



US007343725B2

(12) **United States Patent**  
**Kendall**

(10) **Patent No.:** **US 7,343,725 B2**  
(45) **Date of Patent:** **Mar. 18, 2008**

(54) **CUTTING ATTACHMENT FOR VEHICLE**

(75) Inventor: **Donald H. Kendall**, Chassell, MI (US)

(73) Assignee: **The United States of America as represented by the Secretary of the Army**, Washington, DC (US)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

3,841,656 A	10/1974	Kramb et al.
4,162,606 A	7/1979	Weichel
4,253,296 A	3/1981	Boydston
4,658,519 A	4/1987	Quenzi
4,790,085 A	12/1988	Rossmann
4,826,103 A	5/1989	McKown
4,946,488 A	8/1990	Davison
5,097,911 A	3/1992	Kendall
5,308,114 A	5/1994	Williams et al.
5,531,478 A	7/1996	Houston et al.
5,586,785 A	12/1996	Warner et al.

(Continued)

(21) Appl. No.: **11/482,299**

(22) Filed: **Jun. 26, 2006**

(65) **Prior Publication Data**

US 2007/0294992 A1 Dec. 27, 2007

(51) **Int. Cl.**

**A01D 34/00** (2006.01)

(52) **U.S. Cl.** ..... **56/12.7; 56/15.9**

(58) **Field of Classification Search** ..... 37/302;  
144/34.6; 56/229, 10.4, 12.7, 14.7, 15.9,  
56/17.1, 233

See application file for complete search history.

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

1,614,856 A	1/1927	Overbeck, Jr.
2,200,230 A	5/1940	Hojnowski
2,694,282 A	11/1954	Kirby
2,793,487 A	5/1957	Wobermin
2,821,217 A	1/1958	Shald ..... 144/34.1
3,033,253 A	5/1962	Purdy ..... 144/34.1
3,557,850 A	1/1971	Owens et al. .... 144/34.6
3,704,031 A	11/1972	Confer
3,724,579 A	4/1973	Albertson
3,743,316 A	7/1973	Stotesbery
3,770,293 A	11/1973	Anderson

**OTHER PUBLICATIONS**

U.S. Appl. No. 10/885,389, filed Jul. 7, 2004, Chopra, Kewal, Hedge Breaching Device.

*Primary Examiner*—Thomas B. Will

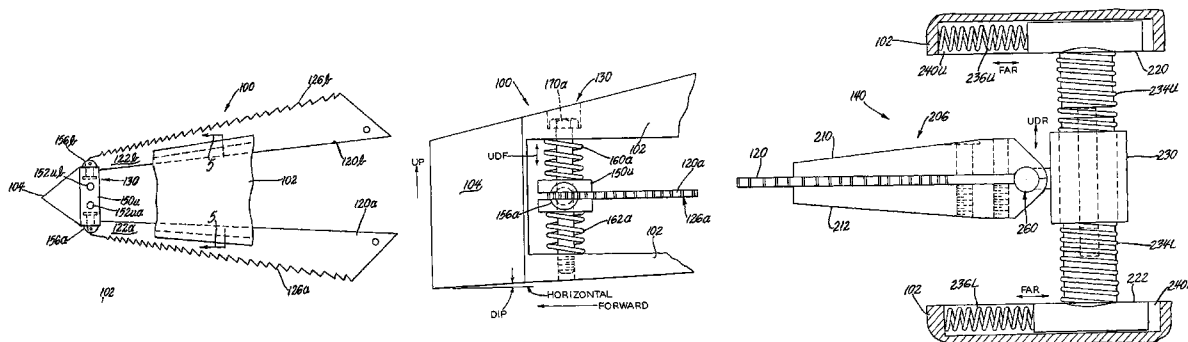
*Assistant Examiner*—Mai T Nguyen

(74) *Attorney, Agent, or Firm*—David L. Kuhn; Thomas W. Saur; Luis Miguel Acosta

(57) **ABSTRACT**

A debris cutting system for attachment to a vehicle. The system includes a nose shaped projection that extends horizontally in the forward direction from the forward moving end of the vehicle. The projection includes a front blade mount subsystem, a pair of rear blade mount subsystems, and left and right blades that are mounted within the front blade mount subsystem and respective ones of the rear blade mount subsystems. Each blade has a respective blade front, blade rear and teeth. The front blade mount subsystem provides vertical movement at the front of the blades, the rear blade mount subsystems provide vertical and longitudinal movement at the rear of the blades such that cutting of debris is enhanced and potential damage to the blades is reduced as the vehicle moves forward.

**6 Claims, 10 Drawing Sheets**



## Report Documentation Page

*Form Approved*  
*OMB No. 0704-0188*

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE <b>18 MAR 2008</b>	2. REPORT TYPE <b>N/A</b>	3. DATES COVERED <b>-</b>	
4. TITLE AND SUBTITLE <b>Cutting Attachment For Vehicle</b>		5a. CONTRACT NUMBER	
		5b. GRANT NUMBER	
		5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) <b>Donald H. Kendall</b>		5d. PROJECT NUMBER	
		5e. TASK NUMBER	
		5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>US Army RDECOM-TARDEC 6501 E 11 Mile Rd Warren, MI 48397-5000</b>		8. PERFORMING ORGANIZATION REPORT NUMBER <b>18959</b>	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S) <b>TACOM/TARDEC</b>	
		11. SPONSOR/MONITOR'S REPORT NUMBER(S) <b>18959</b>	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release, distribution unlimited</b>			
13. SUPPLEMENTARY NOTES <b>US Patent No.: US 7,343,725 B2</b>			
14. ABSTRACT			
15. SUBJECT TERMS			
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>SAR</b>
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>	
19a. NAME OF RESPONSIBLE PERSON			

# US 7,343,725 B2

Page 2

---

U.S. PATENT DOCUMENTS			
5,600,943	A	2/1997	Ryan
5,970,634	A	10/1999	Dann et al.
6,105,680	A	8/2000	High
6,314,707	B1	11/2001	Ryan
6,439,279	B1	*	8/2002 Underwood ..... 144/34.6
6,701,646	B2		3/2004 Schultz et al.
6,860,040	B2		3/2005 Schultz et al.

