(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 019 737**
A1

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **80102342.5**

(22) Date of filing: **30.04.80**

(51) Int. Cl.³: **B 21 B 13/14**

(30) Priority: **24.05.79 JP 64459/79**

(43) Date of publication of application: **10.12.80**
Bulletin 80/25

(84) Designated Contracting States: **DE FR GB IT**

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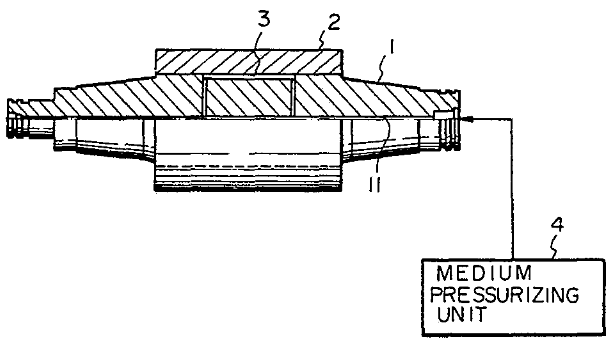
(54) Rolling mill using variable crown roll.

(57) A multi-high rolling mill comprising work rolls and back-up rolls, in which at least one of said rolls is a variable crown roll having the extent of crowning controlled by a pressure medium (Fig. 1).



EP 0 019 737 A1

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ROLLING MILL USING VARIABLE CROWN ROLL

The present invention relates to a multi-high rolling mill using at least one variable crown roll.

The rolling mill to which the principle of the present invention applies comprises at least a pair of work rolls and a back-up roll arranged in at least three-high (mainly four-high) and in a single stand or tandem stands, for applications of either hot or cold rollings and preferably comprises further roll benders as additional equipment.

The term "work roll" as used herein and in the claims is to be understood to mean a roll in direct contact with a material to be rolled and the term "back-up roll" is to be understood to mean a roll directly or indirectly supporting the work roll.

The variable crown roll is so constructed as to be controllable in the extent of crowning of the roll by introducing a fluid or a viscous material under pressure into a predetermined cavity defined between an arbor and a sleeve.

The variable crown roll has been heretofore used in two-high rolling mills but never in three- or more high rolling mills. For example, United States Patents Nos. 3,604,086 and 3,457,617 disclose variable crown rolls which were, however, all applied to two-high rolling mills only. The two-high rolling mills using conventional variable crown rolls had several disadvantages such that the work rolls were unable to withstand high rolling load, it was difficult to manufacture roll sleeves of high hardness, the toughness of the sleeve decreased because of the requirement for higher surface hardness of the rolls, and shape defects are easily caused in the strip in the neighborhood of the pressure receiving sleeve end. Accordingly, such rolling mills were, while suitable for light load rolling such, for example, as temper rolling, not suitable for heavy load rolling such as common hot or cold rolling.

Heretofore, the variable crown roll was not applied to the multi-high rolling mills (particularly to back-up rolls) probably for the following apprehensions:

(1) In view of the fact that the material is rolled by work rolls usually of the diameter as large as 500 - 600 mm, mere application of the variable crown roll (hereinafter referred to simply VC roll) to the back-up rolls is not expected to provide any particular effect.

(2) It is doubtful that pipe-shaped rolls as the VC rolls achieve satisfactory rolling.

(3) The diametrical expanded VC rolls may rather be depressed by the high rolling load failing to provide any effect.

(4) The sleeve holding force may be insufficient, thereby causing roll bending.

(5) The VC rolls may be dangerous from the view point of fatigue safety factor.

Based on many years' experience and theoretical and experimental supports, the inventors have the following views of the above-mentioned apprehensions:

(1) The crowning effect of the back-up roll is provided to the rolled material through the work rolls. In fact, a change of approximately 1/2 - 1/5 of the diametrical expansion in the outer diameter of the rolls appears in the rolled material. The efficiency of this expansion is sufficient for controlling the crown and the shape.

(2) Since the VC roll is provided with a small cavity only in the pressure receiving sleeve portion of the roll, the mill rigidity thereof is substantially the same as that of solid rolls.

(3) The diametrical expansion of the VC roll can be made larger than the depression thereof by the high rolling load.

(4) When the back-up roll is a VC roll, a large sleeve holding force can be provided since the pressure receiving sleeve part length of the back-up roll need not be larger than the width of the material to be rolled. Generally in

the rolling mills, since the work rolls are driven, the torque exerted on the back-up rolls is smaller than that exerted on the work rolls.

(5) It is possible to design the VC rolls having the fatigue safety factor of 1.5 - 3.

Accordingly, the inventors have sufficient reason to state that the VC roll is satisfactorily applicable to the multi-high rolling mills.

Therefore, an object of the present invention is to apply the VC rolls to the multi-high rolling mill to thereby make extensive and manifold rolling practicable.

The basic conception of the present invention is to provide a multi-high (mainly four-high) rolling mill comprising a pair of work rolls and at least one back-up roll, in which at least one of the rolls is a VC roll.

Having this construction as the basis, the present invention intends to provide the following modifications:

a. A four-high rolling mill in which at least one of a pair of back-up rolls is a VC roll or at least one of a pair of work rolls is a VC roll;

b. A four-high rolling mill in which a pair of the back-up rolls are VC rolls of different construction from each other, or a pair of the work rolls are VC rolls of different construction from each other; and

c. A detection signal of the shape or the crowning or both of them of the material to be rolled are utilized to control the extent of the crowning of the VC rolls.

The invention will be better understood from the following description taken in connection with the accompanying drawings.

Fig. 1 is a schematic sectional view of a VC roll;

Figs. 2A to 2F are schematic illustrations of typical roll arrangements of the rolling mill to which application of the present invention is intended;

Figs. 3A and 3B are schematic illustrations of roll stand arrangements of the rolling mill to which application of the present invention is intended;

Fig. 4 is an illustration of function of roll benders;

Figs. 5 to 8 are illustrations of roll arrangements of embodiments of the present invention;

Figs. 9 and 10 are schematic cross sectional views of a four-high rolling mill of another embodiment of the present invention;

Fig. 11 is an illustration of control of the shape and the crowning of the material being rolled by the rolling mill according to the present invention;

Figs. 12 to 17 are graphs showing the results of various tests in the rolling mill according to the present invention;

Fig. 18 is a schematic cross sectional view showing the construction in which the roll benders are assembled to the four-high rolling mill according to the present invention; and

Figs. 19 to 21 are graphs showing the results of various tests in the rolling mill of Fig. 18.

