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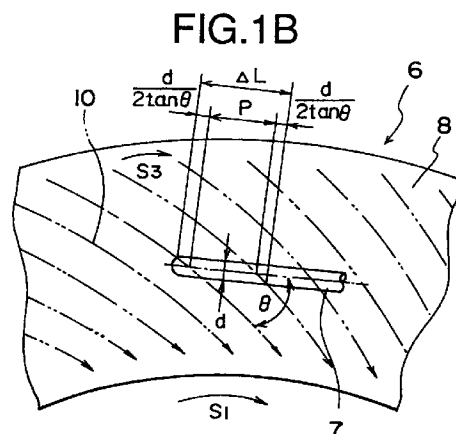
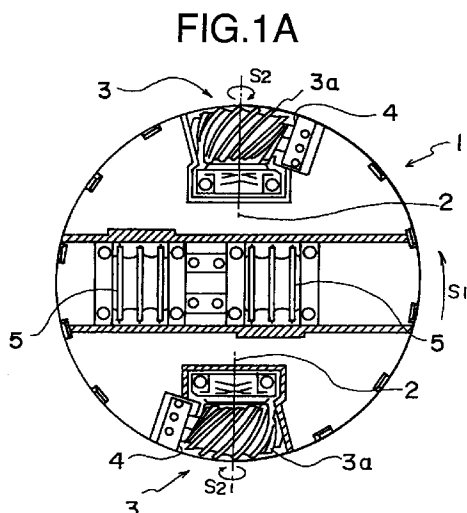
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(54) **SPIRAL-SHAPED ROLLER CUTTER AND TUNNEL EXCAVATOR CUTTER HEAD PROVIDED WITH SAME**

(57) A spiral-shaped roller cutter (3), which can efficiently and surely cut reinforcement (7) embedded in existing pipes (6), and a tunnel excavator cutter head (1) provided with the same. Thus the spiral-shaped roller cutter (3) is provided with a plurality of spiral-shaped blade portions (3a). Also, the cutter head (1) is provided with respective roller cutters (3, 3) which extend substantially radially of the cutter head and are rotatable about respective axes (2, 2) of rotation.



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Description

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention relates to a spiral-shaped roller cutter for cutting a reinforcement embedded in an existing pipe and a tunnel excavator cutter head provided with the same.

BACKGROUND ART

[0002] A conventional cutter head for excavating and crushing an existing pipe is disclosed, for example, in Japanese Unexamined Utility Model Publication No. 4-122798. In accordance with the publication, in Figs. 7A to 8C, a plurality of roller bits 74 to 76 supported in such a manner as to freely rotate around support axes O2 to O4 arranged in a periphery of an axis O1 of rotation of a cutter head 71 at a predetermined angle in a radial direction respectively are arranged on a front surface of the cutter head 71 of a shield excavator 61. That is, they are respectively constituted by a roller bit 74 of a vertical blade type on which blade portions 74b are respectively formed along a plurality of surfaces including the support axis O2, a roller bit 75 of a spiral blade type on which blade portions 75b are spirally formed around the support axis O3 and a roller bit 76 of a horizontal blade type on which circular blade portions 76b are formed at a predetermined interval in a direction of the support axis within a surface perpendicular to the support axis O4. Then, axial portions 74a to 76a of the plurality of roller bits 74 to 76 are rotatably supported to the cutter head 71 through bearings 77 and 77, respectively. An existing pipe 72 in Fig. 9 is constituted by a concrete pipe wall 72a, a vertical reinforcement 72b and a horizontal reinforcement 72c.

[0003] Here, an operation of the roller bit 76 of the horizontal blade type will be described below. In Figs. 10A to 10C, four paths 76c on the surface of the existing pipe 72 to be crushed by the roller bit 76 of the horizontal blade type is coaxial with respect to the center O1 of rotation of the cutter head 71. Accordingly, there is little possibility that the roller bit 76 of the horizontal blade type cuts the vertical reinforcement 72b bent in a direction the same as a rotating direction S1 of the cutter head 71, and this is provided simply in order to crush the concrete pipe wall 72a.

[0004] Next, an operation of the roller bit 74 of the vertical blade type will be described below. In Figs. 11A to 11C, a plurality of paths 74c on the surface to be crushed of the existing pipe 72 by the roller bit 74 of the vertical blade type is substantially perpendicular to the vertical reinforcement 72b bent in the same direction as the rotating direction S1 of the cutter head 71. Accordingly, the roller bit 74 of the vertical blade type can cut the vertical reinforcement 72b at the pitch interval of the blade portion 74b thereof.

[0005] Next, an operation of the roller bit 75 of the spi-

ral blade type will be described below with reference to Figs. 12A to 12B.

Since the roller bit 75 of the spiral blade type is structured such that a blade portion 75b is a spiral having a thread, paths 75c thereof (a two dot chain line) displaces an angle θ_1 from paths (a single dot chain line) along the rotating direction S1 of the cutter head 71, respectively. Accordingly, a vertical reinforcement 72b bent to the same direction as the rotating direction S1 of the cutter head 71 is changed a direction to a position shown by a broken line at a slight angle θ_2 , however, is not cut away. In this case, the disc cutter of the spiral blade type is also disclosed in Japanese Unexamined Utility Model Publication No. 1-138995 as another embodiment. In accordance with the publication, in Figs. 13A to 13B, in a small diameter pipe excavator in which a cutter head 53 having each of disc cutters 54 and 55 in a distal end portion of a leading apparatus 51 in a freely rotatable manner, spiral blades 54b and 55b each having a thread are projected from an outer peripheral surface of each of cutter main bodies 54a and 55a. These spiral blades 54b and 55b also serve the same function as that of the blade portion 75b of the roller bit 75 of the spiral blade type.

[0006] In this case,

- (1) The conventional roller bit 76 of the horizontal blade type is provided in order to crush the concrete pipe wall 72a, and hardly cuts the vertical reinforcement 72b.
- (2) Since the path 74c on the cutting surface of the conventional roller bit 74 of the vertical blade type is perpendicular to the vertical reinforcement 72b, it can cut the vertical reinforcement 72b to chips at an interval of the pitch of the roller bit 74 of the vertical blade type.

However, as shown in Fig. 11B, the vertical reinforcement 72b sinks into the concrete pipe 72a due to a pressing force F1 for pressing the blade tip 74b of the roller bit 74 of the vertical blade type, so that a sufficient reaction force can not be secured. Accordingly, there has been a problem that the vertical reinforcement 72b can not certainly cut by the roller bit 74 of the vertical blade type.

- (3) The conventional roller bit 75 of the spiral blade type can displace the vertical reinforcement 72b bent to the same direction as the rotating direction S1 of the cutter head 71 at a slight angle θ_2 , however, as shown in Fig. 12B, it is almost impossible to cut the vertical reinforcement 72b.

[0007] In this case, when the angle θ_1 is made large, the angle θ_2 is increased, so that it is easy to cut the vertical reinforcement 72b. However, since the pitch of the blade is increased when the pitch angle θ_1 is set to be large in the spiral blade having a single thread, there has been a problem that the vertical reinforcement 72b can not be cut to a suitable length.

DISCLOSURE OF THE INVENTION

[0008] The present invention is made in order to solve the problems in the above prior arts, and an object of the present invention is to provide a spiral-shaped roller cutter and a tunnel excavator cutter head provided with the same, which can efficiently and surely cut a reinforcement embedded in an existing pipe.

[0009] In accordance with a first invention of a spiral-shaped roller cutter in accordance with the present invention, there is provided a spiral-shaped roller cutter having a spiral-shaped blade portion on an outer peripheral surface, wherein the spiral-shaped blade portion is constituted by a plurality of threads.

[0010] Since the spiral-shaped blade portion is constituted by a plurality of threads, the spiral-shaped roller cutter having a great pitch angle and a narrow interval between the blades can be formed. Since the pitch of the blade is widened when increasing the pitch angle by the conventional spiral-shaped blade having a single thread, the interval between the blades is increased. Then, when setting to a plurality of threads, the interval between the blades can be set to be narrower than that of the single thread and in an optional manner even when the pitch angle is increased since it is produced by placing the other thread between one thread.

[0011] In accordance with a second invention of a spiral-shaped roller cutter, there is provided a spiral-shaped roller cutter as recited in the first invention, wherein the spiral-shaped blade portion is formed in a taper shape in a facewidth direction of a tooth.

[0012] In accordance with the structure, a tooth groove gradually becomes wide toward a large diameter side from a small diameter side. Accordingly, the crushed concrete can be easily discharged without stopping the blade groove.

[0013] In accordance with a third invention of a spiral-shaped roller cutter, there is provided a spiral-shaped roller cutter as recited in the first or second invention, wherein a pitch angle of the spiral-shaped blade portion having a plurality of threads is set to be 20 degrees to 80 degrees.

