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(54) **CROSS HELICAL ROLLING MILL FOR SEAMLESS STEEL TUBES.**

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DE-B- 1 427 970
JP-A-57 168 711
JP-B-58 048 243
US-A- 3 719 066

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Description

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

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 having an inclined inlet face and an inclined outlet face 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.

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 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 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 having a satisfactionaly high wear resistance. This amounts to a very high percentage of the production cost of the seemless 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 through a shaft 7 and driveable 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 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 6 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 service life of the disc shoe 6 and the damages on the surface of the shell 3 cannot be satisfactorily solved.

JP-B2-58/48243 discloses a cross helical rolling mill, wherein work rolls, each having an inclined inlet face and an inclined outlet face, are inclinedly disposed at a predetermined work roll lead angle, and a pair of rolls are positioned adjacent to the work rolls.

As disclosed in JP-B2-58/48243 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 guide rollers, a peripheral portion thereof is deformed into a square shape having concave sides, and such a phenomenon has led to rotation of the work rolls becoming impossible and the wall of the shell being 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. 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 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 in Fig. 2 or a back-up roll method shown in Fig. 3, in JP-B2-58/48243.

Fig. 5 is a front view showing roller shoes 10 in a known cross helical rolling mill.

These roller shoes 10 are idle rollers which rotate by themselves, but are not forcedly driven. In consequence, in this case, the roller 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 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.

A further cross-helical rolling mill is disclosed in DE-B-1427970. The mill disclosed therein has work rolls having inclined inlet and outlet faces which are disposed at a predetermined lead angle, and opposed rollers positioned adjacent the work rolls above and below the workpiece. These rollers are preferably driven at a surface speed at least as great as the speed imparted to the workpiece, and may be skewed to impart the same axial movement as is imparted to the workpiece by the work rolls.

The present invention provides a cross helical rolling mill for producing seamless steel tubes comprising, work rolls, each having an inclined inlet face and an inclined outlet face, inclinedly disposed at a predetermined work roll lead angle relative to an axis along which, in use, a shell being rolled extends, a pair of drive-roller shoes positioned adjacent to the work rolls, each drive-roller shoe having an inclined inlet face and an inclined outlet face and being inclinedly disposed at a predetermined drive-roller shoe lead angle of 3° or more with respect to the said axis, in use, the drive-roller shoes being actively rotationally driven at a surface speed greater than the circumferential speed of said work rolls, one of the drive-roller shoes being mounted on a support having a wedge-shaped surface thereon, cooperable with a movable tapered base part whereby movement of the base part effects movement of the drive roller shoe towards or away from said axis.

Advantageously, the forcedly driving force of said drive roller shoes is set at a value such that, in use, the tangential force between a shell being rolled and each drive-roller shoe is 3% or more of the reaction force of each drive-roller shoe.

The preferred embodiments of the present invention will now be described by way of example only with reference to the accompanying drawings in which:

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;

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 rolling mill according to the present invention;

Fig. 7 is a front view showing the conditions of the 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

Fig. 9 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.

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 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 has an inclined inlet face and an inclined outlet face, inclinedly disposed at a work roll lead angle of 10° to 12° for example, and makes a billet 25 on a trough 24 advanceable in the axial direction in a state of being rotatable in the circumferential direction. Additionally, the billet 25 on the trough 24 being in a state of being guided on a cannon 26, is pushed by 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 shoes 28 has an inclined inlet face at which the outer diameter of the shoe is reduced from the axially central portion to the inlet end thereof, and an inclined outlet face 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 drive roller shoe 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 the experiments show that, when the drive roller shoe lead angle is less than 3°, disadvantageous phenomena such as a sticker tend to occur, however, when the drive roller shoe lead angle is 3° or more, the disadvantages are swept away. Therefore, the larger the drive roller shoe 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 drive roller shoe lead angle should naturally be restricted. In the practical use, the largest drive roller shoe lead angle which the strength condition permits should be used.