\* cited by examiner

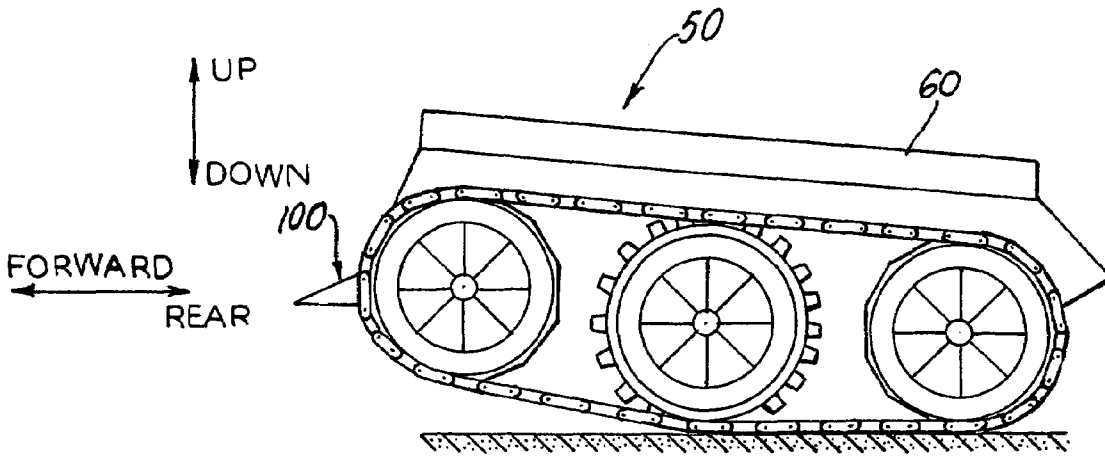


Fig. 1

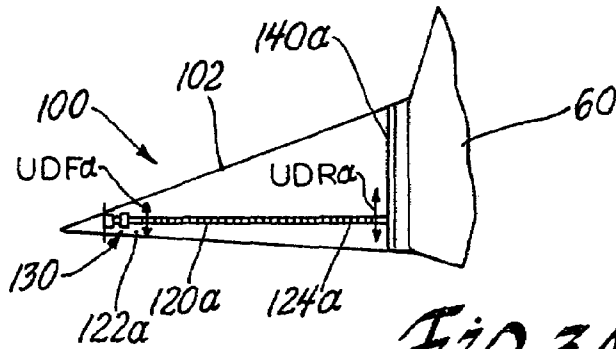


Fig. 3A

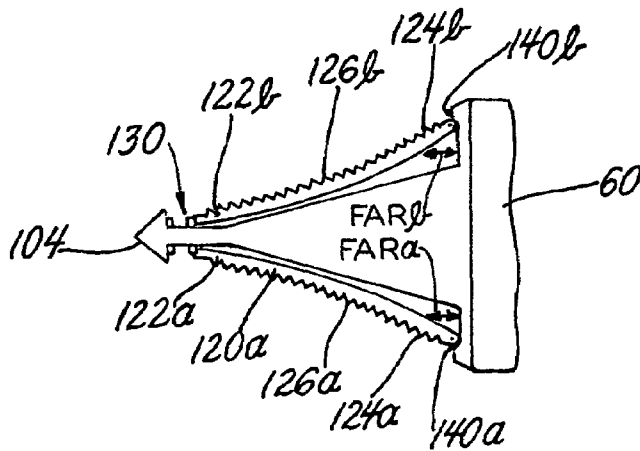
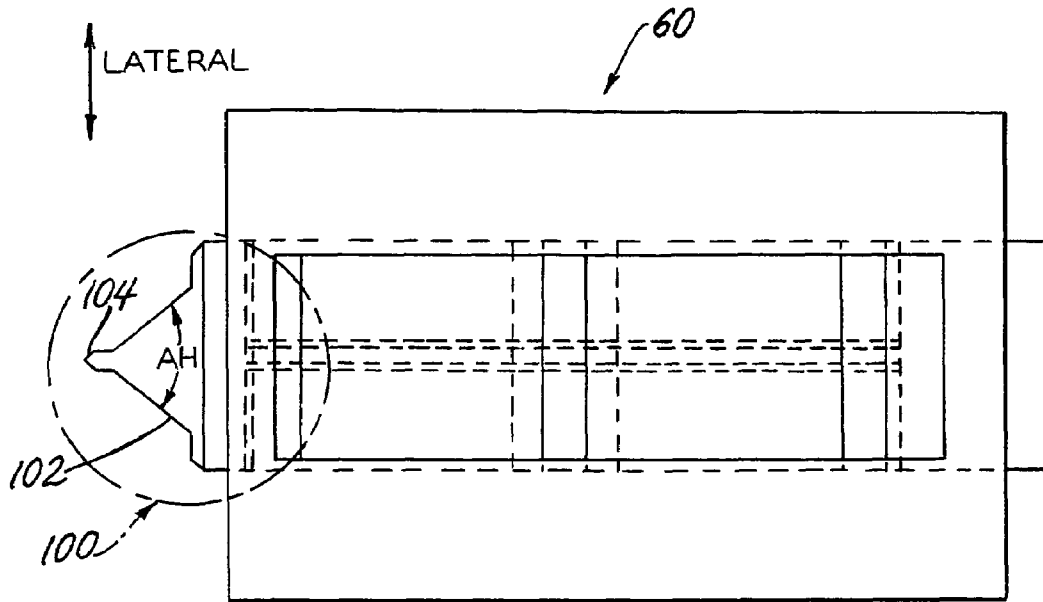
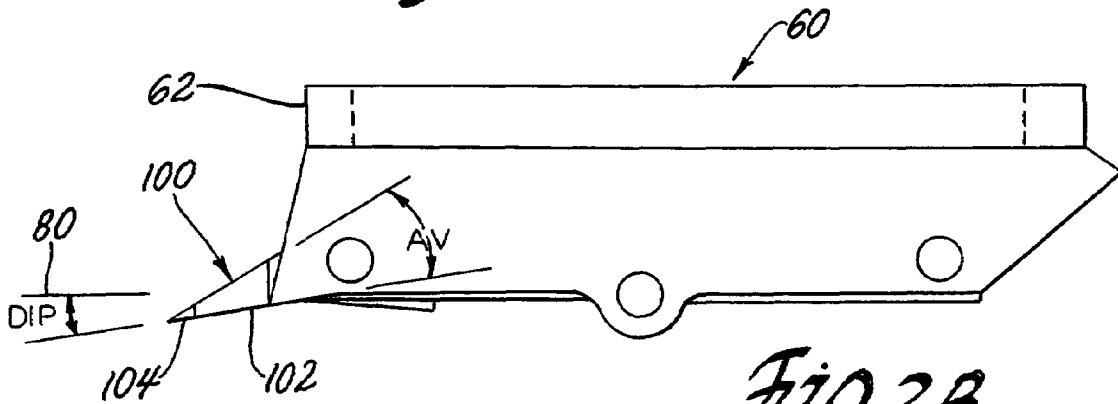


