

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
27 December 2007 (27.12.2007)

PCT

(10) International Publication Number
WO 2007/149295 A2

(51) International Patent Classification:
H01R 4/60 (2006.01)

(21) International Application Number:
PCT/US2007/013953

(22) International Filing Date: 13 June 2007 (13.06.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/814,670 16 June 2006 (16.06.2006) US

(71) Applicant (for all designated States except US): **ESCO CORPORATION** [US/US]; 2141 NW 25th Avenue, Portland, OR 97210-2578 (US).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **MCCLANAHAN, Robert** [US/US]; 11895 SE Kehrl Drive, Milwaukie, OR 97222 (US).

(74) Agent: **SCHAD, Steven, P.**; Esco Corporation, 2141 NW 25th Avenue, Portland, OR 97210-2578 (US).

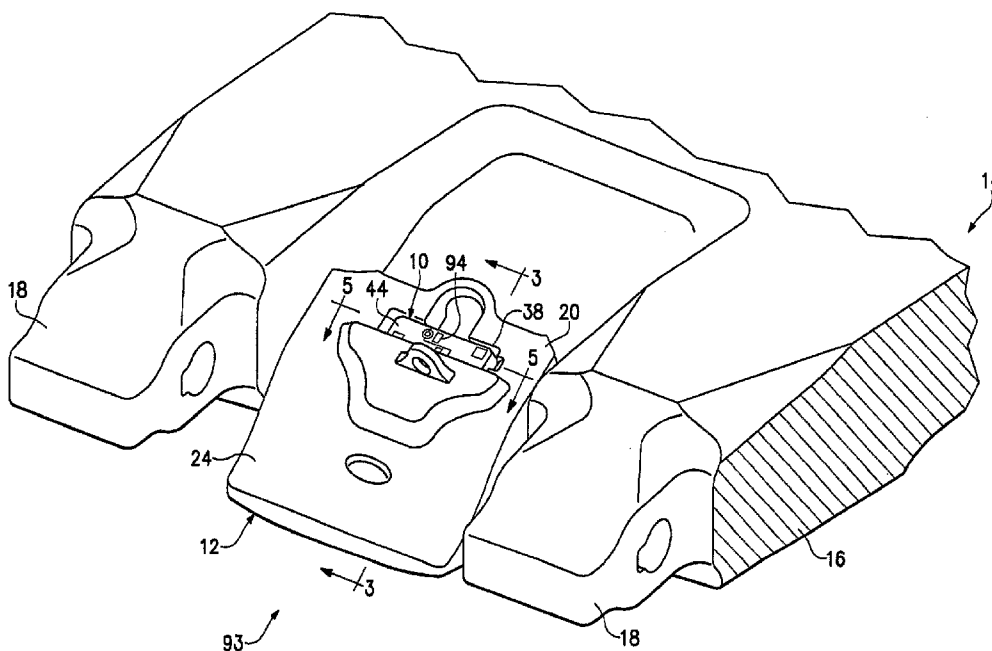
(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— without international search report and to be republished upon receipt of that report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: LOCK FOR SECURING WEAR PARTS TO EARTH-WORKING EQUIPMENT



(57) Abstract: A lock for securing a wear part to earth-working equipment that is foldable between a retaining position to hold the wear part to the equipment and a release position that permits removal of the lock and release of the wear part from the equipment. The lock includes a retainer for releasably holding the lock in the retaining position. The retainer may comprise a threaded wedge received into a complementary threaded passage.

WO 2007/149295 A2

LOCK FOR SECURING WEAR PARTS TO EARTH-WORKING EQUIPMENT

Field of the Invention

[01] The present invention pertains to locks for securing wear parts to earth-working equipment.

Background of the Invention

[02] Wear parts are commonly attached to earth-working equipment such as excavating buckets and the like. For example, teeth and shrouds are generally mounted along the digging edge of an excavating bucket to protect the bucket from wear and to enhance the digging operation. Such wear assemblies typically include a base, a wear member, and a lock to releasably hold the wear member to the base. The base is fixed to the equipment as an integral part of the equipment, or as one or more components that are fixed to the equipment by welding or mechanical attachment. The wear member fits over the base. The assembled base and wear member cooperatively define an opening into which the lock is received to releasably hold the wear member to the base.

[03] Wear members for earth-working equipment are commonly subjected to harsh conditions and/or heavy loading. Accordingly, it is desirable for the lock to be strong to effectively retain the wear member to the equipment, resistant to ejection during use, and easily removed in the field when replacement of the wear part is needed. Many different lock arrangements have been designed in an effort to meet these objectives with varying degrees of success.