Several preferred embodiments of the present invention will now be described with reference to the accompanying drawings. Before describing the present invention in detail, the construction and the function of the VC roll used in the present invention will be described briefly with reference to Fig. 1.

In the basic construction of the VC roll, as shown in Fig. 1, an annular cavity 3 is defined between an arbor 1 and a sleeve 2, to which a medium (for example, water, oil, grease or the like) under high pressure is applied from a medium pressurizing unit 4 through a conduit 11 provided in the arbor 1 so as to control the extent of crowning of the roll (that is, the extent of the diametrical expansion of the roll outer diameter) by regulating the pressure of the medium by means of the unit 4.

The rolling mills to which the present invention is intended are of the types, for example, as shown in Figs. 2 to 4. In roll arrangement, the rolling mills are, in principle, multi-high rolls mainly from three-high to six-high rolls as shown in Figs. 2A to 2F and most suitably four-high rolls as shown in Fig. 2C. Accordingly, the present invention will be described hereinunder as being applied to the four-high rolling mill for the sake of simplicity but it must be understood that application of the present invention is not limited thereto. In roll stand arrangement, the rolling mill may be either of single stand as shown in Fig. 3A or of tandem stands as shown in Fig. 3B. With respect to additional equipment, the rolling mill is preferably provided with roll bender J_W or J_B in the work roll W or back-up roll B thereof.

The basic construction of the rolling mill according to the present invention resides in, as shown with reference to the three-high mill for convenience' sake in Figs. 5A to 5G, the multi-high rolling mill in which at least one of the rolls is the VC roll (hatched in the drawing). Accordingly, the three-high rolling mill according to the present invention may take any of the roll combinations shown in Figs. 5A to 5G. Special effects achieved by this construction will become clear from the ensuing description.

In an embodiment of the present invention, the four-high rolling mill has, as shown in Figs. 6A to 6C, at least one VC roll (hatched in the drawing) in the back-up rolls.

In this embodiment, the extent of crowning of the back-up rolls is first changed. The change then exerts an influence on the work rolls to bend the entire shafts of the work rolls to thereby cause a substantially predetermined extent of change in the crown of the work rolls.

Sheet crown (thickness distribution across the strip width) and shape tests were performed in the four-high rolling mill for test in which, as shown in Fig. 6A, the upper back-up roll is a VC roll of the size 200 mm in outer diameter and 460 mm in length while the work roll is of the size 80 mm in outer diameter and 460 mm in length.

Fig. 12 shows the results of the sheet crown tests performed on an aluminum plate of 4 mm in thickness and 350 mm in width under the rolling load of 20 tons using the four-high rolling mill described above. In Fig. 12, the marks ○, ●, △ and X denote the oil pressure P' (Kg/cm^2) of the VC roll at 0, 165, 340, and 510, respectively. As seen from Fig. 12, as the oil pressure of the VC roll increases, the axial deflection of the work rolls changes. The sheet crown changes with the change in the axial deflection of the work rolls. Thus, the sheet crown control effect according to the present invention was confirmed.

Fig. 13 shows the results of the shape tests performed on a cold rolled coil of 0.4 mm in thickness and 300 mm in width under fixed drafts using the same four-high rolling mill described above. In Fig. 13, the marks ○, ●, and △ indicates the reduction (%) of 0.5, 1.0, and 14.5, respectively. As seen from Fig. 13, as the oil pressure of the VC roll increases, the shape of the rolled material changes from wavy edges to center buckle and, under the predetermined reduction good flatness is obtained at a specified oil pressure. By combining bender it becomes possible to correct quarter buckle shape defect. Thus the shape control effect according to the present invention was confirmed.

The application of the VC roll to the back-up roll provides the following advantages:

(1) Since the roll diameter and the sleeve thickness can be larger than in the work roll, the stress generated in the roll can be reduced.

(2) Since the rolling is performed through the work rolls, the pressure receiving sleeve part length of the back-up roll can be determined independent of the width of the material.

(3) Since the hardness of the surface of the roll may be low, selection of the sleeve material is made easy.

(4) Since the rotational frequency is smaller than in the work rolls with respect to the same rolling speed, design of the rotary joint is made easy.

(5) Since the sleeve thickness becomes large, the value of concavity is smaller than the value of expansion in the outer diameter.

(6) Consequently, the rolling with higher speed, larger load, and larger width is made possible.

In another embodiment of the present invention, the four-high rolling mill has, as shown in Figs. 7A to 7C, at least one VC roll (hatched in the drawing) in the work rolls.

In this embodiment, the extent of crowning of the work-rolls is directly changed and the change is strengthened by the reaction of the back-up rolls.

Sheet crown and shape tests were performed in the four-high rolling mill for test shown schematically in Fig. 7, the work rolls and the back-up rolls of which are of the same size as those of Fig. 6A.

Fig. 14 shows the results of the sheet crown tests performed on an aluminum plate of 4 mm in thickness and 250 mm in width under the rolling load of 20 tons using the four-high rolling mill described above. In Fig. 14, the marks ○, ●, and X denote the oil pressure P' (Kg/cm^2) of the VC roll at 0, 200, and 400, respectively. The curves of Fig. 14 show the similar tendency to those of Fig. 12.

Fig. 15 shows the results of the shape tests performed on a cold rolled coil of 0.4 mm in thickness and 300 mm in width under the reduction of 1% using the same four-high rolling mill with the oil pressure P' (Kg/cm^2) of the VC roll changed. The curves of Fig. 15 show the similar tendency to those of Fig. 13.

The application of the VC roll to the work rolls of the four-high rolling mill provides the following advantages over the application of the VC roll to the work rolls of the two-high rolling mill:

(1) In the four-high rolling mill, since the deflection in the work rolls is received by the back-up rolls, the crowning effect of the VC roll is larger than in the two-high rolling mill.

(2) In the four-high rolling mill, the combination of the diametrical expansion of the VC roll with a work roll bender or with a back-up roll bender to be described hereinunder can correct complicated shape defects such, for example, as quarter buckle.

It will be readily estimated that said effect can be doubled by the use of the VC roll for both the upper and the lower back-up rolls or both the upper and the lower work rolls.

Figs. 16 and 17 show the results of the sheet crown and the shape tests, respectively, performed in a further embodiment of the present invention in which the VC roll is used in one of each of the back-up and the work rolls as shown in Figs. 8A and 8B. The sizes of the rolls of the mills and the sizes and the quality of the specimens used in the tests of Figs. 16 and 17 are the same as those used in the tests of Fig. 14.