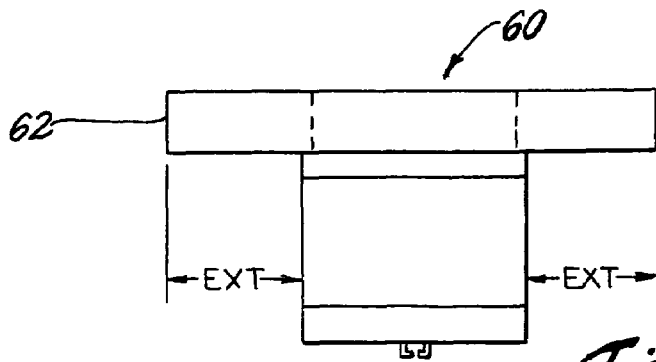
Fig. 3B



*Fig. 2A*



*Fig. 2B*



*Fig. 2C*

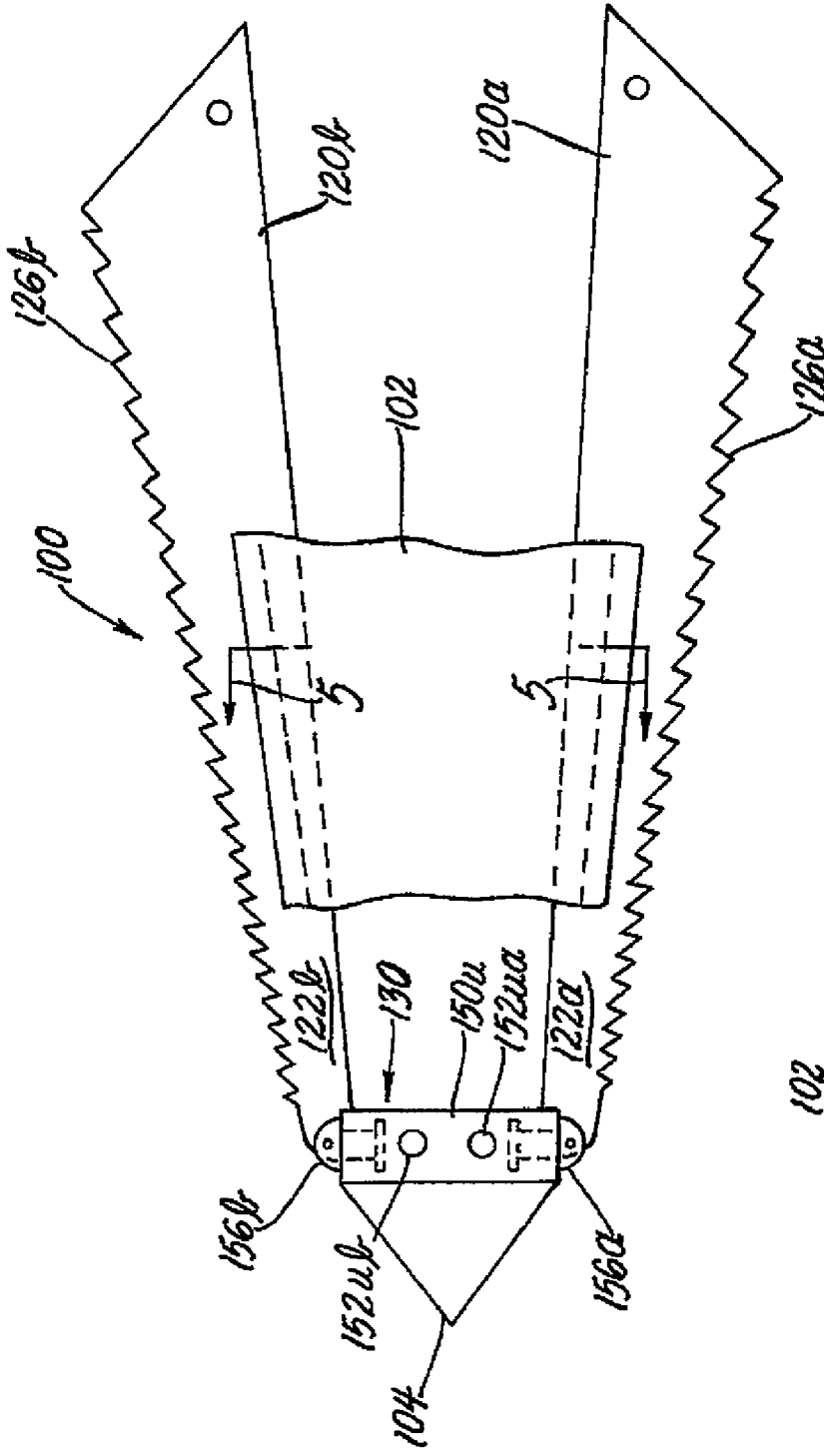


Fig. 4

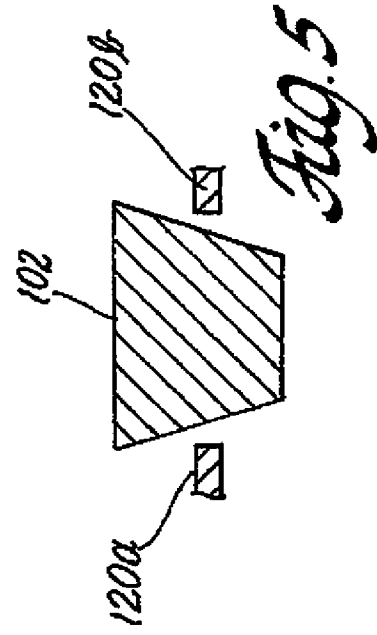
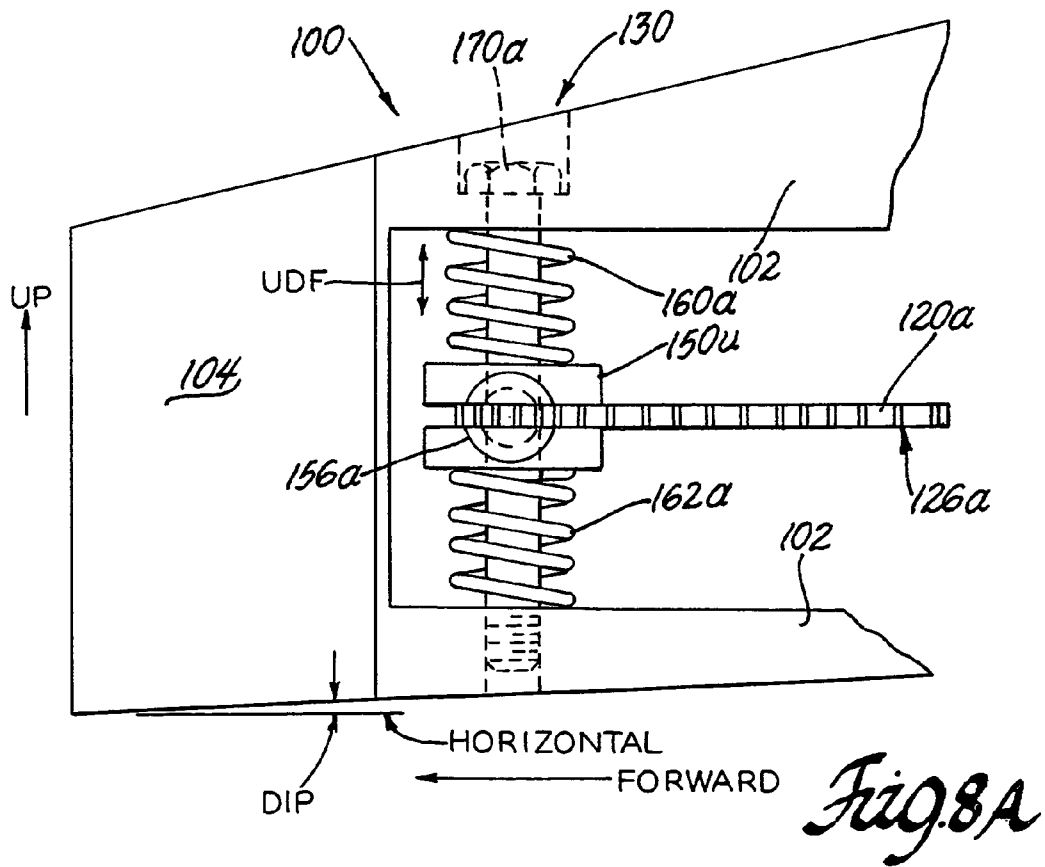
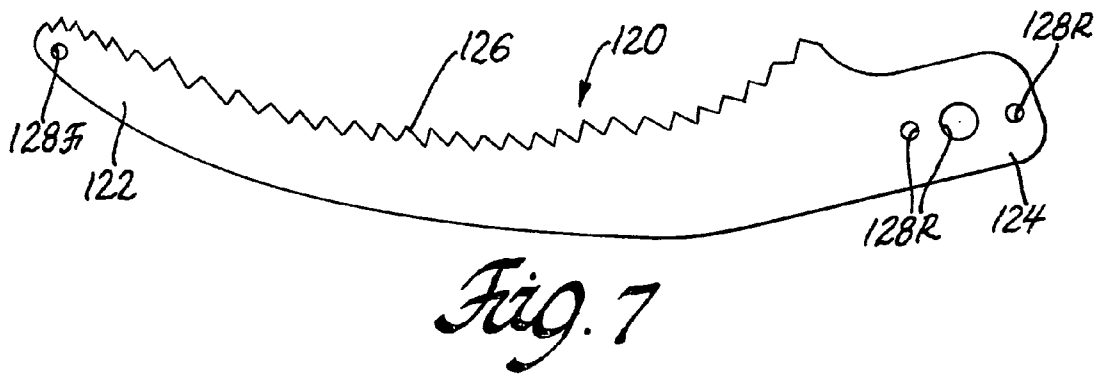
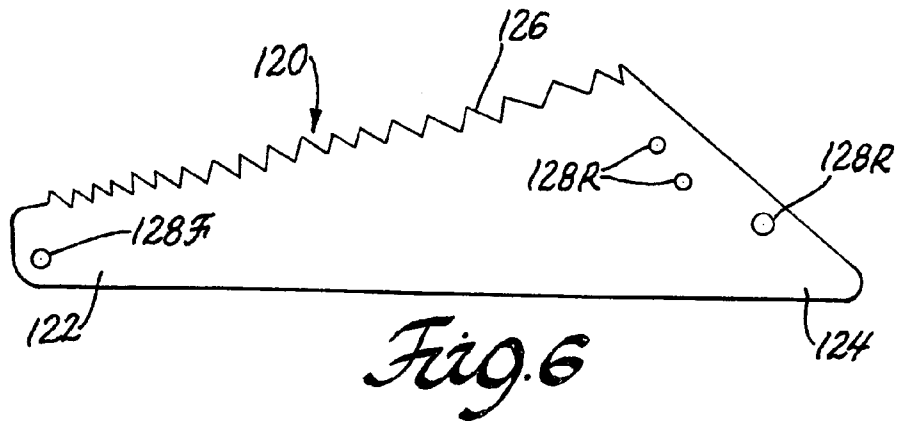


Fig. 5



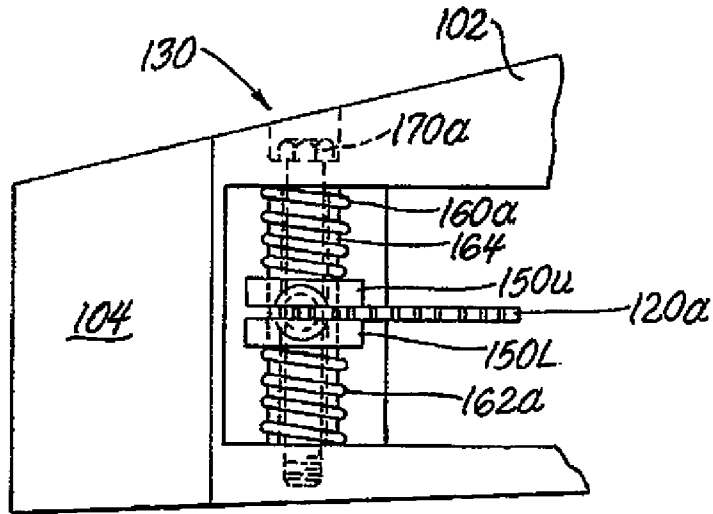


Fig. 8B

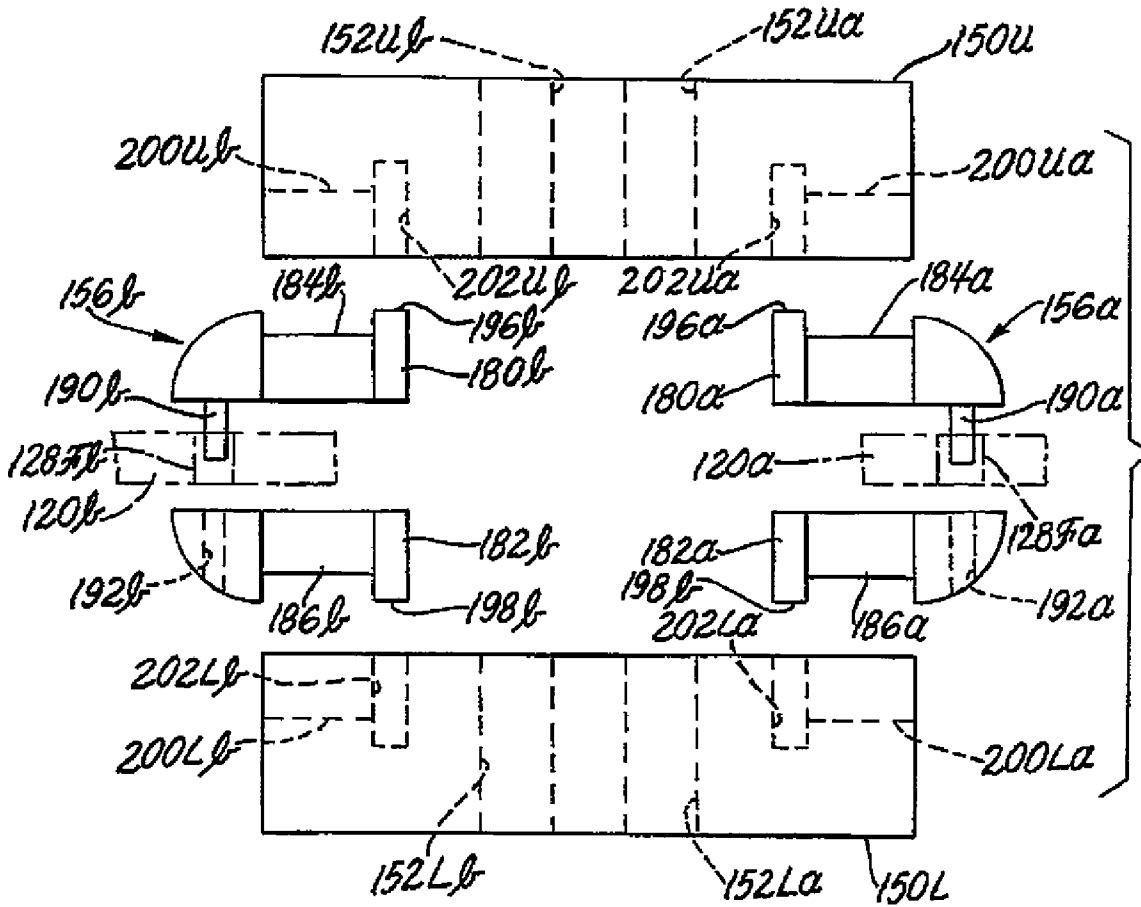
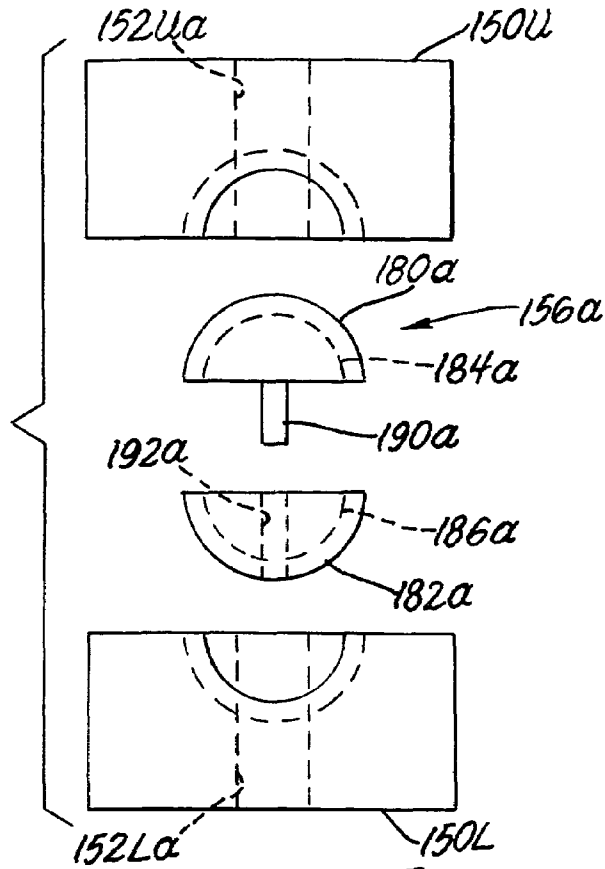
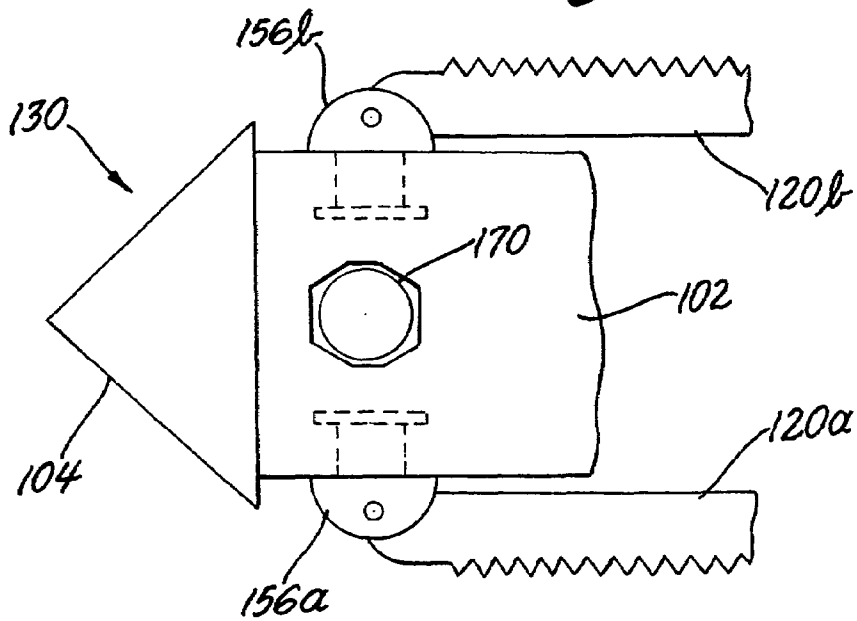