Summary of the Invention

[04] The present invention pertains to improved locks for securing wear parts to earth-working equipment that are strong, durable, resistant to ejection, easy to manufacture at reduced costs, and simple and safe to use.

[05] In accordance with one aspect of the invention, the lock includes bodies that are interconnected for pivotal movement between a retaining position where the lock holds a wear part to the earth-working equipment and a release position where the lock permits release of the wear part from the equipment.

[06] In accordance with one other aspect of the invention, the lock is hinged for movement between the retaining position and the release position. In the retaining position, the lock defines a robust pin that sets within an opening in the wear part to resist loads applied to the wear part during use. In the release position, the lock is articulated about the hinge to permit easy withdrawal or installation of the lock into or from the wear assembly, thus, permitting easy replacement of the wear part in the field.

[07] In accordance with another aspect of the invention, the body of the lock includes end walls that are preferably shaped to cooperate with sides of the opening and thereby prevent ejection of the lock during use. As a result, retention of the lock is achieved by the strength of the pin itself and does not rely upon a movable latch, magnets, additional welding or other separate means that require additional parts and/or are more susceptible to ejection during use.

[08] In accordance with one other aspect of the invention, the lock is made of two bodies that are coupled together by a hinge, which preferably is formed of components that are integral to the bodies. This construction reduces the number of

components, eases manufacturing, reduces costs, and strengthens the lock. In one preferred embodiment, one lock component is formed with an integral post while the other lock component has a complementary hole.

[09] In accordance with another aspect of the invention, the lock is foldable for insertion into and release from a wear assembly, and includes a retainer to prevent folding while in the retaining position to prevent loss of the lock and wear part during use.

[10] In accordance with another aspect of the invention, the lock includes a retainer that is threaded into a passage engaging both components. The retainer may have many different configurations. As examples only, the retainer may extend into both components, may be inserted along a seam between the components, and may extend in one of a multiple of directions. The retainer may also be a threaded rod, wedge or set screw, or have other configurations resisting pivoting or folding of the lock. The retainer is preferably easy to use, and enables installation and removal without the need for hammering, which leads to a safer and easier replacement process.

[11] In accordance with another aspect of the invention, the lock includes movable components that are fixed in the retaining position by a threaded wedge.

[12] In accordance with one other aspect of the invention, the lock is provided with means for effecting articulation and removal of the lock from the wear assembly. In one construction, the lock includes a grip to be engaged by a tool for manipulating the lock. In alternative construction, the lock is provided with a driver that articulates the lock for removal. In one preferred construction, the driver is

threaded through one of the bodies to press against the assembly and move the lock into its articulated release position.

Brief Description of the Drawings

[13] Figure 1 is a perspective view of a wear assembly wherein the wear part is a shroud secured to a lip of an excavating bucket with lock in accordance with the present invention (the lip being only partially shown).

[14] Figure 2 is an exploded perspective view of the wear assembly of Figure 1 without the lock.

[15] Figure 3 is a cross-sectional view taken along line 3-3 in Figure 1.

[16] Figure 4 is a perspective view of the wear part of Figure 1 with the lock in place.

[17] Figure 5 is a cross-sectional view taken along line 5-5 in Figure 1.

[18] Figure 6 is a cross-sectional view also taken along line 5-5 in Figure 1, but with the lock in an articulated release position for removal from the assembly.

[19] Figure 7 is a perspective view of the lock in a locking position.

[20] Figures 8 and 9 are exploded perspective views of the lock.

[21] Figures 10 and 11 are each a perspective view of one of the components of the lock.

[22] Figure 12 is a perspective view of an alternative lock construction in accordance with the present invention.

[23] Figure 13 is a perspective view of the alternative lock in the release position.

[24] Figure 14 is an exploded, perspective view of the alternative lock.

[25] Figure 15 is a cross-sectional view along line 5-5 in Figure 1, but of the alternative lock in the release position.

[26] Figure 16 is a perspective view of a wear assembly wherein the wear part is a shroud securable to a lip of an excavating bucket with a second alternative lock in accordance with the present invention.

[27] Figure 17 is a perspective view of the wear assembly of with the second alternative lock shown in a release position.

[28] Figure 18 is a perspective view of the second alternative lock in the retaining position.

[29] Figure 19 is a perspective view of the second alternative lock with the retainer removed.

[30] Figure 20 is a perspective view of a first component of the second alternative lock.

[31] Figure 21 is a perspective view of a second component of the second alternative lock.

[32] Figure 22 is a perspective view of the second component of the lock with the retainer.