In Fig. 16, the marks ○, ●, and X denote the oil pressure P' (Kg/cm^2) of the VC roll at 0, 100, and 200, respectively. In the bar crown tests of Fig. 16, the rolling load was 25 tons. In Fig. 17, the marks ○ and ● denotes the reduction (%) of 3 and 15, respectively.

As seen from Figs. 16 and 17, the sheet crown and shape control effects show the similar tendency to those described above and as the number of the VC rolls used increases, the effect thereby also increases. It was confirmed that the embodiment shown in Figs. 8A and 8B is effective for control of the shape and particularly for correction of the shape defects such as quarter buckle which was heretofore difficult to be solved by the conventional rolling mills.

The foregoing description assumes that the VC rolls used in pair are of the same internal construction. As shown in Figs. 9 and 10, however, by intentionally making one of the VC rolls in pair different from the other in the variable crown construction (primarily the size of the cavity which is filled by the pressure medium), it is made possible to roll efficiently materials ranging in width radically without changing the rolls. That is, a material of large width is rolled by rolls of large width variable crown construction, a material of small width is rolled by rolls of small width variable crown construction, and a material of intermediate width is rolled by rolls of large width alone or in combination with the rolls of small width variable crown rolls.

It was confirmed that the sheet crown correction and the shape correction effects are obtained by using the VC rolls properly as described above. Accordingly, the sheet crown and shape control system can be constructed by combining the VC rolls with a detector.

For example, as shown in Fig. 11, a rolling mill 21 is provided on the exit/entry side thereof with a sheet crown and shape detector 22, a detection signal of which is transmitted to a control unit 23 in which the detection signal is compared with the set value, to control the medium pressurizing unit 4 (see Fig. 1) of the VC roll provided in the rolling mill 21.

The detector is preferably of non-contact type. Various instruments such as an X-ray thickness meter, a β-ray thickness meter, a flying micrometer and the like can be used as the sheet crown detector. There are various types of the shape detector such as optical type, electromagnetic type, displacement-type, vibration-type, and the like.

The relation between the sheet crown and the shape will now be briefly described. With respect to the sheet thickness distribution of the material to be rolled, if the sheet crown ratio on the entrance side of the mill is Cri and the sheet crown ratio on the exit side of the mill is Cro, and if Cri = Cro, there is no shape defect caused because the widthwise distribution with respect to the longitudinal elongation is uniform. If Cri > Cro, the sheet is elongated more in the center of width than in both the edges into the shape defect of center buckle. On the contrary, if Cri < Cro, the bar is elongated more in both the edges than in the center of width into the shape defect of wavy edges. Accordingly, the sheet crown is closely related to the shape.

Generally, since a small change in the sheet crown causes a large change in the shape, rolling is performed (particularly in cold rolling) paying attention mainly to the shape. However, in the case, as in hot rolling, where the sheet thickness is large and metal flow occurs readily, there is caused no extreme shape defect since the material readily flows widthwise when the sheet crown changes. Accordingly, the crown control is easily effected in hot rolling.

In this way, in a multi-pass rolling the sheet crown control is performed within the range of the shape defect that is not disadvantageous to the rolling operation and the shape control is performed at the final pass. In a tandem rolling, the sheet crown is performed at the upstream stand and the shape-attended control is performed at the final stand.

In the conventional rolling mill, the shape correction was performed by a work roll bender or a back-up roll bender. As an application of the present invention, a combination of the roll bender with the VC roll is possible. The results of numerical experiments show that this construction provides unexpected multiplication effects as described below.

The rolling mill used in the experiments is, as shown in Fig. 18, a four-high mill in which the upper back-up roll B is a VC roll and a roll bender is provided between the work rolls W. Table 1 shows the sizes of this rolling mill and the rolling conditions.

Table 1

Item	Mark	Cold Rolling Temper	Cold Tandem	Hot Tandem
Roll Size (mm)	DB	1524	1524	1422
	Db	900	953.9	781.1
	DW	585	585	713
	Dw	342.9	342.9	457
Rolled Bar Width (mm)	RL1	1200	1000	1000
Mill Size (mm)	RL2	1680	1704	2032
	RL3	2880	2720	3124
	RL4	600	508	546
	RL5	2880	2720	3124
Rolling Load	P	500	900	900
Bending Force (ton)	JW	0 - 80	0 - 100	0 - 180

(Initial Crown: 0)

Figs. 19 to 21 show the results of tests performed on the relation between the work roll bending force J_W (ton) and the bar crown when the oil pressure P' (Kg/cm^2) applied to the VC roll in this rolling mill is varied stepwise.

Fig. 19 shows the results of the cold temper rolling of a material of 1200 mm in width under the rolling load of 500 tons. In Fig. 19, the horizontal axis indicates the bending force J_W (ton) of the work rolls and the vertical axis indicates the bar crown δc (cm) at the position of 1/4 of width. In Fig. 19, A denotes the conventional bending effect (19.2μ), B denotes the effects of change in oil pressure of the VC roll only (31.3μ), and C denotes the multiplication effect (51.6μ) by the VC roll and the bender.

Fig. 20 shows the results of the cold tandem rolling of a material of 1000 mm in width under the rolling load of 900 tons. In Fig. 20, the horizontal and vertical axes and the reference characters A, B and C, respectively, denote the same items as in Fig. 19, provided that A = 14.8μ, B = 21.8μ, and C = 36.5μ.

Fig. 21 shows the results of the hot tandem rolling of a material of 1000 mm in width under the rolling load of 900 tons. In Fig. 21, the horizontal axis J_W, the vertical axis δc, and the reference characters A, B and C, respectively, denotes the same items as in Fig. 19 provided that δc indicates the sheet crown at the point 50 mm from the edge and that A = 27.2μ, B = 39.7μ, and C = 66.9μ.

As clearly seen from Figs. 19 to 21, in the case where a single VC roll is used, the change in oil pressure from 0 - 300 Kg/cm^2 provides the equivalent or better effect than in the conventional roll bender and the combination of the VC roll with the roll bender provides 2 to 4 times higher sheet crown control effect than the conventional roll bender.

While the present invention has been heretofore described with respect to its application to a single stand rolling mill, it will be obvious to those skilled in the art that the present invention is applicable to a continuous hot or cold rolling stand (Fig. 3B). In this case, it is desirable that the VC roll is applied to all the stands. However, even where the VC roll is applied only to limited stands in view of reduction in cost, sufficient effects are obtained therefrom as shown in Tables 2 and 3.

