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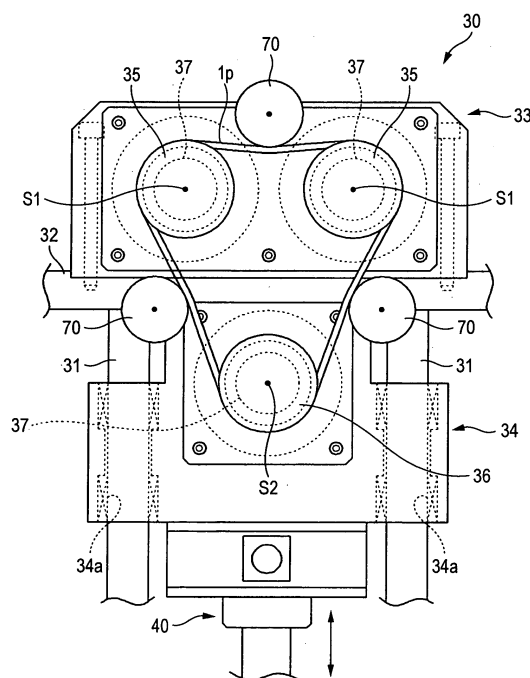
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(54) **Stress applying method for power transmission chain and stress applying apparatus used in said method**

(57) An endless loop chain (1p) is wound around main rollers (35,36). Stress is applied to the chain (1p), including a part thereof where a turning angle is formed toward an outer direction, by endlessly turning the chain (1p) with the main rollers (35,36) and the auxiliary rollers (70) while pressing an outer periphery of the endless loop chain (1p) with auxiliary rollers (70).

FIG. 6



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] This invention relates to a stress applying method for a power transmission chain used in a power transmission system such as a chain-type continuously variable transmission installed in a vehicle etc., and a stress applying apparatus used in the same method.

2. Related Art

[0002] There is known, for example, a system including an input pulley located on an engine-side, an output pulley on a driving wheel-side and an endless power transmission chain would around both pulleys for a continuously variable transmission of an automobile. The power transmission chain is provided by inserting pin members into pin holes formed on link plates. Frictional force is generated by the contact between conical sheave faces in both pulleys and, for example, end faces of the pin members with small sliding in circumferential directions of the sheave faces, and the power is transmitted by such frictional force.

[0003] When such a power transmission chain is manufactured, a plurality of link plates having a pair of pin holes are laminated such that the pin holes are communicated to each other, then, pin members are inserted into the pin holes which are communicated with each other so as to be interconnected turnably to form an endless loop chain. After that, stress is applied to the endless loop chain as suggested by JP H08-74938A. By applying the stress, compressive residual stress is generated by plastic deformation in the link plates, so that the link plates are reinforced.

[0004] Conventionally, to apply such stress to the endless loop chain as described above, the chain is wound around two rollers apart from each other at a predetermined distance, and tensile force is applied to the chain while endlessly turning the chain at high speed by the rollers. However, the chain wound around the pulleys is displaced slightly toward the inner side of the loop at the exit from the pulley in the actual service and thus the turning angle toward the outer side of the loop is eventually formed in the link plates. However, in the conventional stress applying method, such a condition is not simulated. That is, there still remain areas in the link plates in which strength may not be sufficient even in the chain to which the stress has been already applied. Further, if there are the areas in which the strength is not sufficient, a problem arises that sufficient fatigue strength cannot be accomplished and working lifetime is adversely affected.

SUMMARY OF THE INVENTION

[0005] The present invention has been made in view of the above circumstances, and an object of the invention is to provide a stress applying method for a power transmission chain in which sufficient fatigue strength of the chain is accomplished and a long working lifetime can be assured as well as a stress applying apparatus used in the same method.

[0006] The above object has been achieved by following steps:

winding an endless loop chain around a plurality of main rollers, the chain being provided by interconnecting turnably a plurality of laminated link plates to one another through pin members; and applying a stress to the chain by endlessly turning the chain while pressing an outer periphery of the chain with at least one auxiliary roller located between adjacent ones of the main rollers.

[0007] According to the stress applying method of the invention, since the stress can be applied to the endless loop chain including a part in which the turning angle is formed toward the outer direction in the link plates, it is possible to simulate a condition in the actual service that the chain is displaced toward the inner side of the loop at the exit from the pulley.

[0008] Therefore, by applying the stress based on this method, no area exists in the link plates in which strength is not sufficient, and the sufficient fatigue strength is accomplished in the power transmission chain, so that the long working lifetime can be assured. Incidentally, the turning angle toward the outer direction corresponds to a state where the chain is indented toward the inner side of the loop and on the other hand, the turning angle of the link plates toward the inner direction corresponds to a state where the chain is protruded toward the outer side of the loop (namely, a state where the chain is wound around the pulley).

[0009] In the present invention, a turning angle of the link plates in the chain endlessly turned is preferably set to be in a range not less than -5% and not more than +5% of a maximum turning angle in a service condition of the power transmission chain. In this case, the compressive residual stress can be applied to the link plates without applying excessive load.

[0010] In the present invention, the endless loop chain is preferably wound around three of the main rollers so as to form a polygonal shape. In this case, distances between the main rollers can be short, and large impact or vibration is hardly caused during the turning of the chain. Therefore, it is possible to generate compressive residual stress uniformly in the link plates and the quality of the power transmission chains can be stabilized.

[0011] Further, the invention also provides a stress applying apparatus for the power transmission chain in which a stress is applied to an endless loop chain by

endlessly turning the endless loop chain which is provided by interconnecting turnably a plurality of laminated link plates to one another through pin members, the stress applying apparatus comprising:

an apparatus main body including a plurality of main rollers and at least one auxiliary roller located between adjacent ones of the main rollers such that the main rollers and the auxiliary roller are rotatably supported and that the main rollers are capable of being releasably in contact with one another and the auxiliary roller is movable so as to press an outer periphery of the chain would around the main rollers; and

a roller driving means which moves at least one of the main rollers and the auxiliary roller.

