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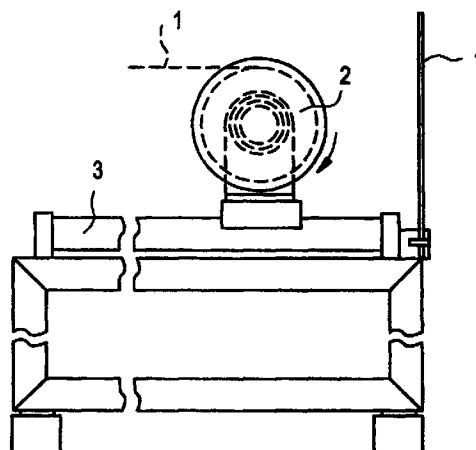
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**(54) A method for reducing or preventing damage to fiber wound on a spool**

(57) A method for reducing or preventing damage to a fiber being wound on a spool (2), caused by the whipping action of a loose fiber end against fiber already wound on the spool (2). The method includes the steps of capturing the loose end of a fiber that is being wound on a spool (2) against the inside surface of a non-circular guard that substantially surrounds the spool (2). The loose end of the fiber is captured against an angled entrance surface of the guard that extends outwardly from the guard. While the spool (2) rotates, the fiber end is maintained against the inner surface of the guard (A1-A7) by centrifugal force, thereby maintaining separation of the free end of the fiber from the fiber already wound on the spool (2). By maintaining the free end of the fiber against the guard during spool (2) rotation, whip damage to the fiber on the spool (2) is substantially reduced or completely prevented.

**FIG.1**



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## Description

### BACKGROUND OF THE INVENTION

#### Field of the Invention

This invention is directed to a method for preventing damage to fiber, such as an optical fiber, being wound on a rotating spool caused by the whipping action of a loose end of the fiber on the fiber already wound on the spool.

#### Description of Related Art

In the optical fiber or plastic filament manufacturing industries, long lengths of fiber or filament are wound at high speeds upon machine rotated take-up spools for shipping and handling. As the fiber is wound on the spool, the fiber is laid down on the spool in successive layers. In the optical fiber industry, fiber spooling takes place at two general locations, at the draw tower where the fiber is originally drawn, and at an off-line screening station where the fiber may be tested. In each of these locations, the fiber can be wound at speeds over 20 meters per second and is maintained at relatively high tension.

During these winding events, the fiber may break due to forces applied by the machine. When the fiber breaks, the loose fiber end of the fiber tends to whip around at high speed due to the fast rotating spool. The uncontrolled loose fiber end whips against fiber already wound on the spool and can cause damage to as much as five to six layers of fiber. In the optical fiber industry, this can amount in damage to approximately 500 meters of fiber. The break event is unpredictable, and the machine must be brought to an immediate stop to prevent whipping damage to the fiber. However, because the break is unpredictable and stopping the spool requires time, there is inevitably a period of time where the spool will continue to rotate and the fiber end will be free to whip against the fiber already wound on the spool causing damage to that fiber.

Ideally, if the spool was suspended in free space, there would be no whip damage because the free end of the fiber would not strike an obstacle and rebound back toward the fiber spool. However, in most cases manufacturers have guards or guards mounted for safety reasons. In many winding applications, guards on the winding machines consist of a square box around the spool, or a deflector plate mounted parallel to the spool. The purpose of these guards is to prevent whipping of the fiber toward an operator after a break. However, these types of guards actually increase the probability that the fiber tip will strike the fiber pack. Any type of angled surface on the guard permits the free end of the fiber to strike an edge thereof, causing the fiber to rebound back against the spool.

Additionally, there must be an opening in the guard

to allow the fiber to be wound on the spool. Any type of opening will produce an angled edge that in turn produces the above described whip action in the fiber end. Furthermore, a perfectly round guard does not provide the necessary surface architecture to capture and maintain the fiber end away from the spool.

### SUMMARY OF THE INVENTION

The present invention is directed to a novel method for reducing or preventing damage to a fiber being wound on a spool by overcoming one or more of the above-described problems associated with fiber winding. The present invention is directed to a novel method for reducing or preventing damage to a fiber being wound on a spool caused by the whipping action of a loose fiber end against fiber already wound on the spool.