Fig. 9





*Fig. 10*



*Fig. 11*

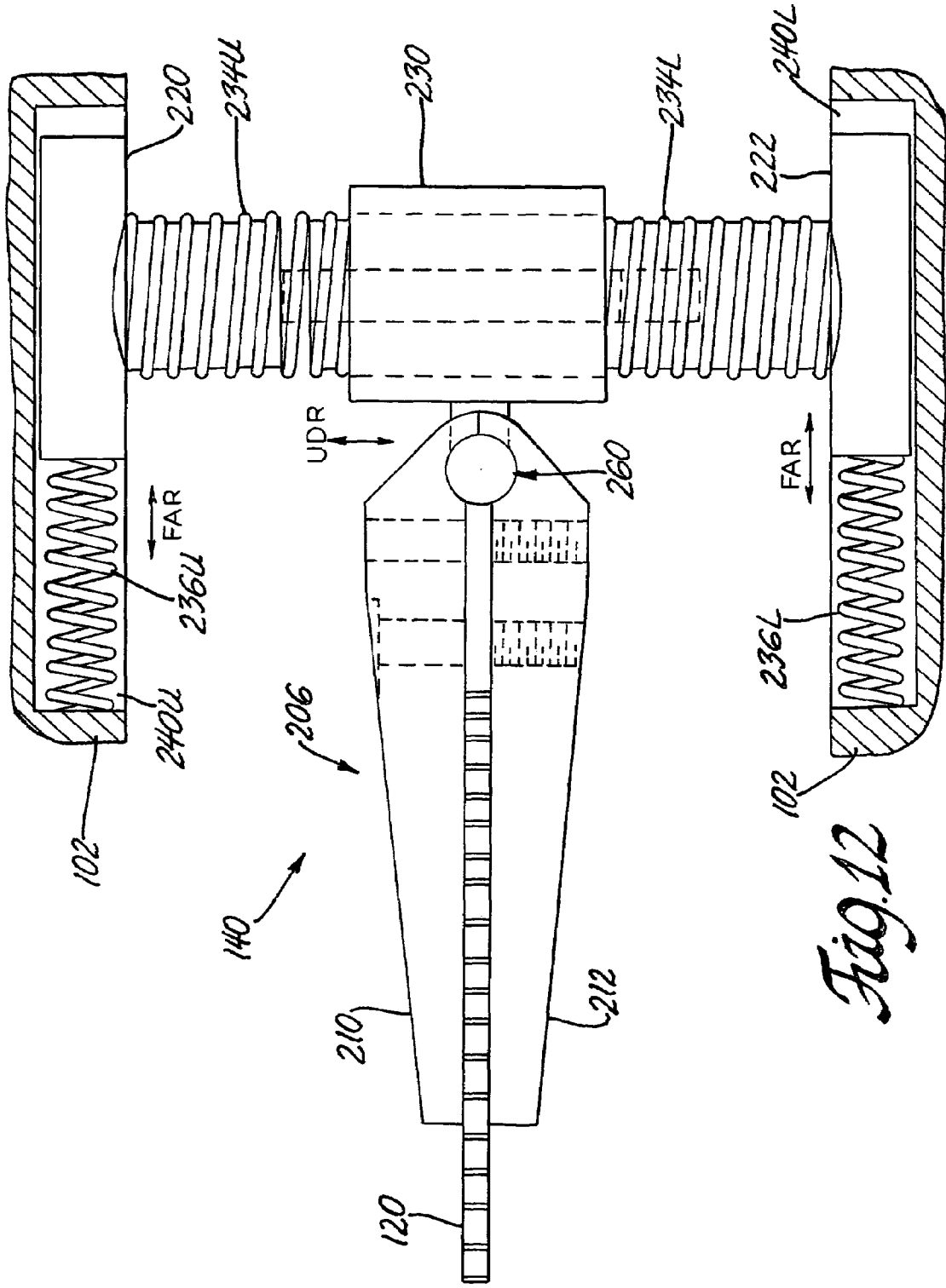
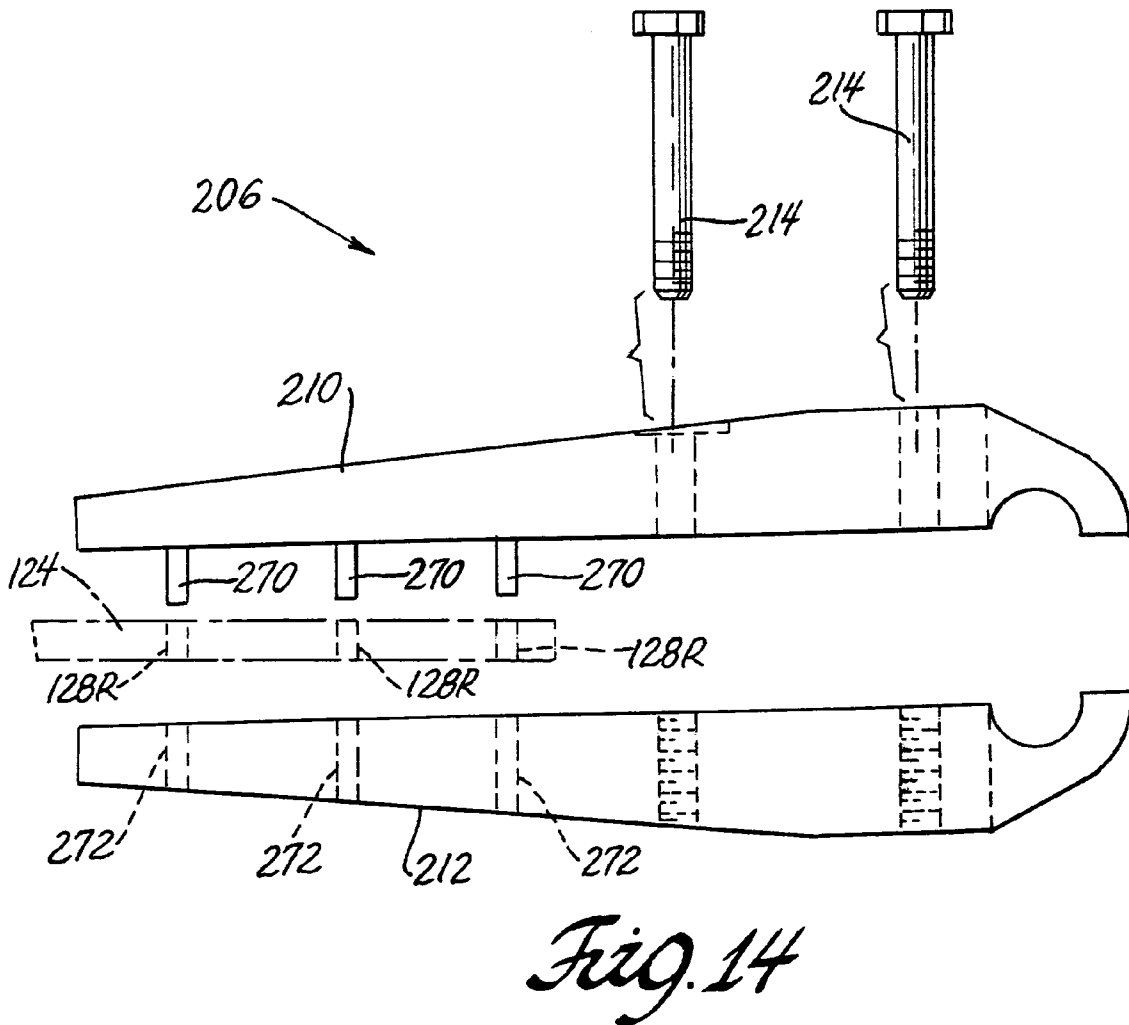
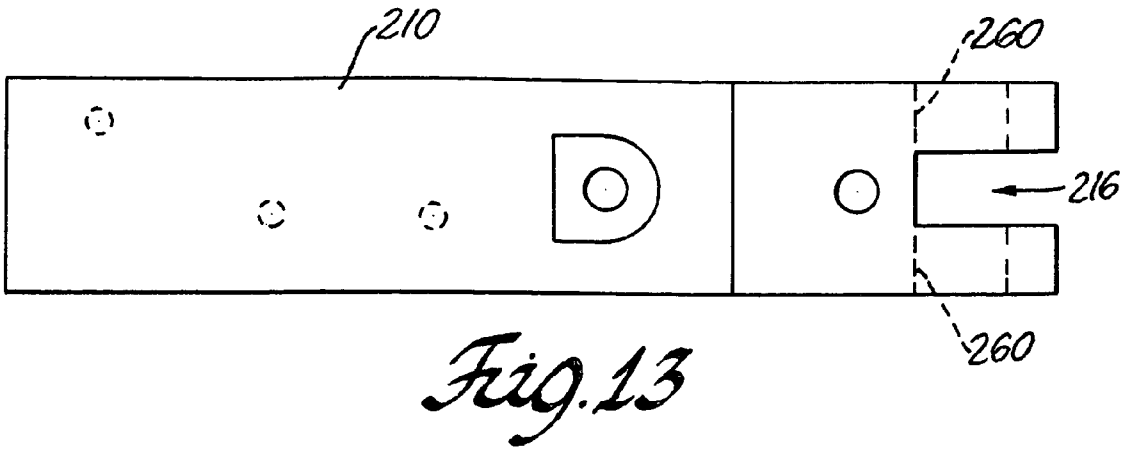
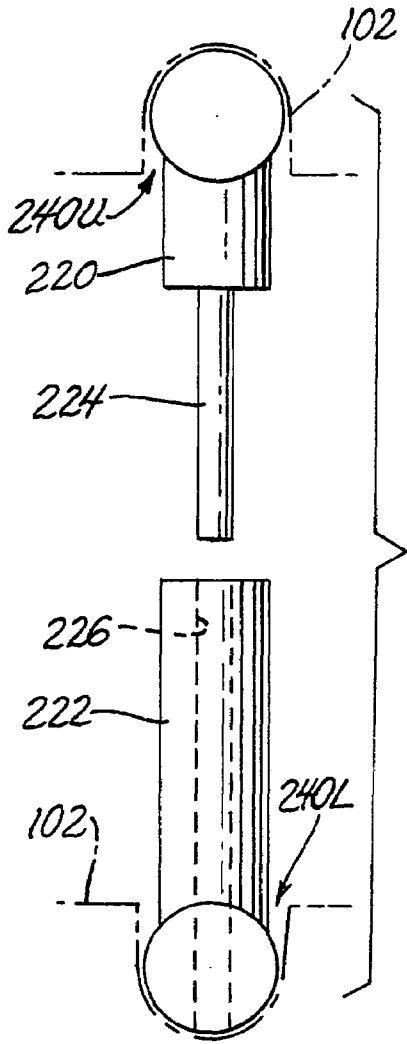
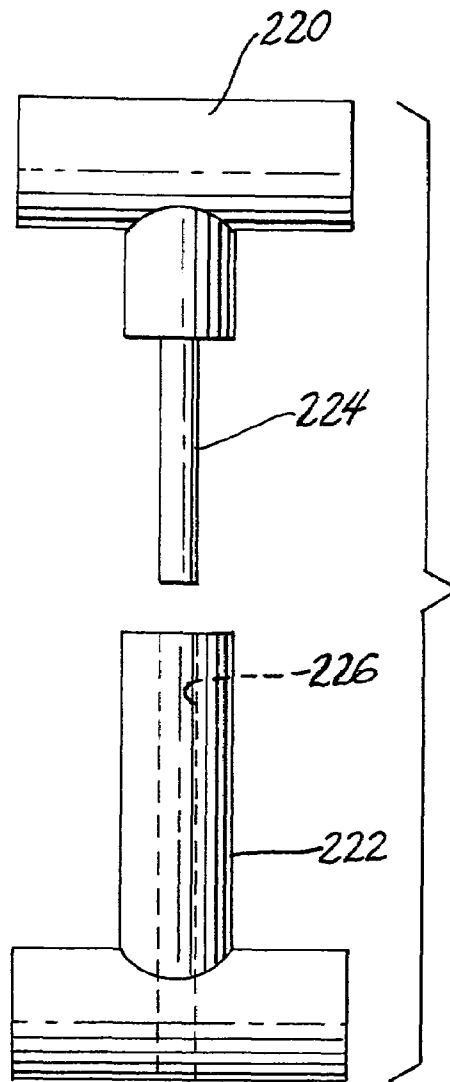


