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**EP-A-0 013 599
EP-A-0 036 786
CH-A- 520 802
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Description

The present invention relates to a yarn cutter for a shuttleless loom and more particularly to a yarn cutter which is suitable for use as a weft yarn cutter for a water jet loom and superior in corrosion resistance, wear resistance and toughness in a weaving process.

Recent water jet looms operate at a very high speed of 400 to 800 rpm and jet 2 to 4 cc of water at every pick. Accordingly, in a yarn cutter employing a metallic blade for cutting weft yarns such as in GB—A—1 121 234, the blade is liable to rust due to the wet operating environment and the cutting performance of the blade deteriorates within a short operating period of time due to repetition of high-speed cutting operation, so that such a yarn cutter has a disadvantage that the durability is unsatisfactory. Some yarn cutters employ an electric heater instead of a metallic blade, however, such yarn cutters also have a problem in respect to durability and often fail in cutting a weft yarn due to cooling of the electric heater by wet weft yarns. The large power consumption of such yarn cutter employing an electric heater as large as approximately 30% of the total power consumption of the loom is a serious problem. When thick yarns of 200 to 500 deniers (220 to 550 dTex) or spun yarns which are likely to be wet with water are used as weft yarns, sometimes, the electric heater consumes a large electric power as great as 50% of the total power consumption of the loom, which is economically disadvantageous.

It is known to coat the blades of scissors with hard materials such as titanium carbide to increase their durability and examples of such coated scissors are described in German Gebrauchsmuster 79 25 369.

It is also known from EP—A—13,599 to make tool bits for machining metals from a zirconia ceramic comprising a dispersion of a zirconia containing cubic phase and a zirconia containing tetragonal phase.

The present invention seeks to provide a yarn cutter suitable for a shuttleless loom, which is superior in corrosion resistance, wear resistance and toughness than known such yarn cutters.

According to the present invention, there is provided a yarn cutter for a shuttleless loom, comprising a pair of knife bodies each having a cutting edge and being driven for relative sliding motion in mutual contact, characterised in that at least the cutting edge of at least one of the said knife bodies is made of a zirconia ceramic comprising a dispersion of a zirconia containing cubic phase and a zirconia containing tetragonal phase, the latter being present in a proportion of between 5 and 70 mol%, and further characterised in that a water supply means is disposed in the vicinity of the cutting edges of the knife bodies such as to deliver water thereto in operation of the loom.

The yarn cutter may be a scissors type or may be a so-called cylinder cutter type consisting of a combination of a cylinder body and a piston body fitted in the cylinder body. As mentioned above, it is preferable that one of the bodies is stationary, while the other is movable in contact with the former.

It is desirable to form the cutting edges of both knife bodies of the ceramic material; however, only one of the cutting edges may be formed of a ceramic material, while the other is formed of a metal such as a sintered hard alloy. In the yarn cutter of the present invention, at least the cutting edge is required to be made of the ceramic material or the cutting edge and the knife body may inclusively be made of the ceramic material. Forming at least the cutting edge of the ceramic material provides corrosion resistance, wear resistance and toughness, which can not be attained by metal cutters.

The provision of the water supply means will further extend the life of the yarn cutter.

Various ways of carrying out the invention are described in detail below with reference to the drawings which illustrate several different embodiments, and in which:

Figure 1 is a perspective view of a water jet loom equipped with a yarn cutter formed as a first embodiment of the present invention;

Figure 2 is a side elevation of a yarn cutter formed as an embodiment of the present invention and a driving mechanism for driving the same;

Figures 3A and 3B are sectional views of the yarn cutter of Figure 2 taken along line III—III of Figure 2;

Figure 4 is a sectional view taken along line IV—IV of Figure 2;

Figure 5 is a longitudinal sectional view of the essential part of another embodiment of a yarn cutter according to the present invention; and

Figure 6 is a schematic representation of a device for evaluating the wear resistance of materials.

Referring to Figure 1, a shed 3 is formed through the alternate up-and-down motion of a pair of heddle frames 2 guiding a plurality of warp yarns 1 arranged in the shape of a band. A weft yarn 4 is inserted through the shed 3 across the arrangement of the warp yarns 1 and is then beaten up with a reed 5 so that a fabric 6 of a predetermined weft density is formed.