[33] Figure 23 is a perspective view of a fourth alternative lock in accordance with the present invention.

[34] Figure 24 is a perspective view of a first component of the fourth alternative lock.

[35] Figure 25 is a perspective view of a second component of the fourth alternative lock.

Detailed Description of the Preferred Embodiments

[36] The present invention pertains to a lock 10 for releasably securing a wear member 12 to earth-working equipment 14. To illustrate the invention in this application, lock 10 is described in the context of securing a shroud to a lip of an excavating bucket. As an example, the disclosed shroud is generally as described in U.S. Patent Application Publication No. 2007-0044349, which is incorporated by reference. Nevertheless, a lock in accordance with the present invention could be used to secure other wear members including, for example, (i) other shrouds (e.g., as disclosed in U.S. Patent No. 5,088,214, which is incorporated by reference), (ii) excavating teeth (e.g., as disclosed in U.S. Patent No. 5,653,048, which is incorporated by reference), (iii) runners or other wear members for buckets (e.g., as disclosed in U.S. Patent No. 5,241,765, which is incorporated herein by reference), (iv) wear members for other kinds of excavators such as dredge cutterheads (e.g., as disclosed in U.S. Patent No. 6,729,052, which is incorporated herein by reference), and (v) wear members for other kinds of earth-working equipment used in connection with excavating operations such as ore chutes, truck bed liners, etc. Additionally, relative terms such as forward, rearward, up or down are used for convenience of explanation with reference to Figure 1; other orientations are possible.

[37] In one embodiment of the invention (Figs. 1-11), shroud 12 fits onto lip 16 between two noses 18 (Figs. 1-3) that support excavating points (not shown). In a preferred construction, lip 16 includes an insert 25 that is fixed into place via welding 32. The insert defines a boss 26 near the front edge 27 of the lip for

securing shroud 12. The lip, of course, could have many different constructions and could include this boss (or another kind of base) without the use of an insert.

[38] Shroud 12 includes a pair of legs 20, 22 to straddle lip 16, and a wearable front end 24 (Figs. 1-4). Leg 20 includes a recess 34 along its inner surface 36 to receive boss 26, and an opening 38 through the leg to receive lock 10. The lock fits within opening 38 and extends below the leg to oppose rear face 40 of boss 26 to hold the shroud in place; i.e., with lock 10 in opening 38, the shroud cannot be pulled from the lip due to the abutment of lock 10 against boss 26.

[39] Lock 10 includes two bodies or components 42, 44 that are pivotally coupled together for movement about a lateral axis 46 between a retaining position (Figs. 5 and 7) and a release position (Fig. 6). In a preferred construction, each body 42, 44 has a generally L-shaped configuration with a base portion 48, 50, and a projection 52, 54 (Figs. 5-10), although other shapes can be used. In the illustrated example, first body 42 includes an integral post 56 projecting from an inner face 58 of projection 52. The second body 44 includes a complementary hole 60 in the inner face 62 of projection 54. The post is received within hole 60 to form a hinge 64 that pivotally couples first and second bodies 42, 44 together for limited movement about axis 46. Alternatively, the hinge could have other constructions including, for example, forming each projection with a hole for receiving a pivot pin secured in place by retaining rings or the like.

[40] Each body 42, 44 is formed with a threaded channel 68, 72. Channel 68 is formed on free end 66 of projection 52, and channel 72 is formed on front surface 70 of base portion 50. When bodies 42, 44 are assembled together and in the retaining position, free end 66 sets opposed to front surface 70 so that channels

68, 72 are aligned with each other to collectively form a passage 74. Preferably, each channel 68, 72 defines, in lateral cross-section, a semi-circle so that the two channels collectively form a complete circular passage, though less than a full semi-circle for each or one channel is possible. Preferably both channels 68, 72 are formed with thread segments to cooperatively define a threaded passage 74. Nevertheless, the channels could be partially threaded or threads provided along only one channel.

[41] A retainer 76 in the form of a threaded rod is threaded into passage 74 with lock 10 in the retaining position to prevent relative movement between the two components 42, 44. A hex socket 77 or other tool engaging formation is provided at the top of retainer 76 for turning the retainer. With the retainer inserted in passage 74 (Figs. 1, 3-5 and 7), bodies 42, 44 cannot be pivoted about axis 46. As a result, the lock presents a strong, integral pin to resist heavy loading and prevent release of shroud 12 from lip 16. When retainer 76 is removed, bodies 42, 44 can pivot about axis 46 from the retaining (or locked) position to the release position (Fig. 6). The bottom corners 82, 84 of free ends 66, 78 are rounded or otherwise shaped to provide sufficient clearance for components 42, 44 to pivot about axis 46 to the release position. Corners 82, 84 preferably abut against front faces 70, 80 of bodies 42, 44 in the release position to ease removal and installation of the lock.