[0012] According to the stress applying apparatus of the invention, since the outer periphery of the chain which is wound around the main rollers is brought into a pressed state with the auxiliary roller, the stress can be applied to the chain including the state that the turning angle of the link plates is formed toward the outer direction. Therefore, it is possible to simulate the state that the chain is displaced toward the inner side of the loop at the exit from the pulley in the actual service. Accordingly, by applying the stress to the chain by using this apparatus, no area exists in the link plates in which strength is not sufficient, and the sufficient fatigue strength is accomplished in the power transmission chain, so that the long working lifetime can be assured.

[0013] According to the stress applying method and apparatus, since no area exists in the link plates in which strength is not sufficient, the sufficient fatigue strength is accomplished in the power transmission chain, and the long working lifetime can be assured.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

Fig. 1 is a perspective view showing a state that a power transmission chain is wound around an input pulley and an output pulley.

Fig. 2 is a sectional view showing an essential part of the embodiment in which the power transmission chain is wound around the input pulley.

Fig. 3 is a schematic perspective view showing an essential part of the chain.

Fig. 4 is a sectional view showing a state that pins and strips are provided into a link plate.

Fig. 5 is a front view of a three-roller type pre-load apparatus.

Fig. 6 is a front view of an essential part of the three-roller type pre-load apparatus.

Fig. 7 is a sectional view of a vicinity of an upper roller or a lower roller.

Fig. 8 is an explanatory view showing states that a

turning angle of the link plates are formed toward an outer direction and toward an inner direction.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] A preferred embodiment of the present invention will now be described in detail with reference to the drawings.

[0016] Figs. 1 and 2 show a chain-type continuously variable transmission C (hereinafter called "continuously variable transmission") as an embodiment of a power transmission system related to the invention. Figs. 3 and 4 show a power transmission chain 1 (hereinafter called "chain") used in the power transmission system according to this embodiment. The continuously variable transmission C according to the embodiment is mounted, for example, in an automobile, and includes an input pulley 10 made of metal (structural steel etc.) as first pulley, an output pulley 20 made of metal (structural steel etc.) as second pulley and the power transmission chain 1 wound around these pulleys.

[0017] The input pulley 10 is attached to an input shaft 11 connected to an engine-side so as to be integrally rotatable therewith and includes a stationary sheave 12 having a conical slant surface 12a, a movable sheave 13 having a conical slant surface 13a opposed to the conical slant surface 12a. A V-shape groove is formed by the conical slant surfaces 12a, 13a of the sheaves 12, 13. This V-shape groove clamps and holds the chain 1 with high pressure.

[0018] Further, the movable sheave 13 is connected to a hydraulic actuator (not-shown) to vary a groove width. When the speed is changed, the groove width is varied by moving the movable sheave 13, and accordingly, the chain 1 is moved such that a winding radius of the chain 1 to the input shaft 11 is changed.

[0019] On the other hand, the output pulley 20 is attached to an output shaft 21 connected to a driving wheel-side so as to be integrally rotatable therewith and includes, similarly to the input pulley 10, a stationary sheave 22 and a movable sheave 23 having conical slant surfaces to form a groove to clamp the chain 1 with high pressure.

[0020] Further, the movable sheave 23 of the pulley 20 is connected to a hydraulic actuator similarly to the movable sheave 13 of the input pulley 10. When the speed is changed, the groove width is varied by moving the movable sheave 23, and accordingly, the chain 1 is moved such that a winding radius of the chain 1 to the output shaft 21 is changed.

[0021] In the continuously variable transmission according to the embodiment as described above, the continuous speed variation can be conducted as follows. When the rotation of the output shaft 21 is decelerated, the groove width of the input pulley 10 is enlarged by moving the movable pulley 13 so that the winding radius of the chain 1 to the input shaft 11 is decreased by moving

pin end faces 3a,3b of the chain 1 toward the radial inner direction on the conical sheave surfaces 12a,13a with a sliding contact under a boundary lubrication condition. On the other hand, the groove width of the output pulley 20 is narrowed by moving the movable pulley 23 so that the winding radius of the chain 1 to the output shaft 21 is increased by moving pin end faces 3a,3b of the chain 1 toward the radial outer direction on the conical sheave surfaces 22a,23a with the sliding contact under the boundary lubrication condition.

[0022] By doing so, the rotation of the output shaft 21 can be decelerated. On the other hand, when the rotation of the output shaft 21 is accelerated, the groove width of the input pulley 10 is narrowed by moving the movable pulley 13 so that the winding radius of the chain 1 to the input shaft 11 is increased by moving pin end faces 3a, 3b of the chain 1 toward the radial outer direction on the conical sheave surfaces 12a,13a with the sliding contact under the boundary lubrication condition. On the other hand, the groove width of the output pulley 20 is enlarged by moving the movable pulley 23 so that the winding radius of the chain 1 to the output shaft 21 is decreased by moving pin end faces 3a,3b of the chain 1 toward the radial inner direction on the conical sheave surfaces 22a, 23a with the sliding contact under the boundary lubrication condition. By doing so, the rotation of the output shaft 21 can be accelerated.

[0023] Next, the description will be made on the chain 1 wound around the input pulley 10 and the output pulley 20. The chain 1 is constituted by a plurality of link plates 2 made of metal (carbon steel etc.) as chain component member, a plurality of pins 3 made of metal (bearing steel etc.) as pin member for interconnecting the link plates 2 together and a plurality of strips 4 as pin member that are slightly shorter than the pins 3. Incidentally, Fig. 1 is partially omitted at the center of the chain 1 in the width direction.

[0024] The link plates 2 have a contour line with a gently curved shape. Two pin holes 2a are formed in each link plate 2 so that all link plates have substantially the identical outer shape. The pin 3 which interconnects the link plates 2 is a bar-like body having a side surface coincident with an inner peripheral surface of the pin hole 2a. All pins have substantially identical shape.

[0025] The pin end faces 3a,3b have curved convex surfaces with a predetermined curvature to contact with the pulleys to transmit the power. The strip 4 is formed slightly shorter than the pin 3 and is a bar-like body having a side surface coincident with an inner peripheral surface of the pin hole 2a. All strips have substantially identical shape. The pins 3 and the strips 4 are inserted into the pin holes 2a of the plural link plates 2 that are laminated, so that the link plates are turnably interconnected.

