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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : E02F 9/28 | A1

(11) International Publication Number: **WO 99/23315**

(43) International Publication Date: 14 May 1999 (14.05.99)

(21) International Application Number: PCT/US98/22448

(22) International Filing Date: 23 October 1998 (23.10.98)

(30) Priority Data:
08/961,304 30 October 1997 (30.10.97) US

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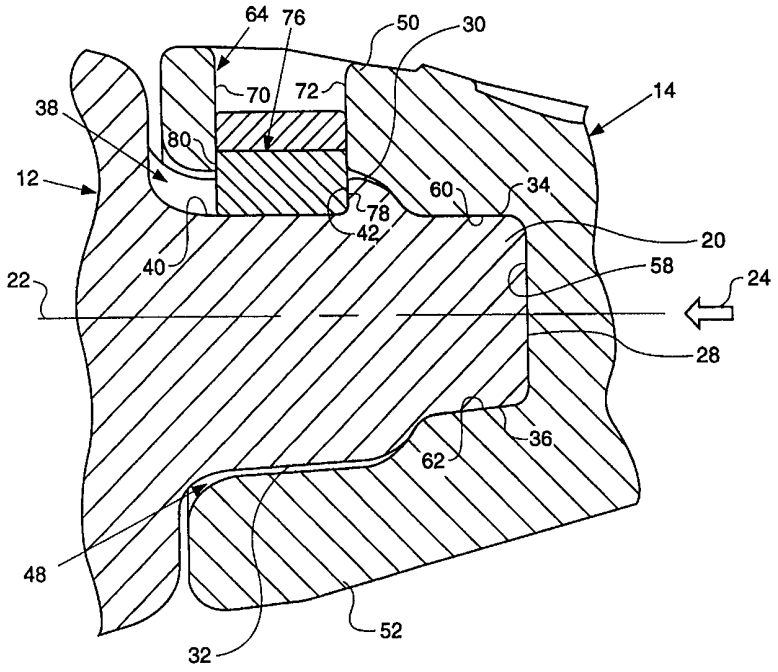
(81) Designated States: AT, AU, BR, CA, CH, CN, CZ, DE, DK, ES, MX, NO, NZ, RO, RU, SE, SG, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: MECHANICAL RETENTION SYSTEM FOR GROUND ENGAGING TOOLS



(57) Abstract

A mechanical retention system (16) is disclosed for detachably retaining a ground engaging tool (14) onto an earthworking implement (10). The retention system (16) uses an elongated steel retainer (76), which has a convolute spring portion (86) between opposite end portions (82, 84) of the retainer (76) to allow the retainer (76) to be compressible in one direction in order to be mounted through a retainer opening (64) in the tool (14) into a retainer pocket (38) in a mounting portion (20) of the implement (10).

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Description

Mechanical Retention System for Ground Engaging Tools

Technical Field

The present invention relates generally to ground engaging tools for earthworking implements and the like and, more particularly, to a mechanical retention system for detachably retaining a replaceable tool onto such implements.

Background Art

Earthworking implements, such as buckets, blades, rippers, bowls and the like, used on earthworking machines, such as loader, excavators, tractors, scrapers and the like, commonly employ ground engaging tools that engage the earth being worked or materials being excavated or loaded. Because of the loading forces and highly abrasive materials encountered, ground engaging tools wear out rapidly and need to be replaced in order to protect the parent material of the implement and to keep the implement working at peak efficiency. Because of such frequent replacement, it is desirable to be able to quickly and easily remove the worn tool and replace it with a new one. Many types of retention devices, such as pins and the like, have been used in the past to retain the tool onto the tool mounting portion of the implement. Some typical examples of retention devices used for retaining bucket teeth are disclosed in U.S. Patent No. 5,068,986 issued 3 December 1991 to Larren F. Jones for Excavating Tooth Point Particularly Suited for Large Dragline Buckets; U.S. Patent No. 5,272,824 issued 28 December 1993 to Erwin D.

Cornelius for Tooth Assembly with Leaf Spring Retainer; and U.S. Patent No. 5,423,138 issued 13 June 1995 to Richard E. Livesay, et al for Tip to Adapter Interface.

Many such prior retention devices perform satisfactorily, but are either complex and expensive, or require special tools or the large exertion of effort to remove and replace the retainers. Other retainers may simply fail during use, resulting in the loss of the tool from the implement.

The present invention is directed to overcoming one or more of the problems encountered in the use of prior art tools and retention devices.

Disclosure of the Invention

In accordance with one aspect of the present invention, a mechanical retention system is provided for detachably retaining a replaceable tool onto an earthworking implement. The retention system includes a generally rectangular retainer opening through the sidewall of the tool that has a pair of opposing end surfaces and a pair of opposing side surfaces. One of the pair of opposing side surfaces defines a first abutment and the end surfaces are disposed a predetermined distance apart to provide the opening with a predetermined length. A retainer pocket is formed in the side surface of a mounting portion of the implement and is positionable in registry with the retainer opening. The pocket defines a second abutment oriented in an opposing relation to the first abutment. An elongated spring retainer is positionable between the abutments to retain the tool onto the implement. The retainer has a pair of opposite side surfaces, a pair of opposite end

portions, an integral convolute spring portion and a thickness sufficient to define a first elevational portion and a second elevational portion. Each end portion has a flange extending therefrom within the confines of the first elevational portion a sufficient distance to provide the retainer with a predetermined length between the flanges that is greater than the predetermined length of the retainer opening. The spring portion is adapted to allow the forcible compression of the retainer to a length sufficient to permit the insertion of the flanges through the retainer opening wherein the first elevational portion is disposed in the retainer pocket where one of the sides of the retainer is in an abutting relation with the second abutment and the second elevational portion is positioned in the retainer opening where the other of the sides thereof is in an abutting relation with the first abutment and each of the flanges are disposed in abutting relation to the interior surface of the sidewall of the tool.

Brief Description of the Drawings

Fig. 1 is a fragmentary perspective view of an implement with a tool mounted onto a mounting portion thereof and being retained by a mechanical retention system embodying the principles of the present invention.

Fig. 2 is a fragmentary cross-sectional view of the retention system taken generally along line 2-2 of Fig. 1.

Fig. 3 is a fragmentary cross-sectional view of the retention system taken generally along line 3-3 of Fig. 1.

Fig. 4 is an exploded perspective view of the retainer and cover illustrated in Figs. 2 and 3.

Fig. 5 is a bottom plan view of the retainer illustrated in Fig. 4.

Fig. 6 a fragmentary perspective view similar to Fig. 1, but of another implement and tool being retained by the mechanical retention system.

Fig. 7 is an enlarged side elevational view of retention system of Fig. 6.

Fig. 8 is a cross-sectional view of the retainers taken along line 8-8 of Fig. 7.

Fig. 9 is a cross-sectional view of another embodiment of the cover for the retainer.

Fig. 10 is a fragmentary cross-sectional view similar to that of Fig. 3, but illustrating another embodiment of the retainer.

Fig. 11 is a perspective view of the retainer shown in Fig. 10.

Best Mode for Carrying Out the Invention

Referring to the drawings and more particularly to Figs. 1 - 5, an earthworking implement 10, which in the exemplary embodiment depicted in Fig. 1 is a bucket, has a ground engaging tool mounting member or adapter 12 upon which is carried a replaceable ground engaging tool 14, which in this case is a tooth. The tool or tooth 14 is detachably retained on the adapter 12 by a mechanical retention system 16 to be more fully described below. It should be appreciated that the exemplary embodiments depicted in the drawings and described herein are merely for illustrative purposes, as it is contemplated that the present invention be used for other closely related ground engaging tool and implement applications.

Examples of related implements include buckets and shovels, bulldozer and motor grader blades, rippers, scraper bowls and the like. Examples of tools for such implements include tips, cutting edges and cutting edge protectors, corner and side protectors. Mounting members 12 may include such things as tooth couplers and adapters and the like. Such implements, mounting members and tools therefor are all well known in the art and all of such uses are intended to be covered by the present invention even though they have not been specifically shown or described herein, as those skilled in the art are readily able to incorporate the teachings of the present invention into such other applications.