The weft yarn 4 is taken out from a cheese 7 at a predetermined unwinding speed by means of a feed roller 8 at a predetermined speed and is pooled temporarily within a vacuum pool pipe 9. The weft yarn 4 thus pooled is then guided through a gripper 10 and jetted out from a jet nozzle 11 together with water. Pressurized water is supplied to the jet nozzle 11 from a water tank 12 by means of a pump 13. The weft yarn 4 is jetted out from the jet nozzle 11 into the shed 3 by the pressurized water.

One end of the weft yarn 4 beaten up with the reed 5 is gripped by the gripper 10, while the other end jetted across the loom to the other end thereof is arrested with weft yarn entangling threads 16 to tighten the weft yarn 4 at a fixed tension while the end of the weft yarn 4 is picked up with the weft yarn entangling threads 16 rotated by means of a yarn end entangling means, for instance, a false-twisting spindle 14. Both ends of the weft yarn 4 are cut by yarn cutters 17 of the present invention which are made of a ceramic

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material and are disposed at the opposite ends of the loom respectively. A water supply pipe 18 is disposed in the vicinity of each yarn cutter 17 to supply water to the yarn cutter 17. Dripping water from the water supply pipes 18 on the corresponding yarn cutters 17 removes textile wastes and dust produced due to the wear of the yarn cutters 17 and mitigates the wear of the cutting edges due to the mutual sliding movement between the cutting edges. The preferable water supply rate is 10 to 100 cc/min. In Figure 1, selvage yarns are indicated at 14.

Referring to Figure 2, the yarn cutter comprises a pair of knife bodies 19 and 20 having cutting edges 19a and 20a on the mutually opposite sides thereof. The knife bodies 19 and 20 include the cutting edges 19a and 20a, respectively, and are formed of a ceramic material. As shown in Figure 4, the knife body 20 is fixed to a shaft 21 and is held practically horizontally at a fixed position, whereas the knife body 19 is supported pivotally in a bearing 30 on the knife body 20 and is urged with a spring 31 so that the knife body 19 is pressed against the knife body 20. The pressure of the spring 31 can be adjusted by a nut 32. It is desirable to mount the knife bodies 19 and 20 on the shaft 21 to make the cutting edges 19a and 20a longitudinally intersect each other so that a large shearing force is produced between the cutting edges 19a and 20a.

One end of a connecting rod 22 is connected pivotally to one end of the knife body 19, while the other end thereof is connected pivotally to one end of a lever 23. The lever 23 is supported pivotally at the central part thereof with a shaft 24 and is urged with a spring 25 so that a roller 26 provided at the other end thereof is always in contact with a cam 27. The cam 27 is fixed to the rocking shaft 28 of the loom and turns in synchronism with the rocking shaft 28. Accordingly, the rotation of the cam 27 causes the lever 23 to rock on the shaft 24 and thereby the knife body 19 is caused to reciprocate on the shaft 21 between a position shown by continuous lines and a position shown by broken lines through the up-and-down motion of the connecting rod 22. The reciprocating motion of the knife body 19 causes the relative sliding motion of the cutting edge 19a of the knife body 19 and the cutting edge 20a of the knife body 20 as shown in Figures 3A and 3B to shear the weft yarn 4 with the cutting edges 19a and 20a. The edge angles α and β of the cutting edges 19a and 20a of the knife bodies 19 and 20, respectively, in the respective cross sections are acute angles which are smaller than 90° , preferably 20° to 80° , more preferably 20° to 60° . Such acute edge angles α and β improve the weft yarn cutting effect of the yarn cutter. At least one of the edge angles α and β is required to be an acute angle which is smaller than 90° , however, the other edge angle may be an angle of 90° .

The water supply pipe 18, which opens directly to the knife body 19, supplies water to the cutting edge 19a as well as to the cutting edge 20a of the knife body 20 disposed below the knife body 19. Consequently, the smooth relative sliding motion between the contiguous cutting edges 19a and 20a is attained and thereby the wear of the ceramic knife bodies is reduced further and the life of the yarn cutter is extended.

In order to attain satisfactory weft yarn cutting operation with those yarn cutters 17, the preferable contact pressure between the cutting edges 19a and 20a is 0.3 kg to 0.5 kg. When the contact pressure is maintained within such a pressure range during the operation of the yarn cutter, satisfactory yarn cutting operation can be attained and in addition, the life of the yarn cutter is extended still further.