[0026] Among the pin 3 and the strip 4 which are inserted into one pin hole 2a, one is press-fitted to the pin hole 2a and the other is rotatably inserted while being brought into a rolling contact with the side surface of the one. Further, the other is press-fitted to another pin hole

2a in another link plate 2 which is adjacently overlapped. On the other hand, the one described above which is press-fitted to the pin hole 2a is rotatably inserted to another pin hole 2a in another link plate 2.

[0027] Thus, the pins 3 and the strips 4, one of which are press-fitted and the others of which are rotatably inserted to the pin holes 2a, turnably interconnects the link plates 2. As described above, the chain 1 is formed by turnably interconnecting the overlapped link plates 2 and laminating the link plates 2.

[0028] In order to reinforce the link plates 2 constituting the chain 1, compressive residual stress is generated in areas at which the pins 3 and the strips 4 are held. In the manufacturing process, stress is applied to an endless loop chain 1p after obtaining by laminating the link plates 2 and turnably interconnecting the link plates 2, inserting the pins 3 and the strips 4 into the pin holes 2a. Hereinafter, the description will be made on the stress applying method for the chain 1.

[0029] Fig. 5 shows a three-roller type pre-load apparatus 100 as stress applying apparatus to apply stress to the chain 1p.

[0030] The apparatus 100 includes an apparatus main body 30, a hydraulic device 40 (roller driving means) located on the lower side of the apparatus main body 30, a base portion 50 and a control device 60 disposed on a side of the apparatus main body 30. As shown in Fig. 6, the apparatus main body 30 includes guide posts 31 standing on left and right sides of the base portion 50 and a stationary support plate 32 disposed on the upper ends of the guide posts 31, a stationary portion 33 fixed on the stationary support plate 32, a lift portion 34 located below the stationary portion 33, upper rollers 35 as main roller provided on the stationary portion 33, a lower roller 36 as main roller provided on the lift portion 34, an auxiliary roller 70 provided on the stationary portion 33 between the upper rollers 35, and a pair of auxiliary rollers 70 provided left and right on the stationary support plate 32 between the upper rollers 35 and the lower roller 36.

[0031] Two of the upper rollers 35 are supported at the same level and the lower roller 36 is supported at a lower position corresponding to the center portion between the upper rollers 35, namely, the upper rollers 35 and the lower roller 36 are disposed so that the chain 1p wound around the rollers 35,36 forms a triangle in a front view of the apparatus.

[0032] Further, insertion holes 34a are formed on left and right sides of the lift portion 34, and the guide posts 31 are inserted to the insertion holes 34a so that the lift portion 34 is movable in the vertical direction so as to be capable of being in contact with and separated from the stationary portion 33. Accordingly, by moving the lift portion 34 up or down (moving the lower roller 36 toward inside or outside of the triangle of the chain 1) by the hydraulic device 40 provided below the lift portion 34, the distance between the upper rollers 35 provided on the stationary portion 33 and the lower roller 36 provided on the lift portion 34 is changed. Incidentally, an inlet hole

32a is formed at the center portion of the stationary support plate 32, so that the upper part of the lift portion is placed within the inlet hole 32a when the lift portion 34 is moved up.

[0033] The upper rollers 35 and the lower roller 36 are formed integrally with supporting shafts 37 as shown in Fig. 7, and the supporting shafts 37 are rotatably supported by bearings 38 provided in the stationary portion 33 or in the lift portion 34. Thus, the upper rollers 35 and the lower roller 36 are rotatably supported in a cantilever manner around axes s1 and s2, respectively. Further, a roller driving means (not shown) is provided in the stationary portion 33, and the rollers 35 are driven by the roller driving means. Guide caps 39 are provided on tip ends of the upper rollers 35 and the lower roller 36, so that the chain 1p can be easily mounted.

[0034] U-shaped grooves u for winding the chain 1p therein are formed on the upper rollers 35 and the lower roller 36. Winding the chain 1 around the upper rollers 35 and the lower roller 36 in the grooves u and moving the lower roller 36 down from such a winding state of the chain 1p, tensile load is applied to the chain 1p. Incidentally, a range of moving down the roller 36 is adjusted such that the applied load is in a range from 1.4 times to 3 times of maximum load under the actual service condition of the chain 1.

[0035] The auxiliary rollers 70 have a diameter slightly smaller than the upper rollers 35 or the lower roller 36 and are rotatably supported in a cantilever manner, being located substantially at the center between two upper rollers 35 or between one of the upper rollers 35 and the lower roller 36 respectively on the outer peripheral side of the loop of the wound chain 1p. An auxiliary roller driving means (not-shown) is provided in the stationary portion 33. The auxiliary rollers 70 are configured to be movable toward the inner side and outer side of the triangle formed by the wound chain 1 by the auxiliary roller driving means, so that the auxiliary rollers 70 can press the outer periphery of the chain 1p.

[0036] Accordingly, as shown in Fig. 6, when the auxiliary rollers 70 are moved toward the inner direction to press the outer periphery of the chain 1p, the chain 1p is bent toward the inner side between two of the upper rollers 35 and between the upper rollers 35 and the lower roller 36. Thus, the chain 1p is bent six times during one turn, and the stress can be suitably applied to the chain 1p, including parts where the turning angle of the link plates 2 is formed toward the outer direction. In other words, it is possible to simulate a state that the chain 1 wound around a pulley is displaced toward the inner side of the loop at the exit from the pulley in the actual service of the chain 1.

[0037] Further, the chain 1p is rotated such that the turning angle of the link plates 2 is kept within a range not less than -5% and not more than +5% of the maximum turning angle under the actual service condition both toward the outer direction and toward the inner direction. In this embodiment, the chain length is set from 650 mm

to 660 mm. For this case, the maximum turning angle θ_1 toward the outer direction S of the link plates 2 is 5°, and the maximum turning angle θ_2 toward the inner direction U of the link plates 2 is 18.5° (See Fig. 8). By setting the turning angle within the above ranges, excessive load to the link plate 2 can be avoided. Incidentally, the turning angle is suitably varied in accordance the chain length, the pulley diameter or the like.

