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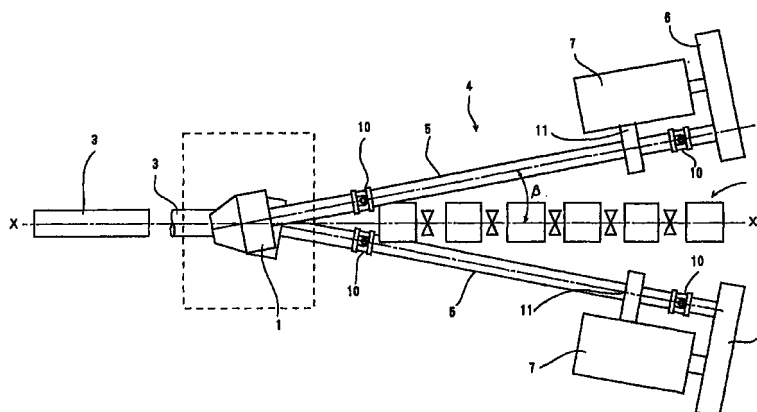
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(54) **PIERCING MILL**

(57) The thus-far adopted premise for drive unit arrangement in a conventional piercing mill is reconsidered in an effort to improve the arrangement of drive unit components. According to the present invention, a piercing mill for the manufacture of seamless steel tube comprises a pair of piercing rolls 1 disposed opposite each other with respect to a pass line along which a tube stock 3 moves while being rolled, a plug disposed along the pass line so as to be positioned between the piercing rolls, and drive units 4 which impart a rotative drive force to the piercing rolls, the drive units 4 each comprising a spindle 5, a reduction mechanism 6, and a main motor 7, the main motor 7 being disposed on the

piercing roll side relative to the reduction mechanism 6 and in parallel with the spindle 5. The drive units axe preferably disposed on an outlet side of the piercing mill. According to the piercing mill of the present invention, since the space occupied by the drive units can be diminished, the arrangement of components of the overall set of production equipment can be made compact. Further, when a continuous tube manufacturing facility is to be realized, an adjacent mill can be disposed in proximity to the piercing mill and thus the overall layout can be optimized.

FIG. 5



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Description

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention relates to a piercing mill for the manufacture of seamless steel tube, and more particularly to a piercing mill which adopts an appropriate arrangement of drive units each including a main motor, thereby enabling compact arrangement of drive units.

BACKGROUND ART OF THE INVENTION

[0002] As a method of manufacturing seamless steel tubes under hot working conditions, the Mannesmann tube-making process is widely employed. In this tube-making process, a round billet heated to a high temperature is fed as a material to be rolled into a piercing mill (a so-called "piercer"), which pierces the axial center portion of the round billet to obtain a hollow shell. The thus-obtained hollow shell is fed, directly or as needed after undergoing an expansion or wall-thinning process in an elongator having the same structure as that of the piercing mill, into a subsequent elongating mill such as a plug mill, a mandrel mill, or the like so as to be elongated. Subsequently, the thus-elongated tube undergoes a finishing process provided by a stretch reducer for shape correction, a reeler for polishing, and a sizer for sizing, thereby becoming a seamless steel tube product.

[0003] FIG. 1 schematically illustrates the arrangement of piercing rolls used in a piercing mill, and FIG. 2 illustrates the arrangement of piercing rolls as seen in the direction of arrow A-A in FIG. 1. As shown in FIG. 1, piercing rolls 1 are disposed symmetrically with respect to a pass line X-X such that their axes each form a cross angle of γ relative to the pass line X-X. The pass line X-X serves as an axis of movement along which a round billet 3 serving as a material to be rolled moves while being rolled. As shown in FIG. 2, one of the piercing rolls 1 is disposed so as to form a feed angle of β relative to the pass line X-X. The other piercing roll 1 not shown in FIG. 2 is disposed opposite the one piercing roll with respect to the pass line X-X such that the other piercing roll 1 is inclined in the opposite direction at a feed angle of β .

[0004] In the piercing mill constructed as above, the round billet 3 is fed along the pass line X-X in the direction of a white arrow and is nipped between the piercing rolls 1, then moves along the pass line while being rolled. The billet 3 thus moving along the pass line is pierced axially by means of a plug 2. In this manner, a hollow shell is obtained. During this operation the plug 2 is supported by a mandrel of a mandrel support device.

[0005] The piercing rolls 1, which impart a rotating motion to the round billet 3, are directly connected to drive units 4, respectively, whereby the piercing rolls can rotate about their respective axes while independently

ensuring the cross angle γ and the feed angle β . In the piercing mill, each drive unit 4 is usually composed of a spindle, a reduction mechanism, and a main motor.