Fig. 12

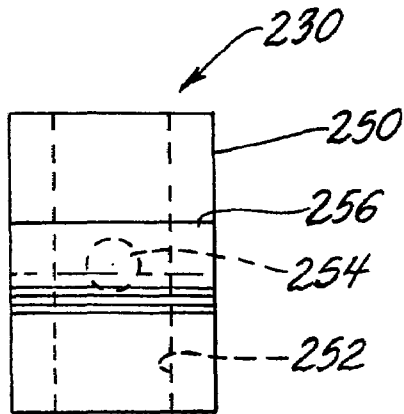




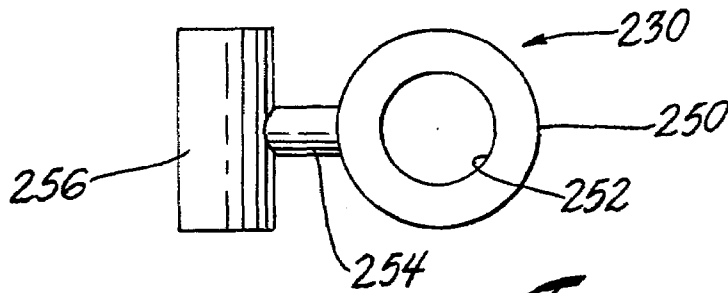
*Fig. 15*



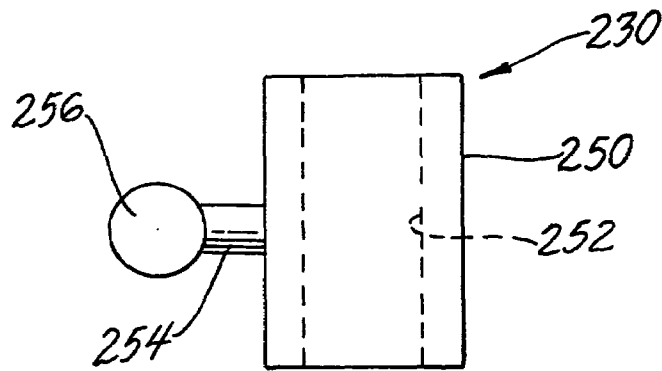
*Fig. 16*



*Fig. 17*



*Fig. 18*



*Fig. 19*

1

**CUTTING ATTACHMENT FOR VEHICLE**

## GOVERNMENT INTEREST

The invention described here may be made, used and licensed by and for the U.S. Government for governmental purposes without paying royalty to me.

## BACKGROUND OF THE INVENTION

## 1. Field of the Invention

The present invention generally relates to a system for a cutting attachment for a vehicle.

## 2. Background Art

For many vehicles, vegetation, plant undergrowth, vines, as well as ropes, wires, and similar debris or like obstructions present a problem for mobility of the vehicle. Cutters are typically attached to the vehicle to attempt to provide an open path for the vehicle. However, removal or clearing the debris to provide a passable path for the vehicle can take a substantial amount of time and energy when conventional approaches to cutting attachments are used.

In particular, conventional cutter attachments on vehicles often fail to accommodate topographical and obstacle variations (e.g., slopes, hills, rocks, etc.) over which the vehicle passes. In particular, conventional simple slider or shoe devices are implemented on the lateral ends of the conventional cutter device to ride on the terrain to attempt to maintain ground clearance for the cutting mechanism. However, obstructions such as rocks, stumps, and the like may be encountered between the slider devices, and the cutting attachment is often impacted against the obstruction and damaged or broken. Further, conventional cutter attachments often fail to provide for quick and simple replacement of dull or damaged cutting surfaces.

Thus, there exists a need and an opportunity for an improved cutting attachment (e.g., a system for cutting debris) for a vehicle. Such an improved debris cutting system for attachment to a vehicle may overcome one or more of the deficiencies of the conventional approaches.

## SUMMARY OF THE INVENTION

Accordingly, the present invention may provide an improved cutting attachment (e.g., a system for cutting debris) for a vehicle. The improved cutting attachment system of the present invention may be implemented as a system for cutting debris that is mounted to the respective vehicle.

According to the present invention, a debris cutting system for attachment to a vehicle is provided. The system comprises a nose shaped projection that extends horizontally in the forward direction from the forward moving end of the vehicle. The projection comprises a front blade mount subsystem and a pair of rear blade mount subsystems. Left and right blades that are mounted within the front blade mount subsystem and respective ones of the rear blade mount subsystems. Each blade has a respective blade front, blade rear and teeth. The front blade mount subsystem provides vertical movement at the front of the blades, the rear blade mount subsystems provide vertical and longitudinal movement at the rear of the blades such that cutting of debris is enhanced and damage to the blades is reduced as the vehicle moves forward.

The front blade mount subsystem comprises an upper front slide, a lower front slide, a left front blade support, and a right front blade support. The left front blade support and

2

the right front blade support are mounted between the upper and lower front slides. The left front blade support supports and holds the left blade front, and the right front blade support supports and holds the right blade front. The left and right front blade supports are cylindrically shaped to provide rotation about a lateral axis and the rotation is limited by the respective blades such that the vertical movement at the front of the blades is provided.

The front blade mount subsystem further comprises upper left and right front springs, lower left and right front springs, and left and right front slide bolts. The upper front slide comprises an upper left slide bolt hole and an upper right slide bolt hole. The lower front slide comprises a lower left slide bolt hole and a lower right slide bolt hole. The respective front slide bolts are received in respective recesses in an upper portion of the nose shaped projection, extend centrally through the respective upper front springs, through the respective upper slide bolt holes, through the respective lower slide bolt holes, centrally through the respective lower front springs, and are threadably fastened in a lower portion of the nose shaped projection such that the respective upper and lower front springs provide compressive force to retain the respective blade fronts.

Each of the cylindrically shaped front blade supports comprises an upper portion and a matching lower portion. The upper portion comprises a substantially semi-cylindrical upper shaft region, a stud portion that extends radially at one end of the upper portion, and a substantially semi-cylindrical upper flange end at the end of the shaft region opposite the stud portion. The lower portion comprises a substantially semi-cylindrical lower shaft region, a radial hole that mates with the stud portion, and a substantially semi-cylindrical lower flange end at the end of the lower shaft region opposite the radial hole. The stud protrudes through a respective front blade mounting hole and into the radial hole to removably clamp the blade front in the front blade support between the respective upper portion and lower portion.

The upper and lower front slides comprise respective substantially semi-cylindrical upper and lower shaft recesses that receive the respective upper and lower shaft regions, and respective substantially semi-cylindrical upper and lower flange recesses that receive the respective upper and lower flange ends. The respective cylindrically shaped upper and lower front blade supports rotate in the upper and lower shaft recesses, and the respective upper and lower flange ends laterally restrain the front blade supports in the front slides.

The rear blade mount subsystem comprises left and right sections. The left and right sections each comprise a blade clamp apparatus that comprises an upper rear blade clamp, a lower tensioner, an upper tensioner, a rear slide, vertical rear tension springs, and longitudinal rear tension springs. The upper rear blade clamp is threadably mechanically coupled to a lower rear blade clamp via bolts. The respective blade rear is clamped between the upper rear blade clamp and the lower rear blade clamp. The lower tensioner that is slidably mechanically coupled to the upper tensioner via a shaft extension on the upper tensioner that snugly fits into a mating cylindrical through bore in the lower tensioner.