[0038] Further, the residual stress is effectively generated at predetermined areas of the link, when the contact radius between the pins and the main rollers (namely, winding radius) is set within a range of 90-100% of the minimum winding radius to the pulley in the service condition of the power transmission chain.

[0039] The control device 60 controls the hydraulic device 40, the roller driving means and the auxiliary driving portion, so that the lower roller 36 is moved up, the upper rollers 35 are rotated, and the auxiliary rollers are moved. Further, a control panel 61 of the control device 60 is provided with buttons to start or stop the hydraulic device 40, the roller driving means and the auxiliary roller driving means, and rotation speed display portion of the upper rollers 35 and the lower roller 36, etc.

[0040] The upper rollers 35 and the lower roller 36 are disposed so that misalignment among the upper rollers 35 and the lower roller 36 is 0 substantially. The rollers 35,36 are inclined slightly toward the outer direction under load-free condition so that the supporting shafts 37 become substantially in parallel with one another when the maximum tensile load is applied to the chain 1p.

[0041] In other words, when the tensile load is applied to the wound chain 1p, the upper rollers 35 and the lower roller 36 are displaced toward the inner side of the loop by bending and the axes s1,s2 of the supporting shaft 37 for the rollers 35,36 become in parallel with one another when the tensile load becomes maximum.

[0042] Next, the description will be made more specifically on a method to apply stress to the chain 1 using the aforementioned three-roller type pre-load apparatus.

[0043] First, the lift portion 34 and the lower roller 36 are moved up and the chain 1p is wound in the grooves u of two of the upper rollers 35 and the lower roller 36. Then, the lower roller 36 is moved down, and the auxiliary rollers 70 are moved to press the outer periphery of the chain 1p to give tension to the chain 1p as shown in Fig. 6.

[0044] Then, the upper rollers 35 are rotated, and the lower roller 36 is further moved down at a predetermined distance from the upper rollers 35 to apply tensile load to the chain 1p while endlessly turning the chain 1p. Incidentally, the chain 1p is endlessly turned several turns at 1000 rpm or less.

[0045] Namely, in this embodiment, required stress (tensile load) is reliably applied to the chain 1p by fewer turns at a lower rotation speed than those of conventional one to generate compressive residual stress at predetermined areas in the link plates 2 with which the pins 3 and the strips 4 are brought into contact by reliably causing plastic deformation therein. After finishing the rotation

of the chain 1p, the rotation of the upper rollers 35 is stopped, and the auxiliary rollers 70 are released from the outer periphery of the chain 1p. Then the lower roller 36 as well as the lift portion 34 is moved up and the chain 1 is released from the upper and lower rollers 35,36 to obtain the chain 1 to which the stress has been applied.

[0046] According to the stress applying method of this embodiment, by applying the stress to the chain 1p, the deformation resistance in the link plates 2 is increased by plastic deformation at the predetermined areas of the link plates 2 with which the pins 3 and the strips 4 are brought into contact, and the chain 1p becomes so-called shake-down state in which the compressive residual stress is generated in the predetermined areas to prevent metal fatigue.

[0047] In particular, in the stress applying method of this embodiment, the stress can be applied by the auxiliary rollers 70 to the chain 1p including a part where the turning angle is formed toward the outer direction in the link plates 2, it is possible to simulate a condition in the actual service that the chain 1 is displaced toward the inner side of the loop at the exit from the pulleys 10,20. Therefore, by applying the stress by this stress applying method, no area exists in the link plates 2 in which strength is not sufficient. Accordingly, the sufficient fatigue strength is accomplished in the power transmission chain 1, so that the long working lifetime can be assured.

[0048] In addition, since the chain 1p is turned through six of the rollers so that the distances between adjacent rollers are short, and the rotation speed of the chain 1p is low, large impact or vibration is hardly caused during the turning of the chain 1p. Therefore, it is possible to generate compressive residual stress reliably and uniformly in the link plates and the quality of the power transmission chains can be stabilized.

[0049] Further, since effective tensile load is applied to all linear parts and curved parts in the link plates during 1-20 turns of endless turning of the chain 1p, the stress is efficiently applied to generate the compressive residual stress in the predetermined areas.

[0050] Since the upper rollers 35 and the lower roller 36 are supported in the cantilever manner, the chain 1p can be easily mounted to the rollers 35,36 and released to thereby improve workability. Further, since the rollers 35,36 are disposed so that the misalignment among the upper and lower rollers 35,36 is 0 substantially, it is possible to prevent non-uniform compressive residual stress which could be caused in the link plates 2 due to the misalignment.

[0051] Furthermore, when the tensile load is applied to the wound chain 1p by rotation thereof, the upper rollers 35 and the lower roller 36 are displaced toward the inner side of the loop by bending. Since axes s1,s2 of the supporting shaft 37 become in parallel with one another when the tensile load becomes maximum, it is possible to prevent non-uniform compressive residual stress which could be caused in the link plates 2 due to inclination of the rollers 35,36.

[0052] Further, since the tensile load applied to the chain 1p is set to be in the range from 1.4 times to 3 times of the maximum load under the actual service condition of the chain 1, metal fatigue can be suppressed at minimum rate to prevent deformation or distortion of the chain 1.

[0053] In the foregoing power transmission system of this embodiment, the power transmission chain 1 in which the working lifetime is assured with sufficient fatigue strength is used. Therefore, the reliable power transmission can be provided over a long term. Incidentally, the power transmission system of the invention is not limited to the construction in which groove widths are varied both in input and output pulleys, but may have a construction in which the groove width is varied only in one of the input and output pulleys and the groove width in the other is fixed at a constant width. In the above description, the embodiment is described that the groove width variation is performed continuously. However, the invention may also be applicable to other power transmission systems in which the speed variation is performed at finite steps or in which the groove width between the sheave faces is constant etc.

[0054] In the stress applying method of this embodiment, the pre-load applying apparatus having three main rollers and three auxiliary rollers is used. However, the number of the main rollers and the auxiliary rollers is not limited specifically. The invention may be provided with, for example, a construction in which two main rollers between which auxiliary rollers are provided, a construction in which three main rollers and only one or two auxiliary rollers are provided, or a construction in which four main rollers or more are provided.