The principal advantage of the present invention is the provision of an arrangement which substantially obviates one or more of the limitations and disadvantages associated with prior arrangements. By maintaining the free end of the fiber against the smooth surface of a guard that substantially surrounds the spool during spool rotation, whip damage to the fiber on the spool is substantially reduced or completely prevented.

Additional features and advantages of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by the process particularly pointed out in the written description and claims hereof as well as the appended drawings.

To achieve these and other advantages and in accordance with the purpose of the invention, as embodied and broadly described, the invention is a method for reducing or preventing damage to a fiber being wound on a spool comprising the steps of winding the fiber on a rotating spool that is substantially surrounded by a non-circular guard having a smooth and continuous inner surface facing the spool; capturing a free end of the fiber against an entrance surface of the guard while the spool rotates; and maintaining the fiber end against the guard inner surface while the spool rotates thereby maintaining separation of the free end of the fiber from the fiber already wound on the spool.

The invention may also include the steps of maintaining the fiber against the inner surface of the guard throughout various degrees of rotation of the spool. The free end of the fiber may be maintained against the inner surface of the guard after it is entrained on the entrance surface of the guard while the spool rotates through at least 90°, 180°, or 270° but less than 360°.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to pro-

vide further explanation of the invention as claimed.

The accompanying drawings are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate an embodiment of the invention and together with the specification serve to explain the principles of the invention.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

Fig. 1 is a side view of a known prior art fiber winding apparatus.

Fig. 2 is a side view of the known prior art fiber winding apparatus illustrating the whip action of a broken fiber end.

Fig. 3 is a side view of one embodiment of the guard according to the present invention.

Figs. 4-9 are side views of the guard illustrated in Fig. 3, further illustrating the sequential path of the loose fiber end around the guard.

### **DETAILED DESCRIPTION OF THE INVENTION**

Fig. 1 illustrates a known prior art apparatus for winding fiber. Fiber 1 is being wound on spool 2 at a relatively high rate of speed, e.g., 30 m/s. The spool 2 sits on a pedestal 3. Fiber 1 is maintained under a relatively high tension to ensure proper winding on spool 2. If the fiber is an optical fiber, it may be supplied directly from any known type drawing apparatus (not shown) or a known type of screening device (not shown).

Ideally, if the reel was suspended in free space, there would be no reason for any type of shield or guard around the reel. However, as depicted in Fig. 1, in order to prevent injuries to operators standing near the spool if the fiber breaks, a guard 4 is mounted behind spool 2. In practice, if the fiber 1 breaks, the loose fiber end will whip back against guard 4.

As depicted in Fig. 2, however, any type of angle or edge on the guard, such as illustrated at reference number 5, that the fiber can catch on, will cause the fiber end or tail to wrap itself around the edge and whip back on the fiber pack. To avoid damage to the fiber caused by whipping, the fiber end can be contained by capturing it with a smooth surface around the spool. Enclosing the spool in a cylinder would keep the fiber end away from the fiber pack by the centrifugal forces caused by the rotating spool. However, there must be an entrance into the cylinder for fiber to enter. As described above, any type of opening will produce a severe whip source for the fiber. Thus, the fiber must be allowed to enter the spool during the winding operation. A perfectly round cylinder around the shipping pool will not prevent whipping of the fiber from causing damage to the fiber pack.

Reference will now be made in detail to the present preferred embodiment of the invention, an example of which is illustrated in the accompanying drawings. The

exemplary embodiment of the invention is illustrated in Fig. 3 and is designated generally by reference numeral 10.

As embodied herein, the invention is directed to a method for reducing or preventing damage to a fiber being wound on a spool comprising several steps. As illustrated in Fig. 3, guard 10 according to the present invention controls the fiber tip during two phases after a break occurs. The first phase is the entry of the tip towards the fiber pack after a break. When the fiber breaks, it bounces around the pulleys of the draw or screening apparatus and takes a direct high speed path into the spool resulting in fiber damage. The second phase is the continuous rotating of the fiber around the spool of fiber. The rotating fiber end can impact on a surface and rebound into the fiber spool with sufficient energy resulting in fiber damage. Maximum separation between the fiber tip and the spool is necessary for ensuring no damage to the fiber pack.

The first step of the invention is winding the fiber on a rotating spool that is substantially surrounded by a non-circular guard 10. Guard 10 preferably has a smooth and continuous inner surface facing the spool. This smooth surface helps to prevent rebound of the fiber back against the fiber pack.