Table 2

Examples in Continuous Cold Mill

Stand No.					Sheet Crown Control Effect	Shape Control Effect	Edge Drop Decreasing Effect
1	2	3	4	5			
●	●	●	●	●	○	◎	○
●	●		●	●	○	◎	○
●				●	○	○	○
				●	X	○	X

Table 3

Examples in Continuous Hot Mill

Stand No.						Sheet Crown Control Effect	Shape Control Effect	Edge Drop Decreasing Effect
1	2	3	4	5	6			
●	●	●	●	●	●	◎	◎	◎
●	●			●	●	○	◎	○
●	●			●		○	○	○
					●	X	◎	X

where: - VC roll applied

- very effective

- effective

- less effective

While Table 3 shows the examples of application of the VC roll to a continuous finishing mill, application of it to a roughing mill is likewise effective. Particularly, its application to a roughing mill of a semi-continuous hot strip mill is effective not only in crown control but also in improvement in the crop loss at the top or bottom of the strip.

In the continuous mill, the combination of the VC roll with the conventional roll bender provides an enlarged range of control.

We claim:

1. A multi-high rolling mill comprising one or more work rolls and one or more back-up rolls, characterized in that at least one of the rolls of said mill is a variable crown roll which is controlled in the extent of crowning by a pressure medium.

2. A four-high rolling mill according to Claim 1, characterized in that at least one of the back-up rolls is a variable crown roll.

3. A four-high rolling mill according to Claim 1, characterized in that at least one of the work-rolls is a variable crown roll.

4. A four-high rolling mill according to Claim 1, characterized in that a pair of the back-up rolls are variable crown rolls which are different in construction from each other.

5. A four-high rolling mill according to Claim 1, characterized in that a pair of the work rolls are variable crown rolls which are different in construction from each other.

6. A rolling mill according to any one of Claims 1 to 5, characterized in that the extent of crowning of the variable crown is controlled by a signal indicative of the shape and/or the sheet crown of the material to be rolled.

7. A rolling mill according to Claim 1, characterized in that roll benders are provided between said work rolls and/or said back-up rolls to control the extent of crowning of the variable crown roll and the roll bending force, thereby controlling the sheet crown and the shape of the material to be rolled.