An essential condition for the yarn cutter 17 of the present invention is to form at least one of the cutting edges of the ceramic material of claim 1. Therefore, the knife bodies 19 and 20 including the cutting edges 19a and 20a may be formed of a ceramic material as in the case of the embodiment as described hereinbefore or it is possible to form only the cutting edges 19a and 20a of a ceramic material and to form the rest part of the knife body of an ordinary metal as shown in Figure 5.

A corrosion resistant, wear resistant and tough yarn cutter which is free from rusting under a wet environment can be provided when at least the cutting edges of the yarn cutter are formed of a ceramic material as defined herein, namely a ceramic material consisting of a dispersion of zirconia containing cubic phase and zirconia containing tetragonal phase, the latter being present in a proportion of 5 to 70 mol%. Such a material has excellent corrosion resistance, wear resistance and toughness and is particularly superior in mechanical strength against thermal shock and bending. Further, zirconia ceramic may contain 70 mol% or less of monoclinic phase in addition to the cubic phase. Addition of the monoclinic phase improves further the mechanical strength of the material against thermal shock.

A composite sintered material of a ceramic and a metal, namely a so called cermet, is applicable to the cutting edges of the yarn cutter of the present invention. A cermet is produced by sintering a ceramic powder and a metal powder. Cermets have the toughness and the plasticity of metals in addition to corrosion resistance and wear resistance.

The yarn cutter of the present invention as described hereinbefore exhibits high cutting performance owing to the use of ceramic materials for the cutting edges and has extended life owing to the high corrosion resistance, high wear resistance, and increased toughness and hence, it improves the weaving efficiency of a shuttleless loom employing the yarn cutters of the present invention. Furthermore, since the yarn cutter of the present invention cuts wefts yarns only through the relative sliding motion of a pair of knife bodies, only an extremely small amount of energy is required for driving the yarn cutter and the power consumption of the yarn cutter is reduced practically to zero as compared with the conventional yarn cutter employing electric heaters.

Although the embodiments of the present invention have been described as applied to a water jet loom, the present invention is applicable also to other shuttleless looms such as a rapier loom and an air jet loom. The use of the rotary motion of the rocking shaft is the most suitable means to drive the yarn cutter,

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however, the beating motion of the slay sword may be used for driving the yarn cutter.

The effects of the present invention will be described hereunder on the basis of the results of experiments.

5 Experiment 1

Figure 7 shows a wear testing device for testing the wear of materials resulting from the frictional action of a wet yarn.

A yarn γ taken out from a cheese 61 is guided into a water tank 63 through a tensor 62 to be made to wet, then is made to pass around a test piece 63 through a contact angle of θ and then is taken up by means of a take-up roller 64 and an aspirator 65. The yarn γ used for the test is a polyester yarn of 18 filaments and 50 deniers (55 dTex) (a semi-dull polyester yarn containing titanium oxide). The test conditions are: yarn speed = 250 m/min, yarn tension = 30 g, contact angle = 120° and test period = continuous 30 min.

Materials subjected to the test were: A = a martensite stainless steel (SAS-440C), B = a tungsten carbide sintered hard alloy, C = a high speed steel (SKH9), and D = a zirconia ceramic. The material D is used for the yarn cutter of the present invention.

The test results are shown in Table 1. Different yet obvious wear was found with the materials A, B and C, whereas no wear was found with the material D.

TABLE 1

Materials	A	B	C	D
Wear	Medium	Slight	Large	None

25 Experiment 2

The respective power consumptions of a water jet loom equipped with a conventional electric heat yarn cutter and a water jet loom equipped with a shearing yarn cutter of the present invention were measured. The material of yarn cutters of the present invention subjected to the first comparative test and the second comparative test was a zirconia ceramic. The weaving conditions for the first comparative test were: weaving width = 150 cm, weaving speed = 400 picks/min, weft yarn = polyester 65%/cotton 35% mixed spun yarn and weaving density = warp \times weft: 105 \times 75/in. The test results are shown in Table 2.

The weaving conditions for the second comparative test were: weaving width = 150 cm, weaving speed = 760 picks/min, weft yarn = 150 deniers (165 dTex) and 48 filaments false twisted polyester filament yarn and weaving density = warp \times weft: 60 \times 60/in (24 \times 24/cm). The results are shown in Table 3.