[0006] FIG. 3 is a schematic plan view showing an arrangement of drive unit components of a conventional piercing mill, and FIG. 4 is a schematic elevation thereof. As shown in FIG. 3, the piercing rolls are inclined in directions opposite to each other with respect to a pass line each at a feed angle of β . As shown in FIG. 3, therefore, in order to ensure the feed angle β of each piercing roll in plan view, spindles 5, which are directly connected to the piercing rolls 1, respectively, are arranged in such a manner that the distance thereof from a conveying device 8 in the piercing mill; namely, a distance from the pass line X-X, becomes longer with increasing distance from the main frame of the piercing mill. Consequently, at end portions of the drive units 4, a large space must be provided on either side of the conveying device 8.

[0007] As is apparent from FIG. 4, which illustrates an equipment arrangement in the vertical direction, the drive units 4 of a conventional piercing mill each require a large space in the vertical direction; namely, a large difference in height. As shown in FIG. 4, in order to maintain the cross angle γ of each piercing roll 1 relative to the pass line X-X, the spindle 5 connected directly to one piercing roll is disposed above the pass line, while the spindle connected directly to the other piercing roll is disposed below the pass line. Also, as the distance from the main frame of the piercing mill increases, the distance from the pass line to each of the spindles 5 increases. Consequently, the height difference between the drive units (i.e., the sum of upper-side and lower-side separation distance with respect to the conveying device 8) becomes considerably large at end portions of the drive units, thus giving rise to the necessity that a base for one main motor be disposed higher than the floor, whereas the base for the other main motor must be disposed a considerable distance below the floor (i.e., through digging deep below the floor).

[0008] As noted previously, the drive units 4 in the piercing mill are each composed of the spindle 5, a reduction mechanism 6, and a main motor 7, which are usually arranged in series for a reason to be stated later. More particularly, the spindle 5 is disposed in direct connection with the associated piercing roll 1, and the main motor 7 is disposed on an extension of the spindle 5 via the reduction mechanism 6. Consequently, the respective main motors 7 at end portions of the drive units 4 are separated from the main frame of the piercing mill by a long distance, and the distance and height difference between the two main motors become greater. Thus, in the conventional piercing mill constructed in such an arrangement, not only a large two-dimensional space, but also a large three-dimensional space must be sacrificed, thus giving rise to the problem that the construction cost increases.

[0009] In recent years, studies have been made in

an effort to realize a continuous manufacturing process in a Mannesmann tube manufacturing facility and to automate and shorten the time of setup for tube production, with a view toward attaining highly efficient production of seamless steel tube, with consequent demand for space saving in each rolling mill. Also, in relation to the piercing mill, reduction in the space occupied by drive units is strongly desired.

SUMMARY OF THE INVENTION

[0010] Conventional piercing mills are designed on the premise that drive unit components are arranged in series in order to make the reduction mechanism compact and to protect the main motors. That is, according to the conventional design concept, in order to simplify the facility, priority has been given to making the reduction mechanism compact while reliably reducing the motor speed in order to effect optimum revolution control for the piercing rolls. In order to make the reduction mechanism compact, the series arrangement of drive unit components may be abandoned, and each main motor may be disposed within the associated reduction mechanism. However, in this case, a sufficient center-to-center distance cannot be secured between the main motor and the spindle, with resultant impossibility of disposing the main motor and the spindle in parallel with each other. Additionally, if the main motor and the spindle are disposed in parallel with each other, there arises a fear that accidental breakage of the spindle may lead to a breakage failure of the main motor. Failure of the main motor would lead to long-term suspension of the rolling mill. Therefore, the premise that the drive unit components are arranged in series is also based avoiding breakage failure of the main motor.

[0011] An object of the present invention is to reconsider the premised arrangement of the components of the drive units in the conventional piercing mill, to thereby improve the arrangement of drive unit components and to provide a piercing mill suitable for highly efficient production of seamless steel tube.

[0012] The gist of the present invention resides in the below-described piercing mill for the manufacture of seamless steel tube, as shown in FIG. 5 and 6:

[0013] A piercing mill for the manufacture of seamless steel tube comprises a pair of piercing rolls 1 disposed opposite each other with respect to a pass line along which a material to be rolled 3 moves while being rolled, a plug (not shown) disposed along the pass line so as to be positioned between the piercing rolls 1, and drive units 4 for imparting a rotative drive force to the piercing rolls, the improvement characterized in that the drive units 4 each comprise a spindle 5, a reduction mechanism 6, and a main motor 7, the main motor 7 being disposed on the piercing roll side relative to the reduction mechanism 6 and in parallel with the spindle 5.

[0014] In the above piercing mill, the drive units are

preferably disposed on an outlet side of the piercing mill. Each main motor may optionally be disposed on the pass line side or on the side opposite the pass line, relative to the spindle, so long as the main motor is disposed on the piercing roll side relative to the reduction mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

10 [0015]

FIG. 1 is a schematic plan view showing the arrangement of piercing rolls used in a piercing mill. FIG. 2 is a sectional view as seen in the direction of arrow A-A in FIG. 1.