Fig. 1

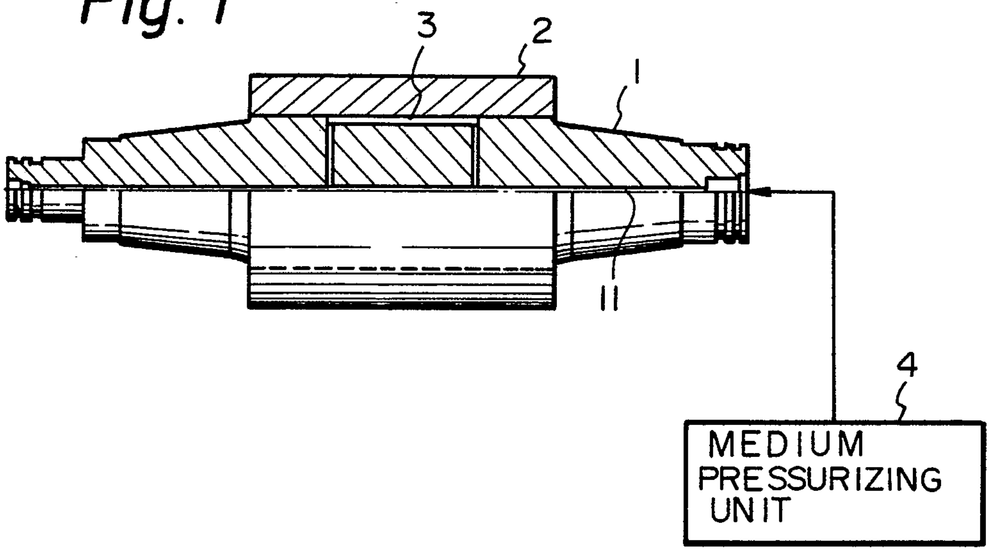


Fig. 2A

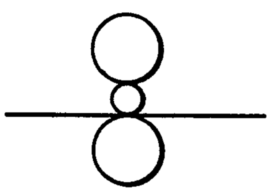


Fig. 2B

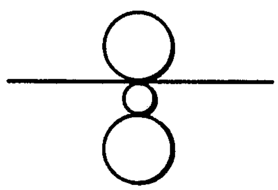


Fig. 2C

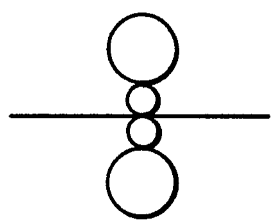


Fig. 2D

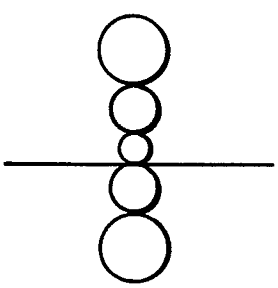


Fig. 2E

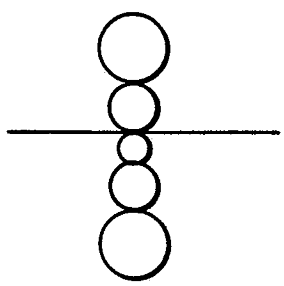


Fig. 2F

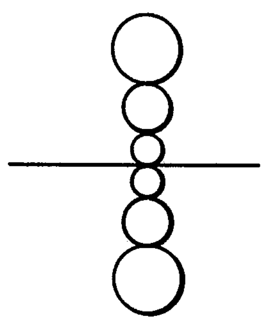


Fig. 3A

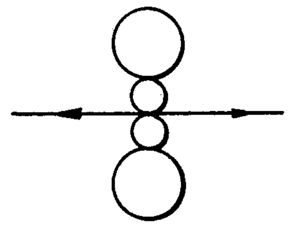


Fig. 3B

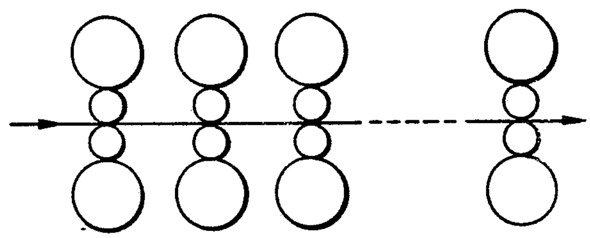


Fig. 4

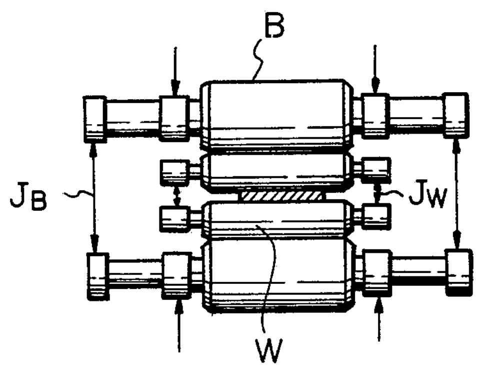


Fig. 5A

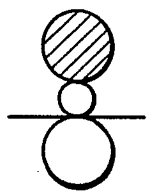


Fig. 5B

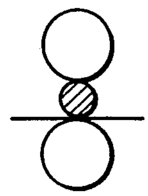


Fig. 5C

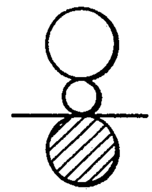


Fig. 5D

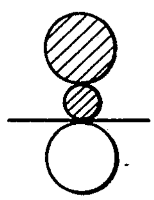


Fig. 5E

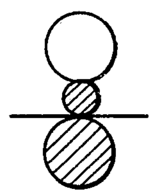


Fig. 5F

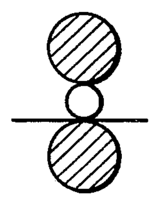


Fig. 5G

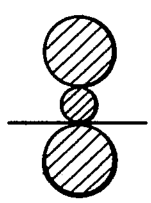


Fig. 6A

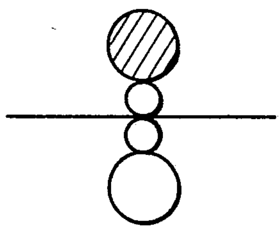


Fig. 6B

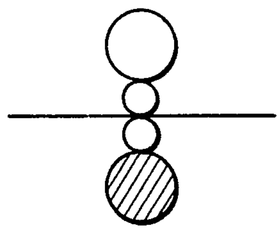


Fig. 6C

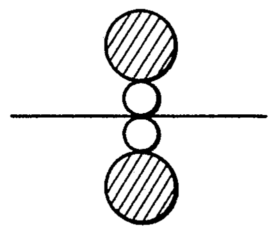


Fig. 7A