[42] Other alternatives are possible. For example, threaded channels could be formed at the free end 78 of projection 54 and the front surface 80 of base portion 48. Also, as an alternative, the rod and passages could be unthreaded with the rod held in place by a detent, retainer clips or other securing devices.

Additionally, other retainers could be used to prevent pivotal movement between bodies 42, 44. For example, other plates or rods could extend through the bodies in different directions and/or at different locations to prevent relative movement between the bodies 42, 44. In addition, the lock could be maintained in the retaining position by an external member or structure that forms part of the assembly but may not be part of the lock. Also, other hinge and retainer constructions could be used to provide sufficient strength, enable articulation for insertion and removal, and allow access for the retainer.

[43] Also, while bodies 42, 44 are disclosed as having the same or similar lengths and forming opposite ends of the lock, other arrangements could be used. For example, the bodies could have different lengths or each extend the full length of the lock. Also, the lock could comprise a foldable element, but not consist of two components joined by a pivot pin. Other arrangements could be used to present a firm, secure lock in the retaining position, but which permits folding of the lock to the release position. In each of these different ways, the lock possesses a shorter length in the release position than in the retaining position so that it is only released when desired.

[44] During use, lock 10 fits in opening 38 of shroud 12 (Figs. 1, 3 and 5). The end walls 86, 88 of bodies 42, 44 are inclined downward and outward to fit under the end walls 90, 92 of opening 38 (Fig. 5). This fit precludes removal or ejection of the lock when retainer 76 is in passage 74. Nevertheless shaped walls such as stepped walls, walls with projections, or otherwise shaped end walls 86, 88 could be used to secure the lock in place. As an alternative, latches, detents, magnets, obstructions or other means could be used to hold lock 10 in opening 38.

[45] To replace a worn shroud, lock 10 must first be removed. To do so, retainer 76 is unthreaded from passage 74, and bodies 42, 44 pivoted about axis 46 to their release position (Fig. 6). In this position, end walls 86, 88 of the lock clear end walls 90, 92 of the opening so that the lock can be withdrawn from the wear assembly 93. At least one body 42, 44 (and preferably both to enable removal from either direction) is provided with a grip 94 to facilitate pivoting of the bodies and pulling the lock from the opening. In the preferred embodiment, grips 94 are formed as inclined cavities to receive a removal tool 101; although other forms of grips could be used. Each body 42, 44 also preferably includes a depression 104 spaced from grip 94 to stably support a fulcrum 107 of tool 101. In use, a gripping end 109 of tool 101 fits into cavity 94 on body 42 (or 44) with fulcrum 107 resting in one depression 104. The lever 111 of tool 101 is pushed downward to pull the middle of lock 10 upward such that the bodies 42, 44 pivot about hinge 64. In this position, the lock can be pulled out of opening 38 with tool 101. Once a new shroud is placed on lip 16, the bodies are manually manipulated into the release position and the lock dropped into opening 38. The bodies naturally extend into their locked position when placed in assembly 93. Retainer 76 can then, again, be threaded into passage 74 to retain bodies 42, 44 in the retaining position (Figs. 1 and 5).

[46] As an alternative, lock 110 (Figs. 12-15) can be used to secure shroud 12 (or other wear members) to lip 16 (or other earth-working equipment) in place of lock 10. Locks 10 and 110 are generally the same except lock 110 includes a different retainer 176, and a driver 177 in place of grips 94. More specifically, lock 110 includes two bodies 142, 144 pivotally connected together for movement between a retaining position (Fig. 12) to hold the wear member to the equipment

and a release position (Fig. 13) to permit installation and removal of the lock. Body 142 includes a post 156 that is received within hole 160 in body 144 to form hinge 164.

[47] Post 156 includes a flat 157 that cooperates with retainer 176. In this embodiment, the retainer is a set screw received into a threaded passage 174 in projection 154; i.e., passage 174 extends between upper surface 179 and hole 160. In the retaining position, flat 157 sets generally perpendicular to passage 174 to enable set screw 176 to be tightened against the flat and thereby prevent relative movement between the bodies 142, 144. This arrangement eliminates the need to align channels 68, 72 for receipt of retainer 76, as in lock 10. Moreover, in this embodiment, the retainer can be retracted to permit release of the lock without removing the retainer. As a result, the lock remains an integral assembly in both the retaining and release positions. This benefit could also be gained for other retainers that simply extend into both bodies but are not inserted along the seam of the two lock bodies.

