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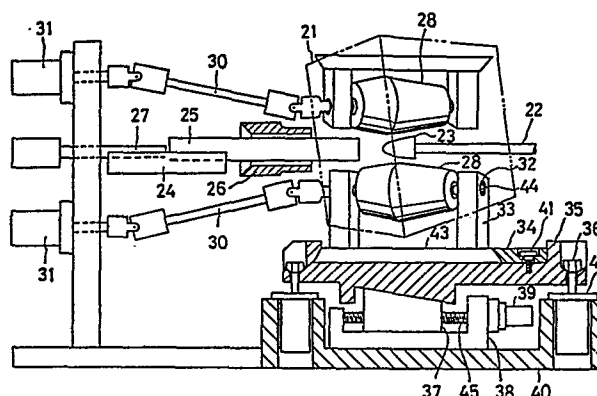
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54 INCLINED ROLLING MILL.

57 An inclined rolling mill includes pressure rolls with an inlet side interfacial angle and an outlet-side interfacial angle which are disposed with an inclination such as to provide a predetermined angle of lead. The rolling mill is provided with a pair of drivable drive roller shoes with an inlet-side interfacial angle and an outlet-side interfacial angle which are disposed at a position adjacent to the pressure rolls with an inclination such as to provide a predetermined angle of lead. Thus, it is possible to stably support a blank pipe being rolled with a compact structure and to effect smooth rolling.



SPECIFICATION

TITLE MODIFIED

see front page

TITLE OF THE INVENTION

CROSS HELICAL ROLLING MILL

FIELD OF THE INVENTION

This invention relates to a cross helical rolling mill used in
5 manufacturing seamless steel pipe.

DESCRIPTION OF THE PRIOR ARTBACKGROUND OF THE INVENTION

In general, in the process of piercing a seamless steel pipe,
there is used a cross helical rolling mill, in which two work rolls each
10 having an inlet interfacial angle and an outlet interfacial angle are
inclinedly (in a state of crossing each other as viewed from above)
disposed at a predetermined lead angle and guide shoes such as fixed
shoes, disc shoes and roller shoes are interposed between the work
rolls.

15 Fig.1 is a front view showing a work roll 1, a plug 2, a shell 3
and a fixed shoe 4 in a cross helical rolling mill. The shell 3 is
drawn by the circumferential speed of the work roll 1 in the tangential
line thereof and makes slips, impinging on the fixed shoe 4, whereby, on
a shoe surface of the fixed shoe 4, there occur worn portions 5A, 5B
20 and 5 as shown in Figs.2 and 3. In Fig.2, designated at 5A is a worn
portion when a thin wall shell is rolled, and denoted at 5B is a worn
portion when a thick wall shell is rolled. Furthermore, on the shoe
surface of the fixed shoe, there occur fine cracks deemed to be caused
by the thermal stress. Then, in the cross helical rolling mill using
25 the fixed shoes 4, in order to prevent the worn portions or cracks
occurring on the shoe surface of the fixed shoe 4 from damaging the

surface of the shell 3, it is necessary to stop rolling from time to time and condition the shoe surface of the fixed shoes 4 by use of a grinder or the like. However, in consideration of short service life of the fixed shoe 4 and for obviating the above-described disadvantages as much as possible, the fixed shoe 4 is formed from a high class material
5 having a satisfactorily high wear resistance. This amounts to a very high percentage of the production cost of the seamless steel pipe.

Fig.4 is a front view showing disc shoes 6 in the cross helical rolling mill, in which each disc shoe 6 is supported on a bearing 8
10 through a shaft 7 and drivable by a driving motor 9. To make the contact surface with the shell 3 suitable, the disc shoe 6 tends to be considerably increased in its diameter, e.g. to reach about three meters, whereby the equipment as a whole becomes long and large, so that it is impossible to apply such disc shoes to the conventional equipment
15 in terms of space. Furthermore, in comparison of the circumferential speed of the work roll 1 with the advance speed of the shell 3, the ratio is about 8 to 1. When the disc shoe 6 rotating in the proceeding direction of the shell 3 is used, the slips phenomena occur at a rate of 85 % between the shell 3 and the disc shoe 6, the problems including the
20 service life of the disc shoe 6 and the damages on the surface of the shell 3 cannot be satisfactorily solved.