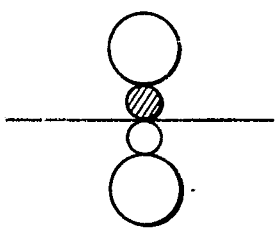


Fig. 7B

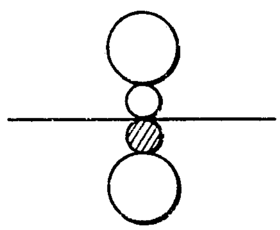


Fig. 7C

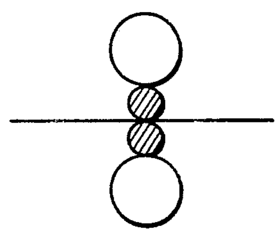


Fig. 8A

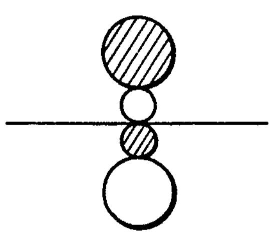


Fig. 8B

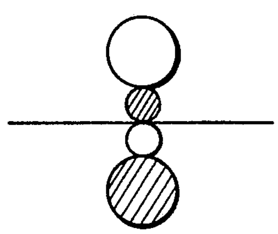


Fig. 9A

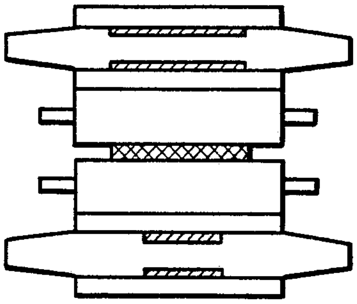


Fig. 9B

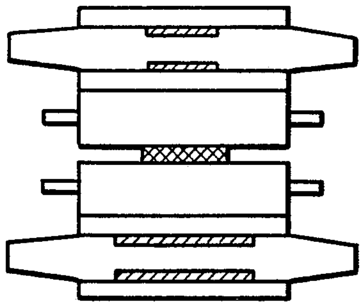


Fig. 10A

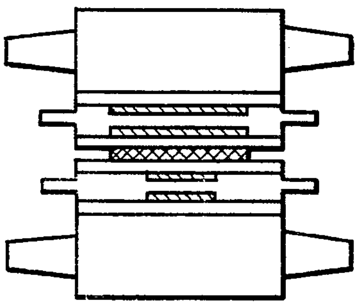


Fig. 10B

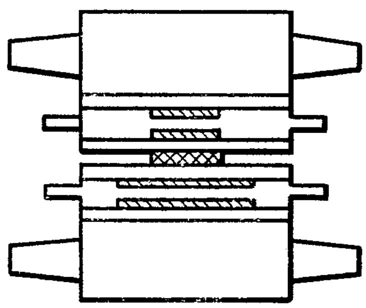


Fig. 11

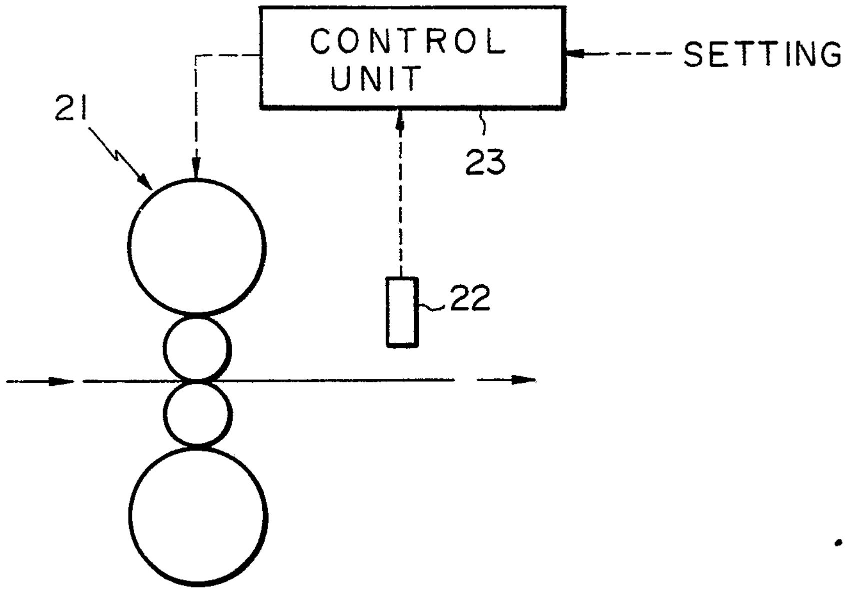


Fig. 12

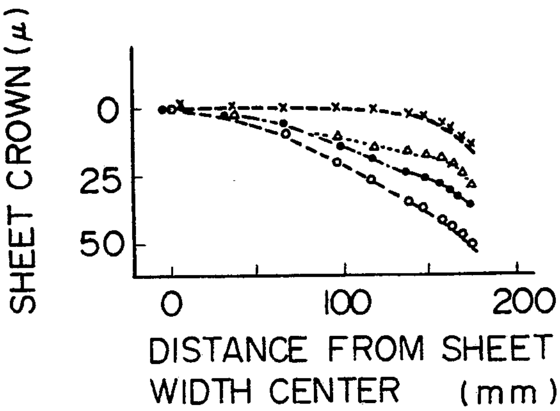

SHEET CROWN (μ)
0
25
50
0
100
200
DISTANCE FROM SHEET WIDTH CENTER (mm)

Fig. 13

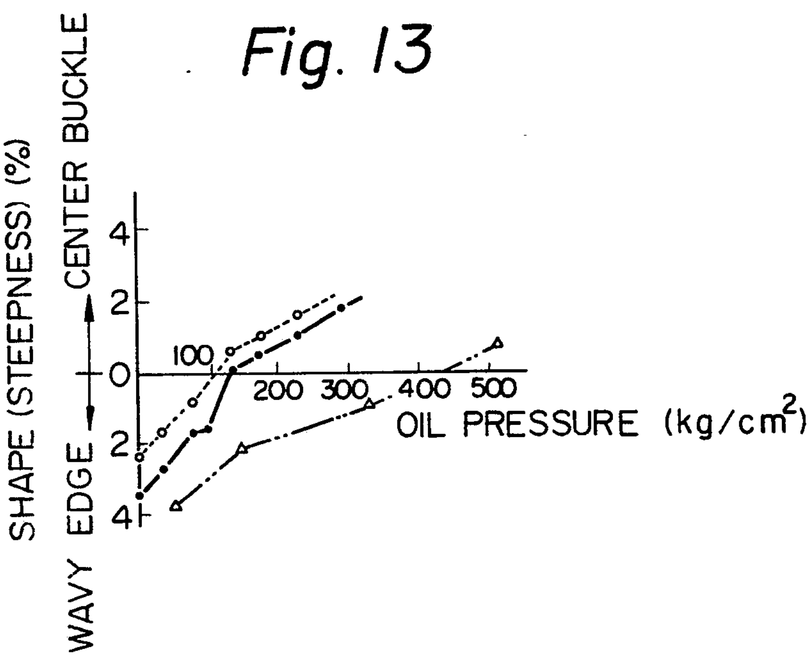

SHAPE (STEEPNESS) (%)
CENTER BUCKLE
WAVY EDGE
4
2
0
2
4
100
200
300
400
500
OIL PRESSURE (kg/cm²)

Fig. 14

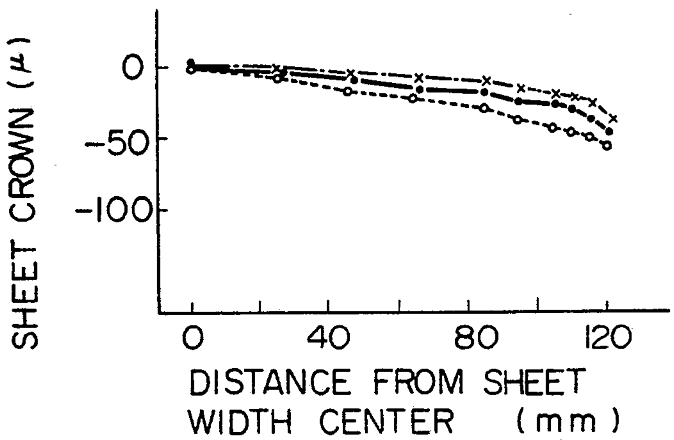

SHEET CROWN (μ)
0
-50
-100
0
40
80
120
DISTANCE FROM SHEET WIDTH CENTER (mm)

Fig. 15

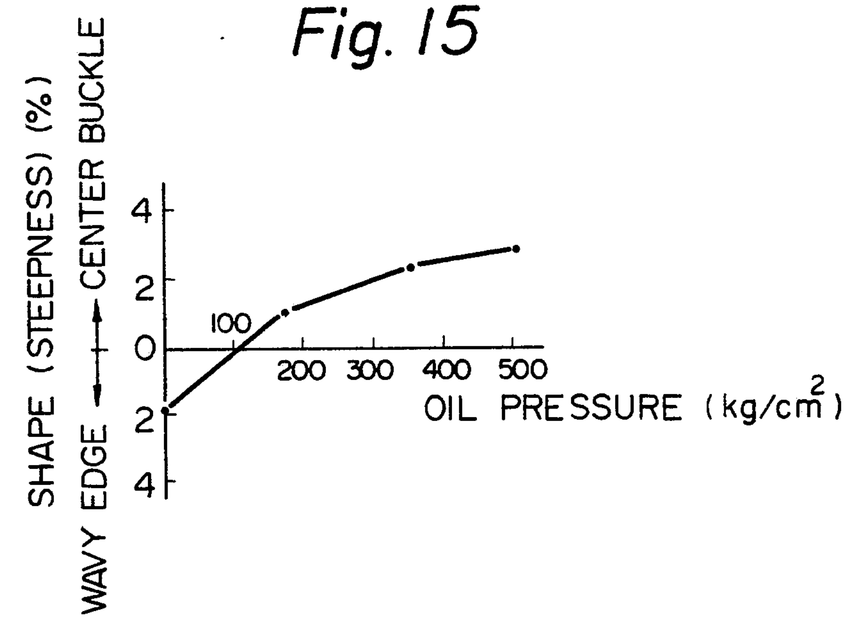

SHAPE (STEEPNESS) (%)
WAVY EDGE ⟷ CENTER BUCKLE
4
2
0
2
4
100
200
300
400
500
OIL PRESSURE (kg/cm²)