[48] As an alternative to grips, lock 110 includes a driver 177 that moves the lock from the retaining position to the release position. Driver 177 eliminates the need for a separate prying tool 101 to remove the lock. In a preferred construction, driver 177 is a threaded rod received in through-hole 181 in body 142 proximate the middle of the lock. Although though-hole 181 is shown adjacent front face 180 it could be located in other parts of body 142 or 144. To remove lock 110, set screw 176 is first loosened or removed. Driver 177 is threaded downward through body 142 to press against a top of boss 26 and push the middle of lock 110

upward. This motion causes bodies 142, 144 to be pivoted about hinge 164 to their release position when the lock can be manually gripped and removed.

[49] Other combinations of features could be used together. For example, a lock with a set screw style retainer could be used with a lock having grips to facilitate engagement with a removal tool. Alternatively, a lock with a driver could be used with a retainer fit in a passage defined between the two bodies.

[50] Figures 16-22 illustrate another alternative lock 210 which can be used to secure wear member 12 to the earth-working equipment. Lock 210 is similar to lock 10 except that retainer 276 is a threaded wedge having a form as disclosed in U.S. Patent No. 7,174,661, which is incorporated by reference. Retainer 276 is a wedge with a narrow leading end 278 and a wide trailing end 280. The wedge is provided with a thread formation preferably in the form of a helical groove 282. A hex socket 284 or other means for turning the retainer is provided at trailing end 280.

[51] Each body or component 242, 244 defines a channel 268, 272. Preferably only one channel 272 includes helical ridge segments 273 for engaging groove 282, but both channels 268, 272 could include such ridges. When bodies 242, 244 are assembled together in the retaining position, channels 268, 272 are aligned with each other to collectively form a tapered, threaded passage 274 adapted to matingly receive retainer 276. Lock 210 operates in essentially the same way as lock 10. Accordingly, lock 210 includes grips 294 and depressions 304 to facilitate use of tool 101. The use of a wedge retainer 276 over threaded rod 76 generally provides a more robust lock in the retaining position. The threaded wedge is also generally easier to remove.

[52] As a further alternative, lock 410 can be secured in the retaining position by a retainer 276 that is horizontally driven between bodies 442, 444 (Figs. 23-25). In lock 410, body 442 includes a tapered channel 468 that extends across end 466 in a direction that is generally parallel to axis 446. Similarly, body 444 includes a tapered channel 472 that extends across end 470 in a direction that is also generally parallel to axis 446. When bodies 442, 444 are in the retaining position (Fig. 23), channels 468, 472 form a tapering passage 474 that matingly receives retainer 276. As with lock 210, one channel 472 preferably includes helical ridge segments to engage groove 282. However, the channel may only be partially threaded or both channels may be threaded.

[53] Threaded rod 76, threaded wedge 276 or set screw 176 could each be secured into the interconnected bodies in a direction parallel or transverse to the pivot axis. If the retainer is inserted in a horizontal direction, either parallel or perpendicular to the pivot axis, clearance (not shown) must be provided in the wear member to permit installation and removal of the retainer. As one example, the wear member could be formed with a generally T-shaped opening that opens in the rear wall of the wear member such as disclosed in U.S. Patent No. 5,653,048.

[54] The above-discussed embodiments are preferred embodiments of the present invention. Various alternatives could be used. For example, the retainers may be threaded rods or threaded wedges in any of the disclosed embodiments. The retainers may have considerably different constructions and include shifting plates, detents, latches, etc. The pivot axis or hinge may be defined in other ways that permit the desired movement of the bodies. Folding of the locking component could also be achieved by other means. In general, various other embodiments as

well as many changes and alterations may be made without departing from the spirit and broader aspects of the invention as defined in the claims.

Claims

1. A lock for securing a wear member to earth-working equipment comprising a plurality of bodies interconnected for pivotal movement about a pivot axis between a retaining position where the lock holds the wear member to the equipment and a release position where the lock can be removed to permit removal of the wear member from the equipment, wherein the lock has a length in a direction transverse to the pivot axis that is greater in the retaining position than in release position.

2. A lock in accordance with claim 1 further including a retainer to prevent the bodies from moving about the pivot axis out of the retaining position.

3. A lock in accordance with claim 2 wherein the retainer is a threaded member that engages each of the bodies in the retaining position and releases at least one of said bodies in the release position.

4. A lock in accordance with claim 3 wherein the retainer is threaded into a passage formed along a seam between the bodies in the retaining position.