FIG. 3 is a schematic plan view showing an arrangement of drive unit components used in a conventional piercing mill.

FIG. 4 is a schematic elevation of the drive unit components shown in FIG. 3.

FIG. 5 is a schematic plan view showing an arrangement of drive unit components used in a piercing mill according to an embodiment of the present invention.

FIG. 6 is a schematic elevation of the drive unit components shown in FIG. 5.

FIG. 7 is a diagram explaining a gate-like guide which prevents a main motor from being damaged, which would otherwise occur due to breakage of a spindle used in the piercing mill according to the embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0016] The piercing mill of the present invention is characterized by abandoning the conventional premise of arranging drive unit components in series and disposing a main motor on the piercing roll side relative to a reduction mechanism and in parallel with a spindle. According to the present invention, in order to realize this arrangement, each reduction mechanism used in the piercing mill of the invention is designed so as to ensure an appropriate center-to-center distance between a main motor and a spindle. According to such a design concept, the main motor can be disposed on the piercing roll side relative to the reduction mechanism and in parallel with the spindle, whereby the overall length of each drive unit is considerably shortened. Consequently, space occupied by the drive units in the piercing mill can be diminished to a remarkable extent and the construction cost can be reduced.

[0017] As noted previously, if the main motor and the spindle are arranged side by side, accidental breakage of the spindle may lead to breakage and failure of the main motor. Usually, upon occurrence of breakage of the spindle, the spindle whirls about a fulcrum, which may be a connection portion between the spindle and the associated piercing roll or a connection portion

between the spindle and the reduction mechanism. In this case, the spindle strikes the main motor adjacent thereto sideways, causing damage to the main motor. However, even such damage to the main motor caused by the spindle can be avoided by providing the main motor with protector means.

[0018] In the piercing mill of the present invention, the space occupied by drive units can be greatly reduced when the foregoing construction is adopted. Therefore, when an additional facility such as a mandrel mill is disposed adjacent to the piercing mill in order to realize a continuous tube manufacturing facility, the additional facility can be disposed in proximity to the piercing mill in order to make the overall layout compact. Also, a piercer plug exchanger and a mandrel exchanger can be arranged in mutual proximity, whereby the mandrel length and the travel distance of a thrust block can be shortened.

[0019] In the piercing mill of the present invention, drive units are preferably disposed on an outlet side of the piercing mill. In the case where efficient production is to be attained in addition to continuous manufacture of tube, the cannon exchanging work in the piercing mill must be automated and the time required for the same must be shortened. Ensuring a sufficient space on an inlet side of the piercing mill is an effective measure for fulfilling this purpose. In other words, provision of drive units on the outlet side of the piercing mill facilitates highly efficient production of seamless steel tube.

[0020] The piercing mill of the present invention will next be described in detail with reference to an embodiment thereof as shown by the drawings.

[0021] FIG. 5 is a schematic plan view showing an arrangement of drive unit components used in the piercing mill embodying the invention, and FIG. 6 is a schematic elevation thereof.

[0022] As is apparent from both figures, priority is given to ensuring a sufficient center-to-center distance between a main motor 7 and a spindle 5, and the main motor 7 is disposed on the piercing roll side relative to a reduction mechanism 6 and in parallel with the spindle 5. Detailed operation of drive units 4 used in the piercing mill proceeds as follows.

[0023] As mentioned previously, piercing rolls 1 are disposed such that they incline in opposite directions at a feed angle of β and are positioned axisymmetrically such that their respective axes intersect with the pass line X-X at a cross angle of γ . In order to transfer rotation power to each piercing roll 1, one end of each spindle 5, is directly connected to the piercing roll 1, and the other end is directly connected to the corresponding reduction mechanism 6 via a cross pin 10. In a plan view of the piercing mill, the drive units 4 are arranged in such a manner that the spindles 5 connected directly to the piercing rolls 1 are spaced further away from a conveying device 8 as the distance from the main frame of piercing mill becomes longer, in order to ensure the feed angle β of each piercing roll. In contrast, as shown in

FIG. 6, in order to ensure the cross angle γ of each piercing roll 1, the drive unit 4 for the upper roll is disposed above the pass line X-X, while the drive unit 4 for the lower roll is disposed below the pass line. Consequently, the height difference becomes great at the end portions of the drive units 4.

[0024] In the piercing mill of the present invention, however, the main motor 7 in each drive unit 4 is disposed on the piercing roll side relative to the reduction unit 6 and in parallel with the spindle 5. Therefore, as shown in FIG. 5, the position of the drive unit is never extended beyond the position of the reduction mechanism 6, nor is there any fear of producing a height difference greater than the height difference between the reduction mechanisms 6.