In the comparative test 1, the number of failures in cutting the weft yarn per 1,000,000 picks (approx. 400 m in woven length) was 9 times and 4 times for the conventional electric heat yarn cutter and for the yarn cutter of the present invention, respectively.

In the comparative test 2, the number of failures in cutting the weft yarn per 1,000,000 picks (approx. 423 m in woven length) was 7 times and 2 times for the conventional electric heat yarn cutter and for the yarn cutter of the present invention, respectively.

It is obvious from Tables 2 and 3 that the conventional electric heat yarn cutter consumes approximately 30% or greater of the total power consumption of the loom, whereas the yarn cutter of the present invention scarcely consumes power, so that the total power consumption of the loom is reduced.

TABLE 2

	Heat cutter		Yarn cutter of the invention	
	Power consumption (KWH)	Ratio (%)	Power consumption (KWH)	Ratio (%)
Main motor	0.91	44.0	0.91	60.7
Blower	0.49	23.7	0.49	39.3
Yarn cutter	0.67	32.3	—	—
Total	2.07	100	1.50	100

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TABLE 3

	Heat cutter		Yarn cutter of the invention	
	Power consumption (KWH)	Ratio (%)	Power consumption (KWH)	Ratio (%)
Main motor	1.45	46.3	1.45	67.4
Blower	0.70	22.4	0.70	32.6
Yarn cutter	0.98	31.3	—	—
Total	3.13	100	2.15	100

Experiment 3

A yarn cutter having paired knife bodies each being made of a zirconia-yttria ceramic was mounted on a water jet loom and was subjected to a test. The test conditions were: weaving speed = 400 picks/min, water supply to the yarn cutter = 100 cc/min, warp yarn = polyester filament yarn, weft yarn = 65 wt% polyester/35 wt% cotton, 45S mixed spun yarn, and weaving density = warp × weft: 105 × 75/in (41 × 30/cm). No failure in cutting the weft yarn occurred during 1,000,000 picks (1000 m in woven length). When no water was supplied, the cutter failed in cutting the weft yarn twice per 1,000,000 picks.

In the weaving operation under the above conditions, the amount of wear of the cutter after the cutting operation of 3,000,000 times was 0.0033 mm, which is equivalent to a limiting cutting frequency of three billion 400 million times. When no water was supplied to the yarn cutter, the amount of wear of the cutter after the cutting operation of 3,000,000 times was 0.049 mm, which is equivalent to a limiting cutting frequency of approximately 50,000,000 times.

Thus the amount of wear of the cutter when water is supplied positively to the cutter is reduced approximately to 67% of the amount of wear of the cutter when no water is supplied to the cutter and the limiting cutting frequency of the cutter when water is supplied positively to the cutter was increased approximately by 68 times that of the cutter when no water is supplied to the cutter.

Experiment 4

Duration tests in a water jet loom were carried out of each of an electric heating yarn cutter (F), a scissors-type yarn cutter of a tungsten carbide (G) and a scissors-type yarn cutter of a zirconia ceramic according to the present invention (H), under the following conditions:

The water jet loom was operated at the rotation velocity of 400 rpm. The weft yarn subjected to cutting comprised of 75-denier, 36-filament polyester yarn.

For evaluation of the duration, it was regarded that the life of the yarn cutter was over when the cutter committed cutting failure ten times per 1,000,000 picks.

The duration values found were, in terms of the number of months (24 hours a day, 30 days a month), 2.5 for the cutter F, 4 for the cutter G and 8 for the cutter H.

Claims

1. A yarn cutter (18) for a shuttleless loom, comprising a pair of knife bodies (19, 20) each having a cutting edge (19a, 20a) and being driven for relative sliding motion in mutual contact, characterised in that at least the cutting edge (19a, 29a) of at least one of the said knife bodies is made of a zirconia ceramic comprising a dispersion of a zirconia containing cubic phase and a zirconia containing tetragonal phase, the latter being present in a proportion of between 5 and 70 mol%, and further characterised in that a water supply means (18) is disposed in the vicinity of the cutting edges (19a, 20a) of the knife bodies such as to deliver water thereto in operation of the loom.

2. A yarn cutter according to Claim 1, characterised in that at least one of the said knife bodies (19, 20) is made entirely of a ceramic.