In the embodiment depicted in Figs. 1-5, the implement or bucket 10 has a cutting edge 18. The cutting edge 18, as customary in the art, carries a plurality of adapters, one of which is shown at 12. The adapter 12 is secured in the present embodiment to the cutting edge 18 by welding and has a forward tooth mounting portion or nose 20, as best shown in Fig. 2. The nose 20 extends along an axis 22, which is generally oriented along the normal direction of working forces exerted on the tooth 14 when the tool is in working engagement with the ground, as depicted by arrow 24, and has a blunt abutment surface 28, which is oriented in a direction normal to the normal working force direction 24 for receiving loading forces from the tooth 14. The nose 20 also has top and bottom side surfaces 30,32 extending rearwardly from the abutment surface 28. Each top and bottom surface is preferably provided with one of a pair of planar surfaces 34,36, adjacent, but normal to the abutment surface 28 for receiving working forces which

are oblique to the normal working force direction 24. The top side surface 30 is provided with a retainer pocket 38 having a bottom 40 and a side abutment 42. The side abutment 42 faces in the same direction as the direction of the normal direction 24 of the working forces and extends in a direction normal to the normal working force direction 24.

The tooth 14 (Fig. 1) is preferably tapered with a sharp forward ground engaging edge 44 for penetrating the ground and a rearward mounting end portion 46. The mounting end portion 46 has a nose receiving socket 48 (Fig. 2) defined by top and bottom sidewalls 50,52, left and right hand sidewalls 54,56 and an abutment surface 58 at the bottom of the socket 48, which mates with abutment surface 28 of the adapter 12 for transferring loads into the adapter in the normal direction of working forces 24. The top and bottom sidewalls 50,52 have a stepped interior configuration with each having a planar surface 60,62 which mate with a respective one of the planar surfaces 34,36 of the nose 20 of the adapter 12 for transferring oblique forces acting on the tooth 14 into the nose 20 of the adapter 12.

The tooth 14 also has a generally rectangular retainer opening 64 disposed through one of the sidewalls of the mounting end portion 46, which, in the embodiment shown, is in top sidewall 50. The retainer opening 64 has a pair of opposing end surfaces 66,68 and a pair of opposing side surfaces 70,72. When the tooth 14 is mounted onto the adapter, the retainer pocket 38 of the adapter 12 is disposed in registry with the retainer opening 64. The side surface 70, which faces in a direction opposite to the normal working force direction 24 defines a first

abutment that is disposed in a spaced opposing relation to the side abutment or second abutment 42. The end surfaces 66,68 of opening 64 are disposed a predetermined distance apart to provide the opening with a predetermined length "L_1".

The mechanical retention system 16 includes an elongated spring retainer 76 having a longitudinal axis 77. The retainer 76 is preferably an integral casting constructed of spring steel or other suitable metal. Retainer 76 includes a pair of opposites sides 78,80, a pair of opposite end portions 82,84 and an integral convolute spring portion 86 between the end portions 82,84. The retainer 76 is of a thickness sufficient to define a first elevational portion 88 disposed below a phantom line 89 in Fig. 3 and a second elevational portion 90 disposed above line 89. Each end portion 82,84 has a flange 92 extending therefrom within the confines of the first elevational portion a sufficient distance to provide the retainer 76 with a predetermined length L_2 between the flanges 92 that is greater than the predetermined length L_1 of the retainer opening 64. The spring portion 86 is adapted to allow the forcible compression of the retainer 76 from its longer non-compressed length L_2 to a shorter compressed length sufficient equal to or less than the retainer opening length L_1 to permit the insertion of the flanges through the retainer opening 64. When the retainer is in its mounted position, as best shown in Fig. 3, the flanges 92 extend beyond the retainer opening 64 and are positioned to engage an interior surface 94 of the top sidewall 50 to lock the retainer 76 in place in its tooth retaining position wherein the first elevational portion 88 of the retainer 76 is disposed in the retainer pocket 38

where one side 78 (Fig. 2) of the retainer 76 is in an abutting relation with the second abutment 42 and the second elevational portion 90 is positioned in the retainer opening 64 where the other side 80 thereof is in an abutting relation with the first abutment 70.

As best shown in Fig. 5, the convolute spring portion 86 of the retainer 76 is formed by a plurality of interleaved slots 96 cut into the retainer, with a first set of the slots 98 extending from one of the sides 78 toward the other side 80 and with a second set of the slots 100 being disposed between adjacent ones of the first set of slots 98 and extending from the other of the sides 80 toward the one of the sides 78.

Each of the end portions 82,84 of the retainer 76 has a upstanding boss 102 thereon that project above the spring portion 86. Each of the bosses 102 have a tool slot 104 formed therein that opens toward its adjacent end surface 66, 68 respectively, of the opening 64, which are adapted to receive a pry tool (not shown) for compressing the retainer 76 in order to permit the removal of the retainer. The retainer 76 has a bottom surface 114 and a chamfered corner 116 between each of the end portions 82,84 and the bottom surface 114 to facilitate in the compression of the retainer 76 as it is being placed into the retainer pocket 38.

The retention system 16 also preferably includes cover 106, which is adapted for receipt in and sized to close the retainer opening 64 above the retainer 76. The cover 106 may be constructed entirely of an elastomeric material, such as rubber or plastic, and provided with a plurality of fingers 108 that are adapted to be received into respective ones

of the interleaved slots 98,100 of the retainer 76 to prevent debris from filling the slots during use. A tongue 110 is provided on opposite ends of the cover, which are adapted to snap into a groove 112 formed on the inwardly facing side of each of the bosses 102 for retaining the cover to the retainer 76.

Alternatively, as shown in Fig. 9, a cover 106A may have a composite construction, where an upper cap portion 107 and tongues 110A are made of plastic or rubber, but a lower finger portion 109 having fingers 108A is constructed from metal. Lower portion 109 also includes a pry groove 111 on its opposite ends.

In another embodiment of the present invention depicted in Figs. 6-8, a larger tooth 118 is shown for use on a larger implement or bucket (not shown). In such applications, the larger tooth 118 is mounted to an intermediate member or coupler 120, instead of to an adapter. Also, it may be desirable to use two retainers 122, rather than the single retainer 76 depicted in the first embodiment. In such a case, the tooth 118 is provided with a pair of retainer openings 124 disposed through the opposite sidewalls 126,128 of the tooth. The coupler 120 has a nose portion 130 similar to nose portion of the adapter of the first embodiment, but has a pair of retainer pockets 132, one of such pockets being formed in a respective one of the side surfaces (not shown) of the nose portion 130. Each of such pockets 132 are positioned to be in registry with a respective one of the retainer openings 124 when the tooth 118 is mounted onto the coupler 120.

As is apparent from the drawings that the features of the retainers 122 and their relationships to the features of the retainer pockets 132 and

retainer openings 124 are similar in nature to those features and relationships of the first embodiment and, therefore function in a similar manner, further description thereof is not deemed necessary and is omitted as any modifications as may be needed for its use in this embodiment will readily come to hand to those skilled in the art.

Shown in Figs. 10 and 11 is another configuration for the retainer. The main difference between the retainer 76 depicted in Figs. 3-5 and retainer 76A depicted in Figs. 10 and 11 is that retainer 76A is provided with a rounded bottom surface 138, rather than the flat bottom surface 114 that retainer 76 has. Also, the nose portion 20 of the adapter 12 is provided with a pocket 38A having an arcuate bottom 40A to match the rounded bottom surface 138 of retainer 76A. The rounded configuration of retainer 76A and bottom 40A is advantageous in providing the retainer 76A with a grater thickness, while minimizing the amount of material removed to provide the pocket 38A in adapter 12, thereby increasing the strength of the adapter 12. The retainer 76A is also provided with a pry pocket 140 and a pry slot 142 in each of the bosses 102A and flanges 92A, respectively, in place of the tool slots 104 shown in Figs. 3 and 4.