[0025] More specifically, as compared with the case of conventional arrangement of drive unit components, the transverse distance and the height difference can be diminished by an amount corresponding to the length of each main motor 7. Further, the overall equipment length can be shortened. This leads to space saving by the piercing mill and is further advantageous in that when a continuous tube manufacturing facility is to be realized an additional machine can be disposed in proximity to the piercing mill and that the overall tube manufacturing line can be made compact.

[0026] When the main motor 7 is to be arranged in parallel with the spindle 5, a study must be conducted with regard to measures for preventing damage to the main motor caused by accidental breakage of the spindle. Usually, breakage of the spindle 5 during the material piercing work takes the form of breakage of the cross pin 10. For example, in the event of breakage of the cross pin 10 located on the main motor side, the spindle motor 5 whirls about the cross pin 10, which is a connection point on the piercing roll side, and violently strikes the main motor 7 located at the same height. As a measure to prevent this, a gate-like guide 11, for example, is provided as breakage prevention means at a position opposite the main motor 7.

[0027] FIG. 7 illustrates such a gate-like guide 11 used for preventing damage to the main motor in the event of breakage of the spindle in the piercing mill of the present invention. As is seen in the same figure, after having been broken, the spindle 5 merely rotates within the gate-like guide 11 and does not strike the main motor 7. Although the gate-like guide shown in FIG. 7 is one example, use of such a breakage prevention means prevents the occurrence of a problem even in the case where the main motor 7 and the spindle 5 are arranged in parallel. Further, an effective measure for preventing breakage of the spindle itself is to use a carrier (not shown) or the like which bears the weight of the spindle and absorbs deflection of the spindle.

[0028] Although in the above embodiment the main motor in each drive unit is disposed on the side opposite the pass line with respect to the spindle, the main motor may be disposed on the pass line side if space permits.

[0029] The drive units used in the invention may be disposed either on the inlet side or the outlet side of the piercing mill. However, the drive units are preferably disposed on the outlet side of the piercing mill as in the above embodiment, in order to utilize the inlet side of the piercing mill effectively. 5

INDUSTRIAL APPLICABILITY

[0030] According to the piercing mill of the present invention, since the space occupied by the drive units can be diminished, the drive unit components can be arranged compactly, and when a continuous tube manufacturing process is to be realized, an additional mill or machine can be disposed in proximity to the piercing mill, whereby the overall layout can be made compact. Also, the present invention facilitates automation of cannon exchanging work in the piercing mill and shortening of the time required for the same work, thus leading to still more efficient production of seamless steel tube. 10 15 20

[0031] Thus, the piercing mill of the present invention can be utilized widely in the field of seamless steel tubes, and can realize efficient production thereof.

Claims 25

1. A piercing mill for the manufacture of seamless steel tube, comprising a pair of piercing rolls disposed opposite each other with respect to a pass line along which material to be rolled moves while being rolled; a plug disposed along said pass line so as to be positioned between said piercing rolls; and drive units for imparting a rotative drive force to the piercing rolls, characterized in that said drive units each comprise a spindle, a reduction mechanism, and a main motor, said main motor being disposed on the piercing roll side relative to said reduction mechanism and in parallel with said spindle. 30 35 40
2. A piercing mill according to claim 1, characterized in that said drive units are disposed on an outlet side of the piercing mill. 45 50 55