The upper tensioner and the lower tensioner are T shaped with substantially similarly sized cylindrical vertical legs and cross-bars, and the lower tensioner is an inverted T shape. The upper tensioner and the lower tensioner are laterally and vertically restrained, and slide in the fore/aft direction in respective mating grooves in the projection via tension exerted by the vertical rear tension springs and longitudinal rear tension springs to provide vertical and longitudinal movement at the rear of the blades. The vertical

rear tension springs are sized to snugly slide over respective vertical leg members of the upper tensioner and the lower tensioner.

The longitudinal rear tension springs are mechanically fastened at a front end to the front end of the respective groove and at a rear end to the front end of a respective cross-bar portion of the T shape of the upper tensioner and the lower tensioner. The rear slide comprises a substantially cylindrical body section that has a center through bore sized to receive the vertical leg of the lower tensioner and freely slide vertically thereon. The rear slide further comprises a connector leg and an axle. The cylindrical body section is implemented as a vertically oriented pipe. The connector leg is generally horizontally and longitudinally oriented and mechanically couples the body section to the axle. The axle is horizontally and laterally oriented.

The respective upper rear blade clamp and the lower rear blade clamp are fastened together to form a substantially cylindrical, laterally oriented receiving bore, the bore is sized to receive the axle to provide vertical and longitudinal movement at the rear of the blades, and a gap in the upper rear blade clamp and the lower rear blade clamp provides a clearance path for the connector leg.

The upper rear blade clamp includes a plurality of pegs that extend downward from the underside of the upper rear blade clamp, the lower rear blade clamp includes a matching plurality of vertical holes that are sized and positioned to mate with the respective pegs. When the upper rear blade clamp and the lower rear blade clamp are fastened together, the pegs extend through respective rear mounting holes in the rear blade to removably fasten the blade rear within the system.

The system further comprises a substantially triangular shaped or "arrowhead" shaped tip at the apex of the projection that intersects, spreads and positions debris to be displaced or cut via the system as the vehicle moves forward.

The above features, and other features and advantages of the present invention are readily apparent from the following detailed descriptions thereof when taken in connection with the accompanying drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagram of a vehicle implementing an example of the present invention;

FIGS. 2(A-C) are diagrams illustrating top, side and end views of a vehicle hull implementing an example of the present invention;

FIGS. 3(A-B) are more detailed diagrams of an example implementation of the present invention;

FIG. 4 is a diagram of a top view of an example of the cutting system of the present invention;

FIG. 5 is a diagram of a cross section of a projection portion of the present invention;

FIGS. 6 and 7 are diagrams of top views of two example blades of the present invention;

FIGS. 8(A-B) are diagrams of a side view of examples of a front mounting subsystem of the present invention;

FIG. 9 is a diagram of an exploded, end view of portions of the front mounting subsystem of the present invention;

FIG. 10 is a diagram of an exploded, side view of portions of the front mounting subsystem of the present invention;

FIG. 11 is a diagram of a top view of an alternative example of a front mounting subsystem of the present invention;

FIG. 12 is a diagram of a side view of a rear mounting subsystem of the present invention;

FIG. 13 is a diagram of a top view of a rear blade clamp apparatus of the rear mounting subsystem of the present invention;

FIG. 14 is a diagram of an exploded, side view of a rear blade clamp apparatus of the rear mounting subsystem of the present invention;

FIG. 15 is a diagram of an exploded, end view of a rear blade tensioner apparatus of the rear mounting subsystem of the present invention;

FIG. 16 is a diagram an exploded, side view of a rear blade tensioner apparatus of the rear mounting subsystem of the present invention; and

FIGS. 17-19 are diagrams of end, side, and top views, respectively, of a slide of the rear mounting subsystem of the present invention.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

With reference to the Figures, the preferred embodiments of the present invention will now be described in detail. Generally, the present invention provides a system for an improved cutting attachment (e.g., a system for cutting debris) for a vehicle. The improved cutting attachment system of the present invention may be implemented as a system for cutting debris (e.g., a "brush blade", and the like) that is mounted (i.e., fastened, fixed, installed, implemented in connection with, etc.) to the respective vehicle. The present invention generally provides a system that promotes clearing a path for passage of the respective vehicle, protection of the vehicle to reduce damage to the vehicle, clearing a fireline, reducing interference with mine clearing equipment, and protection for an operator of the vehicle from injury. The debris that is generally cut and cleared by the cutting attachment of the present invention may include brush, shrubs, small trees and limbs, roots, vines, rope, sea weed, fence material, wire, cable, and the like.

In one example, the cutting attachment (or cutter) of the present invention may be implemented as stand-alone device that is mounted to a respective vehicle. In another example, the cutting attachment of the present invention may be implemented in connection with a vehicle mounted mine clearing system (not shown, e.g., rollers, flails, cutting disks, and the like). The present invention may be advantageously implemented for use in connection with vehicles that operate on road or off road, through swamps and bogs, and through water.

The present invention generally includes a pair of cutting blades (e.g., a blade sub-assembly) that are semi-movably (and, thus, semi-rigidly) attached relative to vertical movement of the vehicle, and to forward/rearward (longitudinal) movement of the vehicle. The partially flexible mounting of the blade sub-assembly generally includes slides, springs, and studs (or bolts), as described in detail below. The partially flexible mounting of the blade sub-assembly may reduce or prevent buckling and excessive flexing of the blades as more dense material is cut and thus reduce or prevent blade breakage.

The vertically partially flexible mounting of the blade sub-assembly may further accommodate uneven terrain over which it may be desirable to operate the vehicle. Such uneven terrain may cause undesirable blade bending, buckling and breakage in conventional approaches. The partially flexible mounting of the blade sub-assembly may provide a

5

substantially parallel orientation of the cutting blades relative to the surface over which the vehicle is operated.

The longitudinally partially movable mounting of the blade sub-assembly may further provide an enhanced displacement of debris before, during, and after the cutting process that is performed via the present invention. As the cutting blades are generally orientated diagonally with respect to the forward motion of the vehicle, the longitudinally partially flexible and movable mounting of the blade sub-assembly of the present invention may yet further provide an enhanced sawing motion to the cutting blades.

Referring to FIG. 1, a diagram illustrating a vehicle **50** having a cutting attachment system (e.g., apparatus, device, etc.) **100** of the present invention is shown as typically implemented (i.e., installed, mounted, fixed, attached, hooked, fastened, mechanically coupled, integrated within, combined with, made part of, incorporated in connection with, etc.). In one example, the vehicle **50** may be implemented as a manned or unmanned mine clearing device. In another example, the vehicle **50** may be implemented as an unmanned multi-purpose vehicle (e.g., a robotic vehicle). In yet another example, the vehicle **50** may be implemented as a manned or unmanned underwater exploration craft. However, the vehicle **50** may be implemented as any appropriate vehicle to meet the design criteria of a particular application.

Forward/reverse (longitudinal) and vertical (up/down) directions relative to the vehicle **50** and system **100** are generally as illustrated. As such, lateral (left/right) directions (see, for example, FIG. 2A) are generally perpendicular to the longitudinal/vertical plane.

In one example (e.g., as illustrated in FIG. 1), the vehicle **50** may be implemented as a tracked (i.e., track steered and track driven) vehicle. In another example (not shown), the vehicle **50** may be implemented as a wheeled vehicle. In yet another example (not shown), the vehicle **50** may be implemented as a so-called half-track (i.e., steered via wheels and driven via a track system) vehicle. In yet a further example (not shown), the vehicle **50** may be implemented as a ski steered and track system driven vehicle (e.g., a snow mobile). However, the vehicle **50** may be implemented having any appropriate vehicle steering apparatus and driving apparatus to meet the design criteria of a particular application.

The vehicle **50** generally comprises a hull structure **60** to which the cutter assembly **100** is generally attached or made part of. The cutting apparatus **100** is generally implemented on the front of the hull **60** (i.e., on the end of the hull **60** that is at the forward moving end when the vehicle **50** is operated in a normally forward direction). However, when desired to meet the design criteria of a particular application, the cutting apparatus **100** may be implemented on the rear end of the hull structure **60** (not shown).

As such, one example implementation of the present invention may include a cutting apparatus **100** at the front end of the vehicle **50**, another example implementation of the present invention may include a cutting apparatus **100** at the rear end of the vehicle **50**, and yet another example implementation of the present invention may include cutting apparatuses **100** at both the front end and the rear end of the vehicle **50**. Further, multiple instances (not shown) of the cutter assembly **100** may be implemented at either or both ends of the vehicle **50** to meet the design criteria of a particular application. Yet further, one or more of the cutting apparatus **100** may be implemented on the upper surface of the hull **60** such that debris above ground level may be cut and displaced.

6

Referring to FIGS. 2(A-C), diagrams illustrating top, side, and rear end views, respectively, of the hull structure **60** are shown in more detail. Details of the vehicle **50** drive/steer mechanism are omitted for clarity. Likewise, some details of the cutting apparatus **100** are omitted for clarity. In one example, the upper portion of the hull **60** may have a deck **62** that may extend past the lower portion of the hull **60** by an amount, EXT. The extension of the deck **62**, EXT, may be substantially laterally equal on the left and right sides of the hull **60**. Implementation of the extension, EXT, on the lateral sides of the hull **60** may provide a vehicle shape that pushes down debris and thus traverses through debris more readily than a conventional vehicle. The implementation of the extension, EXT, may also urge debris into the cutter apparatus **100** such that the debris is chopped, cut, shredded, and like and, thus, the path through which the vehicle **50** is moving may be cleared more completely than by mere pushing debris aside as is provided by some conventional approaches which lack the overhanging extension EXT.

As illustrated in FIGS. 2A and 2B, the cutter **100** comprises a “nose” shaped (e.g., horizontally oriented pyramid shaped) projection **102** having a narrow (pointed) end that extends in the forward direction from the forward end of bottom side of the structure **60**. The cutter **100** may further comprise a substantially triangular shaped or “arrowhead” shaped tip **104** at the apex of the projection **102**. The tip **104**, in connection with the nose **102**, may intersect, spread, and position the debris to be displaced or cut via the cutter system **100** as the vehicle **50** moves forward. The nose shaped structure **102** may be shaped having a horizontal (or lateral) angle, AH, and a vertical angle, AV. Line **80** is a horizontal reference. The nose **102** is generally oriented at an angle, DIP, below the horizontal.