Fig. 4 illustrates a projected fiber path after a fiber break. Due to high tension in the fiber and the direction of spool rotation, when a break occurs, the fiber will tend to whip back directly into the spool area. To prevent the loose end of fiber 1 from striking the fiber already wound on spool 2, arcuate section A1 is positioned to ensure impact of the fiber end to the right of guard mounting arm 6. Arcuate section A1 defines the guard entrance surface.

To prevent damage to the fiber pack by the loose end of fiber 1, the next step in the invention is to capture the free end of the fiber 1 against an entrance surface of guard 10 while the spool rotates. Fig. 5 illustrates the loose end of fiber 1 being captured on the inner entrance surface formed by arcuate section A1. Capture of the loose end of the fiber 1 is accomplished by providing a smooth arcuate surface at a position such that as the loose end of fiber 1 approaches spool 2, it initially impacts on the surface of guard 10 prior to striking the fiber pack. Capture is attained by the arcuate shape of the entrance surfaces A1 and A2 together with the centrifugal forces imparted to the fiber end by rotation of spool 2.

To ensure the loose end of fiber 1 does not rebound and impact on the fiber pack, the final step in the invention is to maintain the fiber end against the inner surface of guard 10 while the spool rotates thereby maintaining separation of the free end of the fiber from the fiber already wound on the spool. Preferably, the fiber end is maintained against the inner surface of guard 10 while spool 2 rotates 90° and more preferably 180° and most preferably 270°.

As shown in Figs. 3 and 4, to ensure fiber is main-

tained on guard 10 throughout spool rotation, the shape of guard 10 is non-circular. To optimize control the loose end of a broken fiber 1, guard 10 is preferably composed of several arcuate sections.

Figs. 3 and 4 illustrates a preferred embodiment of guard 10. In the preferred embodiment, guard 10 is composed of seven arcuate sections, A1 - A7. However, different numbers of sections can be used as long as the interior surface of the guard remains smooth and free of angular surfaces.

Each arcuate section has a different radius, R1 - R7. In order to maximize the amount of surface of guard 10 on which the fiber will be maintained, the radii are offset from the spool center. Depending on the size of the spool and guard, the locations of the offset points may vary.

Figs. 6 and 7 illustrate that the continued smooth, inner guard surface defined by arcuate sections A3 through A7, combined with centrifugal force from rotation of spool 2 maintain the loose end of fiber 1 against the inner guard surface. In other words, the centrifugal force imparted on the fiber end by rotation of spool 2 together with the arcuate shape of guard 10 allows the fiber end to be pulled along the surface of guard 10 with minimal rebound effect. Accordingly, the fiber end is maintained against the guard. Because the inner guard surface is free from angular surfaces, there is no whip effect imparted to the fiber end, and the fiber path conforms with the inner guard surface.

Figs. 8 and 9 illustrate the fiber path along the final section of guard 10 before the fiber reaches the guard entrance. The final section 11 is a substantially straight section of guard. It is positioned to direct the fiber end toward the spool prior to releasing the fiber end toward the guard entrance. This redirection of the fiber path allows the fiber to exit from the guard surface at an angle. As spool 2 rotates, the loose end of fiber 1 is initially projected toward the spool and then is fed directly toward the guard entrance surface formed by arcuate section A1. This fiber path ensures that the loose fiber end will not whip against guard mounting arm 6 and rebound back against the fiber pack. Rather, the loose fiber end takes a path similar to that shown in Figs. 4 and 5 to prevent whip damage to the fiber on spool 2.

It will be apparent to those skilled in the art that various modifications and variations can be made to the above-described invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

## Claims

1. A method for reducing or preventing damage to a fiber being wound on a spool comprising the steps of:

winding the fiber on a rotating spool that is substantially surrounded by a non-circular guard having a smooth and continuous inner surface facing the spool;

capturing a free end of the fiber against an entrance surface of the guard while the spool rotates; and

maintaining the fiber end against the guard inner surface while the spool rotates thereby maintaining separation of the free end of the fiber from the fiber already wound on the spool.