Further, the diameter and the shape of the main rollers and the auxiliary rollers may be changed arbitrarily. The pin member constituting the chain may be provided with a pin body and contact members fixed at opposite ends of the pin body. The chain may be constructed by such a type that neither of the pin and the strip as pin member is press-fitted to the link plate and by a block-type having block members which sandwich laminated link plates.

Claims

1. A stress applying method for a power transmission chain **characterized by** steps of:

winding an endless loop chain around a plurality of main rollers, the chain being provided by interconnecting turnably a plurality of laminated link plates to one another through pin members; and
applying a stress to the chain by endlessly turning the chain while pressing an outer periphery of the chain with at least one auxiliary roller located between adjacent ones of the main rollers.

2. The stress applying method for the power transmission chain according to Claim 1, wherein a turning angle of the link plates in the chain endlessly turned is set to be in a range not less than -5% and not more than + 5% of a maximum turning angle in a service condition of the power transmission chain. 5
3. The stress applying method for the power transmission chain according to Claim 1 or Claim 2, wherein the endless loop chain is wound around three of the main rollers so as to form a polygonal shape. 10
4. A stress applying apparatus for the power transmission chain in which a stress is applied to an endless loop chain by endlessly turning the endless loop chain which is provided by interconnecting turnably a plurality of laminated link plates to one another through pin members, the stress applying apparatus comprising: 15
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an apparatus main body including a plurality of main rollers and at least one auxiliary roller located between adjacent ones of the main rollers such that the main rollers and the auxiliary roller are rotatably supported and that the main rollers are capable of being releasably in contact with one another and the auxiliary roller is movable so as to press an outer periphery of the chain would around the main rollers; and 25
a roller driving means which moves at least one of the main rollers and the auxiliary roller. 30