Other applications of the present invention are also not shown or described, but will be readily apparent to those skilled in the art. For instance, the implement could as well be a ripper, with the mounting portion being a ripper shank and the tool being a ripper tip that is retained by the retainer of the present invention. Such retainer can also be used for retaining couplers to adapters, edge and corner

protectors to buckets, blades and scraper bowls, as all of such applications are contemplated and are intended to fall within the scope of the appended claims hereto.

Industrial Applicability

The present mechanical retention system 16 affords many advantages of prior retention devices. For instance, the present retainer 76 is easily assembled into and removed from the retainer pocket 32 and retainer opening 64 without special tools and without the exertion of a large amount of effort. To install, the retainer 76 is placed into the opening and tapped down with the use of a hammer to compress the convolute spring portion 86. Once the flanges 92 pass the sides of the opening 64, the spring portion 86 will re-expand to its non-compressed state, where the flanges 92 will be seated against the interior surface 94 of the sidewall 50. The cover 106 is put in place to prevent the slots 96 from packing with dirt or other debris during use. To remove, the cover 106 is pried out with a blade screwdriver. Such screwdriver is then inserted into one of the tool slots 104 and leverage is applied to the retainer 76 to cause it to be compress and pried out of the retainer pocket 32 and retainer opening 64.

With the retainer 76 in place, the tooth 14 is prevented from coming off the adapter 12 because it acts as a stop between the first abutment 70 of the retainer opening 64 and the second abutment 42 of the retainer pocket 40. Because of the elevational separation between such abutments 70,42, the retainer 76 is loaded in shear therebetween. It should be noted that the tooth 14 is assembled onto the adapter

12 by movement in the working force direction 24 along axis 22 and can only be removed by movement in a direction opposite to direction 24. Because of this, such shear forces are only exerted on the opposite sides 78,80 of the retainer 76 and not in an end to end direction, as this would tend to compress the retainer 76. The retainer 76 is substantially rigid from side to side. End to end loading is prevented by the orientation of the longitudinal axis 77 of the retainer 76 in a direction transverse to the axis 22.

The operation of the retainers 122 in the embodiment shown in Fig. 6-8 is essentially the same as that described for the first embodiment shown in Figs. 1-5, except for the fact that two retainers are employed, rather than one, and such retainers 122 are located in a respective one of the sides of the tooth, instead of in the top side wall as in the first embodiment.

Other aspects and advantages of the present invention of this invention can be obtained through a study of the drawings, the disclosure and the appended claims.

Claims

1. A mechanical retention system (16) for detachably retaining a replaceable tool (14) onto an earthworking implement (10), said implement (10) including a mounting member (12) with a mounting portion (20) adapted to receive said tool (14) and having an abutment surface (28) in force receiving contact with a mating abutment surface (58) of said tool (14), said tool (14) having a sidewall (50,52) with an interior surface (60) positionable along a corresponding side surface (30,32) of said mounting portion (20), said retention system (16) comprising;

a generally rectangular retainer opening (64) through said sidewall (59,52) of the tool (14), said opening (64) having a pair of opposing end surfaces (66,68) and a pair of opposing side surfaces (70,72), one of said pair of opposing side surfaces (70,72) defining a first abutment (70) and said end surfaces (66,68) being disposed a predetermined distance apart to provide said opening (64) with a predetermined length (L_1) therebetween;

a retainer pocket (38) formed in said side surface (30,32) of said mounting portion (46) and positionable in registry with said retainer opening (64), said pocket (38) defining a second abutment (42) oriented in an opposing relation to said first abutment (70); and

an elongated spring retainer (76) having a pair of opposite sides (78,80), a pair of opposite end portions (82,84), an integral convolute spring portion (86) and a thickness sufficient to define a first elevational portion (88) and a second elevational portion (90), each end portion (82,84) having a flange

(92) extending therefrom within the confines of said first elevational portion (88) a sufficient distance to provide said retainer (76) with a predetermined length (L_2) between said flanges (92) that is greater than said predetermined length (L_1) of said retainer opening (64), said spring portion (86) being adapted to allow the forcible compression of the retainer (76) to a length sufficient to permit the insertion of said flanges through said retainer opening (64) wherein said first elevational portion (88) is disposed in said retainer pocket (38) where one of said sides (78) of said retainer (76) is in an abutting relation with said second abutment (42) and said second elevational portion (90) is positioned in said retainer opening (64) where the other of said sides (80) thereof is in an abutting relation with said first abutment (70) and each of said flanges (92) are disposed in abutting relation to said interior surface (94) of the sidewall (50) of said tool (14).

2. The retention system (16) of claim 1 wherein said implement (10) is a bucket.

3. The retention system (16) of claim 2 wherein said mounting member (12) is an adapter and said tool (14) is a bucket tooth.

4. The retention system (16) of claim 2 wherein said mounting member (12) of said implement (10) includes a coupler and said mounting portion (20) is on said coupler.

5. The retention system (16) of claim 1 wherein said implement (10) is a ripper and said

mounting member (12) is a ripper shank and said tool (14) is a ripper tip.

6. The retention system (16) of claim 1 wherein said retainer (76) is constructed from spring steel.

7. The retention system (16) of claim 6 wherein said convolute spring portion (86) of said retainer (76) is formed by a plurality of interleaved slots (96) cut into said retainer (76), with a first set of said slots (98) extending from one of said sides (78) toward the other side (80) and with a second set of said slots (100) being disposed between adjacent ones of said first set of slots (98) and extending from the other of said sides (80) to the one of said sides (78).

8. The retention system (16) of claim 7 each of said end portions (82,84) of said retainer (76) has a upstanding boss (102) thereon, each of said bosses (102) having a tool slot (104) therein opening toward its adjacent end surface (66,68) of the opening (64) adapted to receive a pry tool for compressing the retainer (76) in order to permit the removal of the retainer (76).

9. The retention system (16) of claim 8 including a cover (106) adapted for receipt in and sized to close said opening (64) above said retainer (76).

10. The retention system (16) of claim 9 wherein said cover (106) is constructed of an

elastomeric material and is provided with a plurality of fingers (108) that are adapted to be received into respective ones of said interleaved slots (98,100) of the retainer (76).

11. The retention system (16) of claim 10 wherein each of the bosses (102) has a groove (112) and wherein said cover (106) has opposing sides, each side having a tongue (110) adapted to snap into a respective one of said grooves (112) for retaining said cover (106) within said retainer opening (64).

12. An elongated retainer (76) for detachably retaining a replaceable tool (14) onto an earthworking implement (10), said implement (10) including a mounting portion (20) adapted to receive said tool (14), said tool (14) having a sidewall (50,52) with a generally rectangular retainer opening (64) of a predetermined length (L_1) therethrough, said mounting portion (20) having a retainer pocket (38) formed in a side surface (70) thereof positionable in registry with said retainer opening (64), said retainer (76) comprising:

a pair of opposite side surfaces (78,80), a pair of opposite end portions (82,84), an integral convolute spring portion (86) and a thickness sufficient to define a first elevational portion (88) and a second elevational portion (90), each end portion (82,84) having a flange (92) extending therefrom within the confines of said first elevational portion (88) a sufficient distance to provide said retainer with a predetermined length (L_2) between said flanges (92) that is greater than said predetermined length (L_1) of said retainer opening

(64), said spring portion (86) being adapted to allow the forcible compression of the retainer (76) to a shorter length sufficient to permit the insertion of said flanges (92) through said retainer opening (64).

13. The retainer (76) of claim 12 wherein said retainer opening (64) has a pair of opposing side surfaces (70,72), one of said pair of opposing side surfaces (70,72) defining a first abutment (70), wherein said pocket (38) defines a second abutment (42) oriented in an opposing relation to said first abutment (70), and wherein said first elevational portion (88) of said retainer (76) is disposed in said retainer pocket (38) where one of said sides (78) of said retainer (76) is in an abutting relation with said second abutment (42) and said second elevational portion (90) is positioned in said retainer opening (64) where the other of said sides (80) thereof is in an abutting relation with said first abutment (70).