As disclosed in Patent Kokai (Laid-Open) No.54203/80, hitherto, when only one guide roller is provided at one side in the direction of a roll gap, the shell enters a gap formed between the work rolls and the
25 guide rollers, a peripheral portion thereof is deformed into a square shape having concave sides, and such a phenomenon has been presented that rotation of the work rolls is impossible and the wall of the shell is broken.

All of this is the phenomenon observed when idler rollers are used. Even when a plurality of roller shoes are provided, the mechanical strength thereof is problematical. Results of experiments show that a reaction force acting on the shoe is varied depending on the shoe gap.

5 Fig.8 shows this relationship. When the shoe gap is less than a certain value, the reaction force acting on the shoe is inversely proportional to the shoe gap, and, when the shoe gap is set at the certain value or more, the reaction force remain at a predetermined value. This predetermined value amounts to about 20 % of the reaction force acting
10 on the work roll. Even if the number of roller shoes is increased, only one roller shoe may come in contact with a shell, whereby the reaction force may amount to as much as 30 tons. Since it has been difficult to support this strength by use of the plurality of roller shoes, this has necessitated to adopt a support block method shown in Fig.2 or a back-up
15 roll method shown in Fig.3 in Patent Kodai (Laid-Open) No.54203/80.

Fig.5 is a front view showing rollers shoes 10 in the cross helical rolling mill as disclosed in Utility Model Kokai (Laid-Open) No.60509 / 81. These roller shoes 10 are idle rollers which rotate by themselves, but are not forcedly driven. In consequence, in this case, the roller
20 shoes 10 are the idle rollers, whereby, when the shell 3 runs into a gap formed between the work rolls 1 and the roller shoes 10, the roller shoes 10 cannot draw out the shell 3, so that the rolling may be stopped to thereby cause a sticker phenomenon. In order to prevent the sticker phenomenon from occurring, there may be proposed to insert a guide plate
25 11 between the work rolls 1 and the roller shoes 10. However, in this case, the same disadvantage as with the fixed shoes occurs, and the effects by use of the roller shoes 10 are not obtainable. Furthermore, when the length of the roller shoe 10 is made substantially equal to

that of the fixed shoe, an insufficient mechanical strength of a shaft to a thrust force acting on the roller shoe 10 occurs, so that the provision of back-up rolls 12 is required.

The present invention has as its object the provision of a cross
5 helical rolling mill, wherein a shell under the rolling is stably supported by a construction rendered compact in size, so that a smooth rolling can be achieved.

DISCLOSURE OF THE INVENTION

To this end, in a cross helical rolling mill, wherein work rolls
10 each having an inlet interfacial angle and an outlet interfacial angle are inclinedly disposed at a predetermined lead angle, a pair of drive roller shoes being drivable and each having an inlet interfacial angle and an outlet interfacial angle are inclinedly disposed at positions adjacent work rolls in a manner to give a predetermined lead angle.

15 BRIEF DESCRIPTION OF THE DRAWINGS

Fig.1 is a front view showing fixed shoes in a cross helical rolling mill;

Fig.2 is a side view showing the fixed shoe in Fig.1 taken out;

Fig.3 is a sectional view taken along the line III- III in Fig.2;

20 Fig.4 is a partially broken away front view showing the disc shoes in a cross helical rolling mill;

Fig.5 is a front view showing the roller shoes in a cross helical rolling mill;

Fig.6 is a side view showing an embodiment of the cross helical
25 rolling mill according to the present invention;

Fig.7 is a front view showing the conditions of rolling by the cross helical rolling mill;

Fig.8 is a chart showing the relationship between the shoe gap and

the reaction force acting on the shoe ; and

Fig9. is a chart showing the relationship between tangential force/shoe reaction force, the rate of occurrence of stickers and the rate of occurrence of flares.

5 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Description will hereunder be given of one embodiment of the present invention with reference to the drawings.

Fig.6 is a side view showing an embodiment of the cross helical rolling mill according to the present invention and Fig.7 is a front
10 view showing the conditions of rolling by the cross helical rolling mill.