[0014] When the pitch angle is made great, the operation that the spiral-shaped roller cutter rolls on the cut surface of the reinforcement is reduced. On the contrary, when the pitch angle is made small, the path along which the spiral-shaped roller cutter rolls on the crush surface gets near a tangential direction of the rotation of the cutter head so as to make it hard to catch the reinforcement. Accordingly, when the pitch angle of the spiral-shaped blade portion is set to be 20 degrees to 80 degrees, the spiral-shaped roller cutter can easily catch the distal end portion of the reinforcement bent in the rotating direction of the cutter head, and the reinforcement caught by the spiral-shaped roller cutter can be easily cut due to the rolling operation of the spiral-shaped roller cutter. In this case, the pitch angle can be determined to an optimum value in accordance with the

object to be cut by changing the number of a plurality of threads.

[0015] In accordance with a first invention of a tunnel excavator cutter head, there is provided a tunnel excavator cutter head comprising a rotatable roller cutter mounted around an axis of rotation extending substantially to a radial direction of the cutter head, wherein the roller cutter is a spiral-shaped roller cutter provided with a spiral-shaped blade portion having a plurality of threads on an outer peripheral surface thereof.

[0016] In accordance with the structure mentioned above, since an angle (a pitch angle) formed between the axial direction of the reinforcement bent in the rotating direction of the cutter head and the spiral-shaped blade portion becomes great in an operation of crushing the concrete embedding the reinforcement by providing the spiral-shaped roller cutter having the spiral-shaped blade portion having a plurality of threads in the tunnel excavator cutter head, the reinforcement can be efficiently cut by a small pressing force due to a rolling operation of the spiral-shaped roller cutter. Further, since the interval between the blades is narrow, the reinforcement and the like can be finely crushed.

[0017] Further, the spiral-shaped roller cutter can easily catch the distal end portion of the reinforcement bent in the rotating direction of the cutter head by changing a number of the threads so as to select a magnitude of the pitch angle to an appropriate value in correspondence to the material to be cut, the reinforcement caught thereby can be easily cut due to a rolling operation of the spiral-shaped roller cutter, and the reinforcement can be shortened so that the length of the cut reinforcement becomes near the pitch length of the spiral-shaped blade portion.

[0018] Accordingly, there are significant effects mentioned below.

(1) The pressing force of the spiral-shaped roller cutter can be reduced by cutting the distal end portion of the reinforcement due to the rolling operation of the spiral-shaped roller cutter. The reinforcement can be surely cut without sinking in the concrete in the same manner as the roller bit of the vertical blade type in the second prior art.

(2) The distal end portion of the reinforcement exposed from the concrete is bent substantially in the rotating direction of the cutter head, however, the path along which the spiral-shaped blade portion of the spiral-shaped roller cutter rolls on the distal end portion of the reinforcement becomes short and the cut area of the reinforcement is reduced, so that the crushing force becomes small. Further, since the angle formed between the cut surface of the reinforcement and the axial direction of the reinforcement becomes near a right angle and the cut piece of the reinforcement is shortened. Accordingly, the cut piece can be easily conveyed in the same manner as normal excavated earth and sand

without being caught in the cutter head or a screw conveyor.

[0019] In accordance with a second invention of a tunnel excavator cutter head, there is provided a tunnel excavator cutter head as recited in the first invention, wherein the spiral-shaped roller cutter is constituted by two kinds of spiral-shaped roller cutters in which pitch angles of the spiral-shaped blade portion having a plurality of threads are mutually directed to inverted directions.

[0020] In accordance with the structure mentioned above, since the two kinds of spiral-shaped roller cutters in which the pitch angles are mutually directed to the inverted directions are mounted to the cutter head, the paths of the respective blade portions of the two kinds of spiral-shaped roller cutters on the crushed surface of the concrete pipe cross to each other, so that even when the reinforcement exposing from the crushed surface of the concrete pipe is bent to a direction of the blade groove of one of the spiral-shaped roller cutters, it can be cut by the other of the spiral-shaped roller cutters.

[0021] In accordance with a third invention of a tunnel excavator cutter head, there is provided a tunnel excavator cutter head as recited in the first invention, wherein the spiral-shaped roller cutter is provided with the spiral-shaped roller cutter provided with the spiral-shaped blade portion having a plurality of threads, and any one of a disc-shaped roller cutter having a disc-shaped blade portion perpendicular to the axis of rotation and a spiral-shaped roller cutter having a thread of spiral-shaped blade portion.

[0022] In accordance with the structure mentioned above, the reinforcement bent in the rotating direction of the cutter head by the spiral-shaped roller cutter having a plurality of threads can be efficiently cut by a small pressing force due to the rolling operation of the spiral-shaped roller cutter. At this time, even when there is a reinforcement bent in the direction of the blade groove of the spiral-shaped blade portion, the reinforcement can be efficiently cut by a small pressing force in the same manner as that of the spiral-shaped roller cutter having a plurality of threads due to the rolling operation of the disc-shaped roller cutter and the spiral-shaped roller cutter having a single thread.

[0023] In accordance with a fourth invention of a tunnel excavator cutter head, there is provided a tunnel excavator cutter head as recited in the third invention, wherein a cutting surface of the spiral-shaped roller cutter provided with the spiral-shaped blade portion having a plurality of threads and a cutting surface of any one of the disc-shaped roller cutter and the spiral-shaped roller cutter having a thread of spiral-shaped blade portion are disposed so as to be shifted at a predetermined amount in a direction of excavating a tunnel.

[0024] In accordance with the structure mentioned above, the concrete portion can be crushed by the roller

cutter suitable for each of the steps and subsequently the reinforcement is cut by the cutting surface of the other kind of roller cutter provided a predetermined amount at the back thereof. As mentioned above, since the roller cutters respectively suitable for crushing the concrete and cutting the reinforcement can be determined, a durability of each of the roller cutters can be improved.

[0025] In accordance with an fifth invention of a tunnel excavator cutter head, there is provided a tunnel excavator cutter head as recited in any one of the first, second, third and fourth inventions, wherein the cutter head is structured such as to rotate in a direction that an angle formed between a crush surface of a existing pipe and a hoop reinforcement within a non-crushed portion rotates from an acute angle to an obtuse angle when crushing the existing pipe in which the hoop reinforcement is embedded.

[0026] In accordance with the structure mentioned above, since the hoop reinforcement can be surely cut without being caught in the cutter head, a cutting efficiency of the hoop reinforcement can be improved. Further, since the hoop reinforcement is cut to a short piece, it can be efficiently conveyed in the same manner as normal excavated earth and sand without being caught in the cutter head or the screw conveyor.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027]

Fig. 1A is a front elevational view of a tunnel excavator cutter head in accordance with a first embodiment of the present invention and Fig. 1B is a schematic view which explains a crushing operation on a crushed surface of an existing pipe by the cutter head in Fig. 1A;

Fig. 2A is an enlarged front elevational view of a spiral-shaped roller cutter in Fig. 1A, Fig. 2B is a side elevational view of Fig. 2A and Fig. 2C is a perspective view of Fig. 2A;

Fig. 3A is a schematic view which explains a rolling and cutting operation by the spiral-shaped roller cutter in Fig. 1A and Fig. 3B is a schematic view which explains a crushing operation of a cutter head in which each of distal end position of outer peripheral portions of two kinds of roller cutters is different from each other;

Fig. 4A is a front elevational view of a tunnel excavator cutter head in accordance with a second embodiment of the present invention and Fig. 4B is a schematic view which explains an operation on a crushed surface of an existing pipe by the cutter head in Fig. 4A;

Fig. 5A is a front elevational view of a tunnel excavator cutter head in accordance with a third embodiment of the present invention and Fig. 5B is a schematic view which explains a crushing operation

on a crushed surface of an existing pipe by the cutter head in Fig. 5A;

Fig. 6A is a perspective view of a concrete existing pipe embedding a hoop reinforcement therein which is crushed by the cutter head in accordance with the first, second or third embodiment and Fig. 6B is an enlarged view of a P portion in Fig. 6A as seen from an arrow V;

Fig. 7A is a vertical cross sectional view of a shield excavator in accordance with a prior art and Fig. 7B is a front elevational view of a cutter head in Fig. 7A; Fig. 8A is a mounting view of a roller bit of a spiral blade type mounted to the cutter head in Fig. 7A, Fig. 8B is a mounting view of a roller bit of a horizontal blade type and Fig. 8C is a mounting view of a roller bit of a vertical blade type;

Fig. 9 is a perspective view of a concrete existing pipe embedding a reinforcement in vertical and horizontal directions;

Fig. 10A is a schematic view which explains an operation of the roller bit of the horizontal blade type on the crush surface of the existing pipe, Fig. 10B is a cross sectional view along a line B-B in Fig. 10A and Fig. 10C is a cross sectional view along a line C-C in Fig. 10A;

Fig. 11A is a schematic view which explains an operation of the roller bit of the vertical blade type on the crush surface of the existing pipe, Fig. 11B is a cross sectional view along a line B-B in Fig. 11A and Fig. 11C is a cross sectional view along a line C-C in Fig. 11A;

Fig. 12A is a schematic view which explains an operation of the roller bit of the spiral blade type on the crush surface of the existing pipe, Fig. 12B is a cross sectional view along a line B-B in Fig. 12A; and

Fig. 13A is a vertical cross sectional view a shield excavator in accordance with another prior art and Fig. 13B is a front elevational view of the cutter head in Fig. 13A.