14. The retainer (76) of claim 13 wherein said sidewall (50,52) of the tool (14) has an interior surface (94) and each of said flanges (92) are disposed in abutting relation to said interior surface (94) of the sidewall (50,52) of said tool (14).

15. The retainer (76) of claim 14 wherein said retainer (76) has a bottom surface (114) and a chamfered corner (116) between each of said end portions (82,84) and the bottom surface (114).

16. A replaceable tool (14) for an earthworking implement (10), said implement (10) including a mounting portion (20) adapted to receive

said tool (14) and having an abutment surface (28) in force receiving contact with a mating abutment surface (58) of said tool (14) and a side surface (30) having a retainer pocket (38) adapted to receive an elongated spring retainer (76) therein, said abutment surfaces (58) being oriented generally normal to the normal direction of working forces (24) exerted on said tool (14) when in working engagement with the ground, and said spring retainer (76) being compressible from a longer non-compressed length to a shorter compressed length between opposite flanges (92) on each end portion (82,84) of the retainer (76), said tool (14) comprising:

a sidewall (50) extending generally parallel to said direction of working forces and having an interior surface (94) positionable along said side surface (130) of said mounting portion (20) of the implement (10); and

a generally rectangular retainer opening (64) through said sidewall (50) of the tool (14), said opening (64) having a pair of opposing end surfaces (66,68) disposed along a longitudinal axis (77) of said opening (64) and a pair of opposing side surfaces (70,72), one of said pair of opposing side surfaces (70,72) defining an abutment (70), said abutment (70) facing in a direction generally opposite to said direction of working forces and said longitudinal axis (77) being oriented in a direction perpendicular to said direction of working forces, and said end surfaces (66,68) being disposed a predetermined distance apart to provide said opening (64) with a predetermined length (L_1) therebetween, said length (L_1) being selected to receive the flanges (92) of said spring retainer (86) when in a compressed state, but

prevent the escape of said retainer (76) through said retainer opening (64) when in a non-compressed state.