2. A method for preventing damage to a fiber being wound on a spool according to claim 1 wherein the free end of the fiber is maintained against the inner surface of the guard after the free end of the fiber is entrained on the entrance surface of the spool while the spool rotates through at least 90°.
3. A method for preventing damage to a fiber being wound on a spool according to claim 1 wherein the free end of the fiber is maintained against the inner surface of the guard after the free end of the fiber is captured on the entrance surface of the spool while the spool rotates through at least 180°.
4. A method for preventing damage to a fiber being wound on a spool according to claim 1 wherein the free end of the fiber is maintained against the inner surface of the guard after the free end of the fiber is captured on the entrance surface of the spool while the spool rotates through at least 270°.
5. A method for preventing damage to a fiber being wound on a spool according to claim 1 wherein the free end of the fiber is maintained against the inner surface of the guard after the free end of the fiber is captured on the entrance surface of the spool while the spool rotates through at least 270° but less than 360°.
6. A method for preventing damage to a fiber being wound on a spool according to claim 1, 2, 3, 4, or 5 wherein the inner surface of the guard comprises a substantial straight end section adapted to direct the path of the loose end of fiber toward the spool.

FIG.1

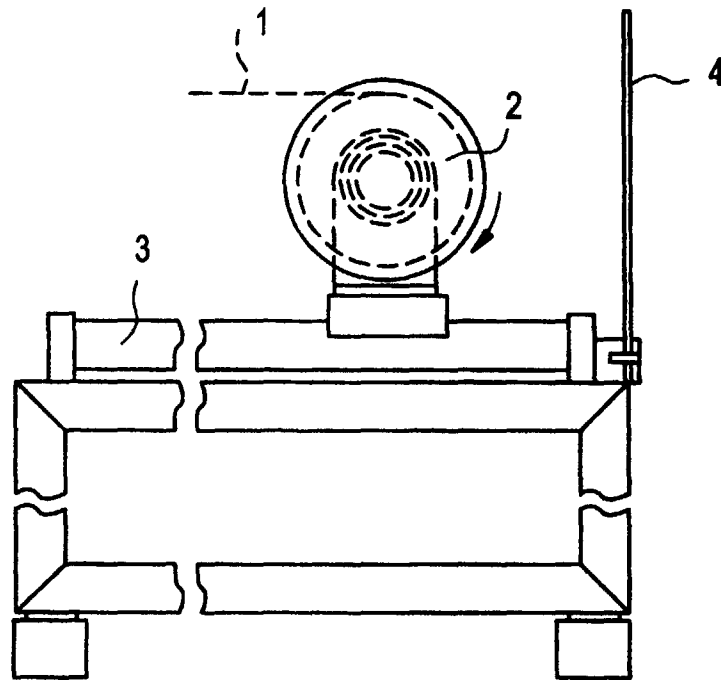


FIG.2

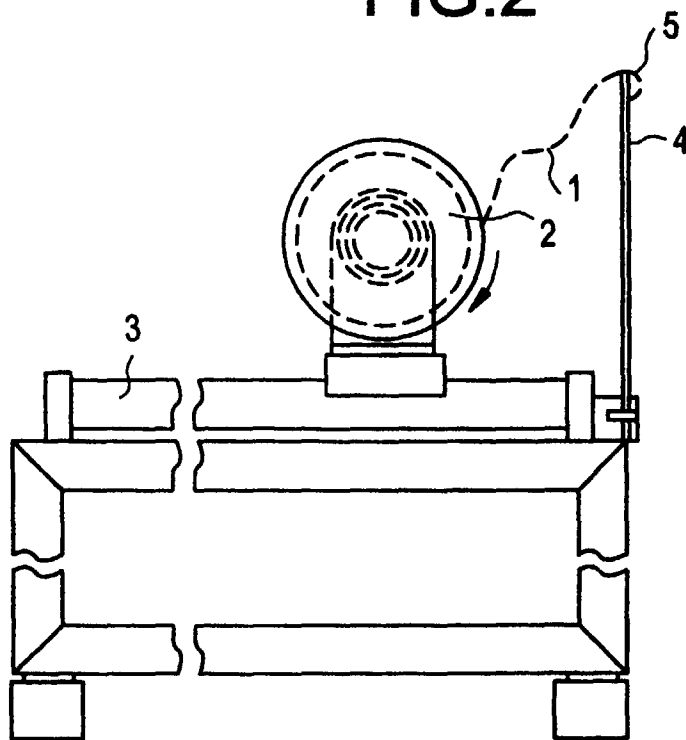


FIG.3

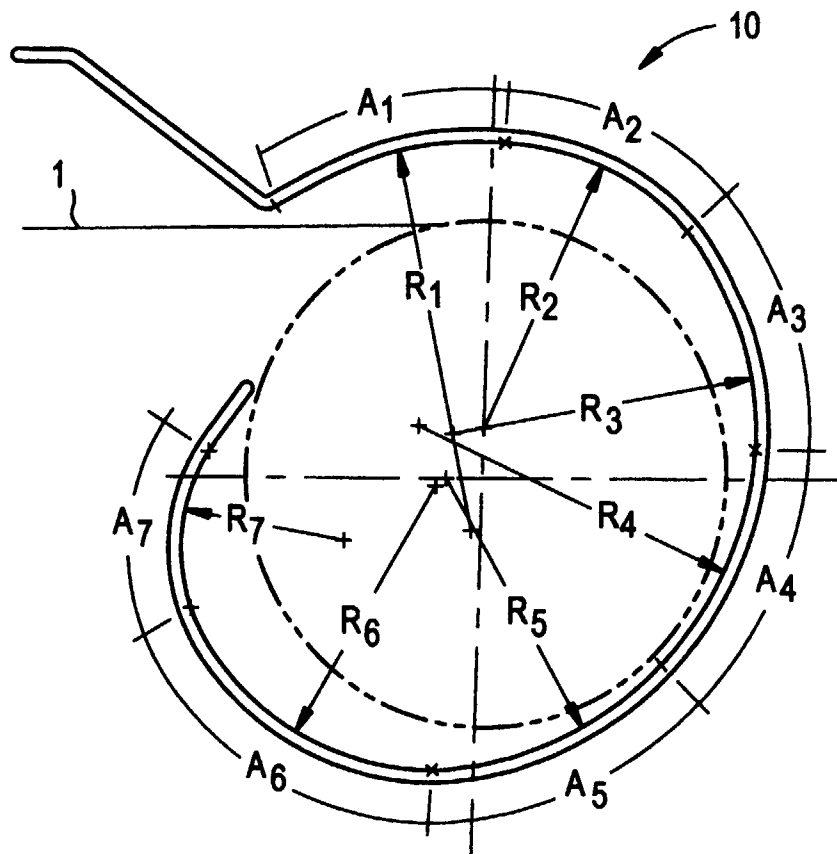


FIG.4

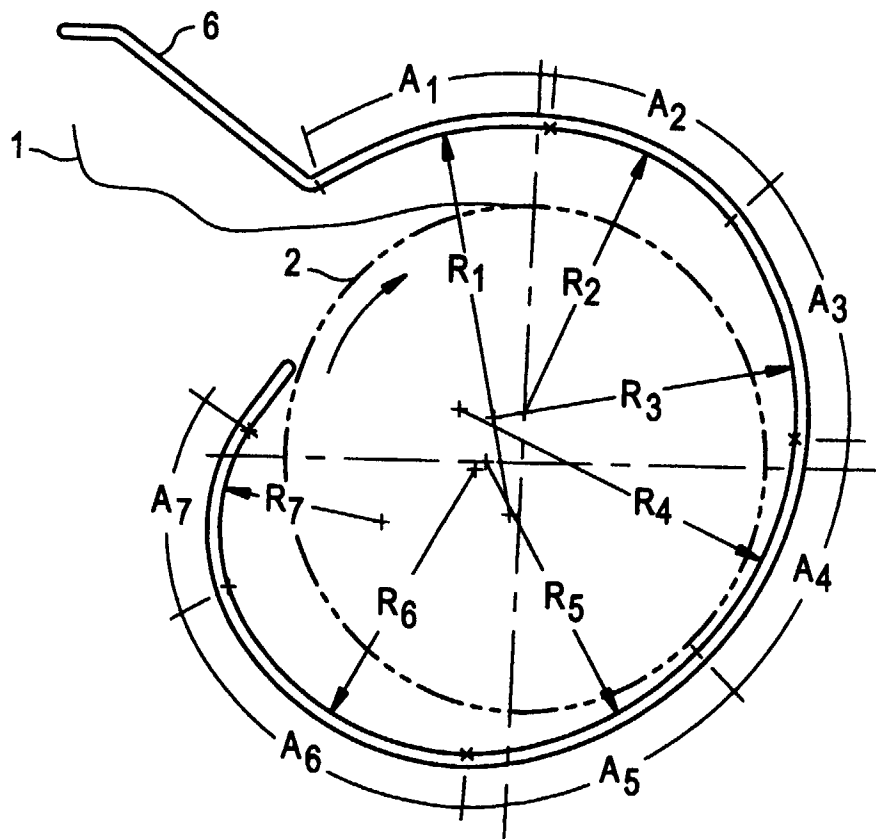


FIG.5

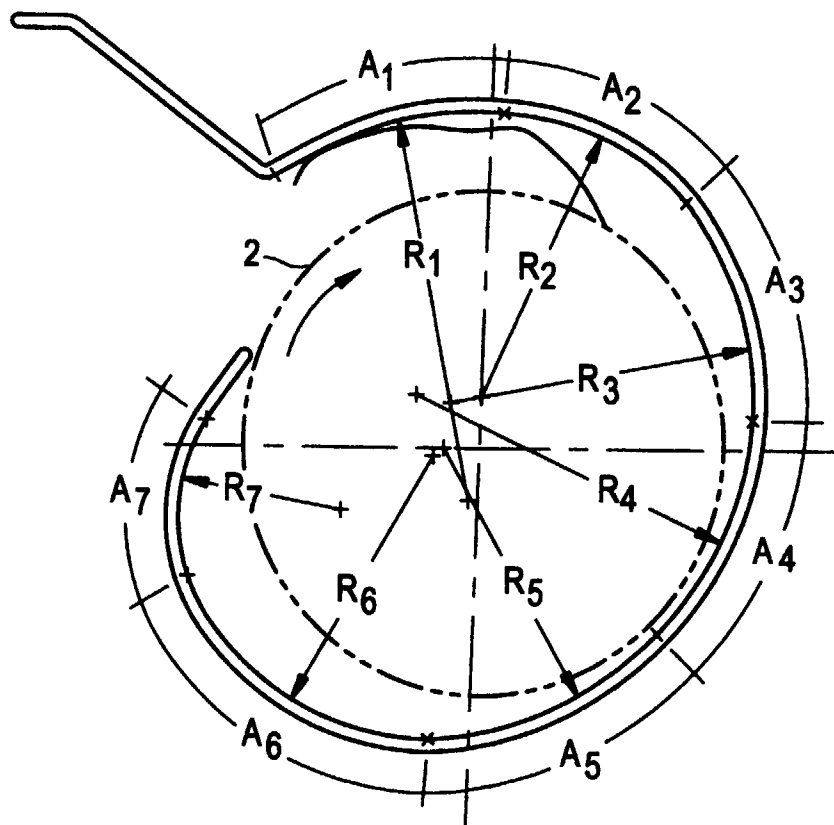