In this cross helical rolling mill, two work rolls 21 are disposed in the right and left sides and a plug 23 supported by a plug bar 22 is interposed between the both work rolls 21. Each of the work rolls 21
15 has an inlet interfacing angle and an outlet interfacing angle, inclinedly disposed at a lead angle of 10° to 12° for example, and makes a billet 25 on a through 24 advanceable in the axial direction in a state of being rotatable in the circumferential direction. Additionally, the billet 25 on the through 24 being in a state of being
20 guided on a cannon 26, is pushed by a pusher 27 to be bitten into a space between the both work rolls 21.

Then, drive-roller shoes 28 are located at two positions in the vertical direction between the both work rolls 21. Each of the drive-roller shoe 28 has an inlet interfacing angle, at which the outer
25 diameter of the shoe is reduced from the axially central portion to the inlet end thereof, and an outlet interfacing angle, at which the outer diameter of the shoe is reduced from the axially central portion to the outlet end thereof.

Furthermore, the center axis of each drive-roller shoe 28 is inclinedly disposed at a predetermined lead angle of 3° to 4° for example, to the axial direction of a shell 29, so that the circumferential surface of the drive-roller shoe 28 can obtain a component of speed of the shell 29 in the proceeding direction thereof.

The results of experiments show that, when the lead angle of the shoe is less than 3° , disadvantageous phenomena such as a sticker tend to occur, however, when the lead angle is 3° or more, the disadvantages are swept away. Therefore, the larger the lead angle becomes, the better the efficiency of piercing work becomes. Thus, the better results can be brought about. However, the space for use should be limited and the lead angle should naturally be restricted. In the practical use, the largest lead angle should be used as far as the strength condition permits.

Furthermore, similarly to the work roll 21, the drive-roller shoe 28 has the inlet interfacial angle and the outlet interfacial angle, whereby, the shell 29 is prevented from coming into contact with the drive-roller shoe 28 at the same position prior to the work roll 21, so that the occurrence of the sticker phenomena can be suppressed. Furthermore, the drive-roller shoe 28 is inclinedly disposed at the predetermined lead angle, hereby the occurrence of slip phenomena become less than 10 %. Thus, the rate of occurrence of slip phenomena is low as compared with the conventional fixed shoe and disc shoe, whereby the efficiency of piercing work is improved, so that a cycle time can be shortened. The rate of occurrence of slip phenomena less than 10 % result in little occurrence of slip phenomena and improved service life of the shoes. Additionally, the shell 29 is obtainable without the surface of the shell 29 being damaged by the drive-roller shoe 28.

Furthermore, in the aforesaid cross helical rolling mill, the drive roller shoes 28 are installed in such a manner as will be described hereunder. More specifically, a section, where the drive-roller shoes 28 are installed, is interposed by the work rolls 21, on the inlet side the section, there are provided a cannon 26, universal joints for driving the work rolls, and the like, and, on the outlet side of the section, there are provided a plug 23, a plug bar support and the like, so that the space is much limited. In consequence, it is very difficult to install the drive-roller shoes 28 and the driving devices in such limited space as described above. However, when the worn portions of the fixed shoes used at present were surveyed, it was recognized that the portions of the fixed shoe directly brought into contact with the shell were considerably narrow as shown in Fig.2. More specifically, as indicated by L in Fig.2, the minimum essential length of the guide shoe may be about 2/3 of a length which has heretofore been required of the guide shoe even when the wall thickness of the shell is small. As the length of the drive-roller shoe 28 is shortened, even a small diameter shaft has a satisfactory bending strength, whereby the back-up rolls for the drive-roller shoes as shown in Fig.5 may be dispensed with, the bearings are rendered compact in size and a specious positional relationship with the cannon 26 on the inlet side is permitted, so that the driving is facilitated. Furthermore, as the drive-roller shoes 28 are connected to the universal joints 30, no specious positional relationship with the cannon 26 is allowed. In consequence, if the diameter of hole of the cannon 26 is set as small as the billet 25 can hardly pass therethrough and the portions of the cannon 26 approaching the universal joints 30 are decreased in wall thickness, then the cannon 26 and the universal joints 30 can be prevented from interfering with

each other.

A shaft 44 of the drive-roller shoe 28 is fixed by bearing 32 and support 33, and a wedge 43 is fixed by a bolt 41 so that a base 43 of the support 33 can be easily detached. A screwshaft 45 is rotated by a hydraulic motor 39 to move a tapered base 37, whereby a lower frame 35 is vertically moved, so that a position of the top surface of the drive-roller shoe 28 can be finely adjusted. Furthermore, the looking after the adjustment is effected by hydraulic cylinders 42 (two set).