Fig. 1

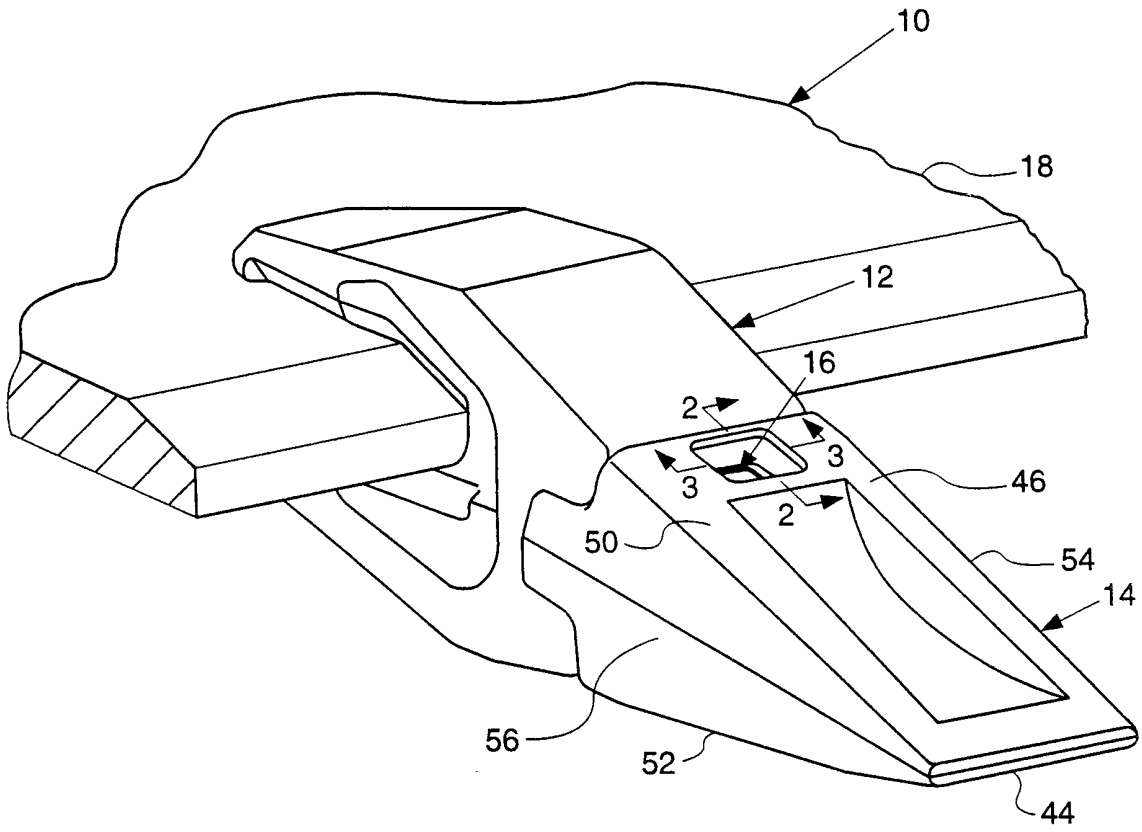

Fig. 2

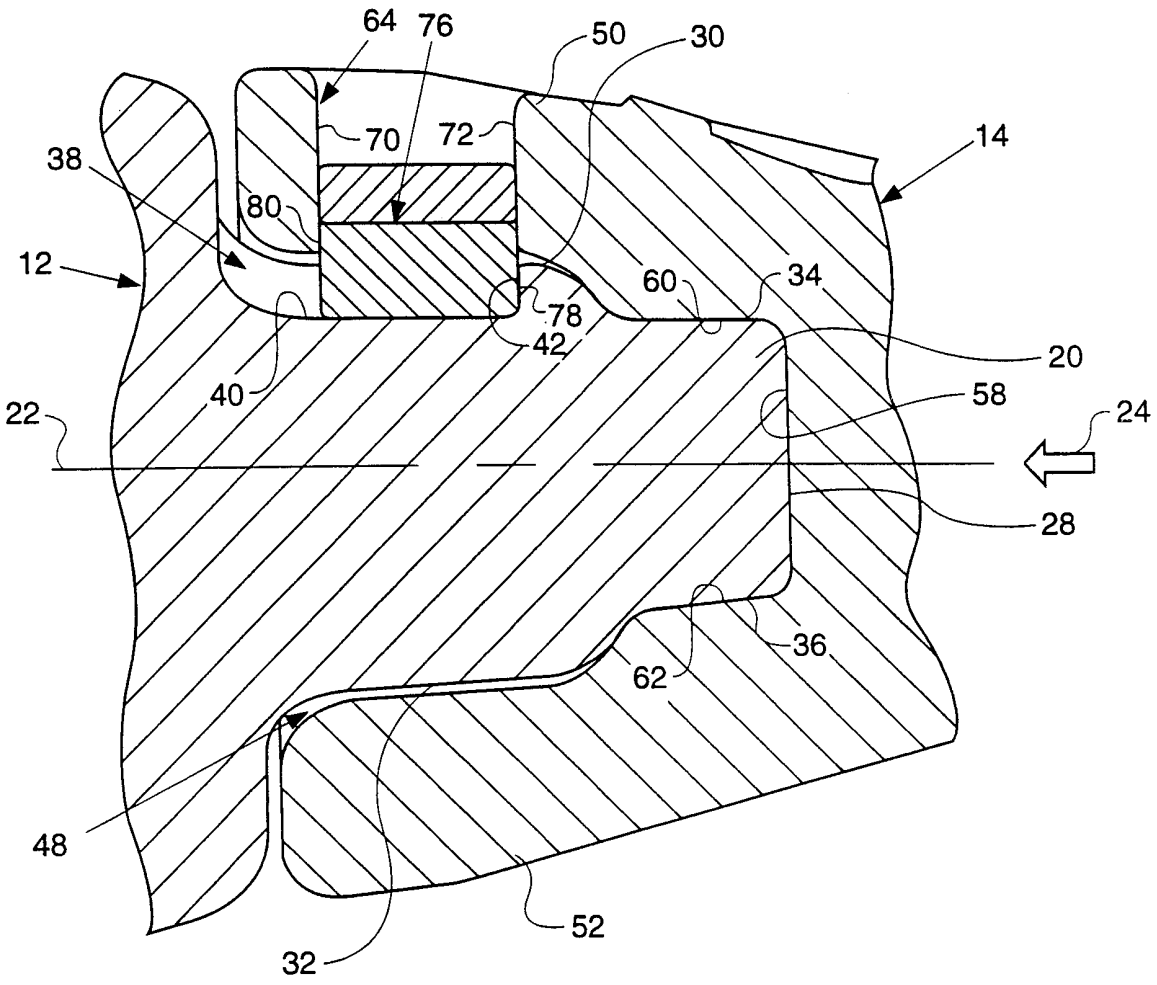
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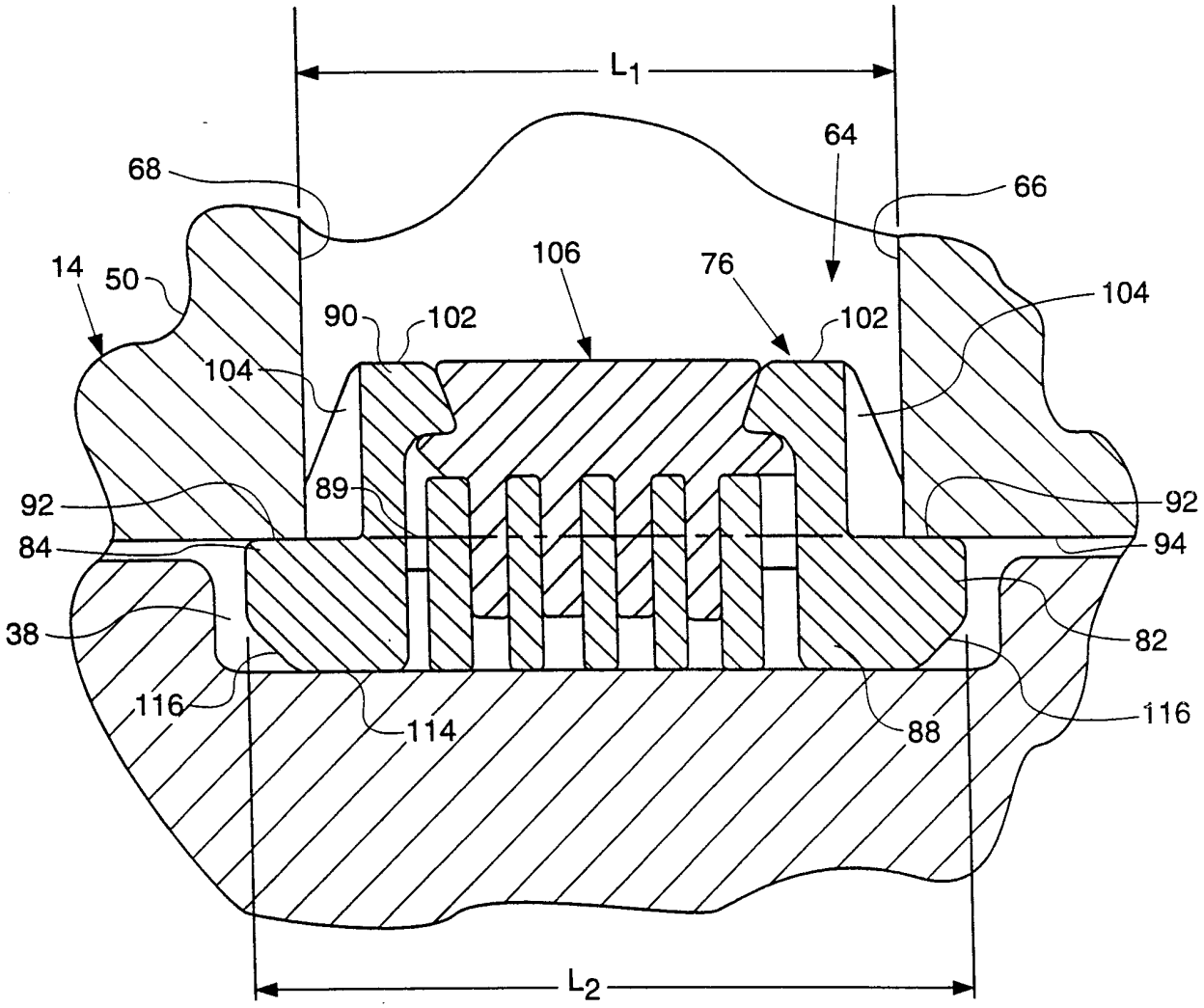
Fig. 3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116
L2