BEST MODE FOR CARRYING OUT THE INVENTION

[0028] A tunnel excavator cutter head in accordance with a first embodiment of the present invention will be in detail described below with reference to Figs. 1A to 3B.

[0029] A tunnel excavator cutter head 1 has axes 2 and 2 respectively in a diametrical direction of the cutter head 1 and near an outer peripheral surface as shown in Fig. 1A, and spiral-shaped roller cutters 3 and 3 having a spiral-shaped blade portion 3a having a plurality of threads formed thereon are respectively mounted to the respective axes 2 and 2 of rotation so as to be freely rotated. Each of cutter bits 4 and 4 is fixed to an edge portion of a mounting hole of each of the spiral-shaped roller cutters 3 and 3 toward a rotational direction S1 of the cutter head 1. In detail, the spiral-shaped roller cut-

ter 3 is provided with the spiral-shaped blade portion 3a having a plurality of threads, as shown in Figs. 2A to 2C. The spiral-shaped blade portion 3a having a plurality of threads is formed in a taper shape and a pitch angle θ thereof is, for example, 45 degrees.

[0030] Each of normal disc cutters 5 and 5 are rotatably mounted in a diametrical direction perpendicular to the axes 2 and 2 of rotation of each of the spiral-shaped roller cutters 3 and 3.

[0031] Next, a crushing operation of an existing pipe 6 in accordance with this embodiment will be described below.

[0032] When the cutter head 1 rotates in a direction of an arrow S1 in Fig. 1A, each of the spiral-shaped roller cutters 3 and 3 is pressed to a crushed surface of the existing pipe 6 and is rotated in a direction of an arrow S2.

[0033] Fig. 1B shows a part of the crushed surface of the existing pipe 6 as seen toward an excavating direction of the tunnel excavator, in which a lateral direction is inverted to the case of Fig. 1A. A front end portion of a reinforcement 7 embedded in the existing pipe 6 projects from the crushed surface of a concrete portion 8 in the existing pipe 6, however, is bent in the S1 direction corresponding to a rotating direction of the cutter head 1 by the cutter head 1.

[0034] Then, since a path 10 of a spiral-shaped blade portion 3a of each of the spiral-shaped roller cutter 3 rotated by a rotation of the cutter head 1 on the crushed surface moves in a direction of an arrow S3 while moving to an inner peripheral direction of the existing pipe 6, as shown by a two dot chain line in Fig. 1B, a distal end of the reinforcement 7 is cut to a length of ΔL by the path 10. In this case, when a pitch of the path 10 along an axial direction of the reinforcement is set to be p, an angle (corresponding to a pitch angle) formed between a rotational tangent of the cutter head 1 and the path 10 of the spiral-shaped blade portion 3 is set to be θ and a diameter of the reinforcement is set to be d, a length ΔL of the cut reinforcement 7 is expressed by the following formula.

$$\Delta L = p + (d/2 \tan \theta) \times 2$$

[0035] Accordingly, the length ΔL of the reinforcement 7 becomes $(d/\tan \theta)$ longer than the pitch p of the path 10 of the spiral-shaped blade portion 3a.

[0036] In this case, when the pitch angle θ of the path 10 is set to be 90 degrees, $\Delta L = p$ is established, which is shortest, and this corresponds to the roller bit 74 of the vertical blade type in accordance with the prior art, so that the effect due to the rolling cut by the spiral-shaped roller cutter 3 can not be obtained.

[0037] That is, when a pitch angle θ of the path 10 (which is equal to the pitch angle of the spiral-shaped blade portion 3a if no slip is present between the spiral-shaped blade portion 3a and the crushed surface of the existing pipe 6) is set to be great, it gets near the roller

bit 74 of the vertical blade type in accordance with the prior art and an operation of rolling on the cut surface of the reinforcement 7 is reduced. On the contrary, when the pitch angle θ of the path 10 is set to be small, it gets near the roller bit 76 of the horizontal blade type in accordance with the prior art, and the path 10 gets near the tangential direction S1 of the rotation of the cutter head 1, so that it is hard to catch the reinforcement 7. Even if the reinforcement 7 can be caught, the cut reinforcement 7 is long since the angle formed between the axis of the reinforcement 7 and the cut surface is small, so that the reinforcement 7 is easily caught in the cutter head 1, the screw conveyor or the like.

[0038] Then, an appropriate pitch angle θ is selected in accordance with the object to be cut among a range of 20 degrees to 80 degrees, however, an angle of 45 degrees ($\Delta L = p + d$) corresponding to a middle value is a standard for selection.

[0039] Next, a case of cutting the distal end portion of the reinforcement 7 bent in the rotating direction S1 of the cutter head 1 by a disc cutter 9 corresponding to a pitch of a plurality of spiral-shaped blade portion 3a shown in Figs. 2A to 2C will be described below with reference to Fig 3A.

[0040] The distal end portion of the reinforcement 7 bent in the same direction as the rotating direction S1 of the cutter head 1 is pressed to the crushed surface of the concrete portion 8 due to a pressing force F by a blade portion 9a of the disc cutter 9 rotating in the S2 direction so as to be cut. As mentioned above, since the disc cutter 9 is pressed to the distal end portion of the reinforcement 7 while rotating, the reinforcement 7 is significantly easily cut in comparison with the case that the disc cutter 9 is simply pressed to the distal end portion of the reinforcement 7. Accordingly, the distal end portion of the reinforcement 7 can be surely cut without entering into the concrete portion 8 by making the pressing force F small.

[0041] Further, a case that a front end position of an outer peripheral portion of the spiral-shaped roller cutter 3 provided with the spiral-shaped blade portion 3a having a plurality of threads corresponding to a specific roller cutter crushes the existing pipe 72 shown in Fig. 9 by a cutter head which is placed a predetermined distance L1 rearward from a front end position of an outer peripheral portion of a disc-shaped roller cutter 12 having the disc-shaped blade portion corresponding to the other kind of roller cutter will be described below with reference to Fig. 3B.

[0042] When crushing the existing pipe 72, the concrete portion 72a is first crushed by the disc-shaped roller cutter 12 since the disc-shaped roller cutter 12 is placed L1 forward from the spiral-shaped roller cutter 3, so that a plurality of vertical reinforcements 72b are exposed from the crushed surface thereof. The vertical reinforcements 72b are cut by the spiral-shaped roller cutter 3 after being bent in the rotational direction thereof by the cutter head 1. As mentioned above, since

the concrete portion 72a can be crushed by the disc-shaped roller cutter 12 and a plurality of vertical reinforcements 72b can be cut by the spiral-shaped roller cutter 3, respectively in an exclusive manner, each of the roller cutters 3 and 12 can be efficiently used.

[0043] Next, a second embodiment in accordance with the present invention will be described below with reference to Figs. 4A and 4B.

[0044] The cutter head 1a in accordance with this embodiment is rotatably mounted by replacing one of two spiral-shaped roller cutters 3 and 3 shown in Fig. 1A by a spiral-shaped roller cutter 23 having an inverse pitch angle. Since the structure is the same as that of the first embodiment except this, the detailed description will be omitted.

[0045] An operation of this embodiment will be described below only in view of the operation different from that of the first embodiment.

[0046] When a cutter head 1a rotates in a direction of an arrow S1, the spiral-shaped roller cutter 23 is rotated in a direction of an arrow S2a since it is pressed to a crushed surface. Accordingly, as shown by a rightward ascending two dot chain line in Fig. 4B, the concrete portion 8 is crushed by a path 10a of a blade portion of the spiral-shaped roller cutter 23 rotated by a rotation of the cutter head 1a on the crushed surface. The distal end portion of the reinforcement 7 projecting from the crushed surface of the crushed concrete portion 8 is cut by the spiral-shaped roller cutter 23 after being bent in the rotational direction S1 of the cutter head 1a.

[0047] Further, since the other spiral-shaped roller cutter 3 is also pressed to the crushed surface, it is rotated in the S2 direction. Accordingly, since the path 10 becomes the same as the path 10 of the blade portion shown by the two dot chain line in Fig. 1B, the distal end portion of the reinforcement 7 projecting from the crushed surface of the crushed concrete portion 8 is finely cut by the spiral-shaped roller cutter 3 and the spiral-shaped roller cutter 23 after being bent in the rotational direction S2 of the cutter head 1a.

[0048] Next, a third embodiment in accordance with the present invention will be described below with reference to Figs. 5A and 5B.

[0049] The cutter head 1b in accordance with this embodiment is rotatably mounted to the cutter head 1b by replacing one of two spiral-shaped roller cutters 3 and 3 shown in Fig. 1A by a known disc-shaped roller cutter 12. Since the structure is the same as that of the first embodiment except this, the detailed description will be omitted.

[0050] An operation of this embodiment will be also described below only in view of the operation different from that of the first embodiment.