The drive-roller shoe 28 is forcedly drivable by a driving device, e.g. a hydraulic motor 31 through the universal joint 30. The driving device may be an electric motor.

Description will hereunder be given of action of the above embodiment.

The billet 25 on the trough 24 is pushed by the pusher 27 to be bitten into the space between the both work rolls 21, further, impinges on the plug 23, pierced and rolled. The shell 29 thus pierced and rolled is flared and comes into abutting contact with the upper and the lower drive-roller shoes 28. Then, the drive-roller shoes 28 are forcedly driven at a speed faster than the circumferential speed of the work rolls 21. In consequence, even when the shell 29 has a thin wall thickness, the shell 29 does not run into the space between the drive-roller shoes 28 and the work rolls 21, whereby no stick phenomenon is caused. More specifically, ingeneral, the rolled shell 29 is drawn in a direction tangential to the work roll 21 and tends to run into the space between the work rolls 21 and the drive-roller shoes 28. However, the drive-roller shoes 28 are rotating at a speed somewhat faster than the circumferential speed of the work roll 21, whereby the shell 29 comes into abutting contact with the drive roller shoes 28. Due to the

friction generated between the shell 29 and the drive-roller shoes 28 at this time, the speed of the shell 29 does not reach the circumferential speed of the drive-roller shoe 28, and, rather the circumferential speed of the shoes 28 comes down to equal to the speed of the shell 29.

- 5 However, the shoes 28 are rotating at a speed faster than the shell 29, the tangential forces of the shoes draw the shell 29. By this, the shell is brought to the opposite side, i.e. the side of the work rolls 21, so that the smooth rolling can be effected. By this, it becomes possible to avoid that the conventional shell runs into the space
- 10 between the work rolls and the shoes to cause the sticker phenomenon which stops the rolling. Since the front portion of the tail end of the shell has been rolled, a force in the axial direction of the shell does not act thereon, accordingly the stress in the circumferential direction is high, the diameter of the shell tends to increase, the shell is
- 15 liable to run into the space, and the flaring tends to occur. The results of experiments prove that there is a predetermined relationship between the occurrence of stickers, the occurrence of flares and tangential force/shoe reaction force.

Here, the reaction force means a pressing force by the shell in a

20 direction indicated by A in Fig.7, the tangential force is a frictional force between the shell and the roller shoes, defined by the radius of torque/roller shoe, namely a force in a direction indicated by B in Fig. 7.

The results of experiments show that, as clear from Fig.9, if

25 tangential force/shoe reaction force exceeds 3 %, then the rate of occurrence of stickers and the rate of occurrence of flares are rapidly decrease.

As has been described hereinabove, in the cross helical rolling

mill according to the present invention, the drive-roller shoes being drivable and each having the inlet interfacial angle and the outlet interfacing angle are inclinedly disposed at positions adjacent the work rolls at a predetermined lead angle. In consequence, the cross helical rolling mill, having a construction rendered compact in size, can stably support the shell under the rolling to effect the smooth rolling.

Furthermore, the present invention is very easily applicable to the existing cross helical rolling mills, whereby the amount of initial investment can be reduced, thus proving highly economical.

WHAT IS CLAIMED IS:

- 1 . A cross helical rolling mill, wherein work rolls each having an inlet interfacing angle and an outlet interfacing angle are inclinedly disposed at a predetermined lead angle, characterized in that a pair of drive-roller shoes being drivable and each having an inlet interfacing angle and an outlet interfacing angle are inclinedly disposed at positions adjacent said work rolls in a manner to give a predetermined lead angle.
- 2 . A cross helical rolling mill as set forth in claim 1, wherein said lead angle of the drive roller shoe is set at 3° or more.
- 3 . A cross helical rolling mill as set forth in claim 1, wherein said drive roller shoes are forcedly driven at a rotational speed faster than the circumferential speed of said work rolls.
- 4 . A cross helical rolling mill as set forth in claim 1, wherein the forcedly driving force of said drive roller shoes is set at a value in which the tangential force to said shell of said shoe is 3 % or more of the reaction force of said shoe.