Fig. 4

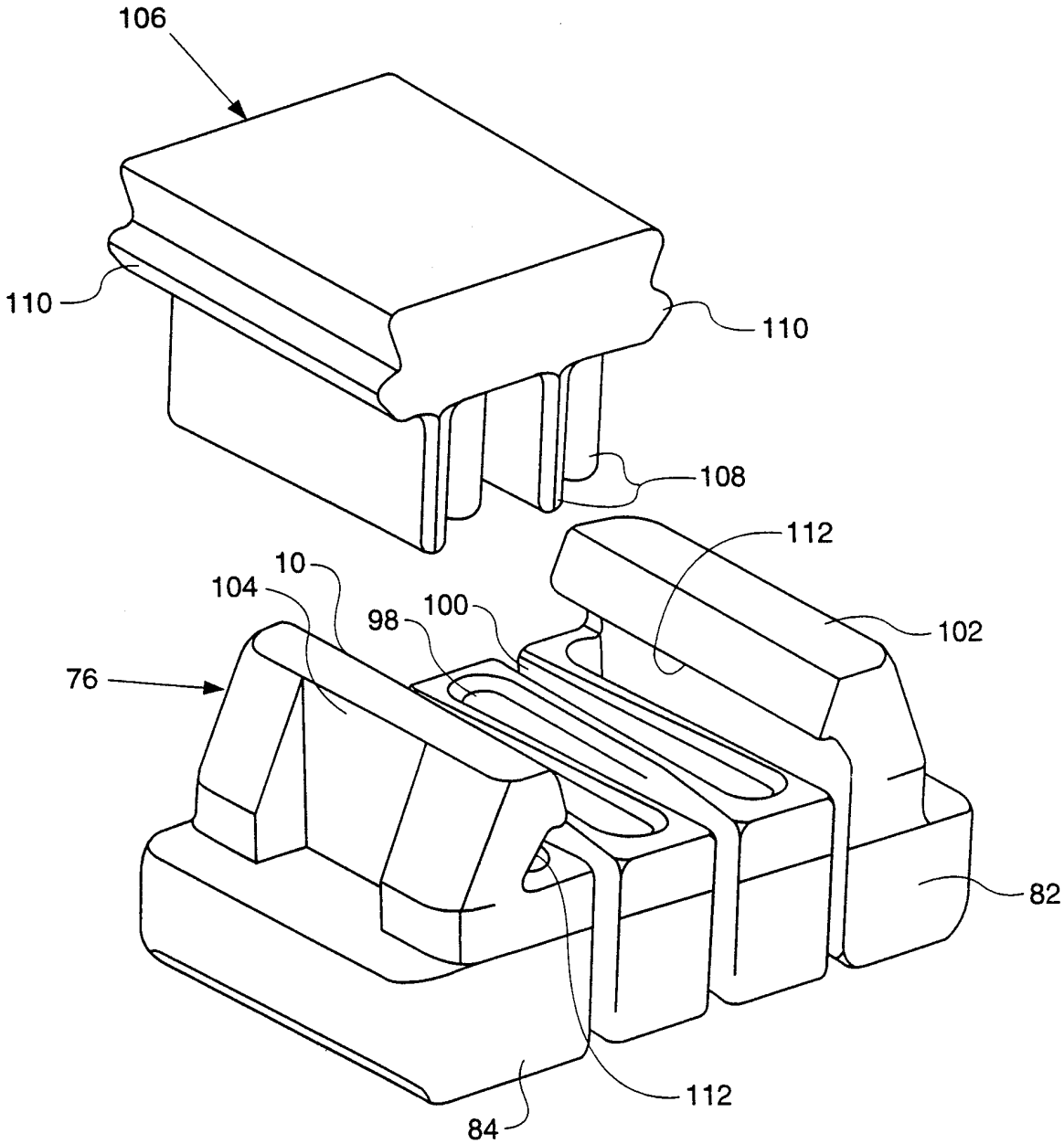


Fig. 5

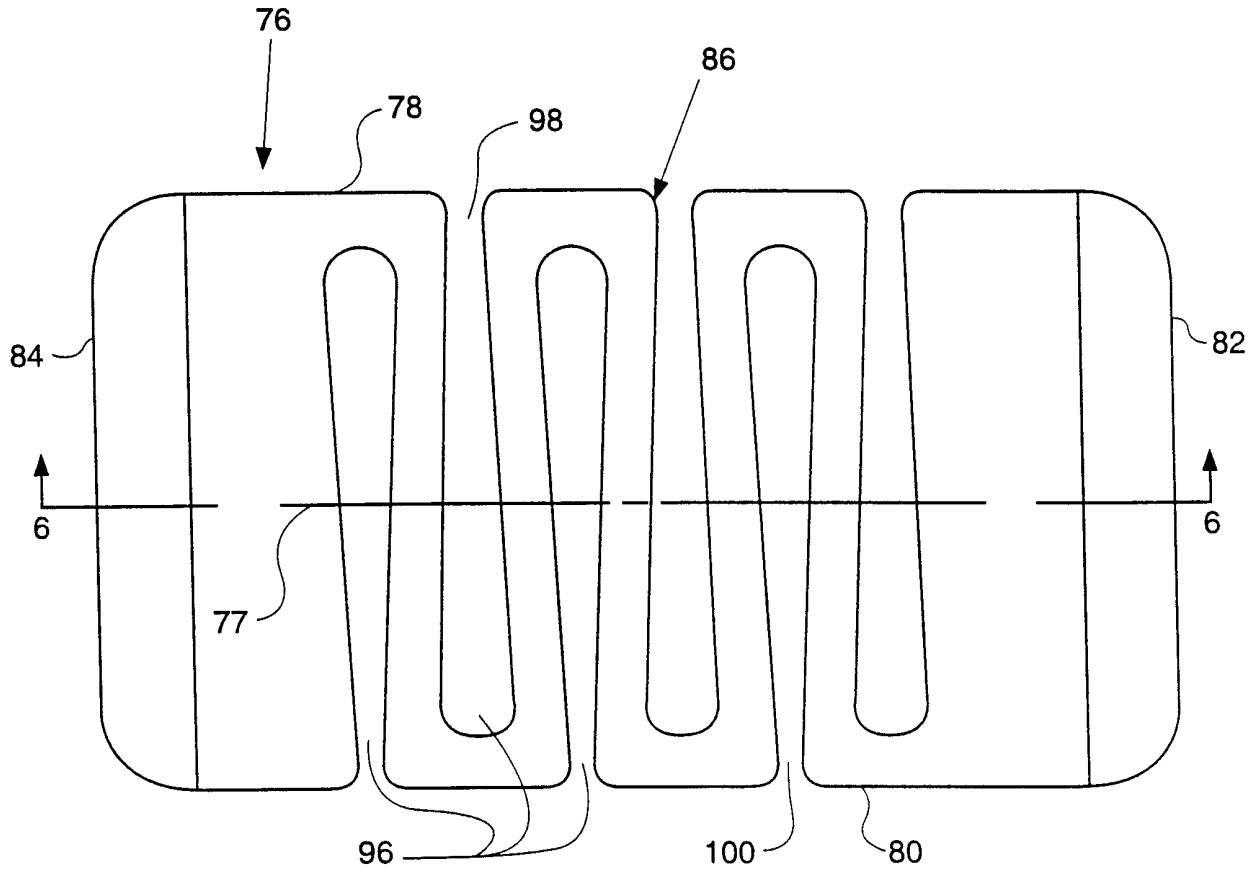


Fig. 6

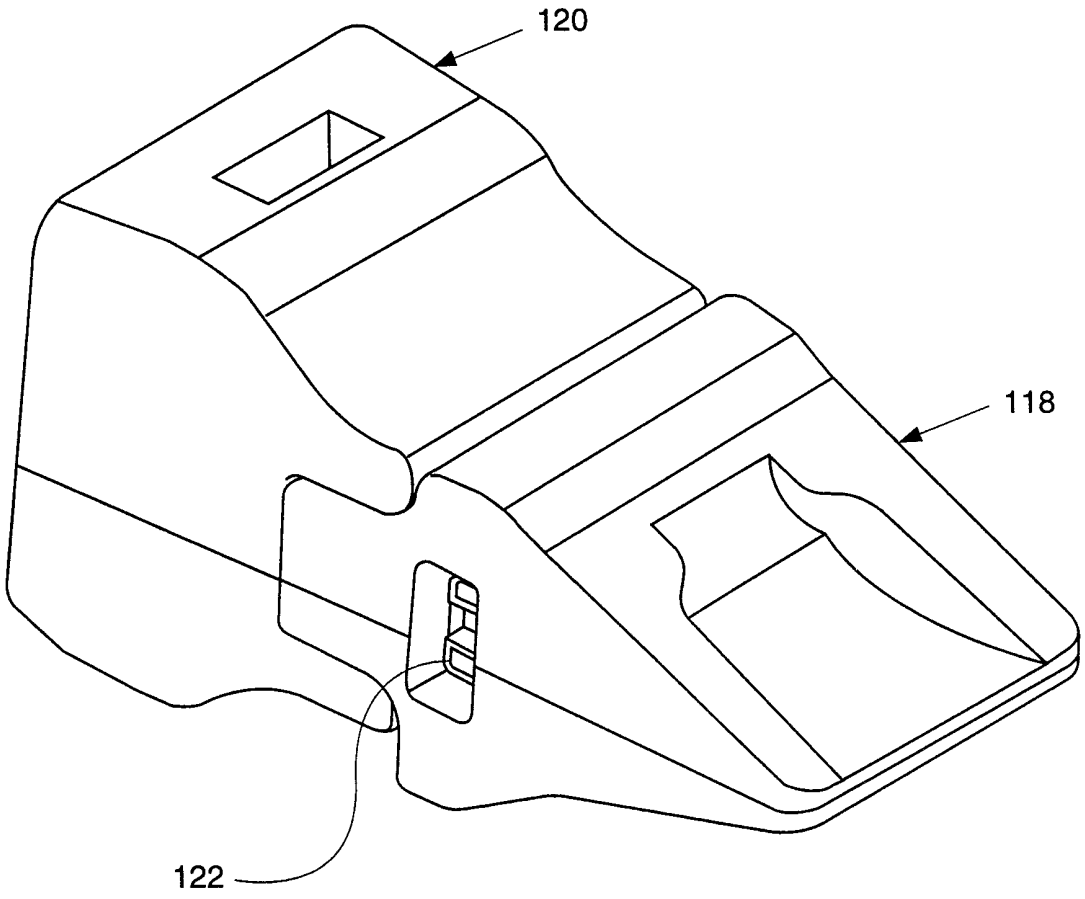


Fig. 7

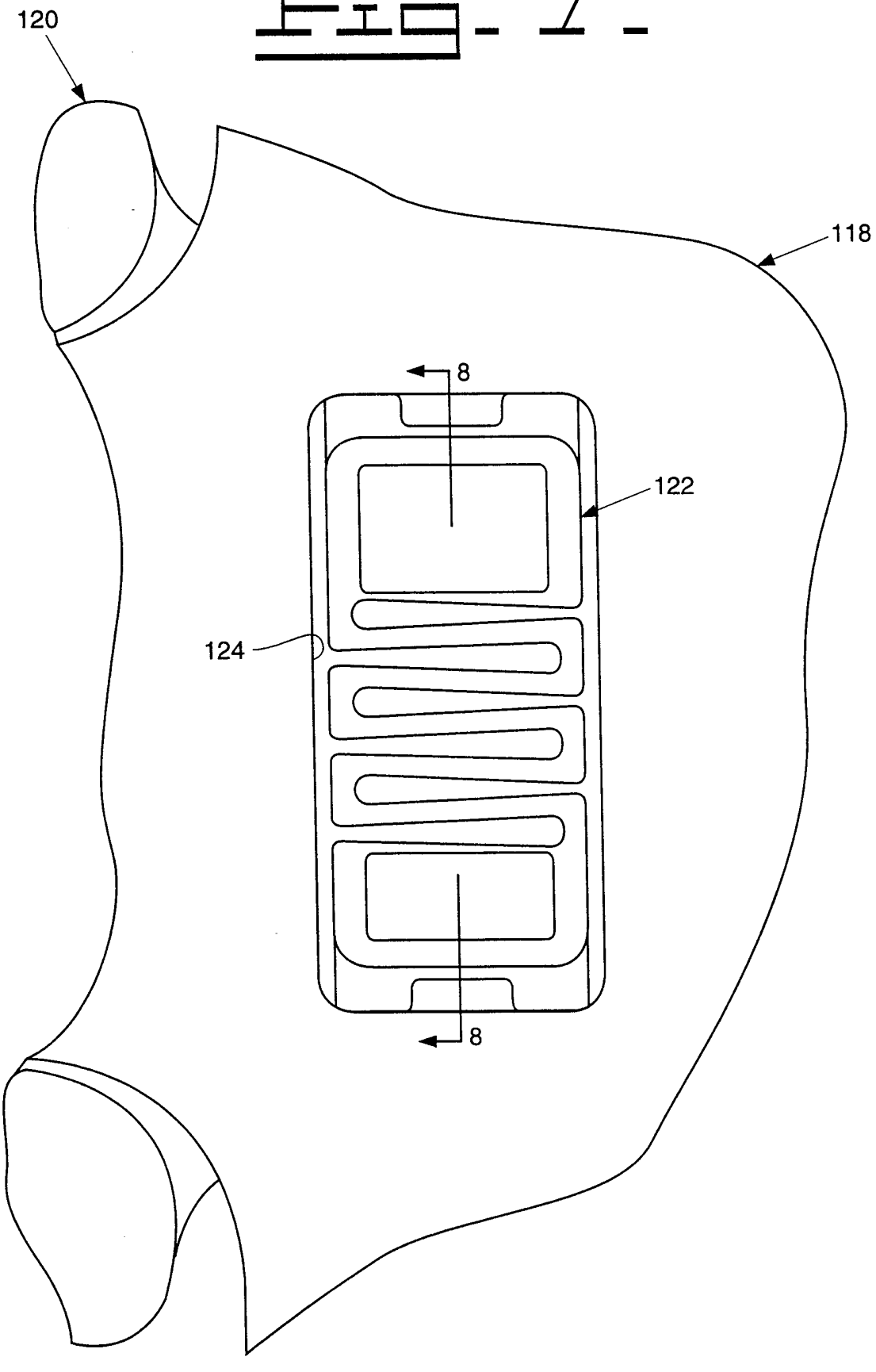


Fig. 8

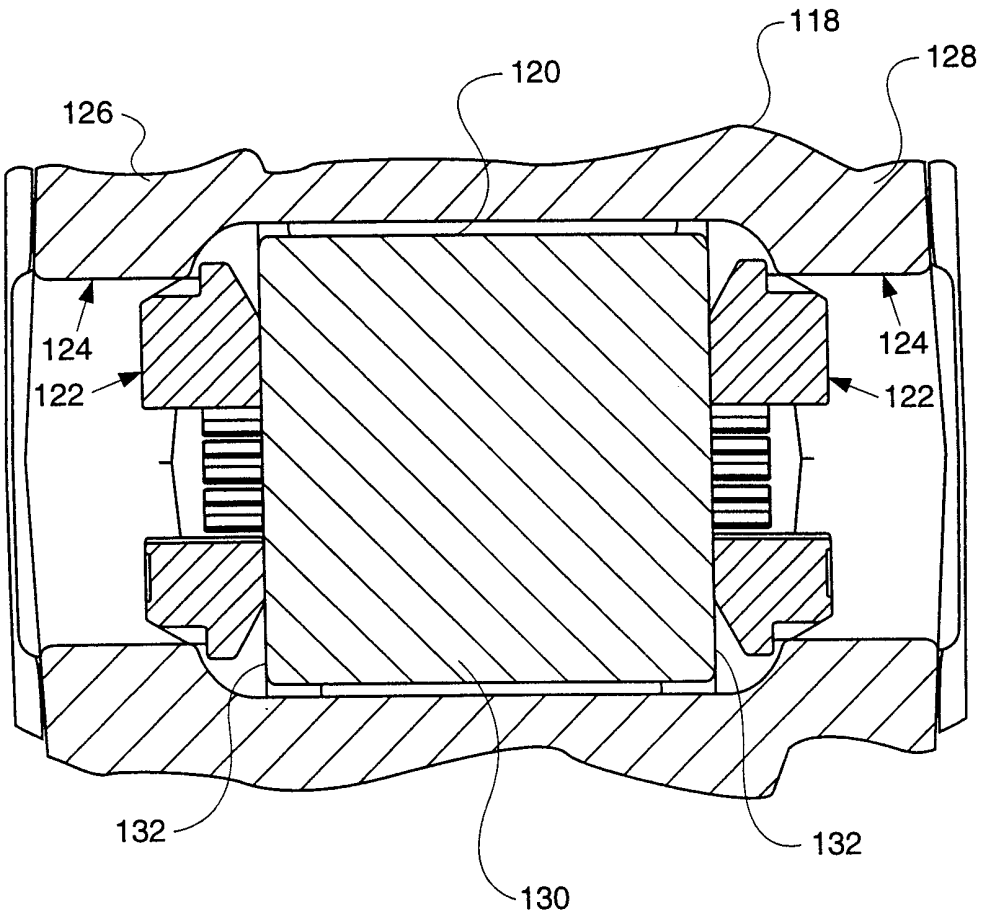


FIG. 9

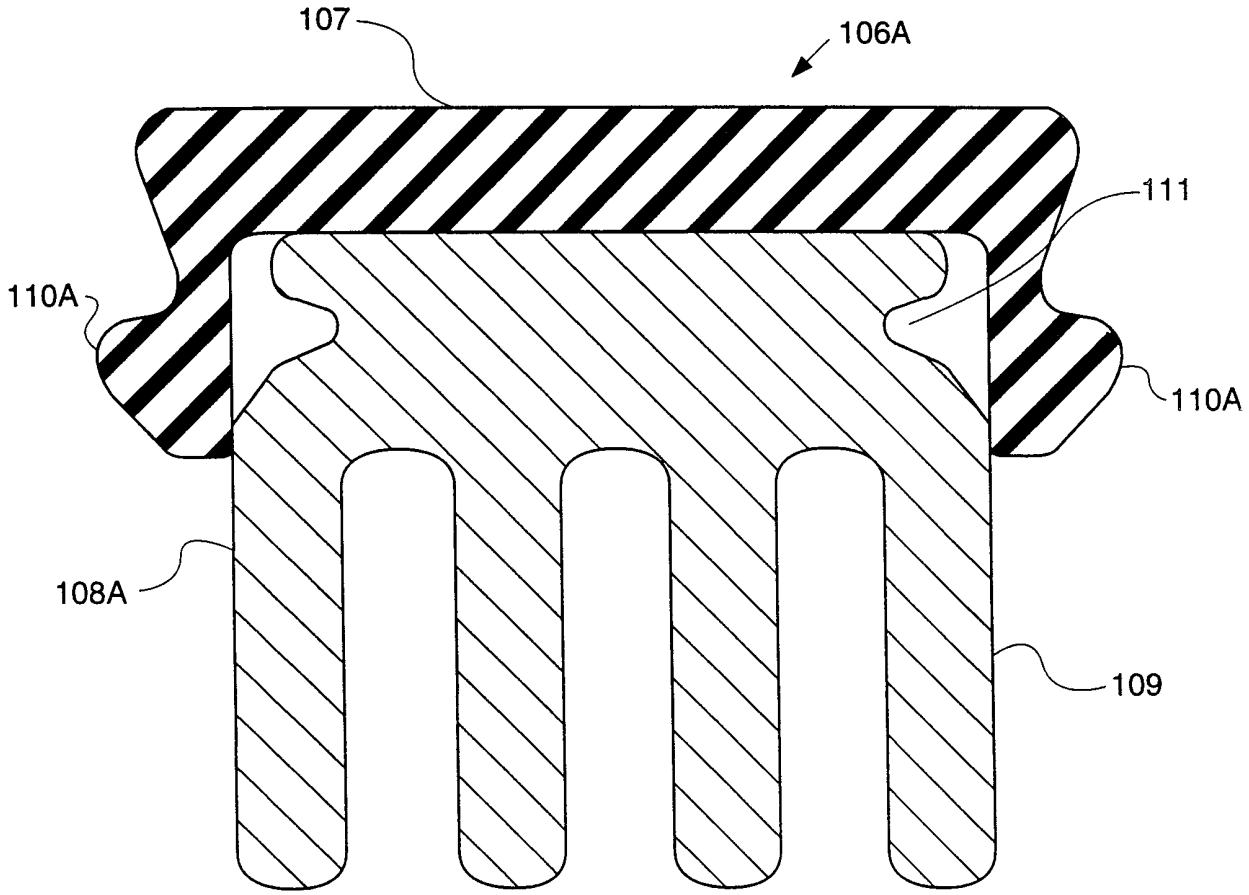


Fig. 10

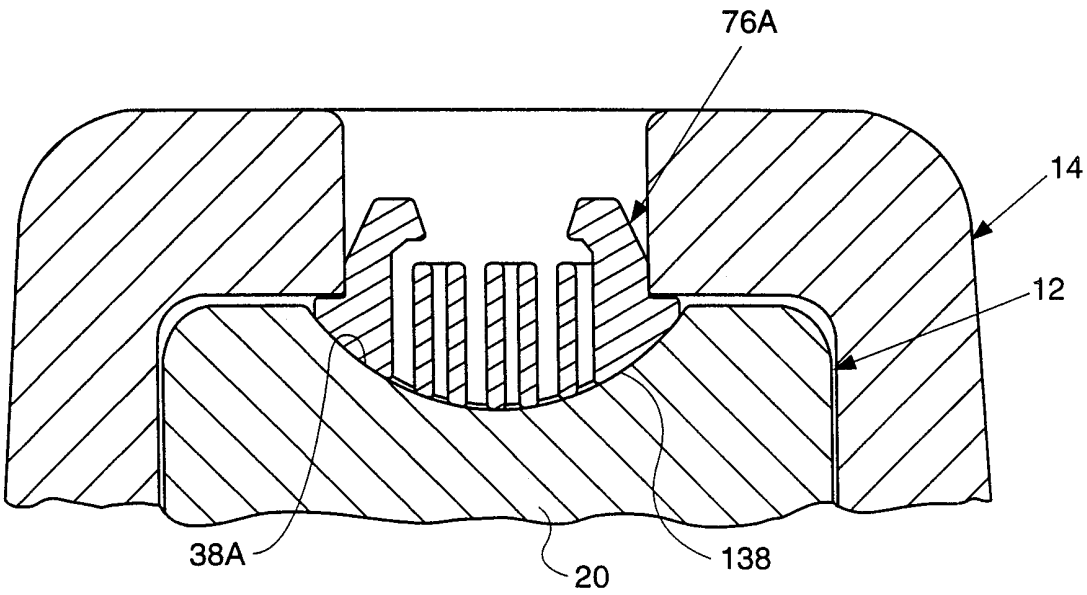
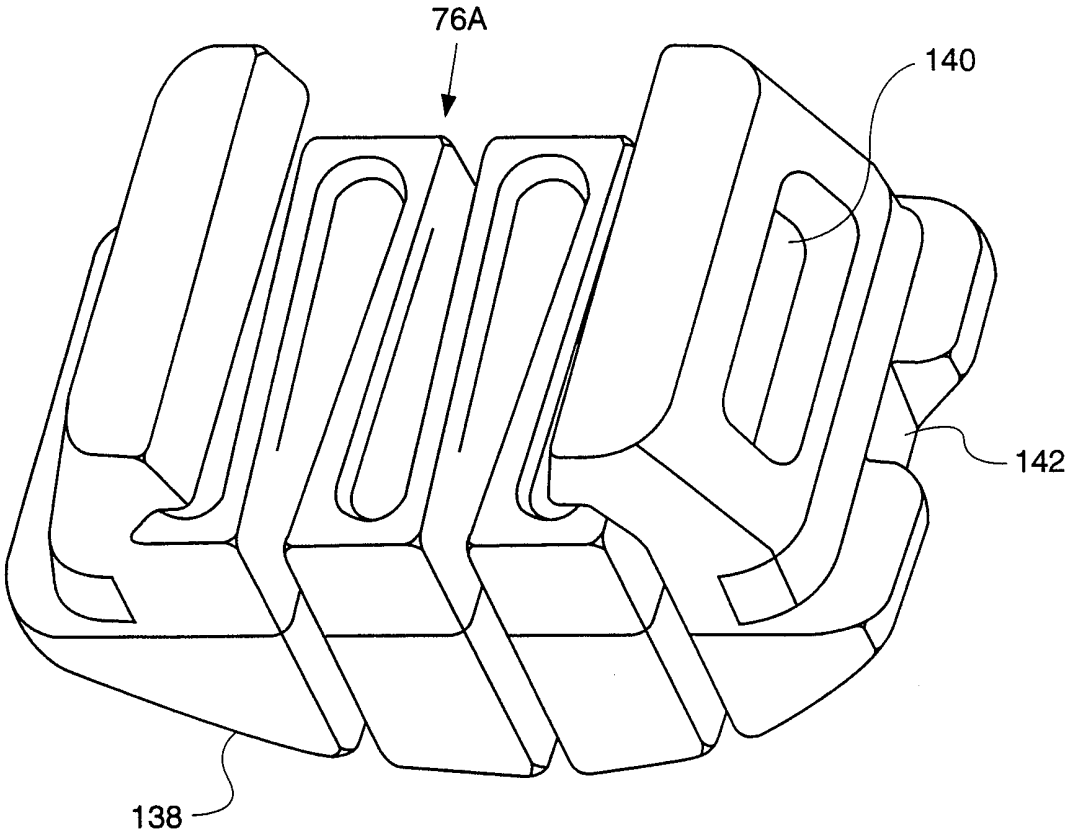


Fig. 11



INTERNATIONAL SEARCH REPORT

Interi ıal Application No
PCT/US 98/22448

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 E02F9/28

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 E02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2 325 991 A (WHITE) 3 August 1943 see figures 1,2 see page 1, right-hand column, line 24 - line 36 see page 1, right-hand column, line 46 - page 2, left-hand column, line 37 ---	1,2,6, 12,13,16
A	FR 2 596 785 A (ORENSTEIN & KOPPEL AG) 9 October 1987 see figures 1,2 see page 6, line 13 - line 37 see page 5, line 7 - page 6, line 8 ---	1,2,8, 12,13,16
A	US 5 088 214 A (JONES LARREN F) 18 February 1992 see abstract; figures 1-3,5,8-10 see column 3, line 1 - column 4, line 4 --- -/--	1,2,8, 12,13,16

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
11 January 1999	26/01/1999

Name and mailing address of the ISA	Authorized officer
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Interr al Application No
PCT/US 98/22448

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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