FIG. 1

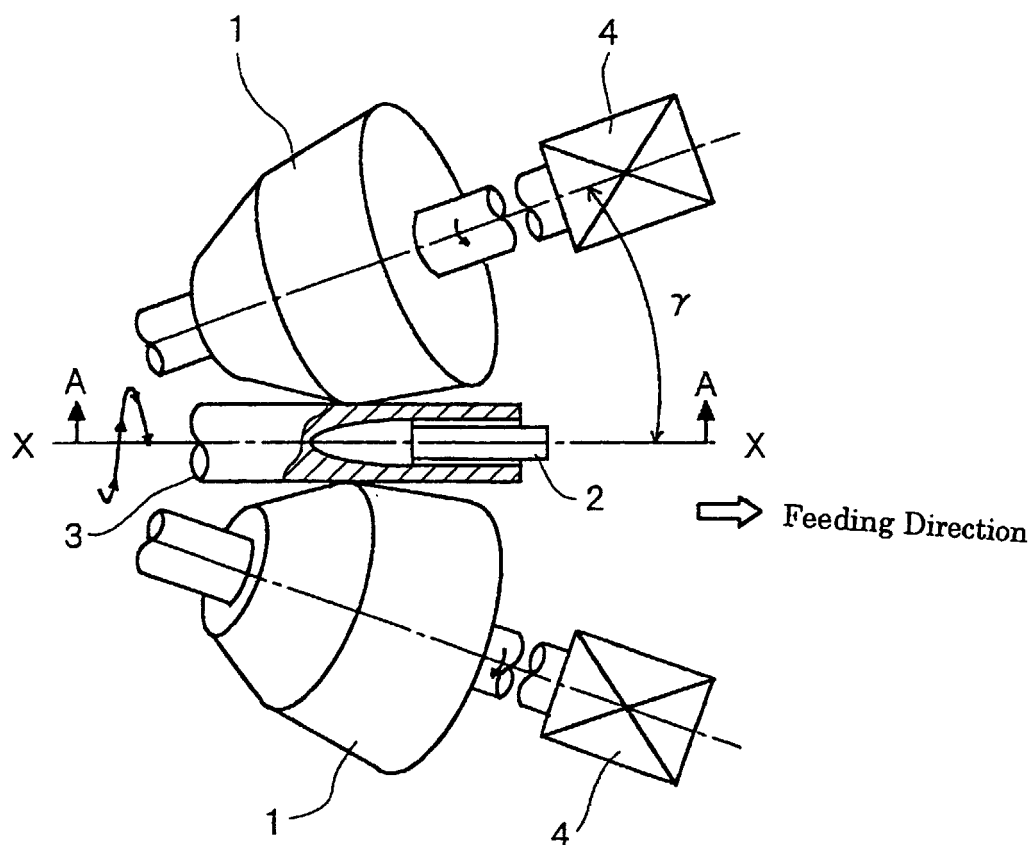


FIG. 2

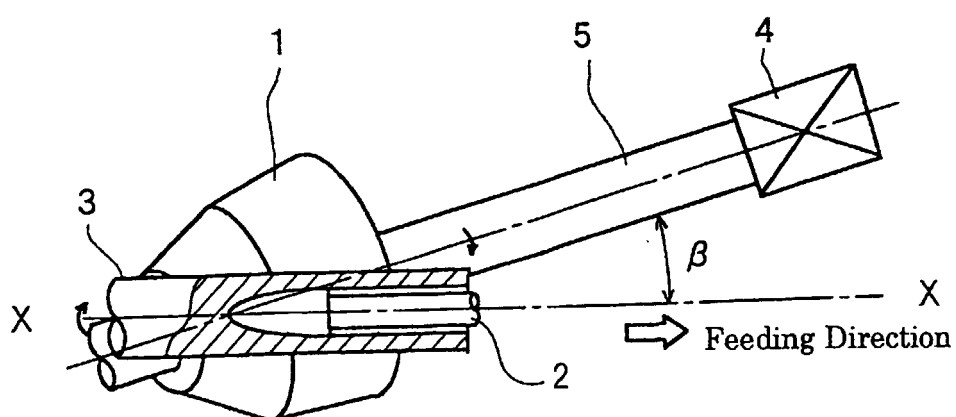