3. A yarn cutter according to Claim 1, characterised in that one of the said knife bodies (19, 20) is fixed, while the other is movable.

4. A yarn cutter according to Claim 1, characterised in that the edge angle of said cutting edges (19a, 20a) as viewed in the cross section is an angle of below 90°.

5. A yarn cutter according to Claim 1, characterised in that the edge angle of said cutting edges (19a, 20a) as viewed in the cross section is an angle of 20° to 80°.

6. A yarn cutter according to any preceding claim characterised in that the zirconia ceramic contains up to 70 mol% of monoclinic phase.

7. A shuttleless water jet loom characterised in that it incorporates a yarn cutter (17) according to any of the Claims 1 to 3.

8. A shuttleless loom according to Claim 7 characterised in that said yarn cutter (17) is driven by the rocking shaft of the loom.

Patentansprüche

1. Fadenabschneider (18) für einen schützenlosen Webstuhl mit einem Paar von Messerkörpern (19, 20), deren jeder eine Schneidkante (19a, 20a) hat und für eine relative Gleitbewegung in gegenseitiger Berührung angetrieben ist, dadurch gekennzeichnet, daß mindestens die Schneidkante (19a, 20a) mindestens eines der Messerkörper aus einer Zirkonoxidkeramik, die eine Dispersion einer Zirkonoxid enthaltenden kubischen Phase und einer Zirkonoxid enthaltenden tetragonalen Phase umfaßt, hergestellt ist, wobei letztere in einem Anteil von 5 bis 70 Mol-% vorhanden ist, und weiterhin dadurch gekennzeichnet, daß ein Wasserzufuhrmittel (18) in Nachbarschaft der Schneidkanten (19a, 20a) der Messerkörper derart angeordnet ist, daß ihnen im Betrieb des Webstuhles Wasser zugeführt wird.
2. Fadenabschneider nach Anspruch 1, dadurch gekennzeichnet, daß mindestens einer der Messerkörper (19, 20) ganz aus Keramik hergestellt ist.
3. Fadenabschneider nach Anspruch 1, dadurch gekennzeichnet, daß einer der Messerkörper (19, 20) fest ist, während der andere beweglich ist.
4. Fadenabschneider nach Anspruch 1, dadurch gekennzeichnet, daß der Kantenwinkel der Schneidkanten (19a, 20a) im Querschnitt gesehen ein Winkel von unter 90° ist.
5. Fadenabschneider nach Anspruch 1, dadurch gekennzeichnet, daß der Kantenwinkel der Schneidkanten (19a, 20a) im Querschnitt gesehen ein Winkel von 20 bis 80° ist.
6. Fadenabschneider nach einem der vorausgehenden Ansprüche, dadurch gekennzeichnet, daß die Zirkonoxidkeramik bis zu 70 Mol-% monokline Phase enthält.
7. Schützenloser Webstuhl mit Wasserstrahl, dadurch gekennzeichnet, daß er einen Fadenabschneider (17) nach einem der Ansprüche 1 bis 3 enthält.
8. Schützenloser Webstuhl nach Anspruch 7, dadurch gekennzeichnet, daß der Fadenabschneider (17) durch die Schwingwelle des Webstuhles angetrieben ist.

Revendications

1. Coupe-fil (18) pour métier sans navette, comprenant une paire de corps de couteau (19, 20) ayant chacun une arête coupant (19a, 20a) et étant entraîné pour être animé d'un mouvement relatif de coulissement en contact mutuel, caractérisé en ce qu'au moins l'arête coupant (19a, 20a) d'au moins l'un des corps de couteau est en céramique de zircone comprenant une dispersion d'une zircone contenant une phase cubique et d'une zircone contenant une phase tétragonale, cette dernière étant présente dans une proportion comprise entre 5 et 70 moles%, et en outre, caractérisé en ce qu'un moyen d'alimentation en eau (18) est placé au voisinage des arêtes coupantes (19a, 20a) des corps de couteau, de manière à leur fournir de l'eau pendant le fonctionnement du métier.
2. Coupe-fil selon la revendication 1, caractérisé en ce qu'au moins l'un des corps de couteau (19, 20) est entièrement en céramique.
3. Coupe-fil selon la revendication 1, caractérisé en ce que l'un des corps de couteau (19, 20) est fixe alors que l'autre est mobile.
4. Coupe-fil selon la revendication 1, caractérisé en ce que l'angle des arêtes coupantes (19a; 20a) tel qu'il est vu dans une section en coupe est un angle inférieur à 90°.
5. Coupe-fil selon la revendication 1, caractérisé en ce que l'angle des arêtes coupantes (19a, 20a) tel qu'il est vu dans une section en coupe est un angle de 20° à 80°.
6. Coupe-fil selon l'une quelconque des revendications précédentes, caractérisé en ce que la céramique de zircone contient jusqu'à 70 moles% d'une phase monoclinique.
7. Métier à jet d'eau sans navette, caractérisé en ce qu'il incorpore un coupe-fil (17) selon l'une quelconque des revendications 1 à 3.
8. Métier sans navette selon la revendication 7, caractérisé en ce que le coupe-fil (17) est entraîné par l'arbre basculant du métier.