The lateral angle, AH, is generally positioned symmetrically about the central longitudinal axis of the hull **60**. However, the lateral angle of the nose **102** may be oriented at any appropriate angle to meet the design criteria of a particular application. The lateral angle, AH, may have a nominal value of 90 degrees, and may have a preferred range of 30 to 120 degrees. The vertical angle, AV, may have a nominal value of 20 degrees, and may have a preferred range of 10 to 45 degrees. The nose angle, DIP, may have a nominal value of 15 degrees below horizontal, and may have a preferred range of 0 to 30 degrees below horizontal.

The pyramid shaped projection **102** in connection with the pointed tip **104**, oriented downward at the angle, DIP, may lift debris for cutting via blades on the apparatus **100** rather than bending down the debris thus destroying the debris via the cutting operation.

Referring to FIGS. 3(A-B), diagrams illustrating more detailed side and top views, respectively, of the cutter assembly **100** are shown. In particular, FIG. 3A is a left side view of the cutter assembly **100**, and FIG. 3B is a top view of the cutter system **100**. Left and right sides are generally labeled with subscripts a and b, respectively. While both left and right side views are generally not shown, one of ordinary skill in the art would understand the generally symmetric relationship of the respective elements of the present invention.

The cutter system **100** generally comprises a pair of blades **120** (e.g., blades **120a** and **120b**) each having a respective blade front **122** (e.g., blade fronts **122a** and **122b**), blade rear **124** (e.g., blade rears **124a** and **124b**) and teeth **126** (e.g., teeth **126a** and **126b**), a front blade mount subsystem **130**, and a pair of rear blade mount subsystems **140** (e.g., rear blade mount subsystems **140a** and **140b**). The blades **120** are generally oriented in the system **100** with a



flat plane in the horizontal plane, and cutting edge containing the teeth **126** pointed outward at about the lateral angle, AH.

The present invention generally provides vertical (i.e., up and down) movement, UDF (e.g., left side and right side, UDFa, and UDFb (not shown), respectively), at the front of the blades **120** via the front blade mount subsystem **130** (described in more detail in connection with FIGS. 4-8). The present invention generally further provides vertical (i.e., up and down) movement, UDR (e.g., left side and right side, UDRa, and UDRb (not shown), respectively) and longitudinal (i.e., fore/aft) movement, FAR (e.g., left side and right side, FARa and FARb, respectively), at the rear of the blades **120** via the rear blade mount subsystems **140** (described in more detail in connection with FIGS. 12-19).

Although arcuate (as described in connection with FIGS. 8-10), the motion UDF is generally limited by the blade **120** to a substantially up and down motion. The motion UDR in combination with the motion FAR may be an arcuate motion. As such, the partially constrained/partially free motion of the blades **120** may provide enhanced cutting performance when compared to conventional approaches via the motion of the blades **120** as UDF, UDR, and FAR when an obstruction is encountered as the vehicle **50** proceeds in the forward direction. Further, the partially constrained/partially free motion of the blades **120** may provide reduced damage to the blades **120** when an obstruction is encountered as compared to conventional approaches.

The front movement (UDF) and rear movement (UDR and FAR) of the blades **120** provided by the present invention generally cooperate to provide at least one of (i) more effective blade protection from deformation, damage or breakage, (ii) more effective cutting operation, and (iii) more efficient displacement of debris whether cut or uncut, when compared to conventional approaches.

In one example, the blades **120** may be implemented having a substantially straight cutting edge (see, for example FIG. 6). In another example, the blades **120** may be implemented having a curved cutting edge (see, for example, FIG. 7). In yet another example, the blades **120** may be implemented having a compound surface (i.e., a combination of straight and curved) cutting edge (not shown).

Referring to FIG. 4, a diagram illustrating a partial top view of one example of the apparatus **100** is shown. A section line 5-5 is taken through the nose-shaped projection **102** and is illustrated as FIG. 5. A portion of the front of the nose-shaped projection **102** is not illustrated such that portions of the front blade mount subsystem **130** may be shown.

In one example, the front blade mount subsystem **130** generally comprises an upper front slide **150U**, a lower front slide **150L** (shown, for example, in FIGS. 8(A-B) and 9), a left front blade support **156a**, and a right front blade support **156b**. The left front blade support **156a** generally supports and holds the front end **122a** of the left cutting blade **120a**. The right front blade support **156b** generally supports and holds the front end **122b** of the right cutting blade **120b**. The upper front slide **150U** may have a left slide bolt hole **152Ua** and a right slide bolt hole **152Ub**. The lower front slide **150L** may have a left slide bolt hole **152La** and a right slide bolt hole **152Lb** (see, FIG. 10).

Referring to FIG. 5, a cross-section view of the projection **102** taken at the line 5-5 in FIG. 4 is shown. The nose-shaped extension **102** may have an inverted trapezoidal shape (i.e., the more narrow side of the trapezoid may be on the lower edge of the extension **102**).

Referring to FIG. 6, a top view of one example of a straight blade version of a blade **120** is shown. The blade **120**

may have at least one front blade retention hole **128F**, and at least one rear retention hole **128R**.

Referring to FIG. 7, a top view of one example of a curved blade version of a blade **120** is shown.

Referring to FIGS. 8(A-B)-10 concurrently, in particular FIGS. 8(A-B) provide a side view of the forward end of the cutting apparatus **100** showing additional detail of examples of the front blade mount subsystem **130**. FIG. 9 is a diagram illustrating an exploded view from the front of a portion of the front blade mount subsystem **130**. FIG. 10 is a diagram of an exploded side view illustrating more detail of the upper front slide **150U**, the lower front slide **150L**, and the left front blade support **156a**.

As illustrated in FIG. 8A, the front blade mount subsystem **130** generally further comprises an upper left front spring **160a**, a lower left front spring **162a**, and a left front slide bolt **170a**. Not shown, are right side symmetric elements, i.e., an upper left front spring **160b**, a lower left front spring **162b**, and a left front slide bolt **170b**. The springs **160** and **162** are generally implemented as coil springs having a center opening that is sized to snugly receive the slide bolt **170**.

The front blade support **156** is generally cylindrically shaped to provide limited rotation about a lateral axis. That is, the front blade support **156** may perform as an axle in a lateral direction. Rotation of the front blade support **156** is generally limited by the blade **120**.

The slide bolts **170** may mechanically couple elements of the front blade mount subsystem **130** (e.g., the upper front spring **160**, the upper front slide **150U**, the front blade support **156**, the blade front **122**, the lower front slide **150L**, and the lower front spring **162**). The springs **160** and **162**, in connection with the front blade support **156**, may provide compressive forces to mechanically limit the movement of elements of the front blade mount subsystem **130** (e.g., the upper front slide **150U**, the front blade support **156**, the blade front **122**, and the lower front slide **150L**) to provide partial up and down motion and lateral axis rotational motion to the front end **122** of the blade **120**.

The bolt **170** is generally received in a recess in an upper portion of the nose shaped projection **102**, extends centrally through the spring **160**, through the upper slide bolt hole **152U**, through the lower slide bolt hole **152L**, centrally through the spring **162**, and is threadably fastened in a lower portion of the nose shaped projection **102**. In another example (see, FIG. 8B), bushings (or sleeves) **164** may also be installed centrally in the springs **160** and **162** and through the holes **152** to hold and position the bolts **170**, and to reduce friction and wear as the springs **160** and **162** compress and extend.

With reference to FIGS. 9 and 10, the front blade support **156** is generally cylindrically shaped, and generally comprises an upper portion **180** (e.g., upper portions **180a** and **180b**) and a matching lower portion **182** (e.g., lower portions **182a** and **182b**). The blade front **122** (shown in phantom in FIG. 9) is generally clamped in the front blade support **156** between the respective upper portion **180** and lower portion **182**.

The upper portion **180** generally comprises a substantially semi-cylindrical shaft region **184**, a stud portion **190** that extends radially at one end of the upper portion **180**, and a substantially semi-cylindrical flange end **196** at the end of the shaft region **184** opposite the stud portion **190**. The lower portion **182** generally comprises a substantially semi-cylindrical shaft region **186**, a radial hole **192** that mates with the stud portion **190**, and a substantially semi-cylindrical flange end **198** at the end of the shaft region **186** opposite the hole

192. The stud 190 generally protrudes through a respective hole 128F and into the mating hole 192 to removably fasten (e.g., restrain, hold, etc.) the blade 120.

The upper/lower front slide 150U/L may include a substantially semi-cylindrical shaft recess 200U/L that generally receives the respective shaft regions 184 (upper) and 186 (lower), and a substantially semi-cylindrical flange recess 202U/L that may receive the respective flange ends 196 (upper) and 198 (lower). The substantially cylindrical front blade support 156 may rotate in the recesses 200 and 202 to provide the substantially vertical (up/down) motion UDF to the blade 120. The flange ends 196 and 198 generally laterally restrain the front blade support 156 in the front slide 150.

Referring to FIG. 11, a diagram illustrating a simplified, partial top view of another example of the apparatus 100 is shown. The front blade mount subsystem 130 may be implemented having a single slide bolt 170. The single slide bolt 170 may be positioned (i.e., disposed, located, etc.) substantially centrally between left and right front blade supports 156a and 156b. As such (though not shown), a single spring 160 and a single spring 162 are generally implemented when a single slide bolt 170 is implemented.

Referring collectively to FIGS. 12-19, diagrams illustrating components of the rear blade mount subsystem 140 are shown. Referring particularly to FIG. 12, a diagram illustrating a simplified, partial side view of an example of the rear blade mount subsystem 140 is shown. Sectional views of a portion of the pyramid shaped projection 102 are included.

FIGS. 13 and 14 are diagrams of a top view and an exploded side view, respectively, of a blade clamp apparatus of the present invention. FIGS. 15 and 16 are diagrams illustrating end and side views, respectively, of upper and lower tensioner apparatuses of the present invention, in an unassembled (i.e., exploded or not yet slidably coupled as in normal operation) state. In FIG. 15, respective portions of the projection 102 are shown in phantom. FIGS. 17-19 are diagrams of an end view, a top view, and a side view, respectively, of a slide apparatus of the present invention.

The rear blade mount subsystem 140 generally comprises a blade clamp apparatus 206 formed by (i.e., that comprises) an upper rear blade clamp 210 that is generally threadably mechanically coupled (or fastened) to a lower rear blade clamp 212 via bolts 214 (shown in FIG. 14), an upper tensioner 220 that is generally slidably mechanically coupled to a lower tensioner 222 via a shaft extension 224 on the upper tensioner 220 that snugly fits into a mating cylindrical through bore 226 in the lower tensioner 222, a slide 230, vertical rear tension springs 234 (e.g., spring 234U and spring 234L), and longitudinal rear tension springs 236 (e.g., spring 236U and spring 236L).