[0051] When the cutter head 1b rotates in a direction of an arrow S1, the disc-shaped roller cutter 12 is rotated in a direction of an arrow S4 since it is pressed to a crushed surface. Accordingly, as shown by a two dot chain line in Fig. 5B, the concrete portion 8 is

crushed by paths 11 of four blade portions of the disc-shaped roller cutter 12 rotated by a rotation of the cutter head 1b on the crushed surface. The distal end portion of the reinforcement 7 projecting from the crushed surface of the crushed concrete portion 8 is bent in the rotational direction S1 of the cutter head 1b. As mentioned above, when the concrete portion 8 is crushed by the disc-shaped roller cutter 12, the other spiral-shaped roller cutter 3 is reduced in a load for crushing the concrete portion 8, so that a cutting performance of the reinforcement 7 and a durability of the spiral-shaped roller cutter 3 are widely improved.

[0052] Further, when the crushing surface of the disc-shaped roller cutter 12 is placed so as to be a predetermined amount forward from the cutting surface of the spiral-shaped roller cutter, the concrete portion 8 can be surely crushed by the disc-shaped roller cutter 12, so that a load of the spiral-shaped roller cutter 3 is further reduced, whereby the performances mentioned above are further improved.

[0053] Next, as shown in Fig. 6A, a crushing and cutting operation of an existing pipe 6a in which a plurality of vertical reinforcements 13 and a spiral-shaped hoop reinforcement 7 corresponding to the horizontal reinforcement are embedded in a concrete portion 8a will be described below.

[0054] When the existing pipe 6a is excavated by the cutter head 1, 1a or 1b mentioned above, a distal end portion of the hoop reinforcement 7a is projected from a crushed surface 8b in a state of being inclined to a surface 8b to be crushed of the concrete portion 8a since the horizontal reinforcement is the hoop reinforcement 7a. In this case, when rotating the cutter head 1, 1a or 1b in a direction that an angle formed between the crush surface 8b of the existing pipe 6a and the hoop reinforcement 7b within the concrete portion 8a corresponding to a non-crushed portion changes to an acute angle α from an obtuse angle β as shown in Fig. 6B, that is, a direction of an arrow X, it rotates toward a root portion from the distal end of the hoop reinforcement 7a, so that the hoop reinforcement 7a is caught in the cutter head 1. Accordingly, the concrete portion 8a in the root portion of the hoop reinforcement 7a on the crushed surface 8b is broken and a sufficient reacting force against the pressing force by each of the roller cutters 3, 23 and 12 mounted in the cutter head 1 can not be secured. As a result of this, the pressing force of each of the roller cutters 3, 23 and 12 is reduced, so that the hoop reinforcement 7a can not be surely cut.

[0055] In this case, when rotating the cutter head 1, 1a or 1b from an inverted direction of an arrow Y, the cutter head rotates toward the distal end from the root portion of the hoop reinforcement 7a, so that the hoop reinforcement 7a is not caught in the cutter head 1, 1a or 1b. Accordingly, the concrete portion 8a in the root portion of the hoop reinforcement 7a on the crushed surface 8b is not broken, and the pressing force of each of the roller cutters 3, 23 and 12 is increased. As a result of this, the

hoop reinforcement can be surely cut. In this case, since a cutting of a plurality of vertical reinforcement 13 is performed by the same manner as that of the prior art, the description thereof will be omitted.

INDUSTRIAL APPLICABILITY

[0056] The present invention is useful for a spiral-shaped roller cutter and a tunnel excavator cutter head provided with the same, which can efficiently and surely cut a reinforcement embedded in an existing pipe.

Claims

1. A spiral-shaped roller cutter (3) having a spiral-shaped blade portion on an outer peripheral surface, wherein said spiral-shaped blade portion (3a) is constituted by a plurality of threads.
2. A spiral-shaped roller cutter as claimed in claim 1, wherein said spiral-shaped blade portion (3a) is formed in a taper shape in a facewidth direction of a tooth.
3. A spiral-shaped roller cutter as claimed in claim 1 or 2, wherein a pitch angle of said spiral-shaped blade portion (3a) having a plurality of threads is set to be 20 degrees to 80 degrees.
4. A tunnel excavator cutter head comprising a rotatable roller cutter mounted around an axis of rotation extending substantially to a radial direction of the cutter head (1), wherein said roller cutter is a spiral-shaped roller cutter (3) provided with a spiral-shaped blade portion (3a) having a plurality of threads on an outer peripheral surface thereof.
5. A tunnel excavator cutter head as claimed in claim 4, wherein said spiral-shaped roller cutter (3) is constituted by two kinds of spiral-shaped roller cutters (3, 23) in which pitch angles of said spiral-shaped blade portion (3a) having a plurality of threads are mutually directed to inverted directions.
6. A tunnel excavator cutter head as claimed in claim 4, wherein said spiral-shaped roller cutter (3) is provided with the spiral-shaped roller cutter provided with said spiral-shaped blade portion (3a) having a plurality of threads, and any one of a disc-shaped roller cutter (12) having a disc-shaped blade portion perpendicular to said axis of rotation and a spiral-shaped roller cutter having a thread of spiral-shaped blade portion.
7. A tunnel excavator cutter head as claimed in claim 6, wherein a cutting surface of the spiral-shaped roller cutter (3) provided with said spiral-shaped blade portion (3a) having a plurality of threads and

a cutting surface of any one of said disc-shaped roller cutter (12) and the spiral-shaped roller cutter having a thread of spiral-shaped blade portion are disposed so as to be shifted at a predetermined amount in a direction of excavating a tunnel.

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8. A tunnel excavator cutter head as claimed in claim 4, 5, 6 or 7, wherein said cutter head (1) is structured such as to rotate in a direction that an angle formed between a crush surface (8b) of a existing pipe and a hoop reinforcement (7b) within a non-crushed portion (8a) rotates from an acute angle to an obtuse angle when crushing the existing pipe in which the hoop reinforcement is embedded.