FIG.1

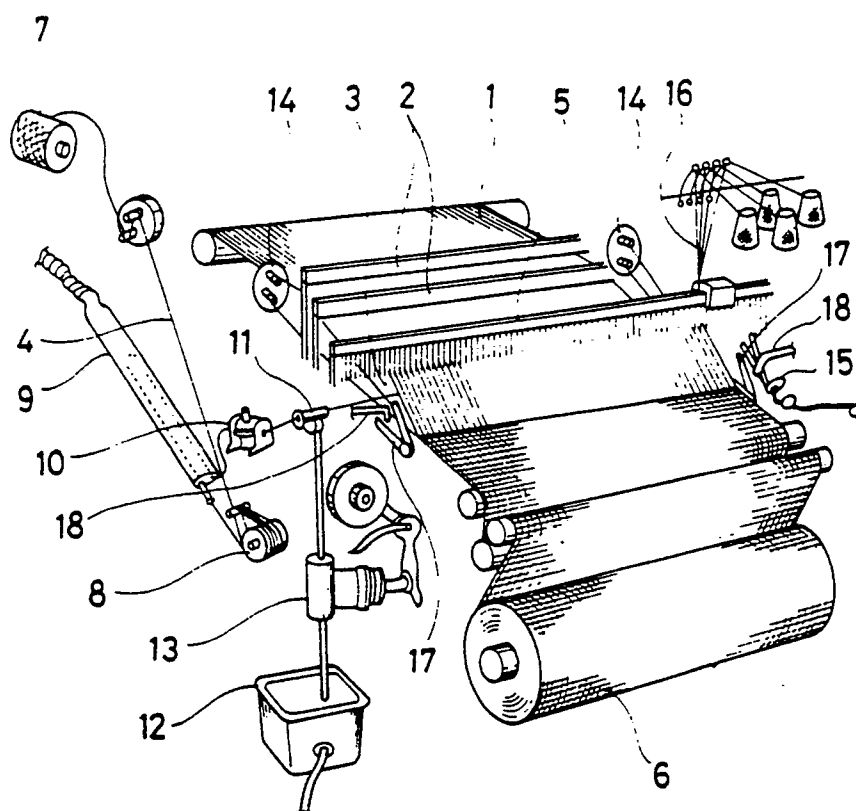


FIG.2

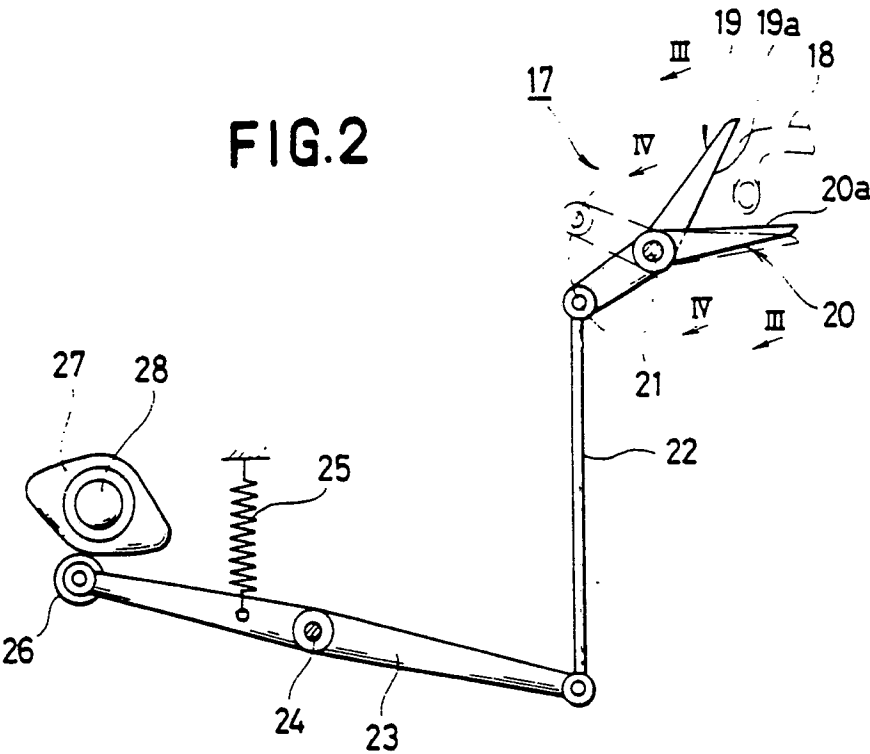


FIG.3A

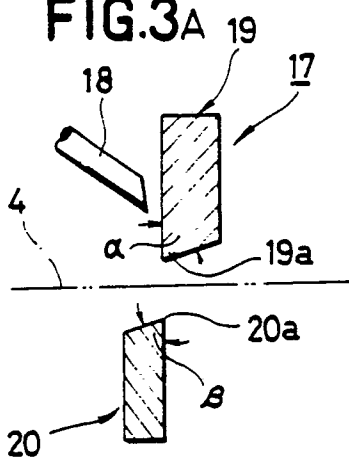