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FIG. 1

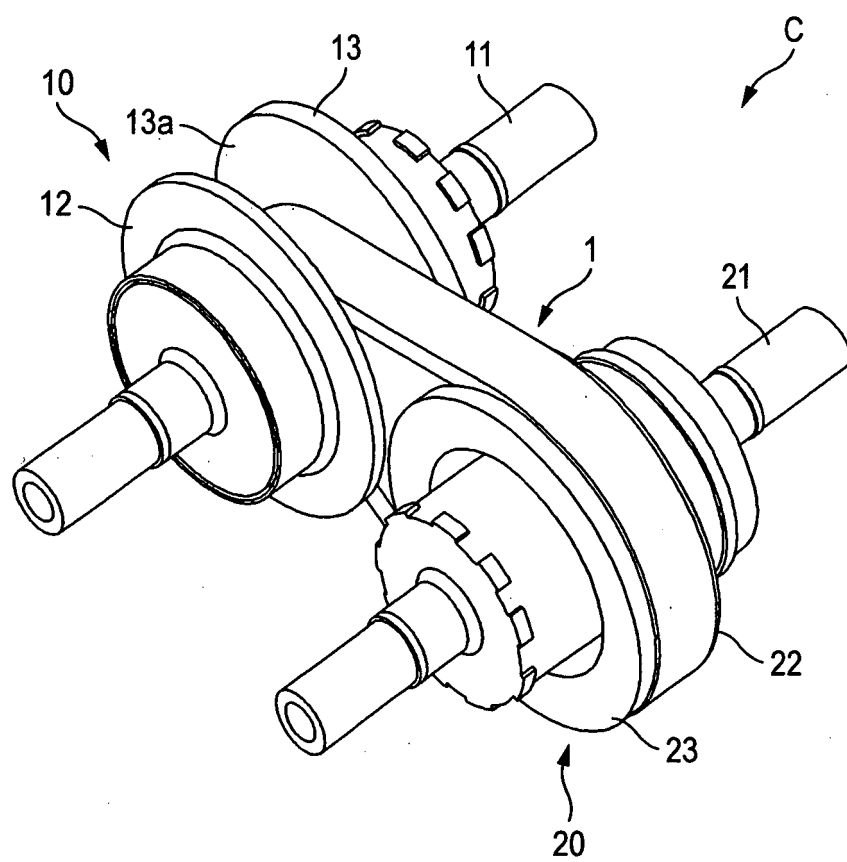


FIG. 2

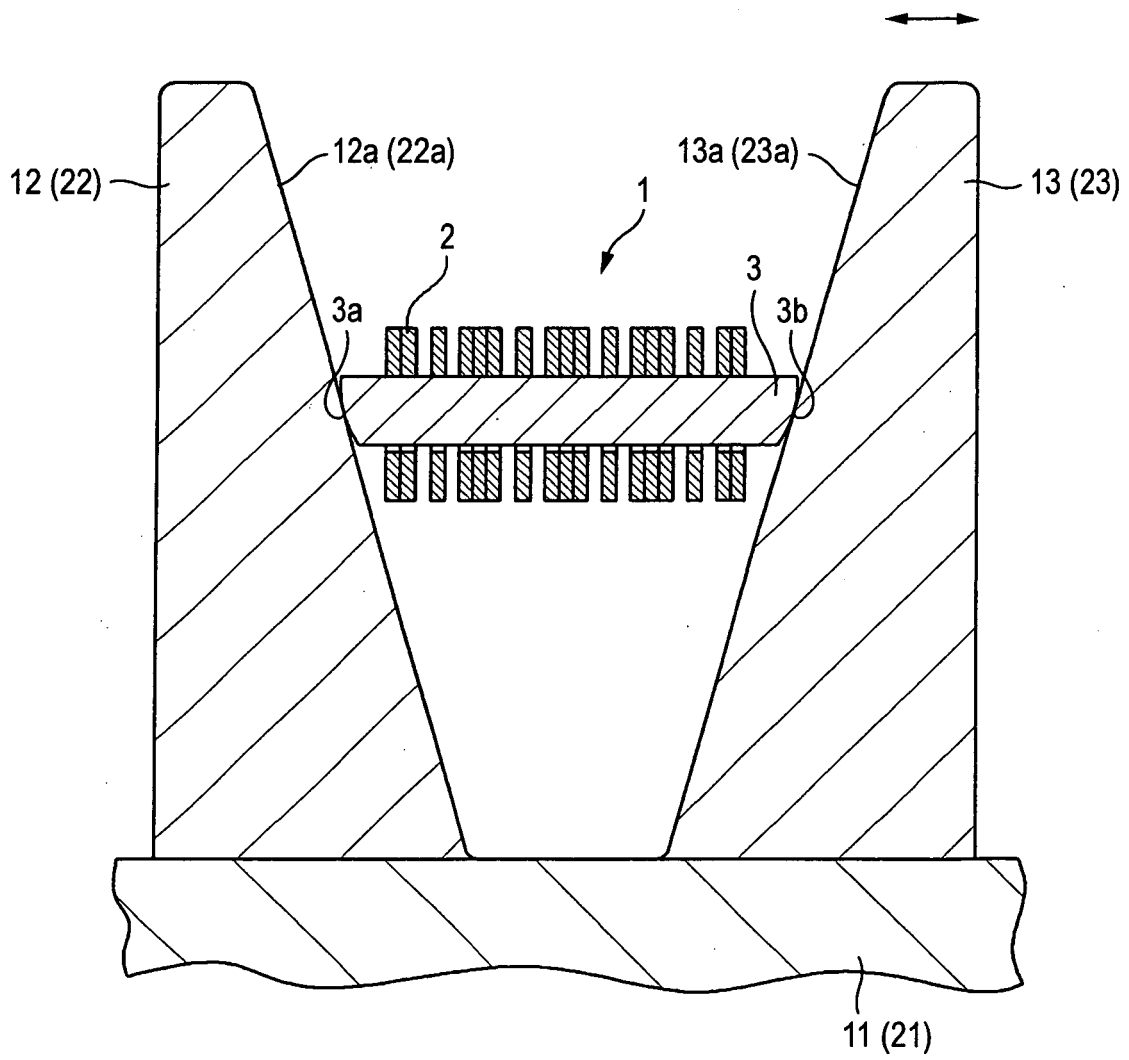


FIG. 3

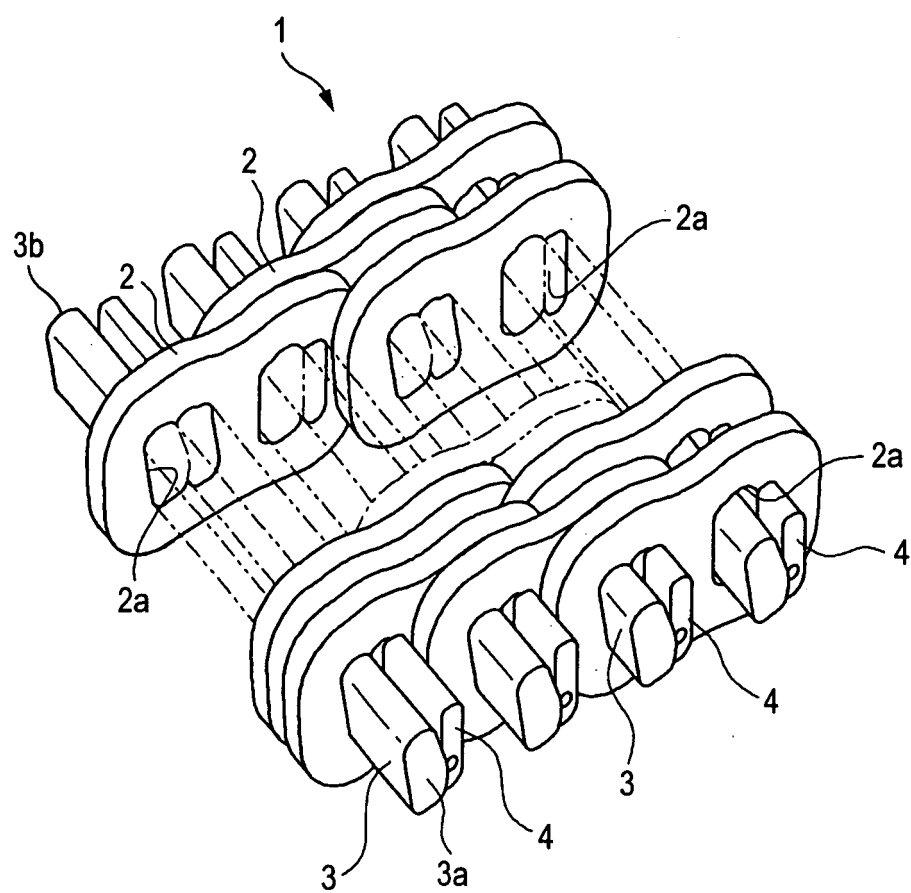


FIG. 4

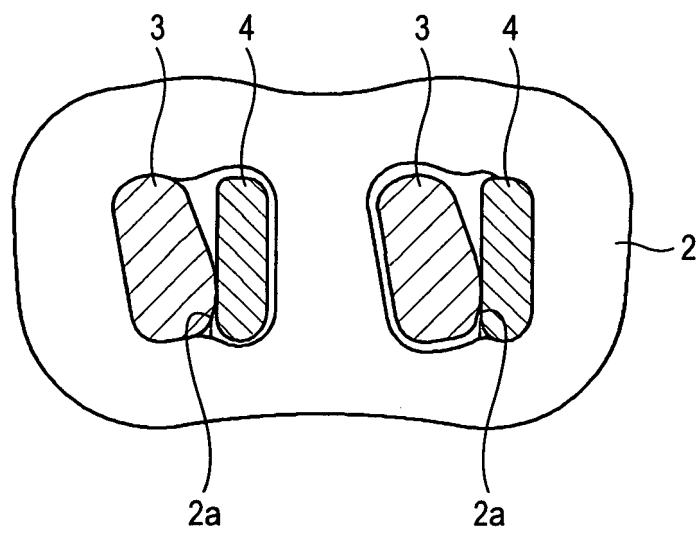


FIG. 5

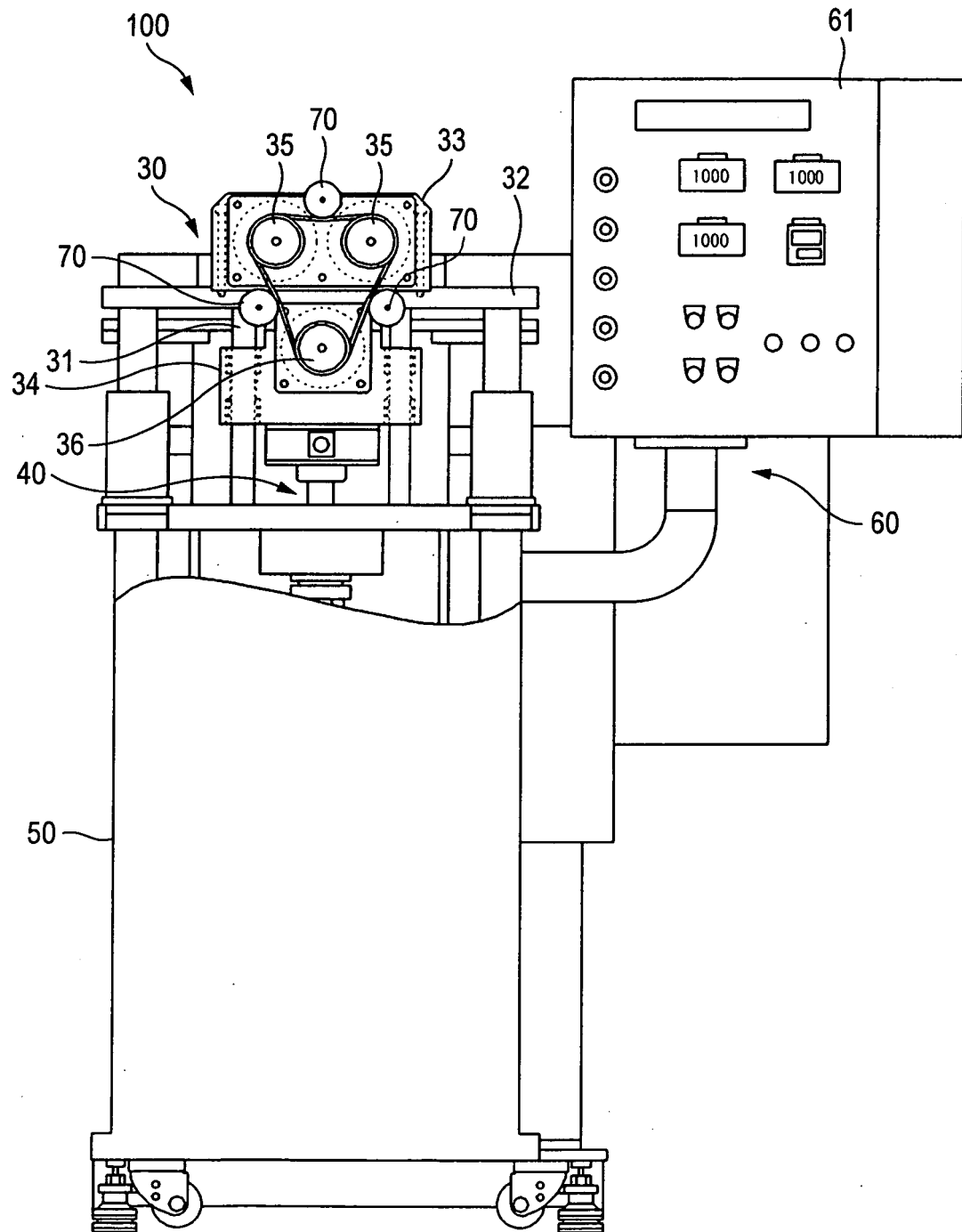


FIG. 6