FIG. 3

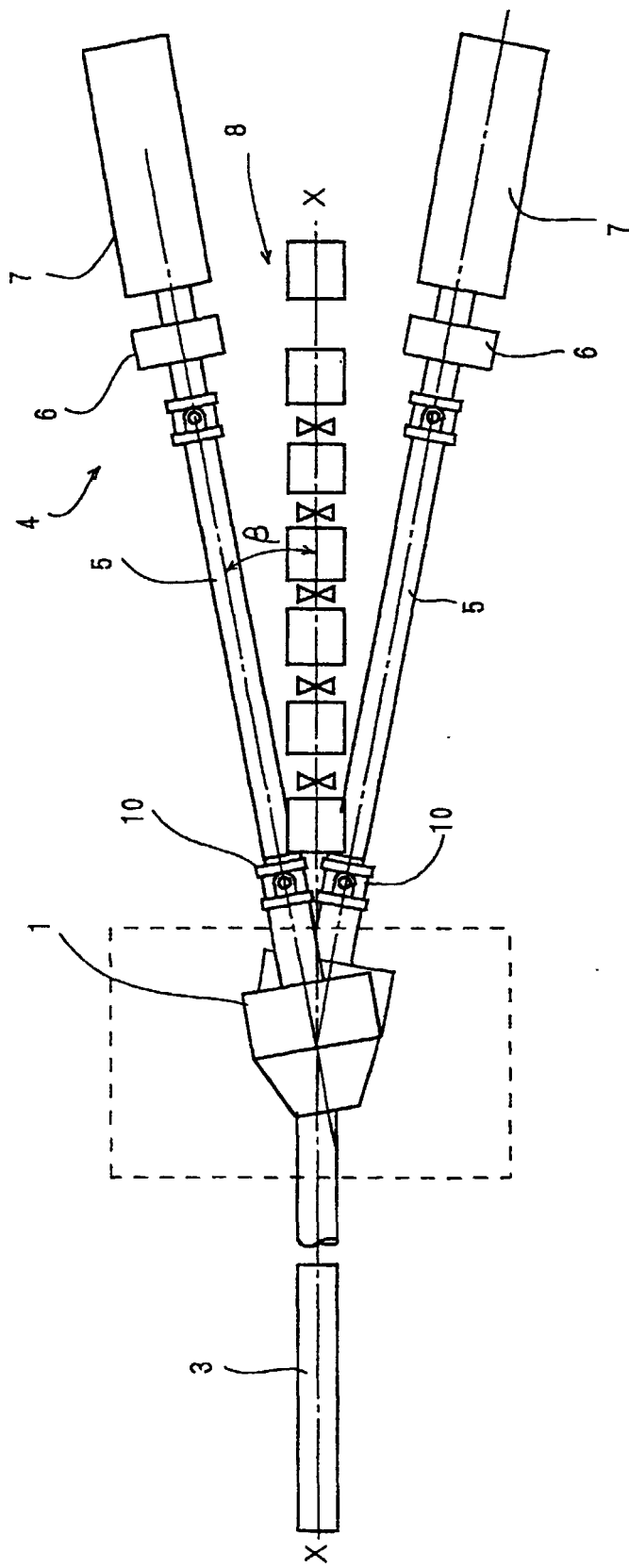
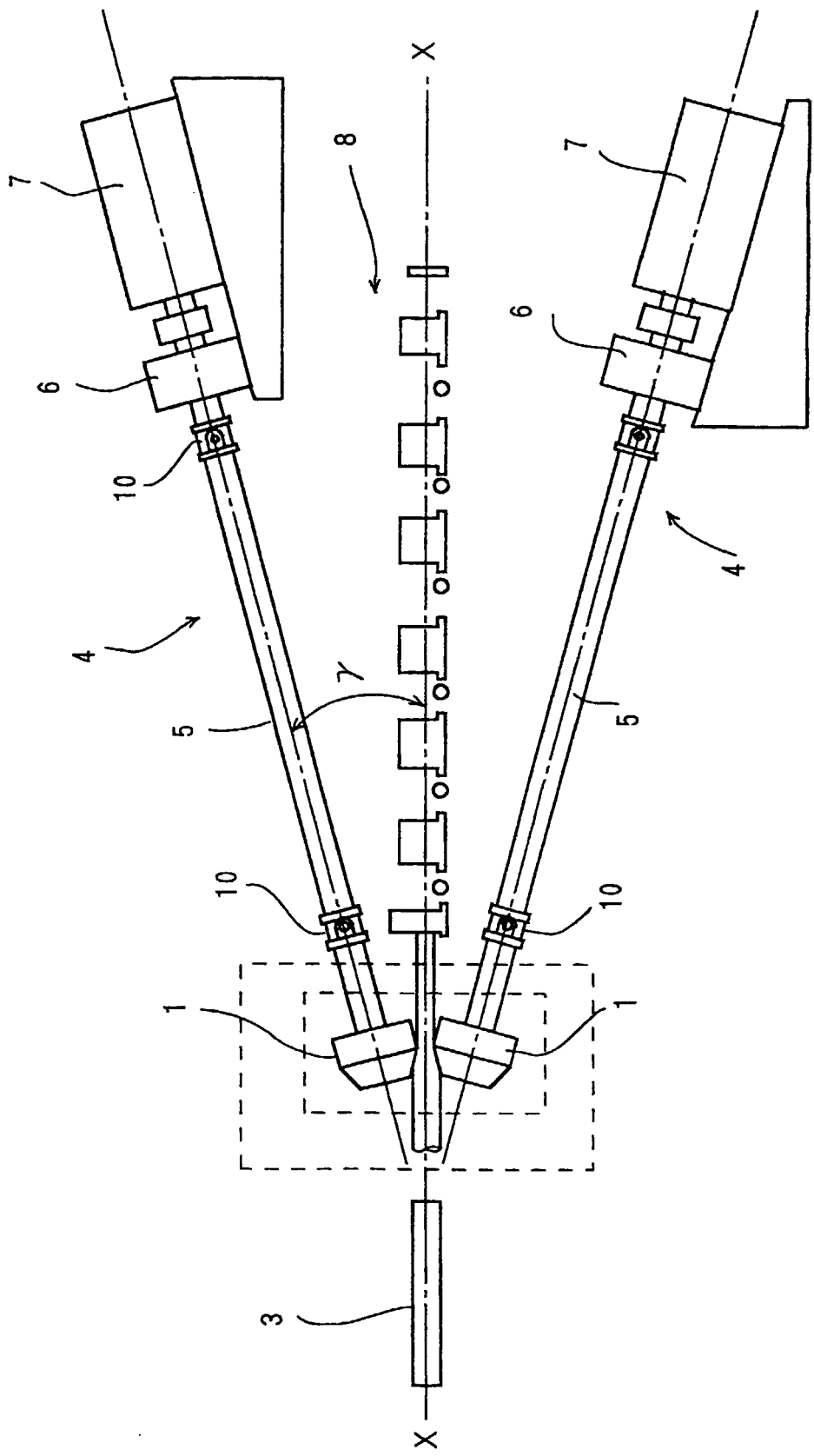