Fig. 16

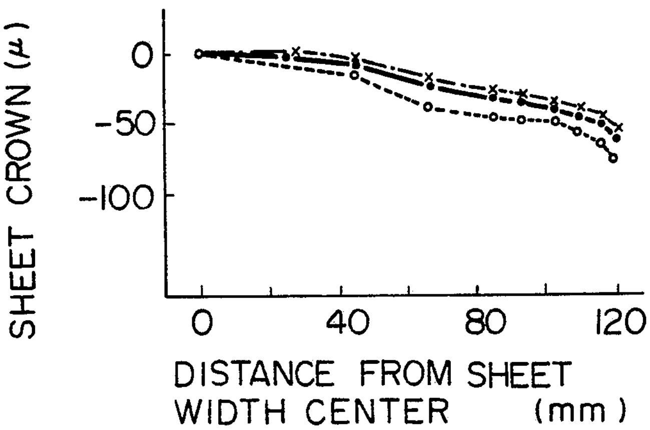

SHEET CROWN (μ)
0
-50
-100
0
40
80
120
DISTANCE FROM SHEET
WIDTH CENTER (mm)

Fig. 17

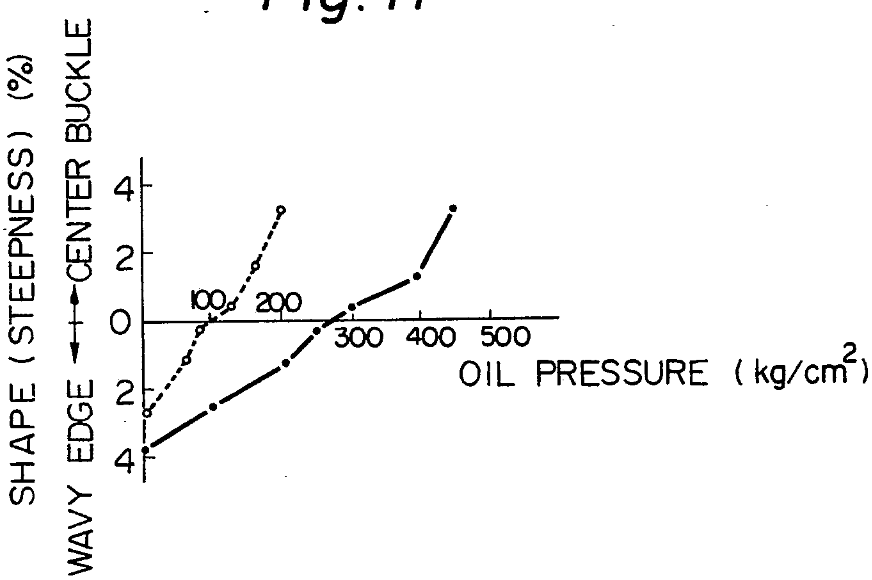

SHAPE (STEEPNESS) (%)
WAVY EDGE ←→ CENTER BUCKLE
4
2
0
2
4
100
200
300
400
500
OIL PRESSURE (kg/cm²)