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FIG.1

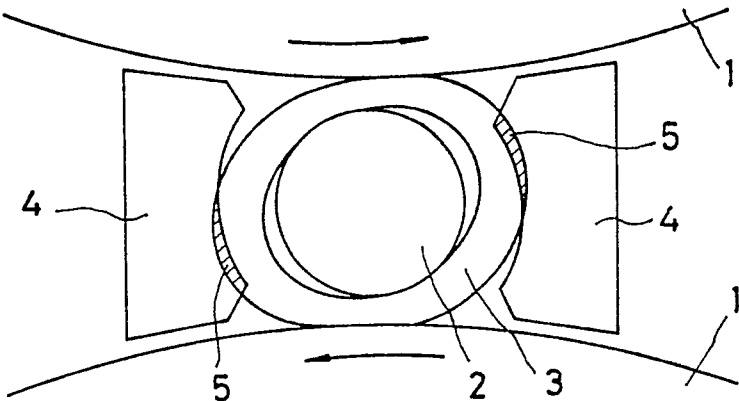
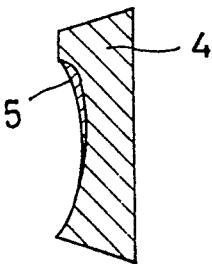
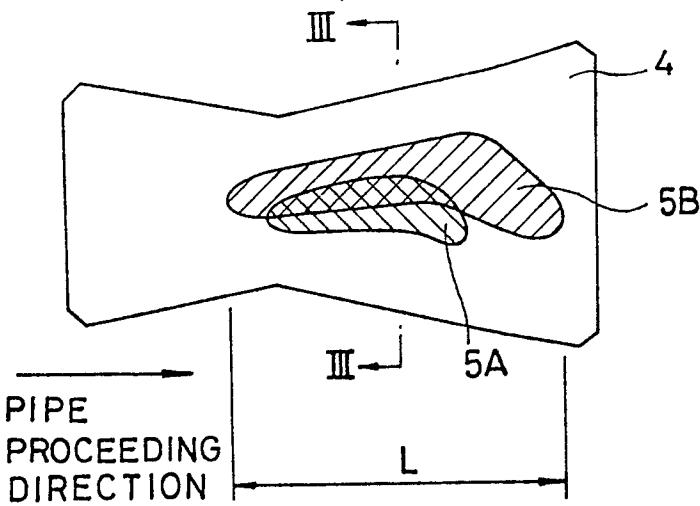


FIG.2

FIG.3



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FIG. 4

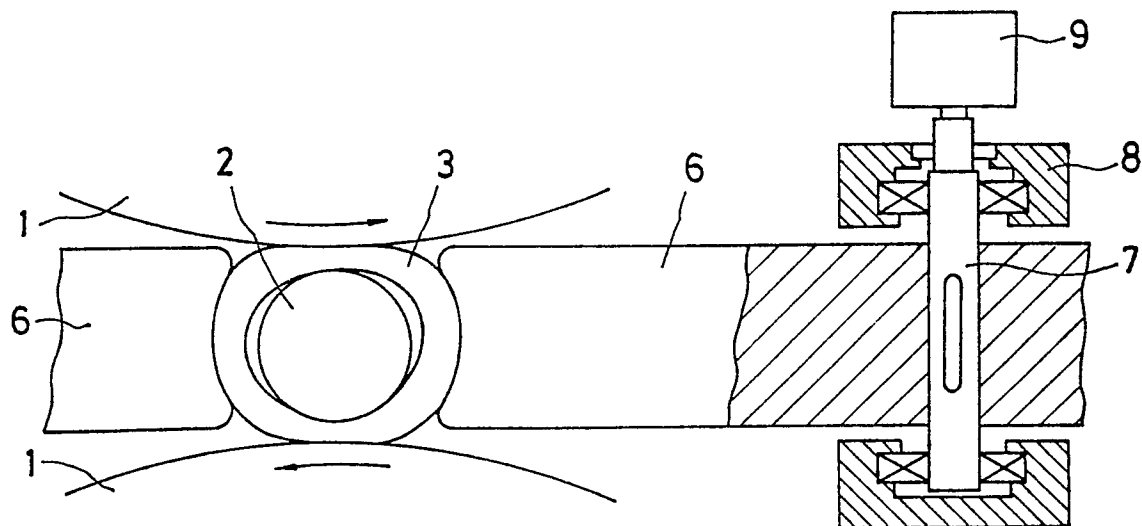
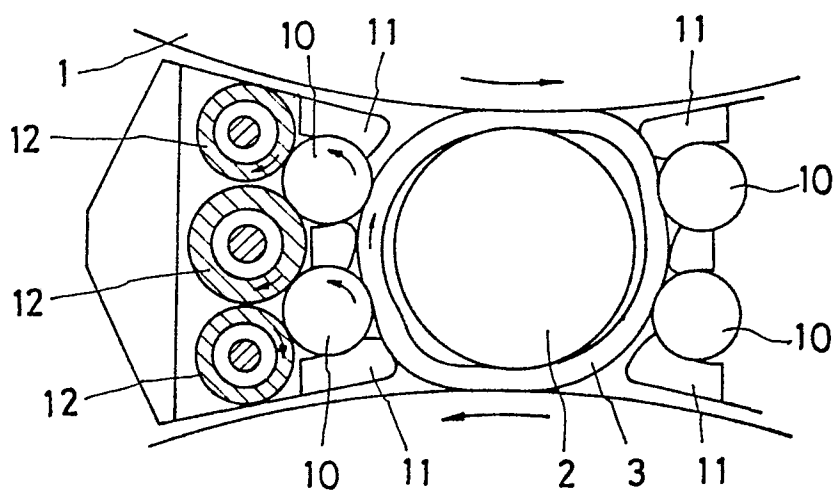