Furthermore, similarly to the work roll 21, the drive-roller show 28 has an inclined inlet face and an inclined outlet face, 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 drive roller shoe lead angle, whereby the occurrence of slip phenomena becomes 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 of less than 10% results 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 of 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, in 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 relatively 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 spacing from the cannon 26 on the inlet side is permitted, so that driving is facilitated. However, as the drive-roller shoes 28 are connected to the universal joints 30, no scope for their positioning relative to the cannon 26 is allowed. In consequence, if the diameter of the hole of the cannon 26 is set so small that 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 fitted 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 locking after the ajustment 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 the use 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, and is 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, thus avoiding any stick phenomenon. More specifically, in general, 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 tends to fall towards the speed of the shell 29. 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 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 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 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 tangential force/shoe reaction force exceeds 3%, then the rate of occurrence of stickers and the rate of occurrence of flares are rapidly decreased.

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 an inclined inlet face and an inclined outlet face are inclinedly disposed at positions adjacent the work rolls at a predetermined drive roller shoe lead angle. In consequence, the cross helical rolling mill, having a construction rendered compact in size, can stably support the shell during rolling to effect 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.

Claims

1. A cross helical rolling mill for producing seamless steel tubes comprising work rolls (21), each having an inclined inlet face and an inclined outlet face, inclinedly disposed at a predetermined work roll lead angle relative to an axis along which, in use, a shell being rolled extends, and a pair of drive- roller shoes (28) positioned adjacent to the work rolls (21), each drive-roller shoe (28) having an inclined inlet face and an inclined outlet face and being inclinedly disposed at a predetermined drive-roller shoe lead angle of 3° or more with respect to the said axis, in use, the drive-roller shoes (28) being actively rotationally driven at a surface speed greater than the circumferential speed of said work rolls (21), one of the drive-roller shoes (28) being mounted on a support (33) having a wedge-shaped surface (43) thereon, cooperable with a movable tapered base part (37) whereby movement of the base part (37) effects movement of the drive roller shoe (28) towards or away from said axis.

2. A cross helical rolling mill according to claim 1, wherein the active rotational driving force of said drive-roller shoes (28) is set at a value such that, in use, the tangentail force between a shell (29) being rolled and each drive-roller shoe (28) is 3% or more of the reaction force of each drive-roller shoe.

3. A cross helical rolling mill according to claim 1 or 2, wherein, in use, the drive-roller shoe lead angle is set at from 3° to 4°.

4. A cross helical rolling mill according to any preceding claim, wherein the tapered base part (37) is mounted with a screw shaft extending therethrough, rotation of which causes movement of the base part (37).

Patentansprüche

1. Schrägwalzwerk zur Erzeugung nahtloser Stahlrohre mit Arbeitswalzen (21), die jeweils eine schräge Einlauffläche und eine schräge Auslauffläche aufweisen und unter einem vorbestimmten Arbeitswalzen-Anstellwinkel gegenüber einer Achse schräg angeordnet sind, entlang welcher sich im Be trieb ein gewalzter Mantel erstreckt, und mit einem Paar Antriebsrollenschuhe (28), die angrenzend an die Arbeitswalzen (21) angeordnet sind, wobei jeder Antriebsrollenschuh (28) eine schräge Einlauffläche und eine schräge Auslauffläche aufweist und gegenüber der genannten Achse schräg unter einem vorbestimmten Antriebsrollen-Anstellwinkel von 3° oder darüber angeordnet ist, wobei die Antriebsrollenschuhe (28) im Betrieb wirksam mit einer Oberflächengeschwindigkeit, die größer als die Umfangsgeschwindigkeit der Arbeitsrollen (21) ist, drehangetrieben werden und einer der Antriebsrollenschuhe (28) an einer Halterung (33) mit einer keilförmigen Oberfläche (43) an dieser befestigt ist, welche mit einem beweglichen sich verjüngenden Basisteil (37) zusammenwirkt, wodurch aufgrund einer Bewegung des Basisteils (37) eine Bewegung des Antriebsrollenschuhs (28) auf die Achse zu und von dieser fort erfolgt.

2. Schrägwalzwerk nach Anspruch 1, bei welchem die wirksame Drehantriebskraft der Antriebsrollenschuhe (28) auf einen solchen Wert eingestellt ist, daß im Betrieb die Tangentialkraft zwischen einem gewalzten Mantel (29) und jedem Antriebswalzenschuh (28.) 3 % oder mehr der Reaktionskraft jedes Antriebsrollenschuhs beträgt.