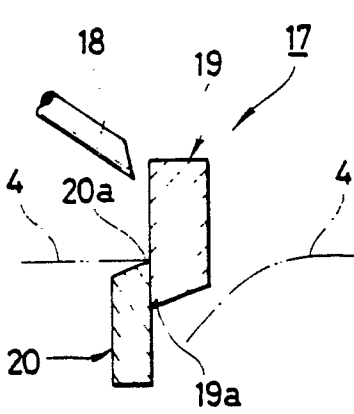


FIG.3B



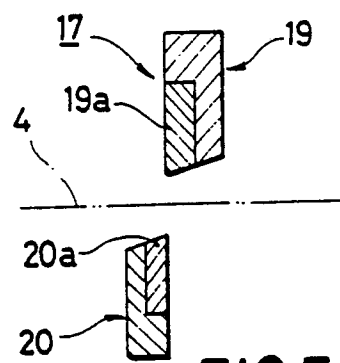
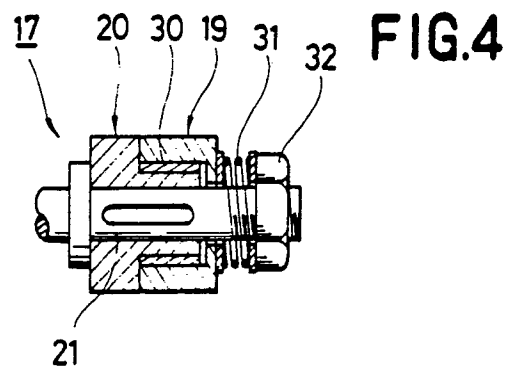


FIG.5

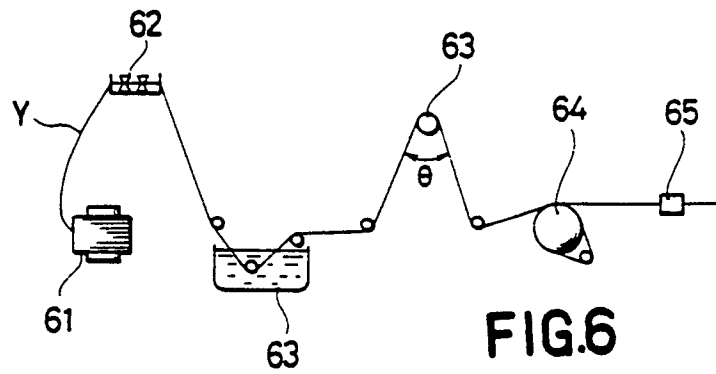


FIG.6