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FIG.1A

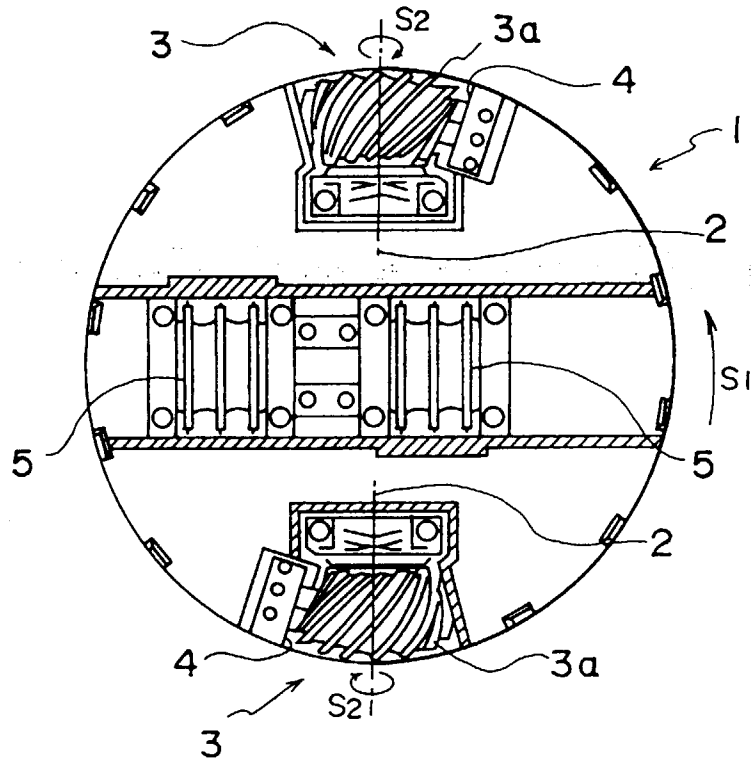


FIG.1B

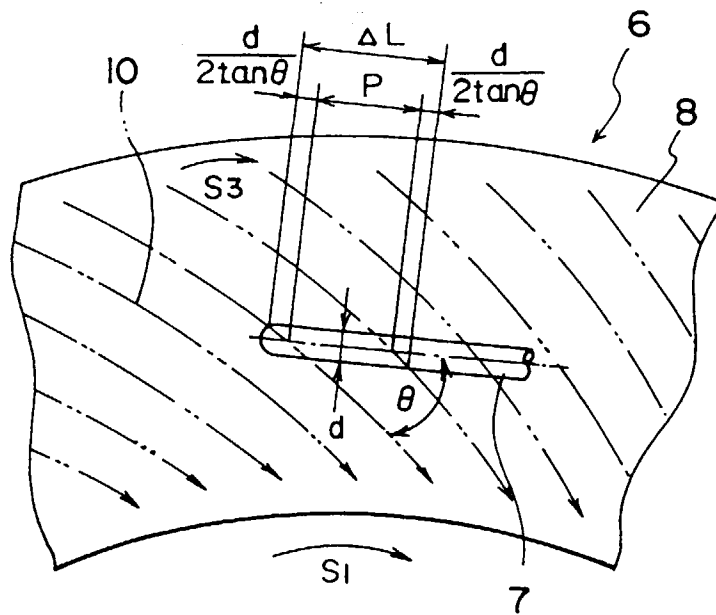


FIG.2A

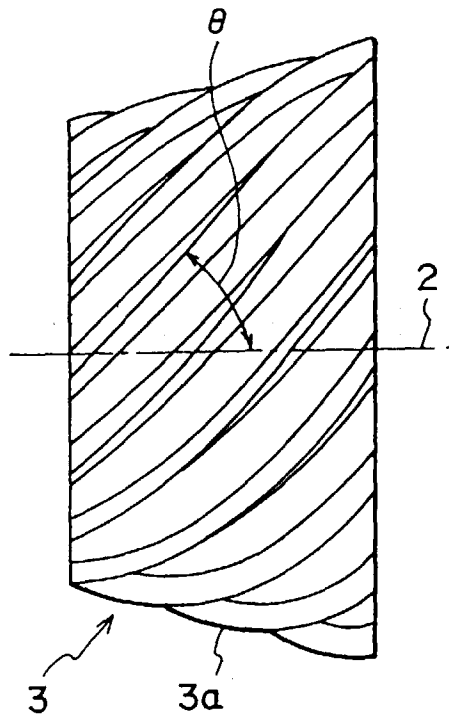


FIG.2B

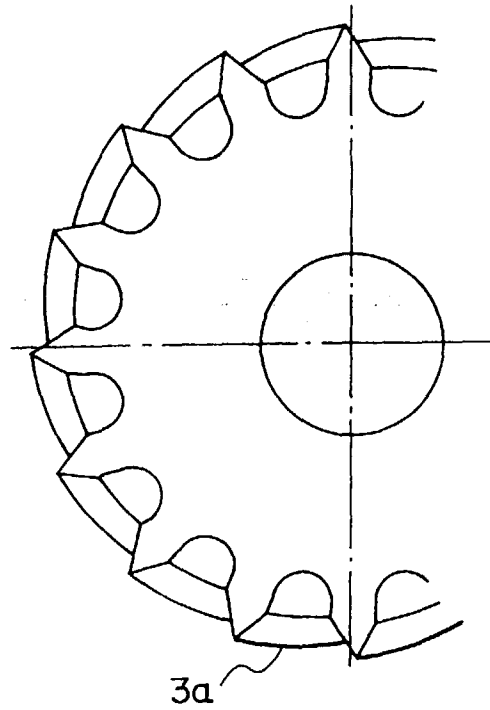


FIG.2C

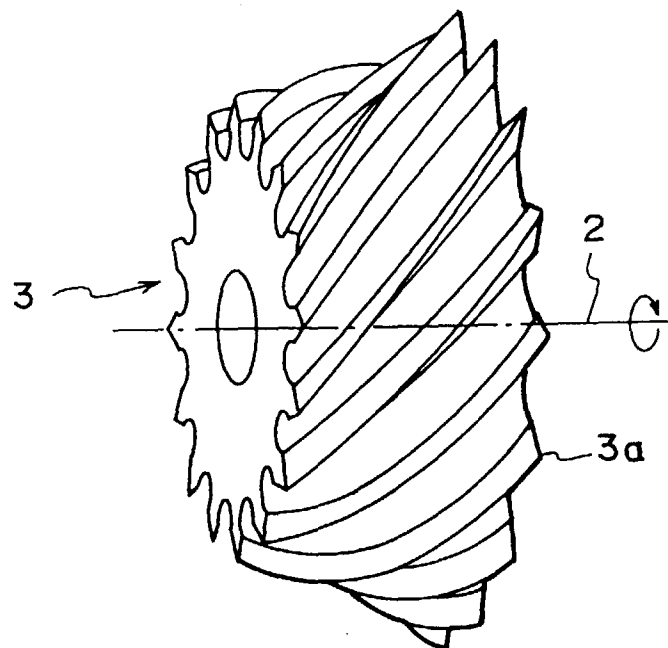


FIG.3A

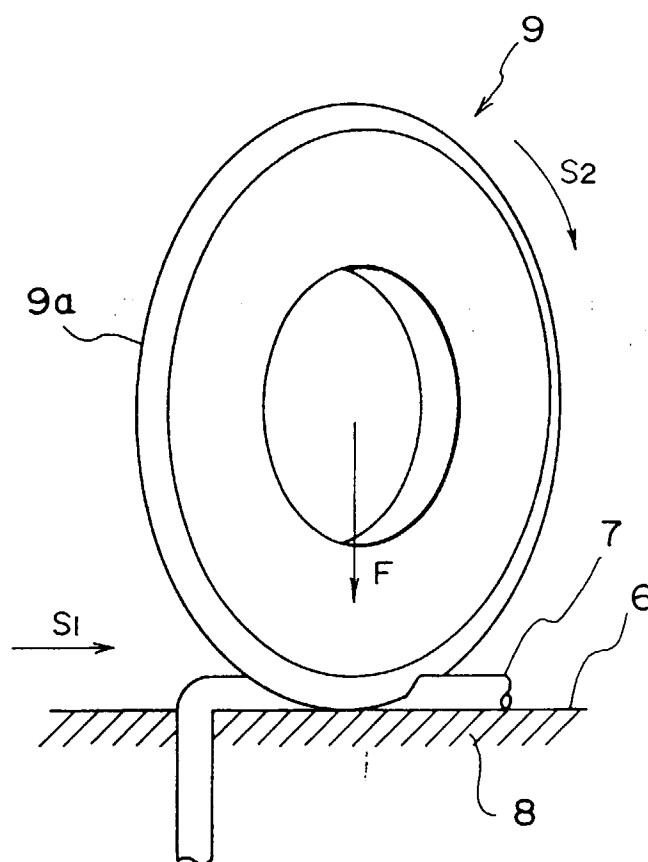


FIG.3B

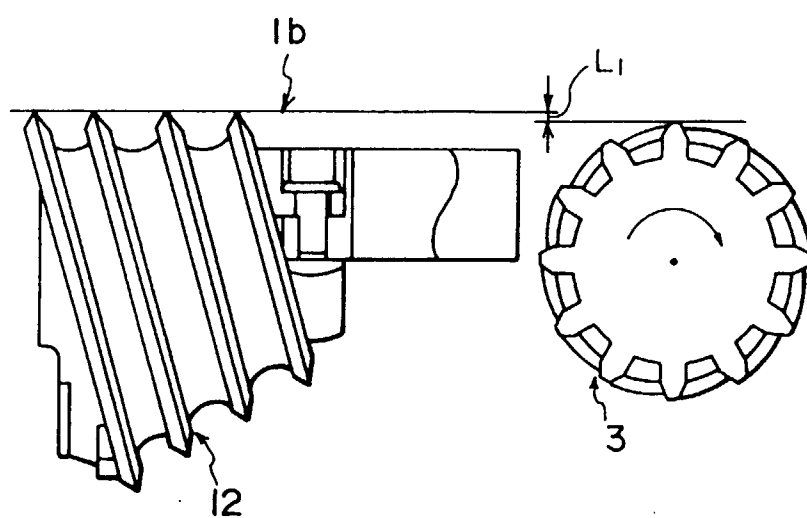


FIG.4A

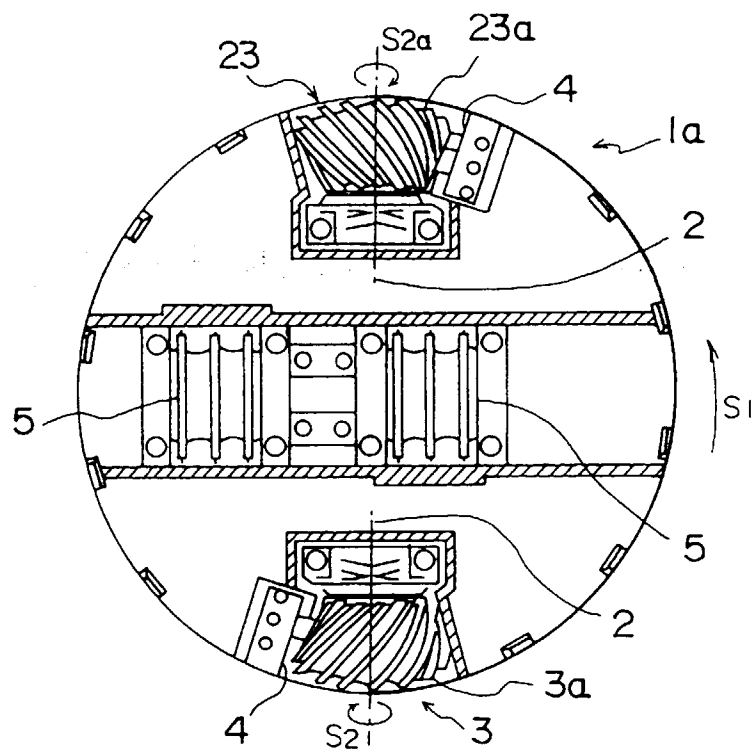


FIG.4B

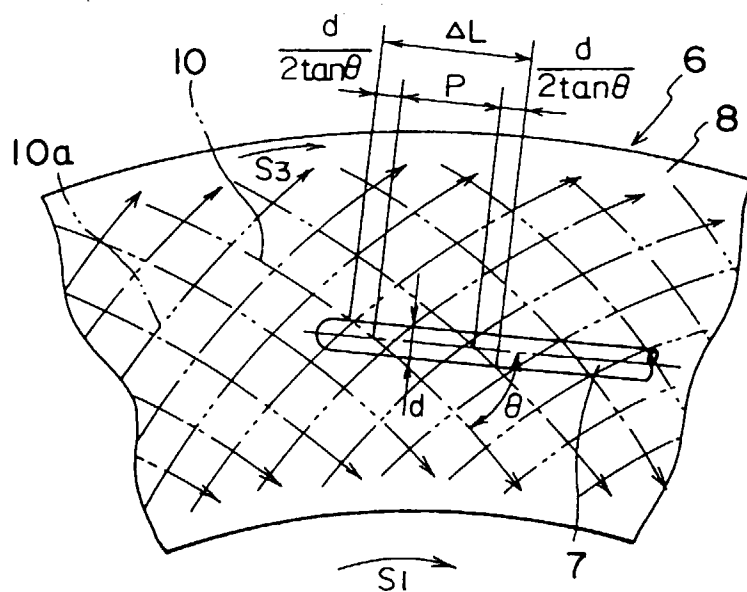


FIG.5A

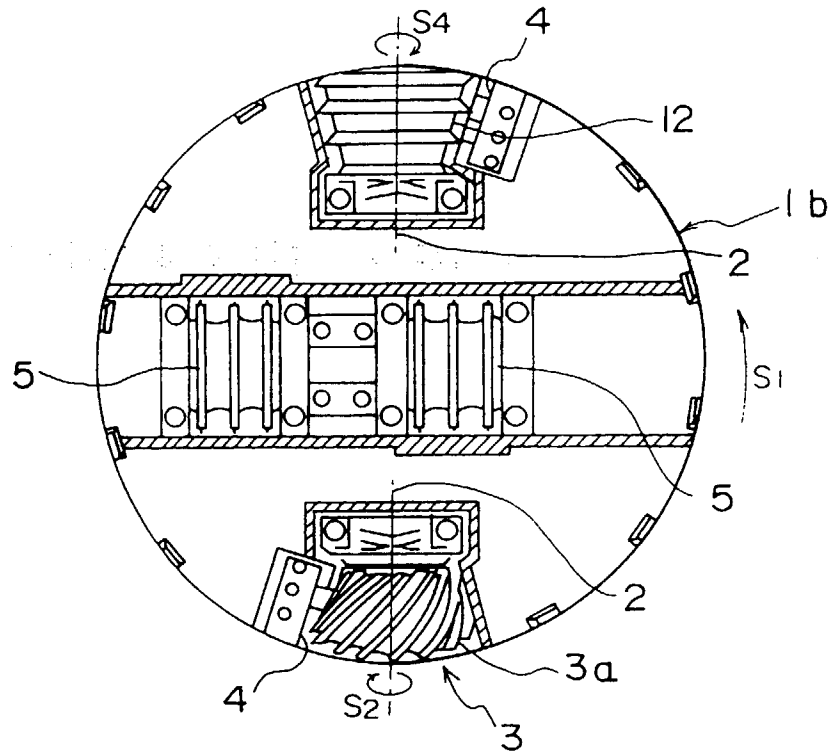


FIG.5B

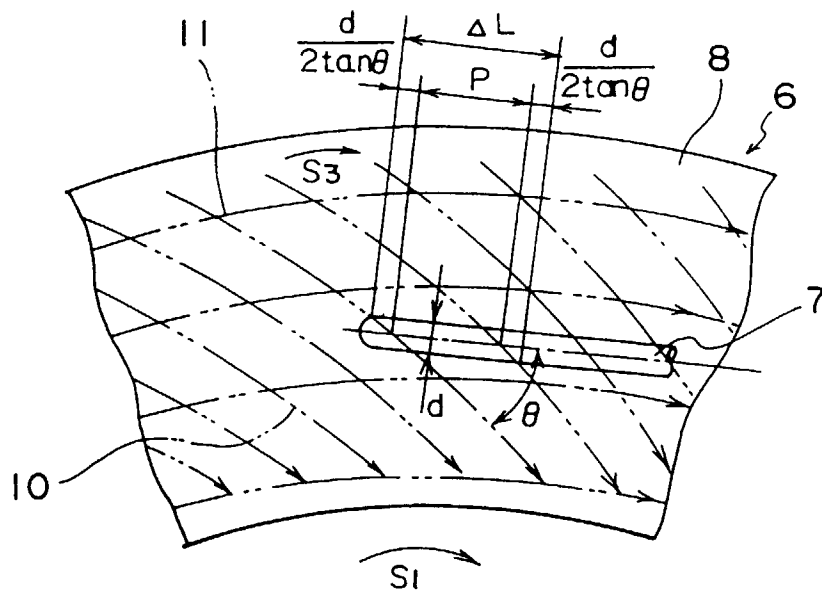


FIG.6A

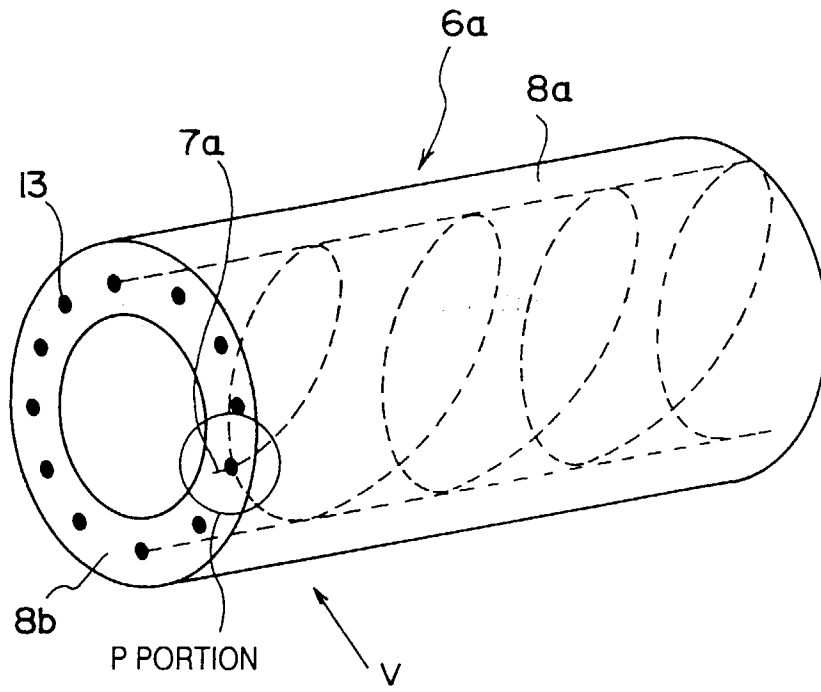


FIG.6B

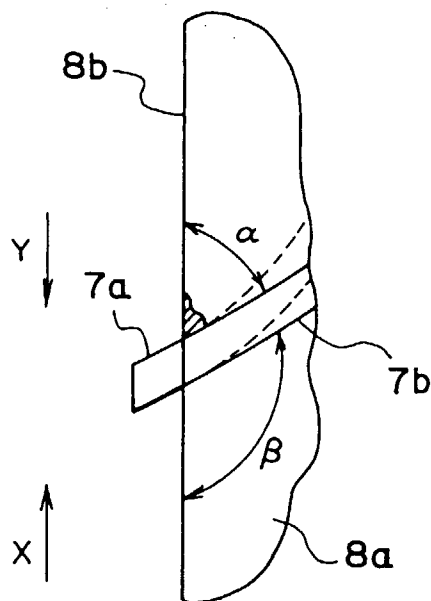


FIG.7A PRIOR ART

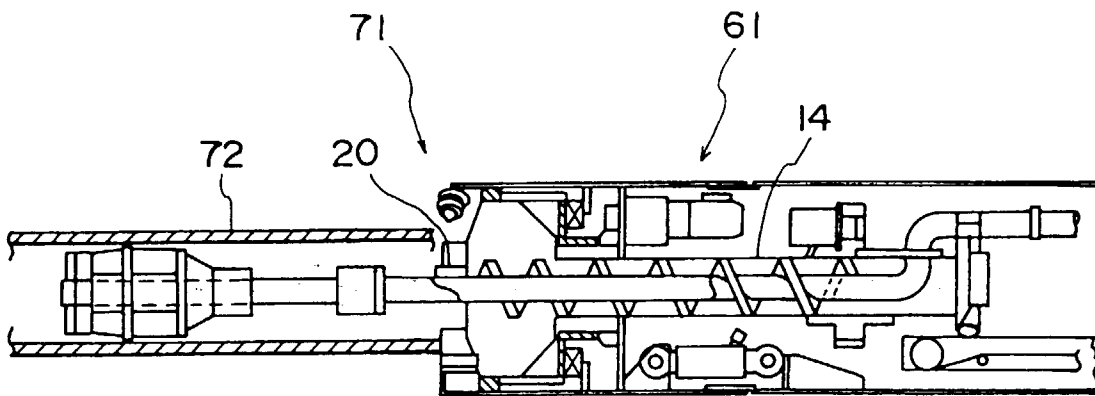