FIG. 4



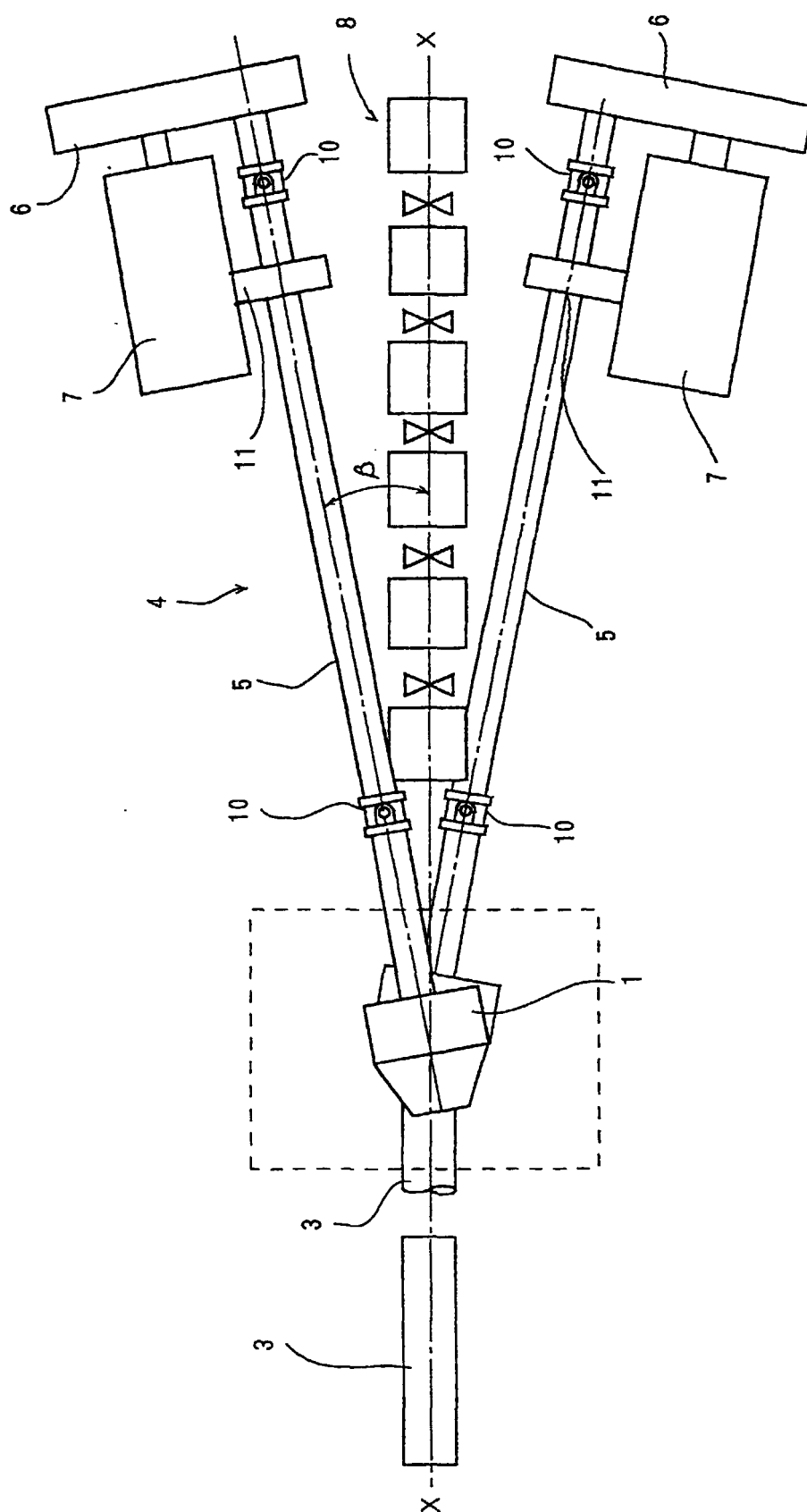


Fig. 5

FIG. 6

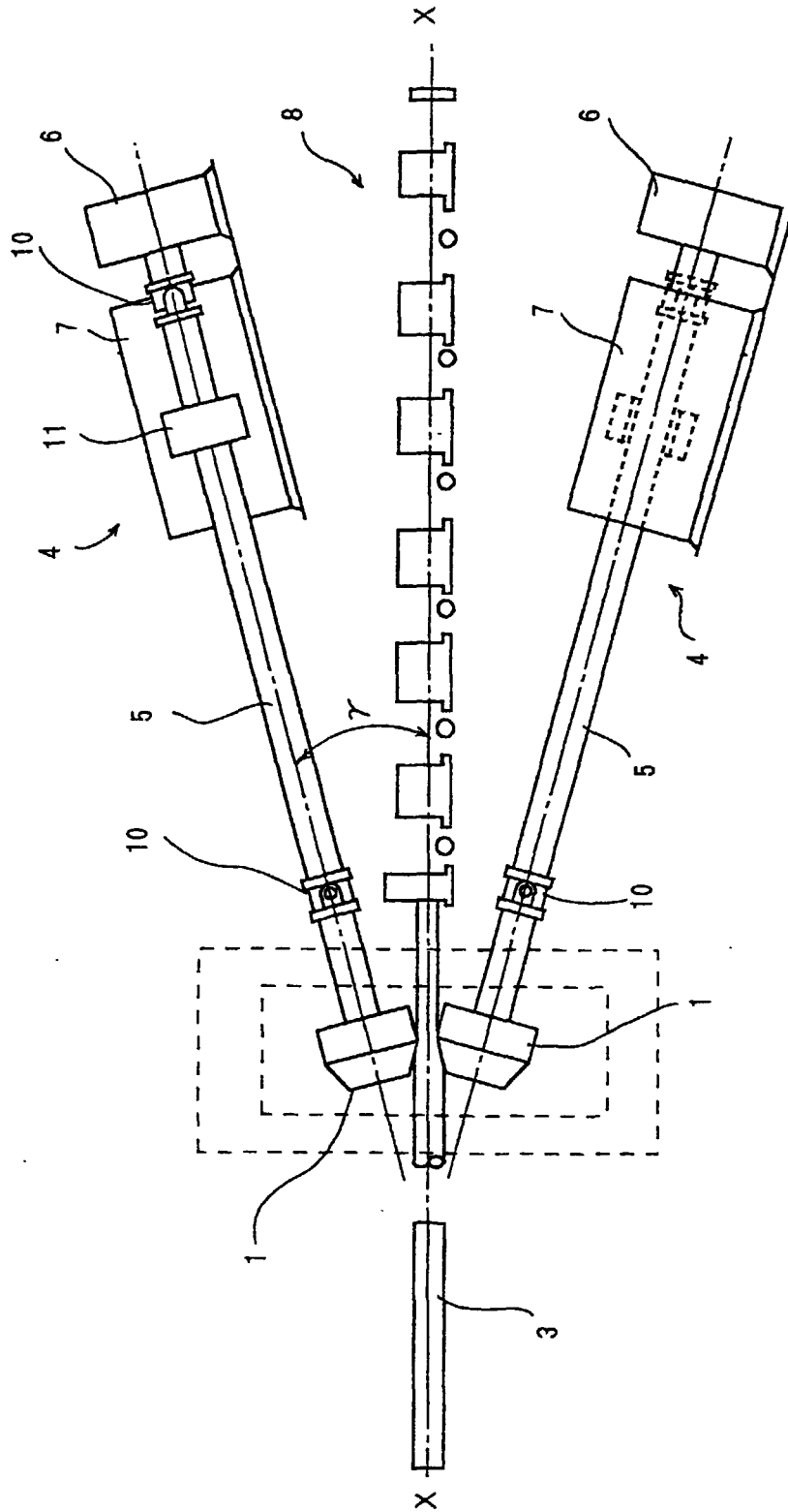
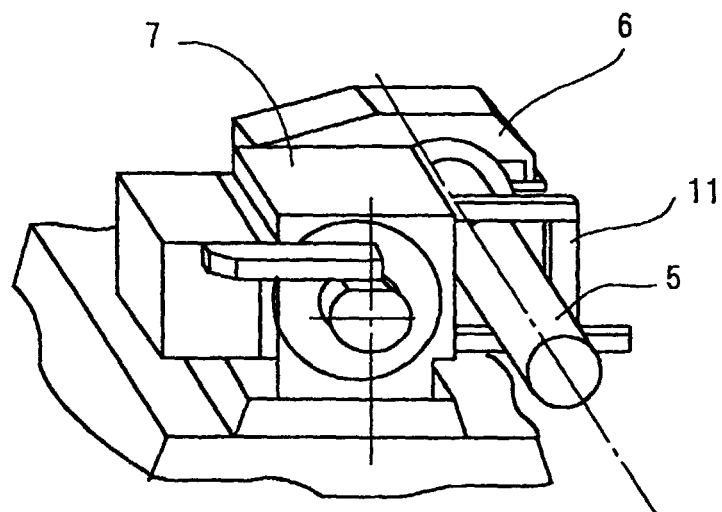


FIG. 7



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP98/04571

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl. ⁶ B21B19/04		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) Int.Cl. ⁶ B21B19/00-19/04, 35/00-35/14		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-1998 Kokai Jitsuyo Shinan Koho 1971-1998 Jitsuyo Shinan Toroku Koho 1996-1998		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, 7-18405, Y2 (Sumitomo Heavy Industries, Ltd.), 1 May, 1995 (01. 05. 95), Fig. 1 (Family: none)	1, 2
A	JP, 7-8365, B2 (Italimpianti of America Inc.), 1 February, 1995 (01. 02. 95), Fig. 1 & US, 5142893, A	1, 2
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
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Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
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