5. A lock in accordance with claim 3 wherein the retainer is a threaded wedge.

6. A lock in accordance with claim 2 wherein the retainer is inserted into a passage formed along a seam between the bodies in the retaining position.

7. A lock in accordance with claim 6 wherein the retainer is inserted into the passage in a direction generally transverse to the pivot axis.

8. A lock in accordance with claim 6 wherein the retainer is inserted into the passage in a direction generally parallel to the pivot axis.

9. A lock in accordance with claim 1 further including at least one grip for a tool to engage at least one of the bodies to move the lock from the retaining position to the release position.

10. A lock in accordance with claim 9 further including a recess defining a fulcrum for the tool.

11. A lock in accordance with claim 1 wherein one of said bodies defines a post and the other of said bodies defines a hole for receiving the post to define the pivot axis.

12. A lock in accordance with claim 1 wherein each of the bodies has a generally L-shaped configuration.

13. A lock for securing a wear member to earth-working equipment comprising an elongate foldable element that can be folded between a first position having a first length and a second position having a second length that is shorter than the first length, and a retainer for selectively preventing folding of the element in the first position.

14. A lock in accordance with claim 13 wherein the retainer is a threaded member and the foldable element includes a threaded passage for receiving the retainer.

15. A lock in accordance with claim 14 wherein the passage and the retainer each has a tapered shape.

16. A lock in accordance with claim 13 wherein the foldable element includes at least one grip for connection by a tool to engage and fold the foldable element from the first position to the second position.

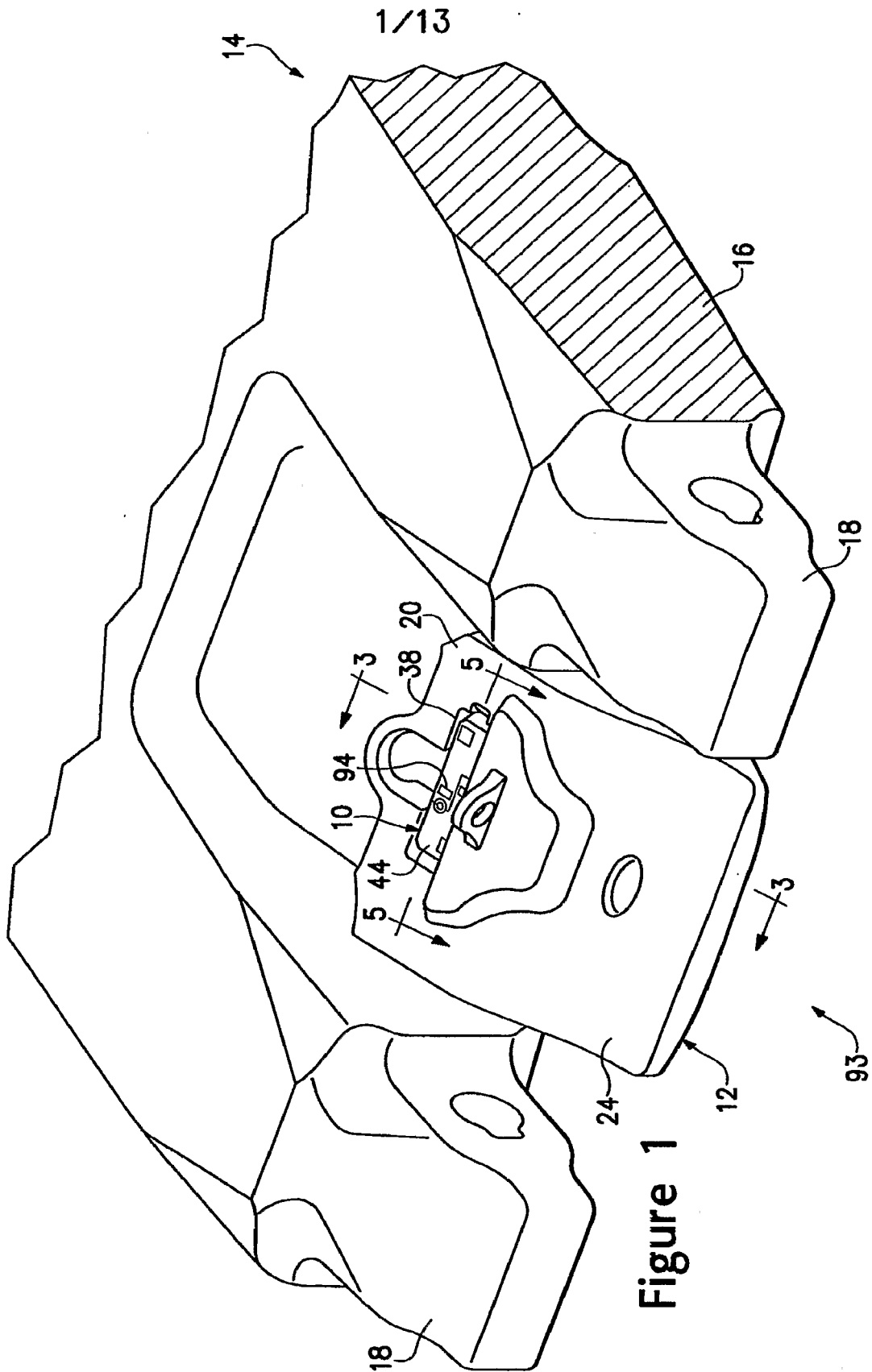
17. A lock for securing a wear member to earth-working equipment comprising two components that are interconnected and movable between a first position for securing the wear member to the equipment and a second position for permitting removal of the lock and release of the wear member from the equipment, and a threaded wedge for releasably maintaining the two components in the first position.