FIG. 5



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FIG. 6

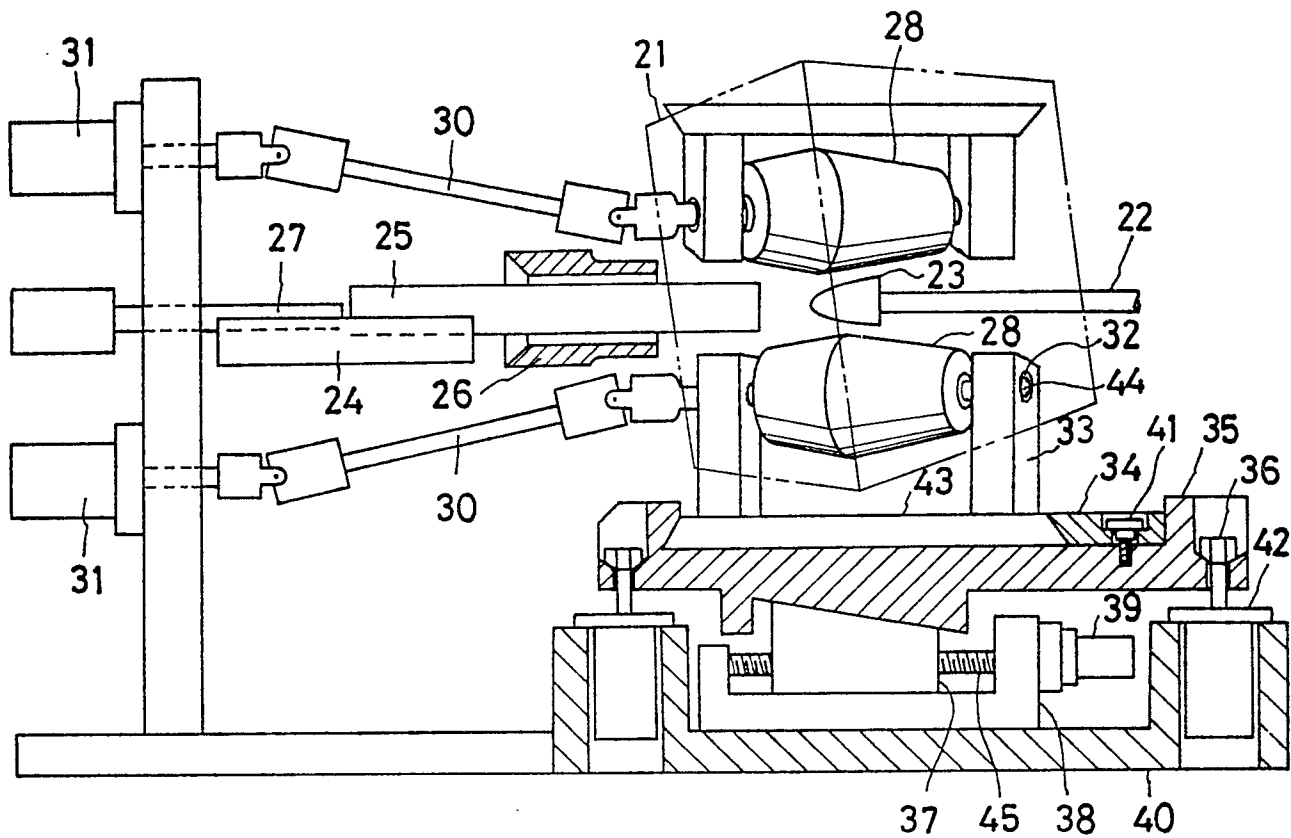
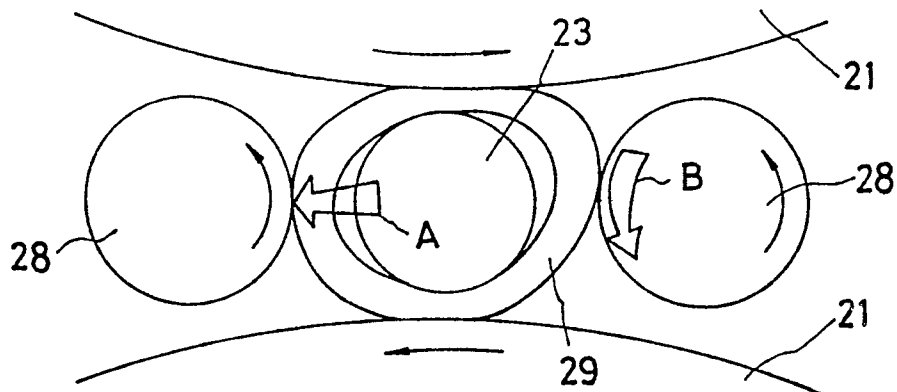