FIG.6

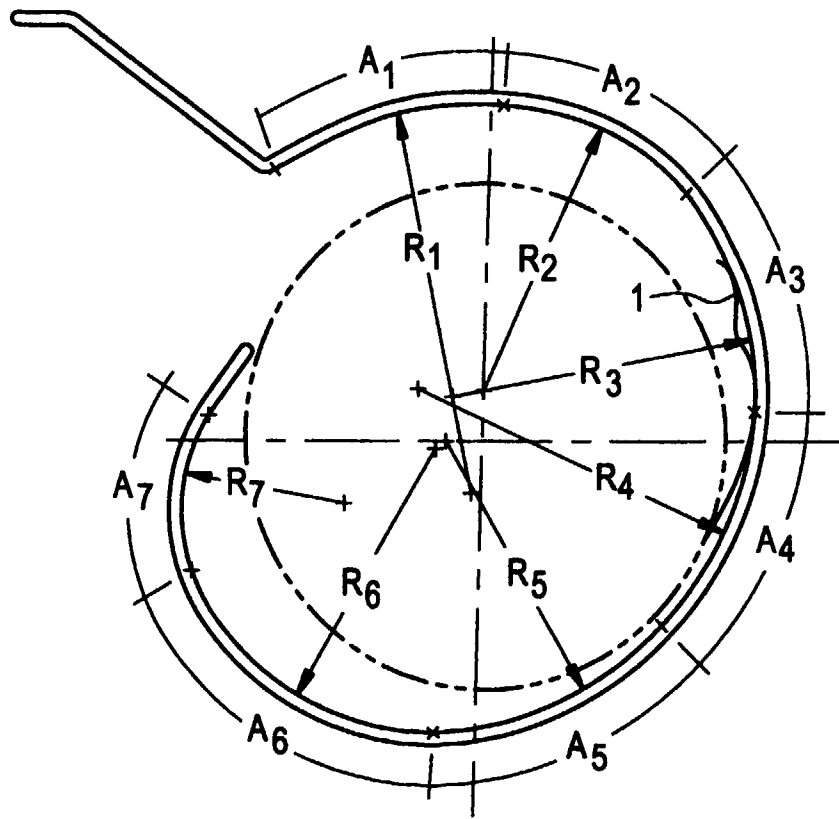


FIG.7

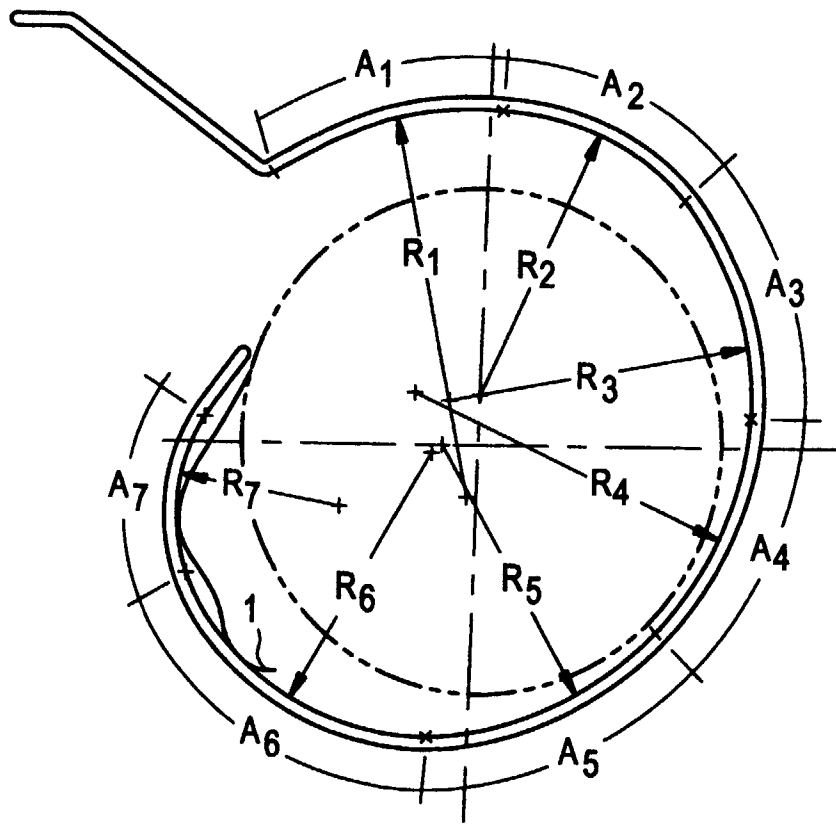


FIG.8

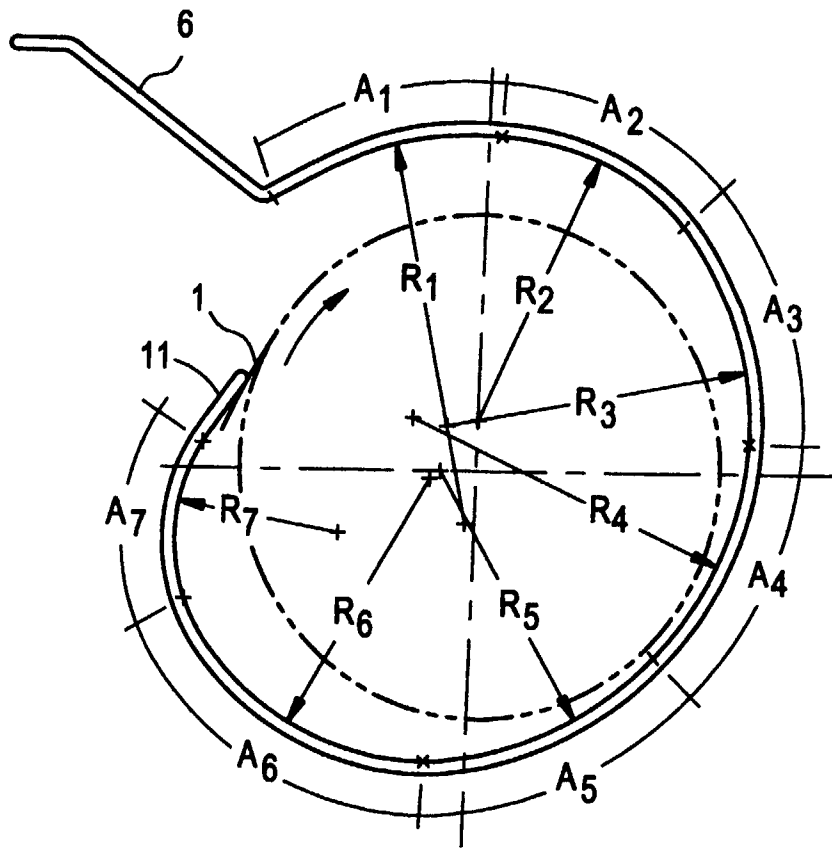
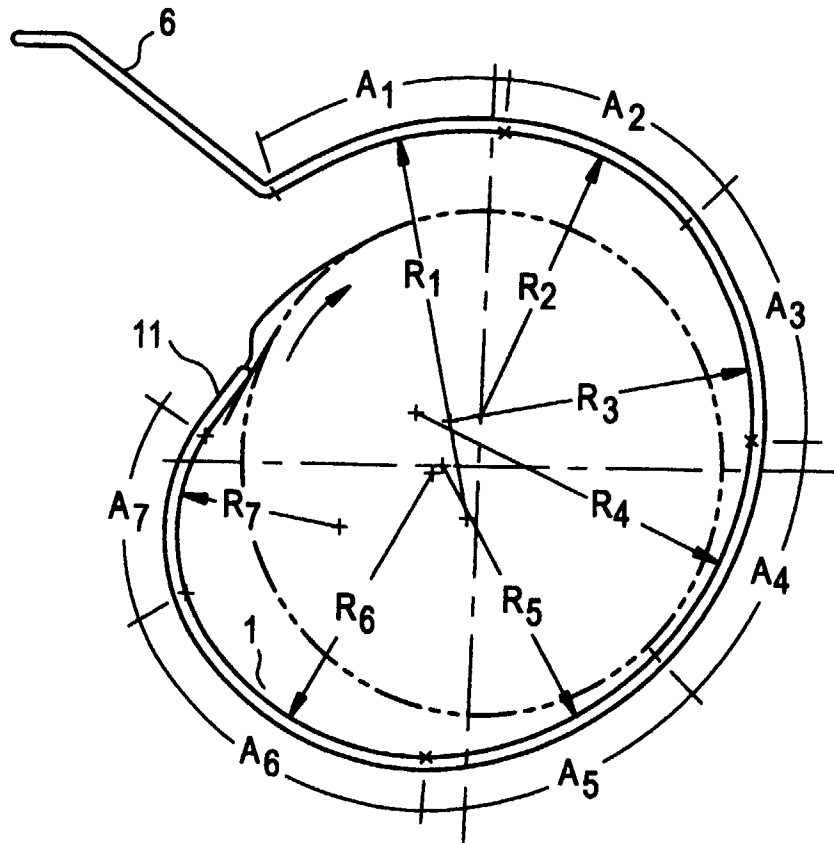


FIG.9





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# EUROPEAN SEARCH REPORT

Application Number  
EP 98 11 1134

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US 3 182 921 A (A.W. NELSON) 11 May 1965 * column 6, line 14 - column 9, line 6; figure 4 *	1-6	B65H54/72
X	FR 2 138 613 A (MAILLEFER SA) 5 January 1973 * page 3, line 30 - page 4, line 22 * * page 7, line 3 - page 8, line 4; figures *	1-5	
X	FR 2 249 015 A (MAILLEFER SA) 23 May 1975 * page 3, line 26 - page 6, line 4; figures 2,3 *	1-5	
X	FR 638 449 A (ELECTRICAL RESEARCH PRODUCTS INC.) 24 May 1928 * page 2, line 47 - page 3, line 17; figures *	1-5	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B65H
Place of search		Date of completion of the search	Examiner
BERLIN		1 October 1998	David, P
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons &amp; : member of the same patent family, corresponding document</p>			

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