3. Schrägwalzwerk nach Anspruch 1 oder 2, bei welchem im Betrieb der Antriebsrollenschuh-Anstellwinkel zwischen 3° und 4° eingestellt ist.

4. Schrägwalzwerk nach einem der vorangehenden Ansprüche, bei welchem der sich verjüngende Basisteil (37) mit einer durch diesen hindurchgehenden Schraubenwelle angeordnet ist, deren Umlauf eine Drehbewegung des Basisteils (37) bewirkt.

Revendications

1. Laminoir transversal à course hélicoïdale pour la production de tubes d'acier sans soudure, comportant des cylindres de travail (21) présentant chacun une face d'entrée inclinée et une face de sortie inclinée, disposés de façon à être inclinés d'un angle d'attaque prédéterminé par rapport à un axe le long duquel, lors de l'utilisation, un manchon en cours de laminage s'étend, et une paire de sabots (28) à rouleaux d'entraînement placés de façon à être adjacents aux cylindres de travail (21), chaque sabot (28) à rouleau d'entraînement ayant une face d'entrée inclinée et une face de sortie inclinée et étant disposé de façon à être incliné d'un angle d'attaque prédéterminé de 3° ou plus par rapport audit axe, lors de l'utilisation, les sabots (28) à rouleaux d'entraînement étant entraînés activement en rotation à une vitesse de surface supérieure à la vitesse circon-

férentielle desdits cylindres de travail (21), l'un des sabots (28) à rouleaux d'entraînement étant monté sur un support (33) portant une surface (43) en forme de coin, pouvant coopérer avec une partie d'embase mobile (37) à plan incliné de façon qu'un mouvement de la partie d'embase (37) ait pour effet de rapprocher ou d'éloigner dudit axe le sabot (28) à rouleau d'entraînement.

2. Laminoir transversal à course hélicoïdale selon la revendication 1, dans lequel la force active d'entraînement en rotation desdits sabots (28) à rouleaux d'entraînement est établie à une valeur telle que, lors de l'utilisation, la force tangentielle entre un manchon (29) en cours de laminage et chaque sabot (28) à rouleau d'entraînement soit égale à 3 % ou plus de la force de réaction de chaque sabot à rouleau d'entraînement.

3. Laminoir transversal à course hélicoïdale selon la revendication 1 ou 2, dans lequel, lors de l'utilisation, l'angle d'attaque des sabots à rouleaux d'entraînement est établi à une valeur de 3° à 4°.

4. Laminoir transversal à course hélicoïdale selon l'une quelconque des revendications précédentes, dans lequel la partie d'embase (37) à plan incliné est montée de façon à être traversée par un arbre fileté dont la rotation provoque un mouvement de la partie d'embase (37).