FIG.7B PRIOR ART

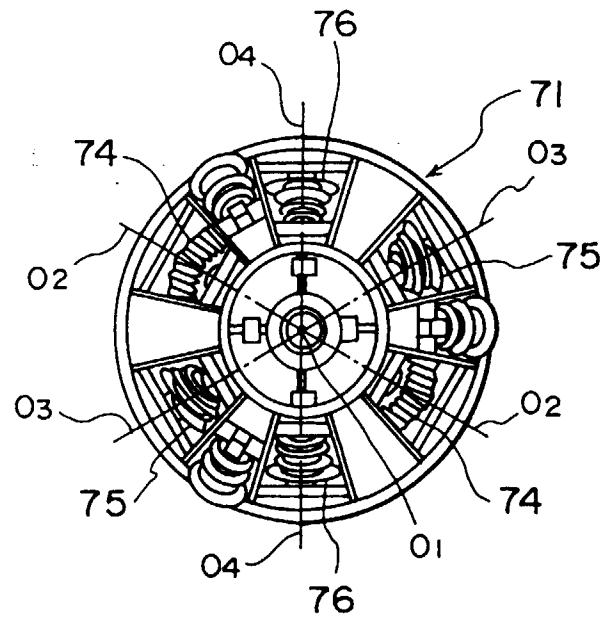


FIG.8A PRIOR ART

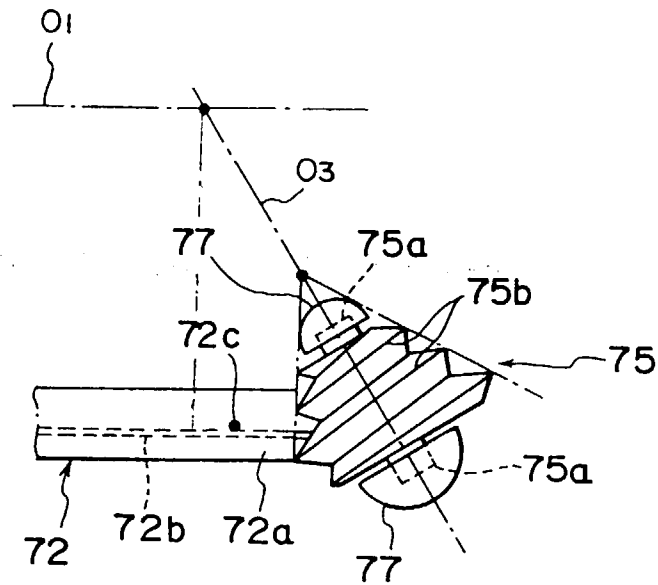


FIG.8B PRIOR ART

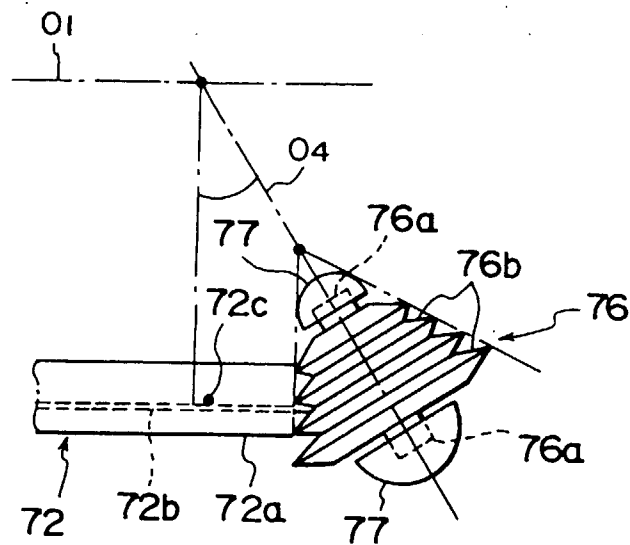


FIG.8C PRIOR ART

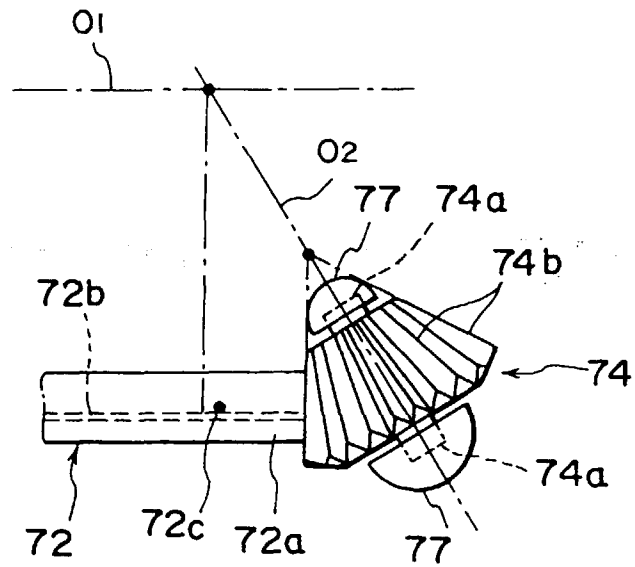


FIG.9

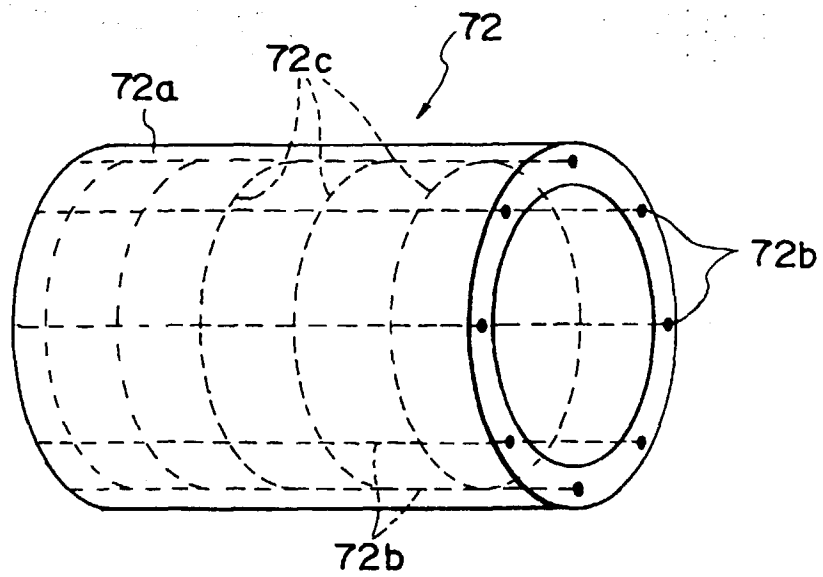


FIG. 10B PRIOR ART

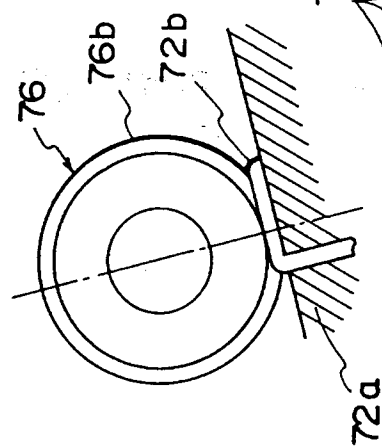


FIG. 10B PRIOR ART

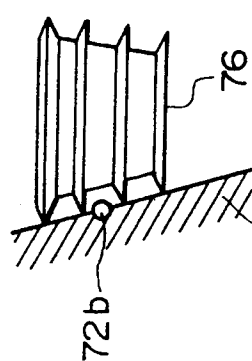


FIG. 10A

PRIOR ART

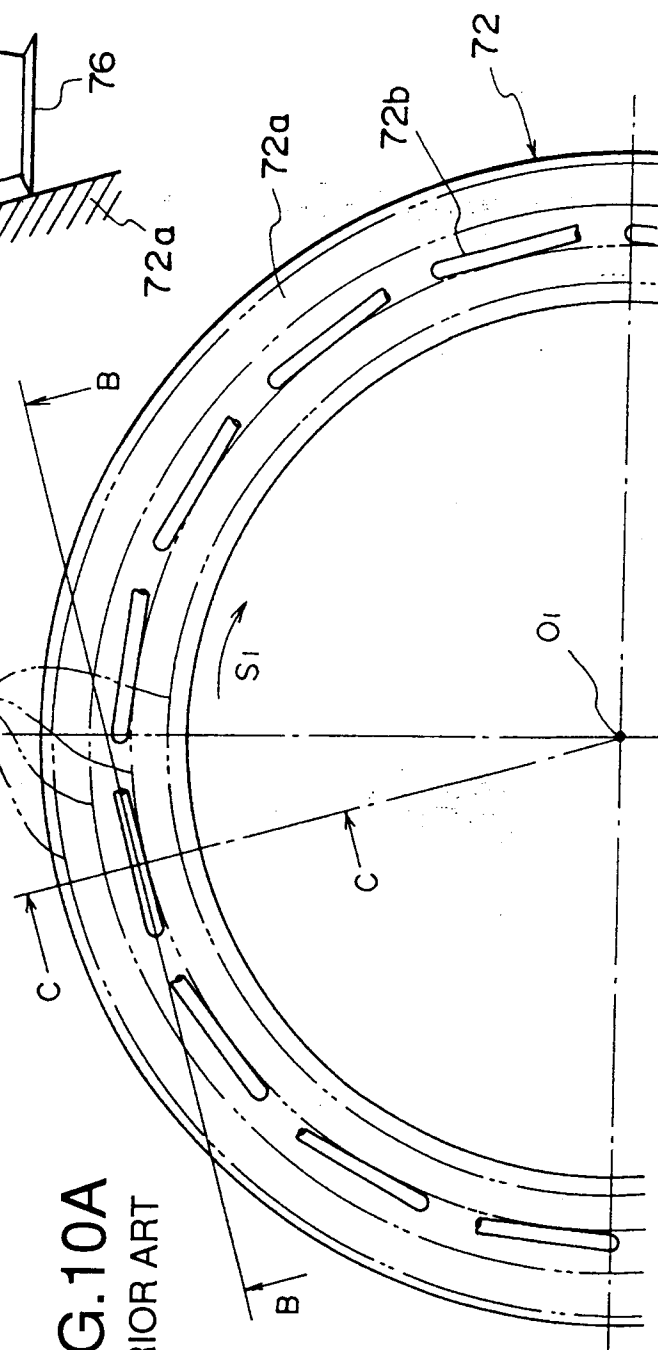


FIG.12A PRIOR ART

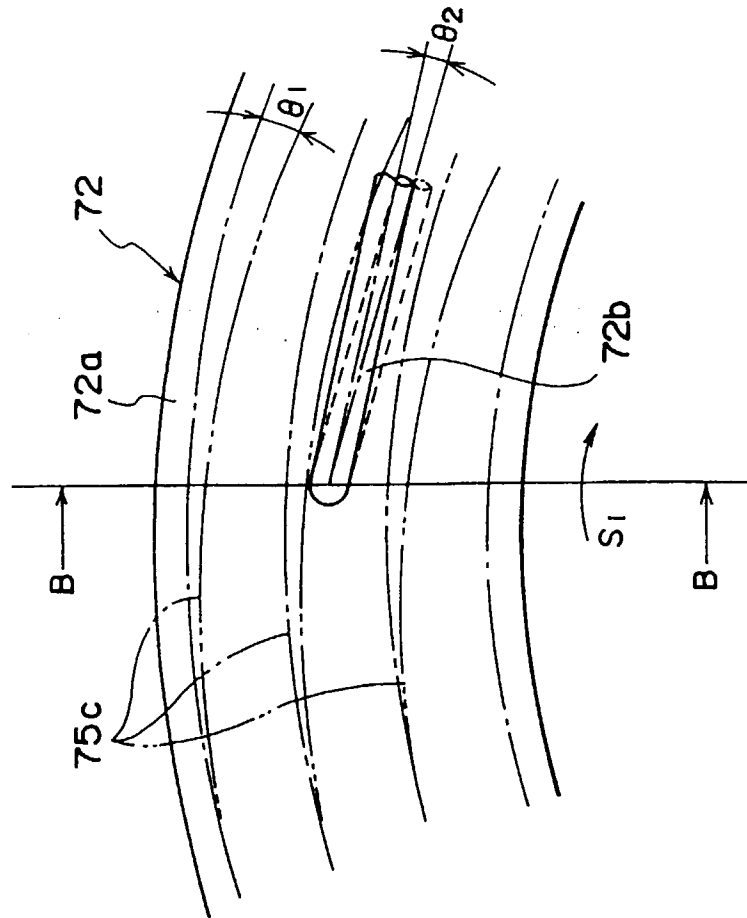


FIG.12B PRIOR ART

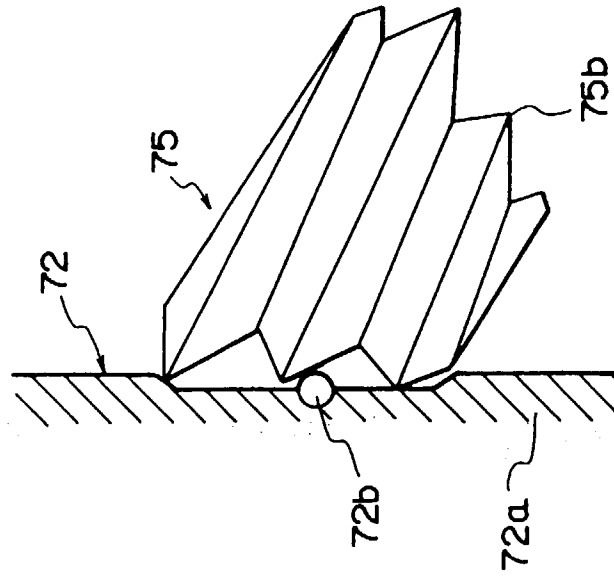


FIG.13B PRIOR ART

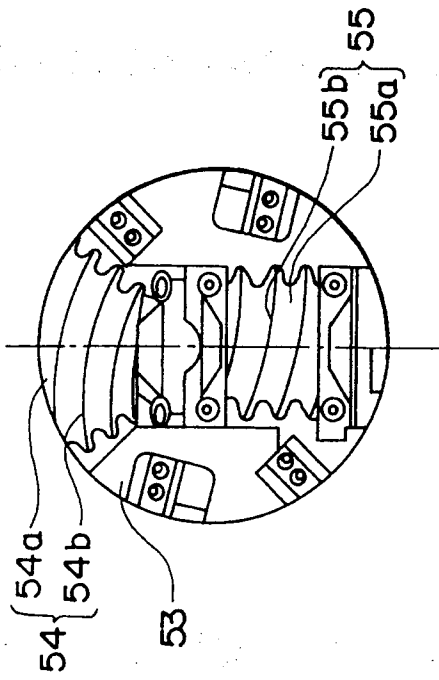
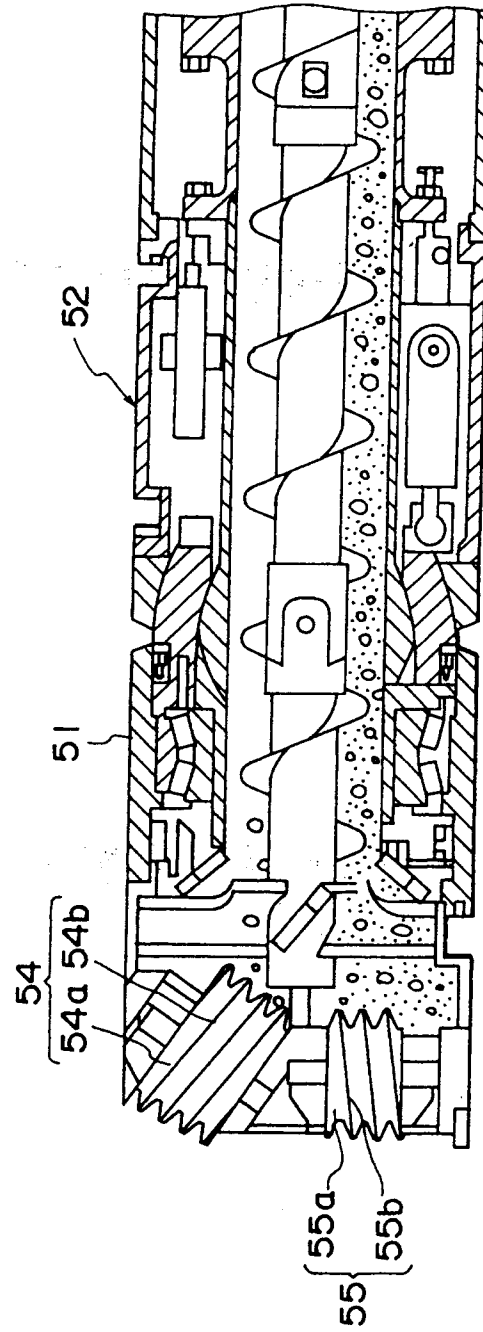


FIG.13A PRIOR ART