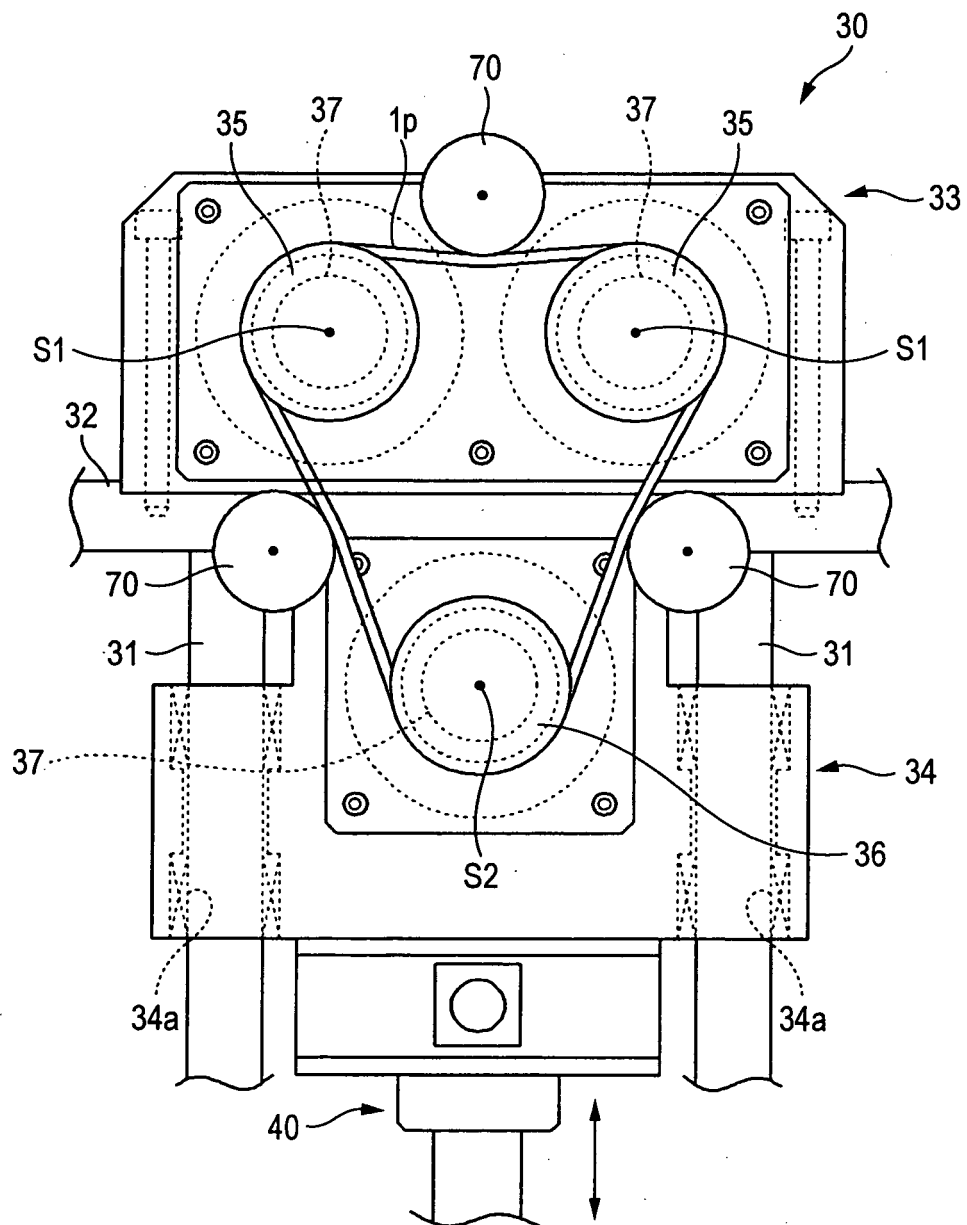


FIG. 7

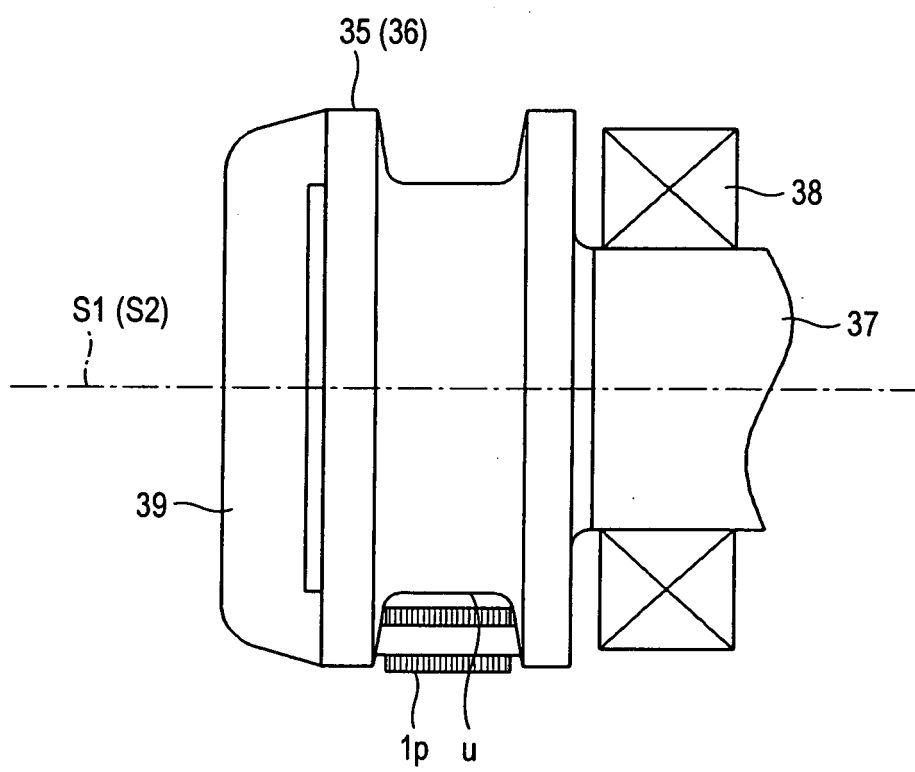
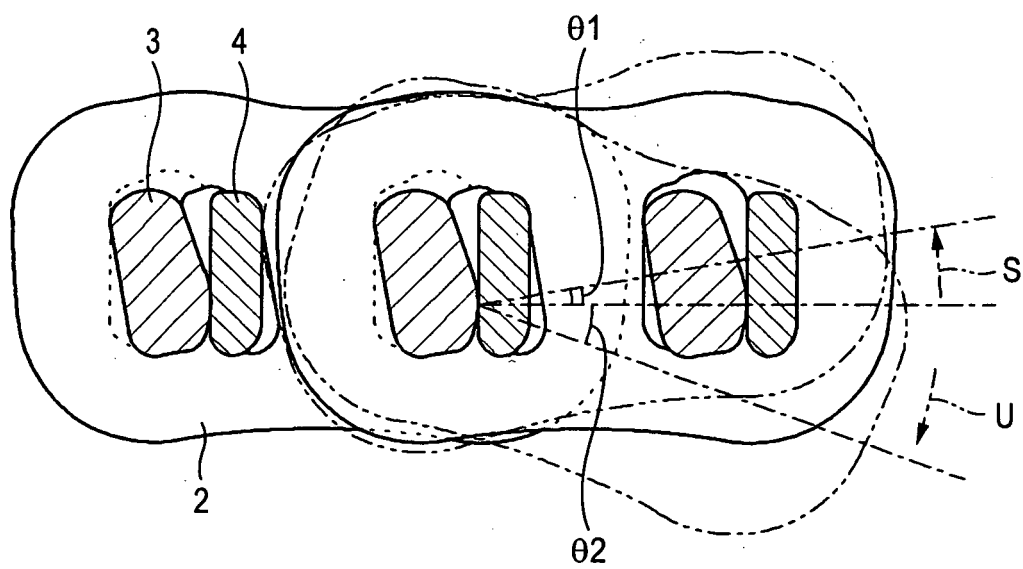


FIG. 8





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 02 3251

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 1 721 686 A (GEAR CHAIN IND BV [NL]) 15 November 2006 (2006-11-15) * paragraph [0025]; figure 1 *	1,4	INV. B21L15/00
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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			G01M F16G F16H B21L
Place of search		Date of completion of the search	Examiner
Munich		26 March 2008	Augé, Marc
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