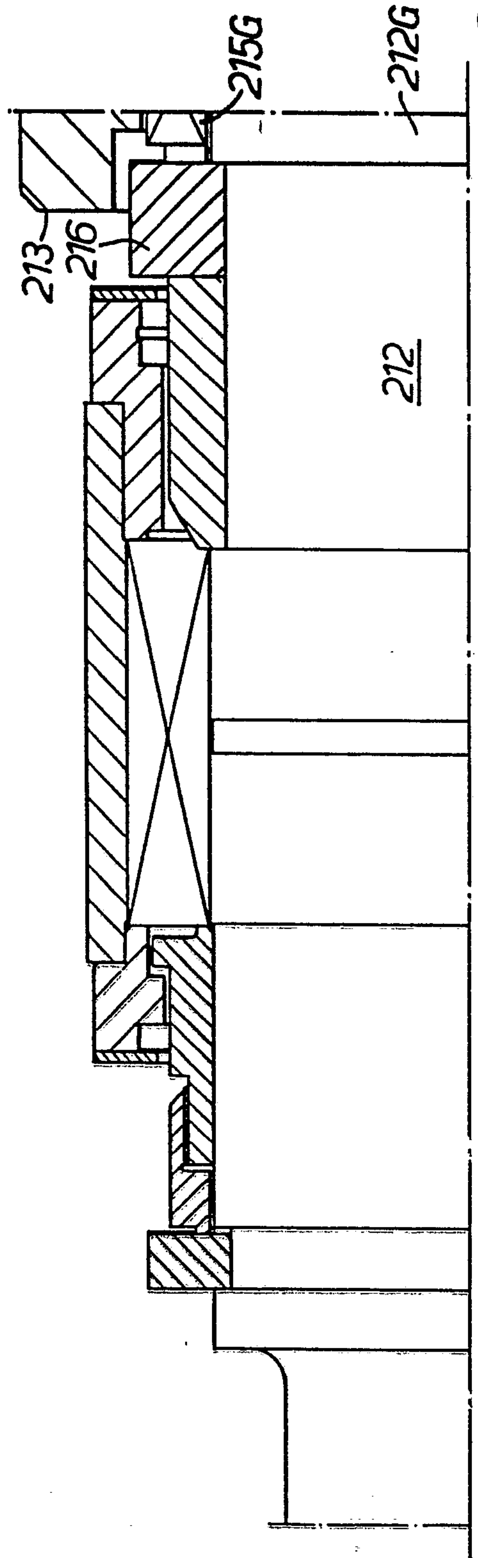


FIG. 12A.

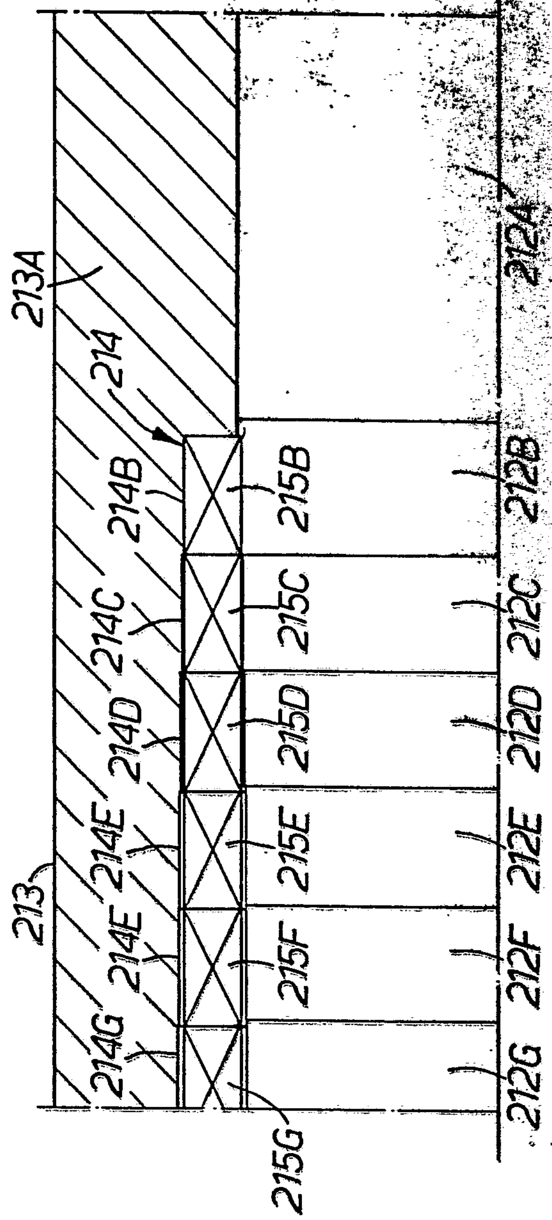
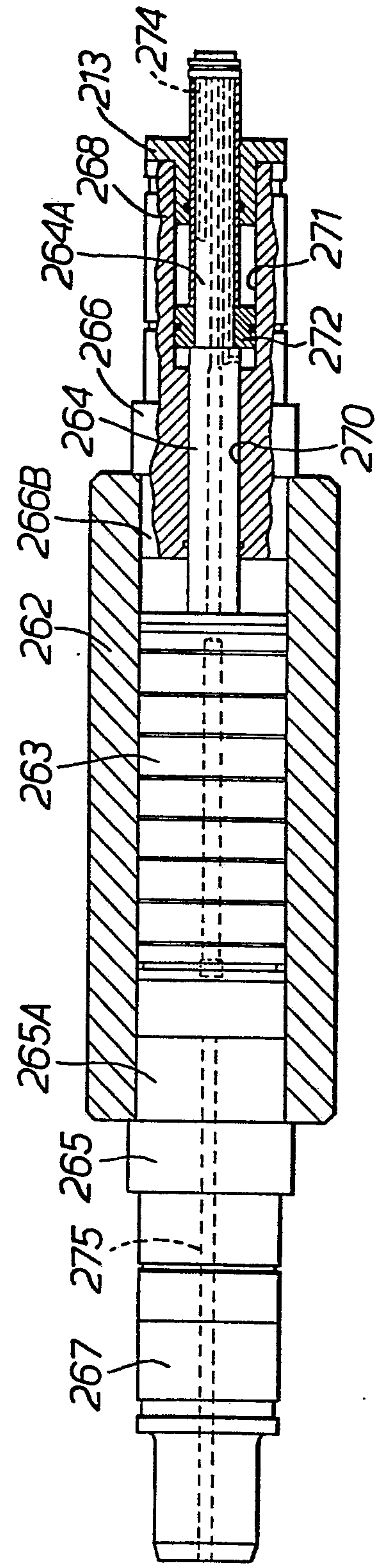


FIG. 12B.


274
213
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266B
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265A
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FIG. 13.

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European Patent Office

EUROPEAN SEARCH REPORT

Application number
EP 81 30 3277

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
X	FR - A - 958 248 (ACIERIES) * Page 2, lines 16-25; figures 3,4 * --	1
A	DE - C - 119 885 (SCHURMANN)	2-4
A	CH - A - 593 724 (LEHMANN)	2,7,13
A	JP - A - 51 103058	5-7
A	DE - A - 2 624 876 (BOOS)	11
A	DE - A - 2 314 502 (ROTERT) ----	1

CLASSIFICATION OF THE APPLICATION (Int. Cl.3)

B 21 B 13/14
B 21 B 27/02

TECHNICAL FIELDS SEARCHED (Int. Cl.3)

B 21 B

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
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E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	15-10-1981	SEMBRITZKI

EPO Form 1503.1 06.78