The upper tensioner 220 and the lower tensioner 222 may be T shaped with substantially similarly sized cylindrical vertical legs and cross-bars. The lower tensioner 222 is generally an inverted T shape. The upper tensioner 220 and the lower tensioner 222 may be laterally and vertically restrained, and slide in the fore/aft (longitudinal) direction in respective mating grooves 240 (e.g., grooves 240U and 240L) in the structure 102 via tension exerted by the vertical rear tension springs 234 and longitudinal rear tension springs 236 as the movements FAR and UDR. The horizontal cross-bars of the upper tensioner 220 and the lower tensioner 222 and the matching grooves 240 are shown as having a circular cross-section, however, any appropriate shape may be implemented.

The vertical rear tension springs 234 are generally sized to snugly slide over respective vertical leg members of the upper tensioner 220 and the lower tensioner 222. The longitudinal rear tension springs 236 are generally mechanically fastened at a front end to the front end of the respective groove 240 and at a rear end to the front end of a respective cross-bar portion of the T shape of the upper tensioner 220 and the lower tensioner 222 via any appropriate technology, as would be understood by one of ordinary skill in the art.

The rear blade mount subsystem 140 is generally installed in the projection 102 by compressing the springs 234 and 236, installing the upper tensioner 220 and the lower tensioner 222 in the respective grooves 240U and 240L, and releasing the springs 234 and 236.

The slide 230 may have a substantially cylindrical body section 250 that has a center through bore 252 sized to receive the vertical leg of the lower tensioner 222 and freely slide vertically thereon as the movement UDR. The slide 230 may further comprise a connector leg 254 and an axle (e.g., cylindrical leg) 256. The body section 250 is generally implemented as a vertically oriented pipe or tube shaped portion of the slide 230. The connector (or coupling) leg 254 is generally horizontally and longitudinally oriented and mechanically couples the body section 250 to the axle 256. The axle 256 is generally horizontally and laterally oriented.

FIGS. 13 and 14 are a top view and an exploded side view, respectively, of the blade clamp apparatus 206. As illustrated in FIG. 14, the respective rear blade portion 124 (shown in phantom) may be clamped between the upper rear blade clamp 210 and the lower rear blade clamp 212. When the upper rear blade clamp 210 and the lower rear blade clamp 212 are fastened together via the bolts 214, a substantially cylindrical, laterally oriented receiving bore 260 is formed. The bore 260 is generally sized to receive the cylindrical leg (axle) 256 to provide rotational movement at the joint formed by the leg 256 in the bore 260 as the slide 230 moves longitudinally and vertically through the motions FAR and UDR. A gap 216 in the blade clamp apparatus 206 may provide a clearance path for the coupling leg 254.

The upper rear blade clamp 210 generally includes a plurality of pegs 270 that extend downward from the underside of the clamp 210. The lower rear blade clamp 212 generally includes a matching plurality of vertical holes 272 that are sized and positioned to mate with the respective pegs 270. When the upper rear blade clamp 210 and the lower rear blade clamp 212 are fastened together, the pegs (or shafts) 270 extend through respective holes 128R in the blade 120 to removably fasten the blade rear 124 within the cutting apparatus 100.

As illustrated in FIGS. 15 and 16, the upper tensioner 220 generally includes the shaft portion 224 that extends vertically downward and slidingly mechanically mates in the hole (or through bore) 226 in the vertical leg of the lower tensioner 222 to provide the movement UDR. The shaft 224 and mating hole 226 may, in cross-section, be cylindrical, square, hexagonal, or any other appropriate shape to meet the design criteria of a particular application.

The springs 160, 162, 234, and 236 generally have a spring constant that is selected (i.e., predetermined, chosen, calculated, etc.) to provide retention of the blade 120 within the system 100 while providing the movement UDF, UDR, and FAR such that cutting motion of the blade 120 is enhanced and damage to the blade 120 is reduced or prevented during normal operation.

The cutting apparatus 100 of the present invention may be advantageously augmented by further implementing an additional cutting apparatus (or apparatuses) across the front

11

and top of the vehicle 50. Such an additional cutting apparatuses may, in one example, be implemented as a vehicle wire cutter as shown and described in U.S. Pat. No. 5,586,785 to Warner, et al., which is incorporated by reference herein in its entirety. However, such an additional cutting apparatus may be implemented as any appropriate device to meet the design criteria of a particular application.

While illustrated and described as a single device, the cutting system 100 may be implemented as a plurality of cutters 100 as shown and described herein when desired to meet the design criteria of a particular application.

As is apparent then from the above detailed description, the present invention may provide an improved system for a cutting apparatus that may be mounted to a vehicle.

Various alterations and modifications will become apparent to those skilled in the art without departing from the scope and spirit of this invention and it is understood this invention is limited only by the following claims.

What is claimed is:

1. A debris cutting system for attachment to a vehicle, the system comprising:

a nose shaped projection that extends horizontally in the forward direction from the forward moving end of the vehicle, the projection comprising a front blade mount subsystem, a left rear blade mount subsystem, and a right rear blade mount subsystem; and

a left blade and a right blade that are mounted within the front blade mount subsystem and within the respective left and right rear blade mount subsystems, wherein each blade has a respective blade front, blade rear and teeth, and the front blade mount subsystem provides vertical movement at the front of the blades, the rear blade mount subsystems provide vertical and longitudinal movement at the rear of the blades such that cutting of debris is enhanced and damage to the blades is reduced as the vehicle moves forward, and the front blade mount subsystem comprises:

an upper front slide;

a lower front slide;

a left front blade support; and

a right front blade support, wherein

the left front blade support and the right front blade support are mounted between the upper and lower front slides, the left front blade support supports and holds the left blade front, the right front blade support supports and holds the right blade front, and the left and right front blade supports are cylindrically shaped to provide rotation about a lateral axis and the rotation is limited by the respective blades such that the vertical movement at the front of the blades is provided.

2. The system of claim 1, wherein the front blade mount subsystem further comprises:

upper left and right front springs, lower left and right front springs, and left and right front slide bolts; and

the upper front slide comprises an upper left slide bolt hole and an upper right slide bolt hole;

the lower front slide comprises a lower left slide bolt hole and a lower right slide bolt hole, wherein

the respective front slide bolts are received in respective recesses in an upper portion of the nose shaped projection, extend centrally through the respective upper front springs, through the respective upper slide bolt holes, through the respective lower slide bolt holes, centrally through the respective lower front springs, and are threadably fastened in a lower

12

portion of the nose shaped projection such that the respective upper and lower front springs provide compressive force to retain the respective blade fronts.

3. The system of claim 2, wherein each of the cylindrically shaped front blade supports comprises an upper portion and a matching lower portion; and

the upper portion comprises a substantially semi-cylindrical upper shaft region, a stud portion that extends radially at one end of the upper portion, and a substantially semi-cylindrical upper flange end at the end of the shaft region opposite the stud portion, and the lower portion comprises a substantially semi-cylindrical lower shaft region, a radial hole that mates with the stud portion, and a substantially semi-cylindrical lower flange end at the end of the lower shaft region opposite the radial hole, and the stud protrudes through a respective front blade mounting hole and into the radial hole to removably clamp the blade front in the front blade support between the respective upper portion and lower portion, wherein

the upper and lower front slides comprise respective substantially semi-cylindrical upper and lower shaft recesses that receive the respective upper and lower shaft regions, and respective substantially semi-cylindrical upper and lower flange recesses that receive the respective upper and lower flange ends, and the respective cylindrically shaped upper and lower front blade supports rotate in the upper and lower recesses, and the respective upper and lower flange ends laterally restrain the front blade supports in the front slides.

4. The system of claim 1, wherein the left and right rear blade mount subsystems each comprise:

a blade clamp apparatus that comprises an upper rear blade clamp that is threadably mechanically coupled to a lower rear blade clamp via bolts, wherein the respective blade rear is clamped between the upper rear blade clamp and the lower rear blade clamp;

an upper tensioner;

a lower tensioner that is slidably mechanically coupled to the upper tensioner via a shaft extension on the upper tensioner that snugly fits into a mating cylindrical through bore in the lower tensioner;

a rear slide;

vertical rear tension springs; and

longitudinal rear tension springs, wherein

the upper tensioner and the lower tensioner are T shaped with substantially similarly sized cylindrical vertical legs and cross-bars, and the lower tensioner is an inverted T shape;

the upper tensioner and the lower tensioner are laterally and vertically restrained, and slide in the fore/aft direction in respective mating grooves in the projection via tension exerted by the vertical rear tension springs and longitudinal rear tension springs to provide vertical and longitudinal movement at the rear of the blades;

the vertical rear tension springs are sized to snugly slide over respective vertical leg members of the upper tensioner and the lower tensioner;

the longitudinal rear tension springs are mechanically fastened at a front end to the front end of the respective groove and at a rear end to the front end

## 13

of a respective cross-bar portion of the T shape of the upper tensioner and the lower tensioner;  
 the rear slide comprises a substantially cylindrical body section that has a center through bore sized to receive the vertical leg of the lower tensioner and freely slide vertically thereon;  
 the rear slide further comprises a connector leg and an axle;  
 the cylindrical body section is implemented as a vertically oriented pipe;  
 the connector leg is generally horizontally and longitudinally oriented and mechanically couples the body section to the axle; and  
 the axle is horizontally and laterally oriented.

5. The system of claim 4, wherein the respective upper rear blade clamp and the lower rear blade clamp are fastened together to form a substantially cylindrical laterally oriented receiving bore, the bore is sized to receive the axle to provide vertical and longitudinal movement at the rear of the

## 14

blades, and a gap in the upper rear blade clamp and the lower rear blade clamp provides a clearance path for the connector leg; and

the upper rear blade clamp includes a plurality of pegs that extend downward from the underside of the upper rear blade clamp, the lower rear blade clamp includes a matching plurality of vertical holes that are sized and positioned to mate with the respective pegs, when the upper rear blade clamp and the lower rear blade clamp are fastened together, the pegs extend through respective rear mounting holes in the rear blade to removably fasten the blade rear within the system.

6. The system of claim 1, further comprising a substantially triangular shaped or "arrowhead" shaped tip at the apex of the projection that intersects, spreads and positions debris to be displaced or cut via the system as the vehicle moves forward.

\* \* \* \* \*