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP97/02512

A. CLASSIFICATION OF SUBJECT MATTER Int. C1 ⁶ E21D9/08, E21D9/06, E21B10/10, E21B10/16 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. C1 ⁶ E21D9/08, E21D9/06, E21B10/10, E21B10/16 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1940 - 1996 Kokai Jitsuyo Shinan Koho 1971 - 1997 Toroku Jitsuyo Shinan Koho 1994 - 1997 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.
X	JP, 43550, C1 (Clarence Edward Read), September 29, 1922 (29. 09. 22) (Family: none)	1 - 3
X Y	Microfilm of the specification and drawings annexed to the written application of Japanese Utility Model Application No. 85654/1989 (Laid-open No. 25694/1991) (Mitsubishi Heavy Industries, Ltd. and another), March 15, 1991 (15. 03. 91), Fig. 5 (Family: none)	1, 3, 4 6
Y	Microfilm of the specification and drawings annexed to the written application of Japanese Utility Model Application No. 25142/1991 (Laid-open No. 122798/1992) (K.K. Zenitakagumi and two others), November 5, 1992 (05. 11. 92) (Family: none)	6
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* 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 when the document is taken alone "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		
Date of the actual completion of the international search October 3, 1997 (03. 10. 97)		Date of mailing of the international search report October 14, 1997 (14. 10. 97)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.		Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)