FIG. 7



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FIG.8

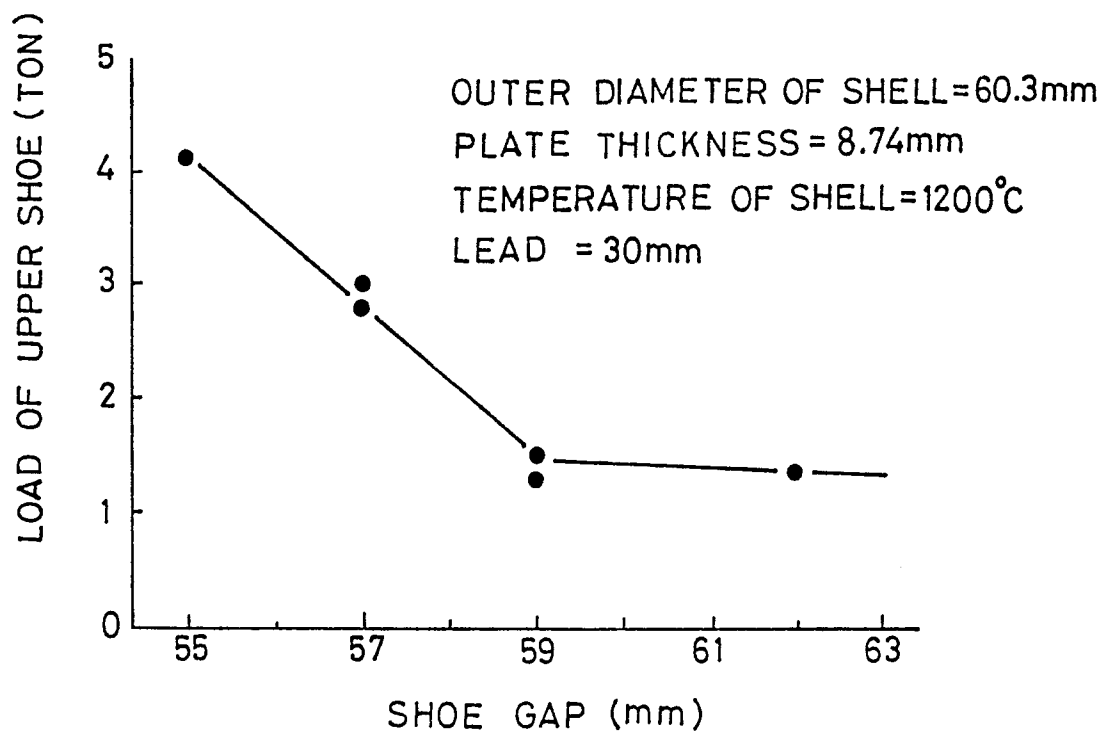
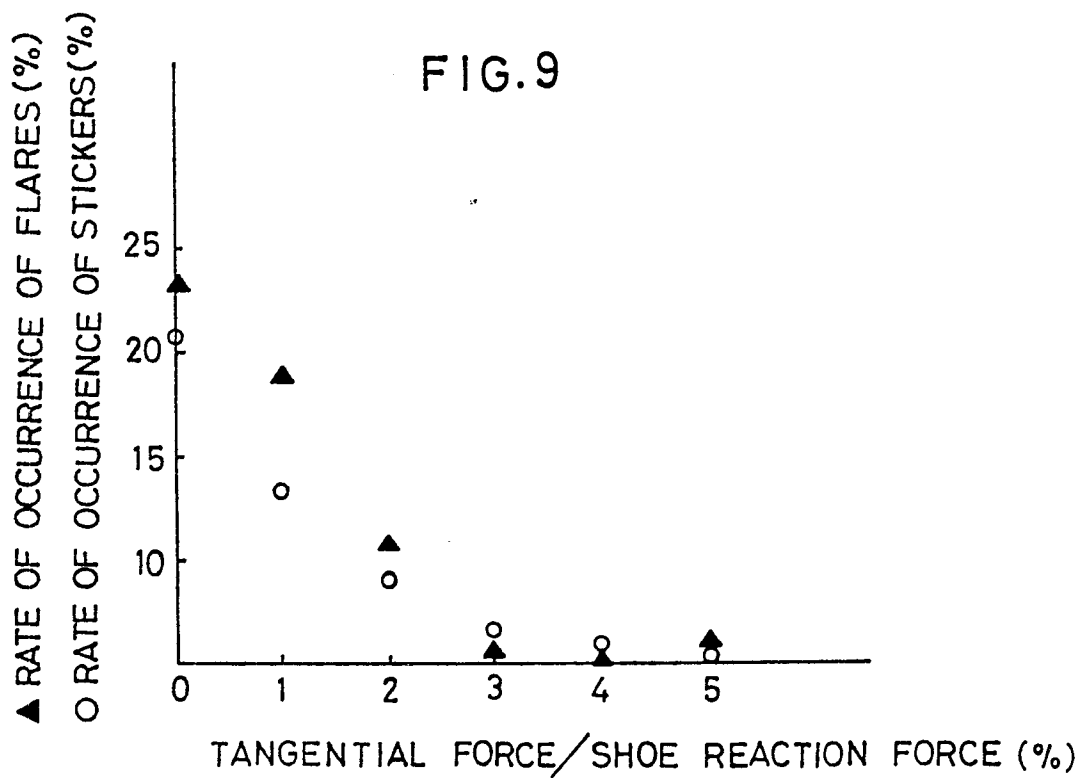


FIG.9



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INTERNATIONAL SEARCH REPORT

International Application No. PCT/JP84/00450

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) ¹		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int. Cl. ³ B21B 25/00, 19/04		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁴		
Classification System	Classification Symbols	
IPC	B21B 19/02 - 19/10, 25/00 - 25/06	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁵		
Jitsuyo Shinan Koho		1926 - 1984
Kokai Jitsuyo Shinan Koho		1971 - 1984
III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴		
Category ⁶	Citation of Document, ¹⁵ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸
A	JP, B2, 58-48243 (Nippon Steel Corp.) 21 January 1983 (21. 01. 83)	1 - 4
A	JP, A, 57-168711 (Sumitomo Metal Industries, Ltd.) 18 October 1982 (18. 10. 82) & BE, A, 891,932 & FR, A, 2,503,590 & GB, A, 2,096,505 & DE, A, 3,212,742 & ES, A, 511,187	2
¹⁶ Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search ¹⁹		Date of Mailing of this International Search Report ²⁰
December 11, 1984 (11.12.84)		December 17, 1984 (17.12.84)
International Searching Authority ¹		Signature of Authorized Officer ²¹
Japanese Patent Office		