Fig. 18

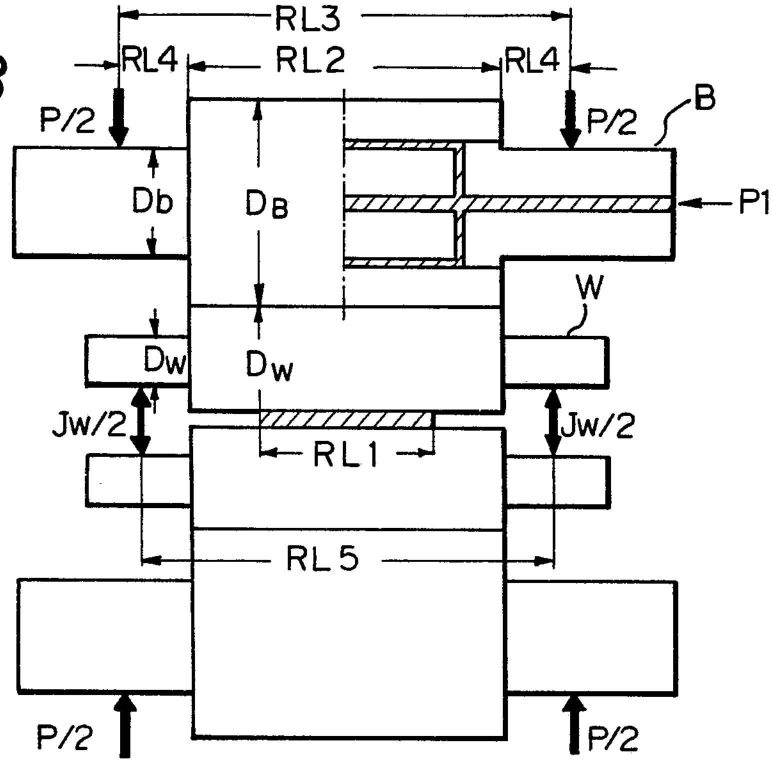

RL3
RL4
RL2
RL4
P/2
P/2
B
Db
DB
P1
W
Dw
Dw
Jw/2
Jw/2
RL1
RL5
P/2
P/2

Fig. 19

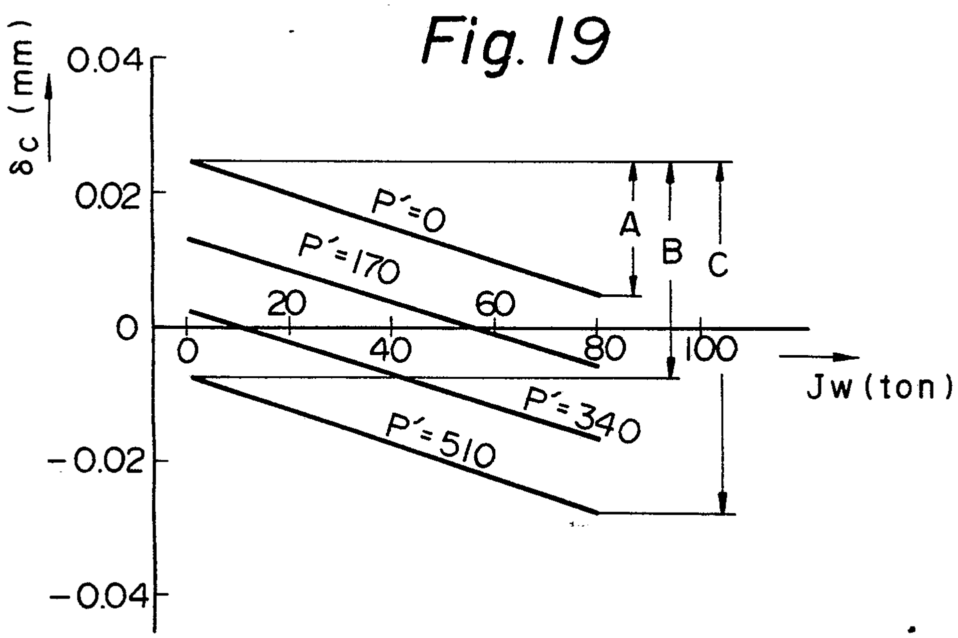

δc (mm)
0.04
0.02
0
-0.02
-0.04
P'=0
P'=170
P'=340
P'=510
A
B
C
0
20
40
60
80
100
Jw (ton)

Fig. 20

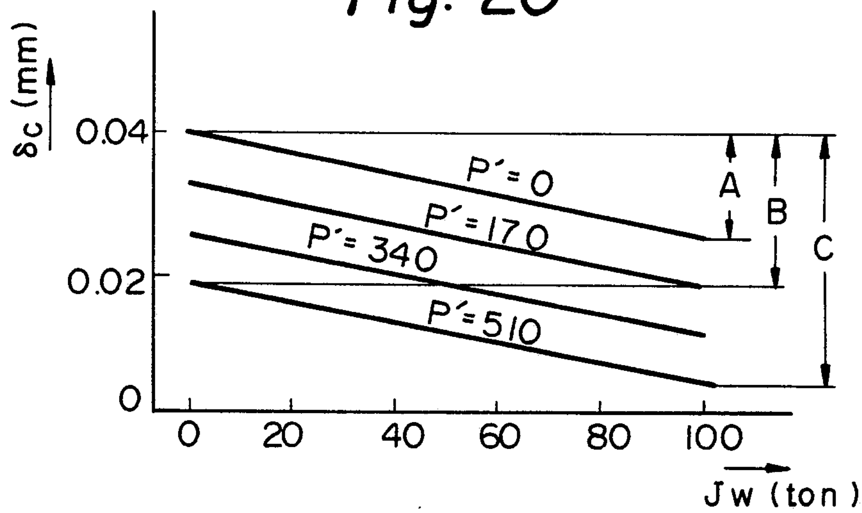
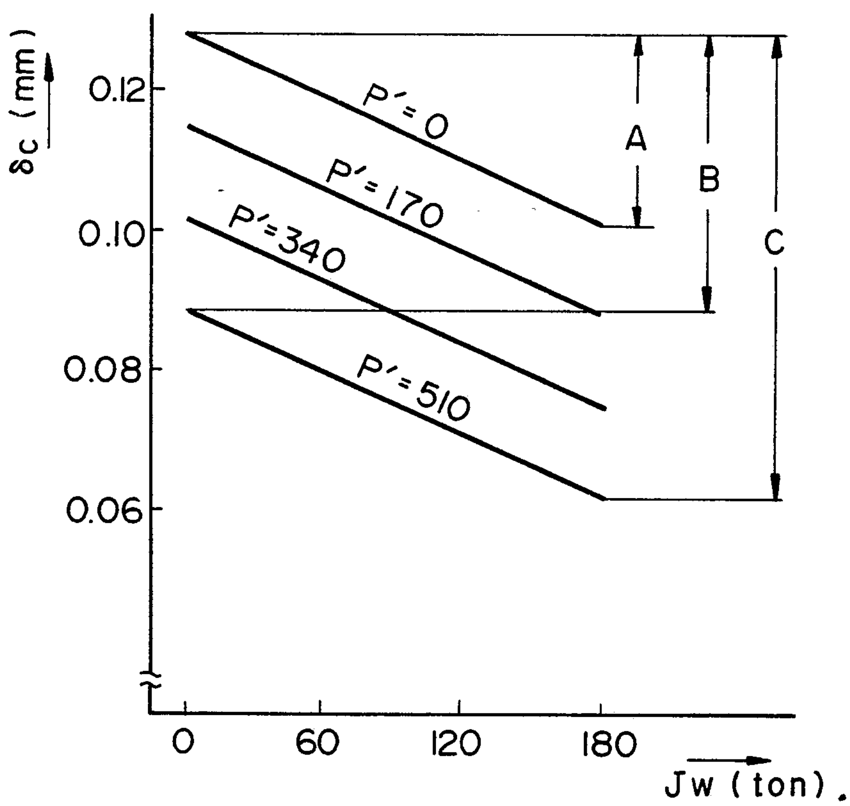

δc (mm)
0.04
0.02
0
P′ = 0
P′ = 170
P′ = 340
P′ = 510
A
B
C
0
20
40
60
80
100
Jw (ton)

Fig. 21


δc (mm)
0.12
0.10
0.08
0.06
P′ = 0
P′ = 170
P′ = 340
P′ = 510
A
B
C
0
60
120
180
Jw (ton)

European Patent Office

EUROPEAN SEARCH REPORT

Application number
EP 80 10 2342.5

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
	DE - A - 1 452 009 (ACCUROLL) * claims 7 to 11; fig. 3 * --	1,2
	DE - A1 - 2 507 233 (ESCHER WYSS) * claim 1; fig. 1 * --	1
	DE -A1 - 2 651 028 (ESCHER WYSS) * claim 6; fig. 1 * --	1
D	US - A - 3 604 086 (BRETSCHNEIDER) * complete document * --	
D	US - A - 3 457 617 (NOE et al.) * complete document * --	
A	DE - A - 1 602 200 (VEB WISSENSCHAFT-LICH-TECHNISCHES ZENTRUM) * complete document * --	
A	DE - A - 1 602 155 (SIEMAG) * complete document * --	
A	FR - A - 1 507 837 (BWG BERGWERK- UND WALZWERK-MASCHINENBAU GMBH) * complete document * ----	

CLASSIFICATION OF THE APPLICATION (Int. Cl.3)

B 21 B 13/14

TECHNICAL FIELDS SEARCHED (Int.Cl.3)

B 21 B 13/00
B 21 B 29/00
B 21 B 37/00

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
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
Berlin	28-08-1980	SCHLAITZ