FIG.1

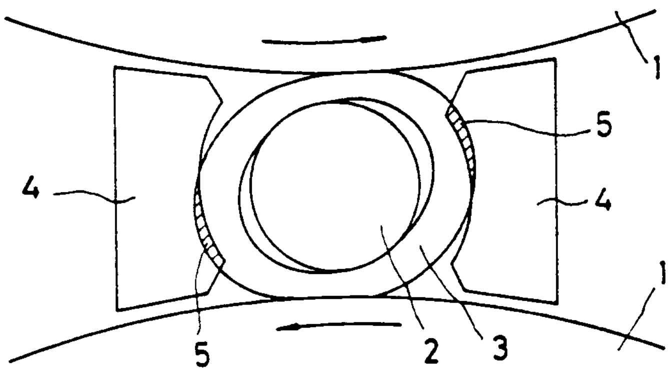


FIG.2

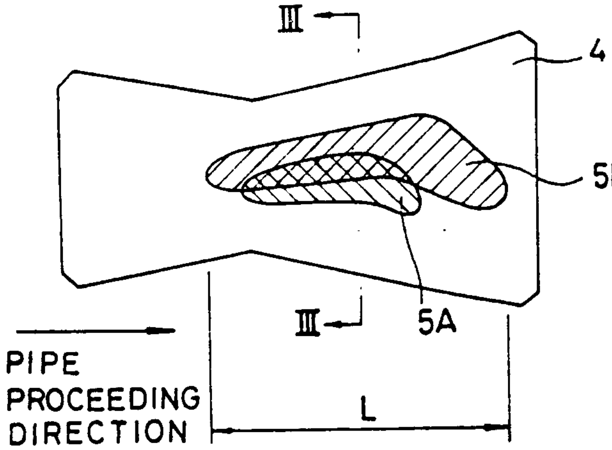


FIG.3

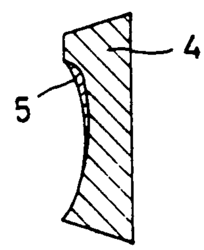


FIG.4

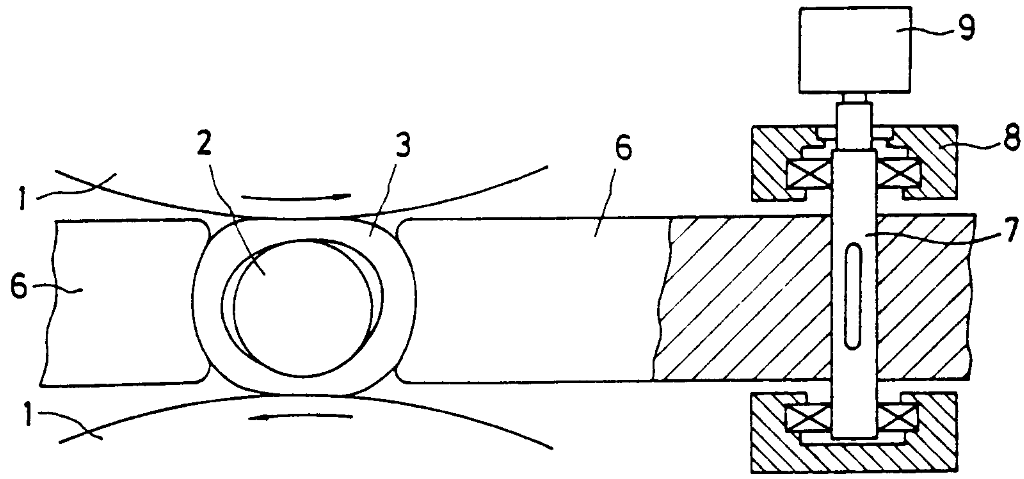


FIG.5

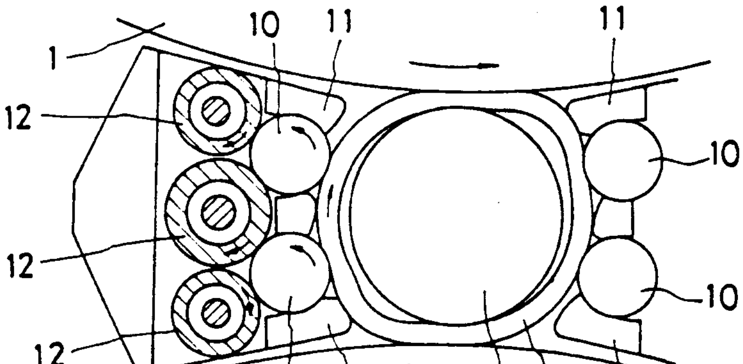
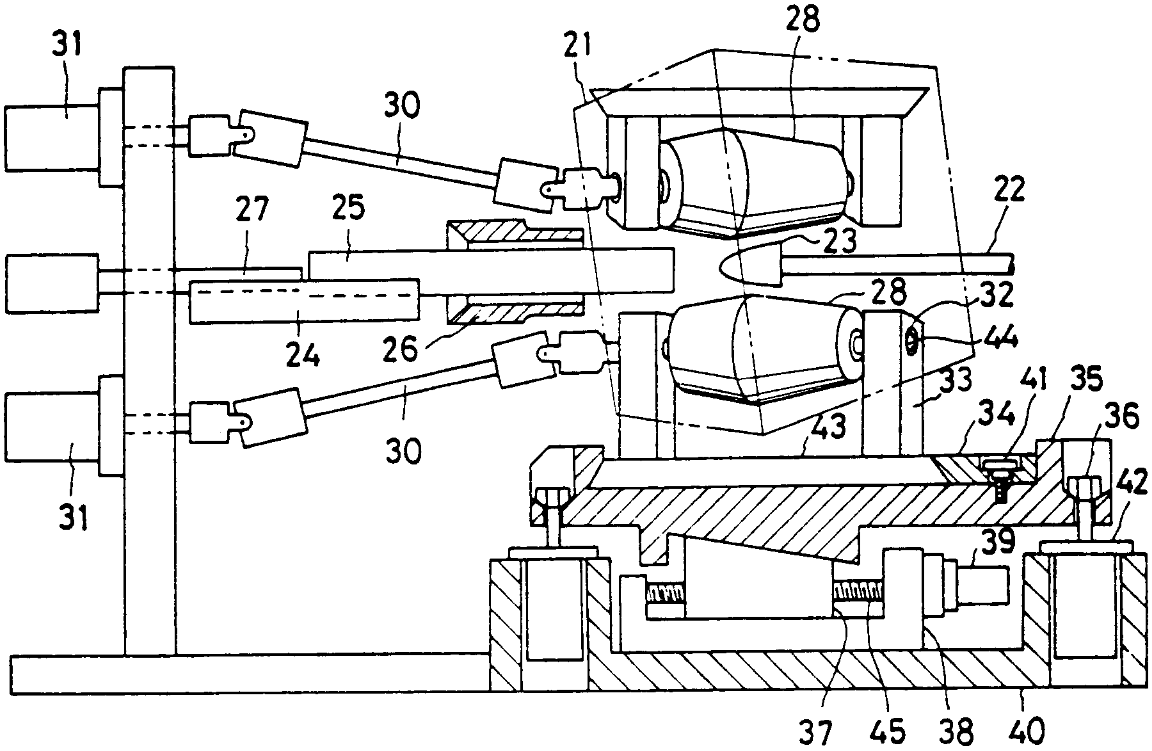


FIG.6


31
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22
23
28
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44
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31
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37
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38
40

FIG.7

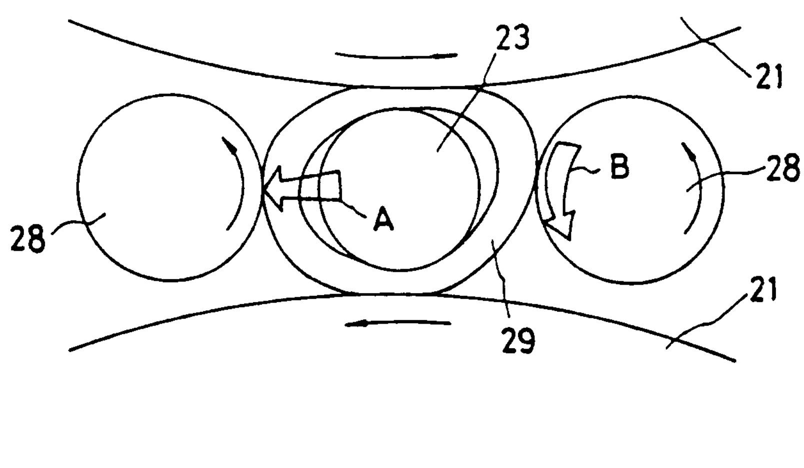

23
21
B
28
A
28
21
29

FIG.8

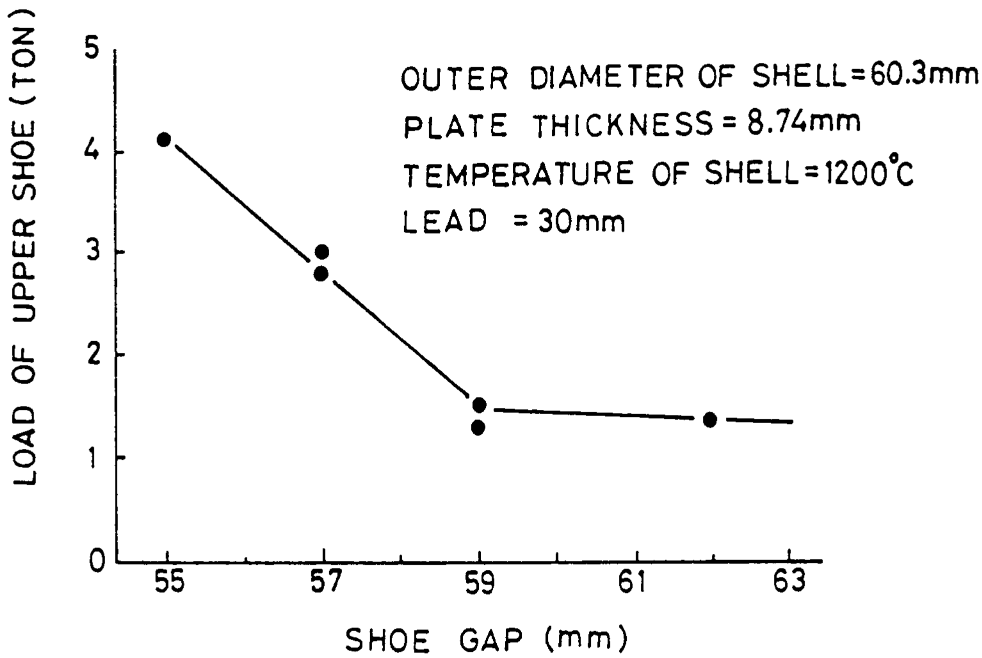
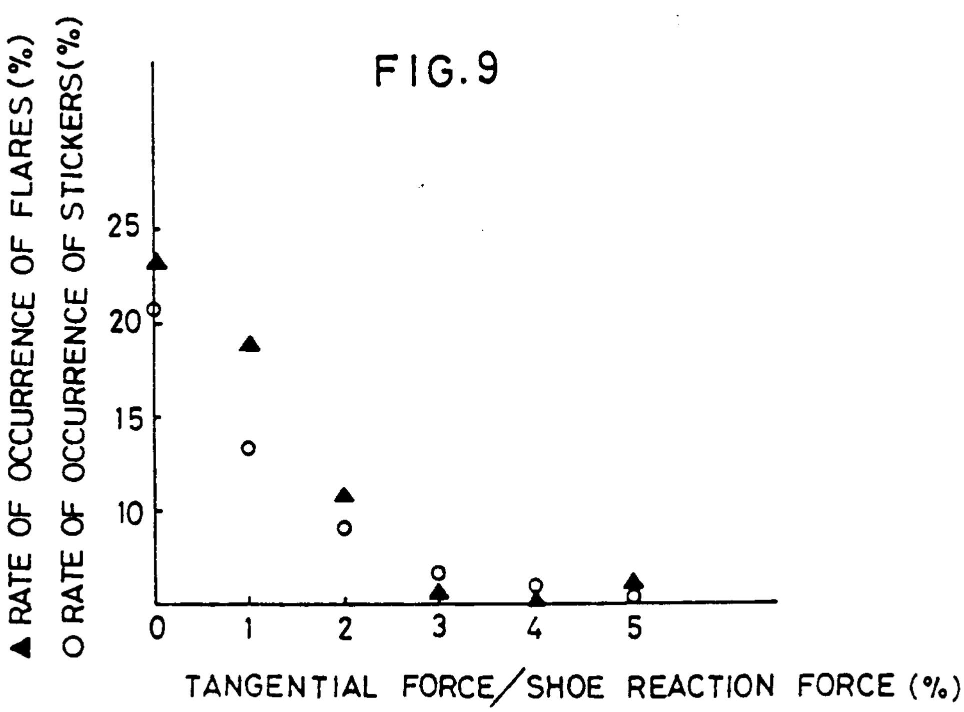

OUTER DIAMETER OF SHELL=60.3mm
PLATE THICKNESS=8.74mm
TEMPERATURE OF SHELL=1200°C
LEAD =30mm
LOAD OF UPPER SHOE (TON)
5
4
3
2
1
0
55
57
59
61
63
SHOE GAP (mm)

FIG.9


▲ RATE OF OCCURRENCE OF FLARES (%)
O RATE OF OCCURRENCE OF STICKERS (%)
25
20
15
10
0
1
2
3
4
5
TANGENTIAL FORCE/SHOE REACTION FORCE (%)