18. A lock in accordance with claim 17 wherein the components are pivotally movable about a pivot axis such that the lock defines a longer length in the first position as compared to the second position.

20. A lock in accordance with claim 18 wherein the components define a tapered, threaded passage extending generally transverse to the pivot axis.

21. A lock in accordance with claim 18 wherein the components define a tapered, threaded passage extending generally parallel to the pivot axis.

22. A lock in accordance with claim 17 wherein at least one of the components defines a tapered, threaded passage for receiving the threaded wedge.



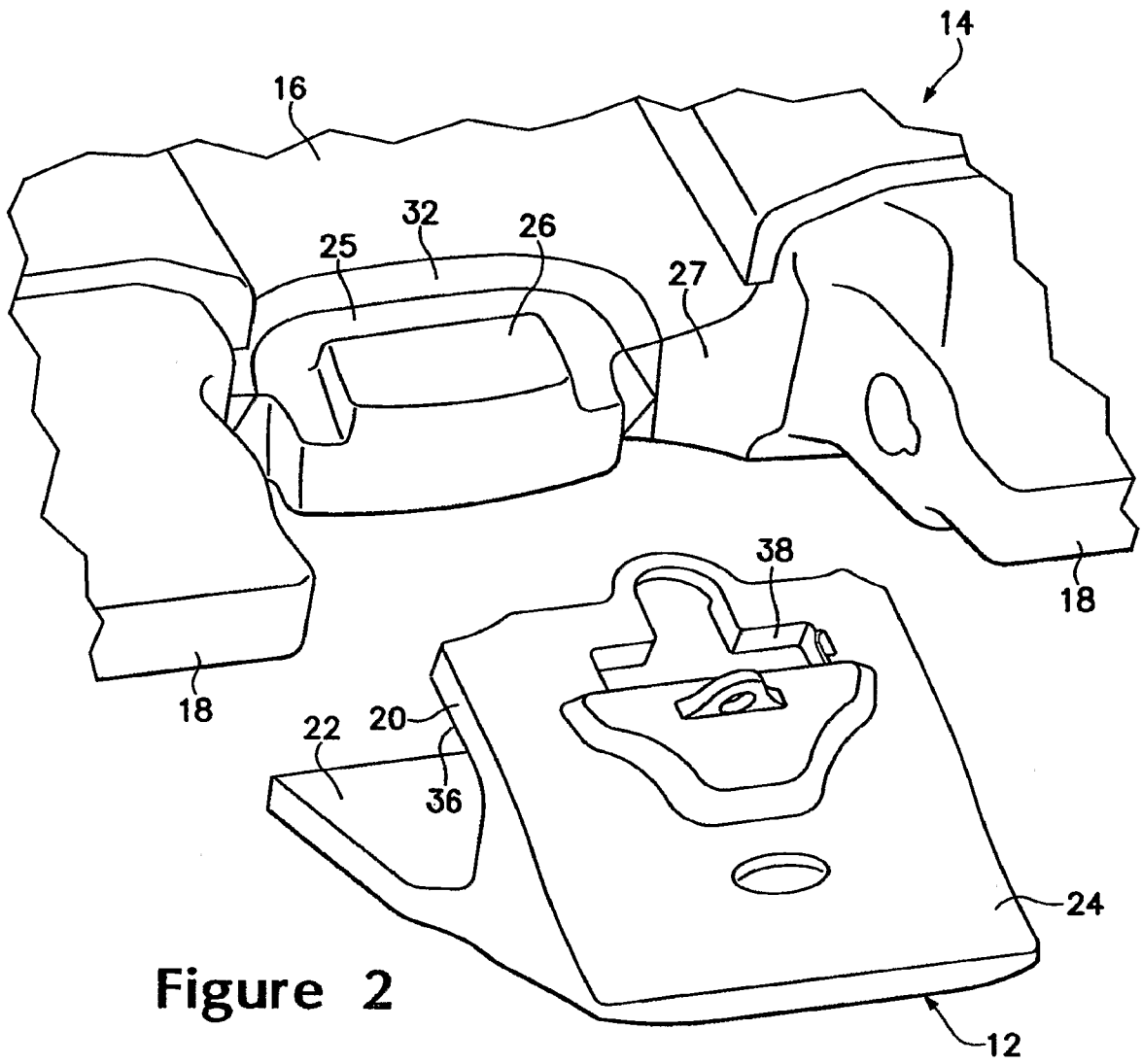


Figure 2

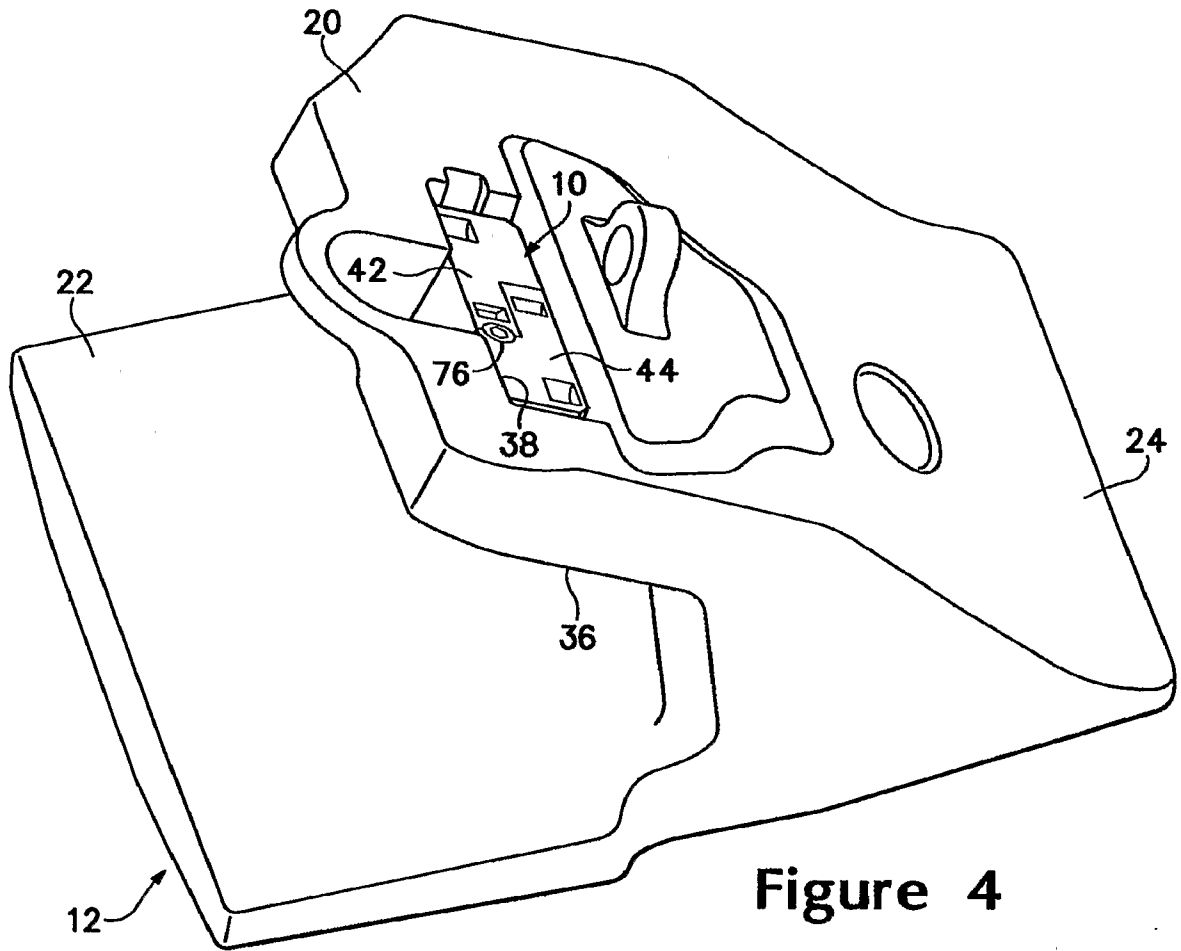


Figure 4

5/13

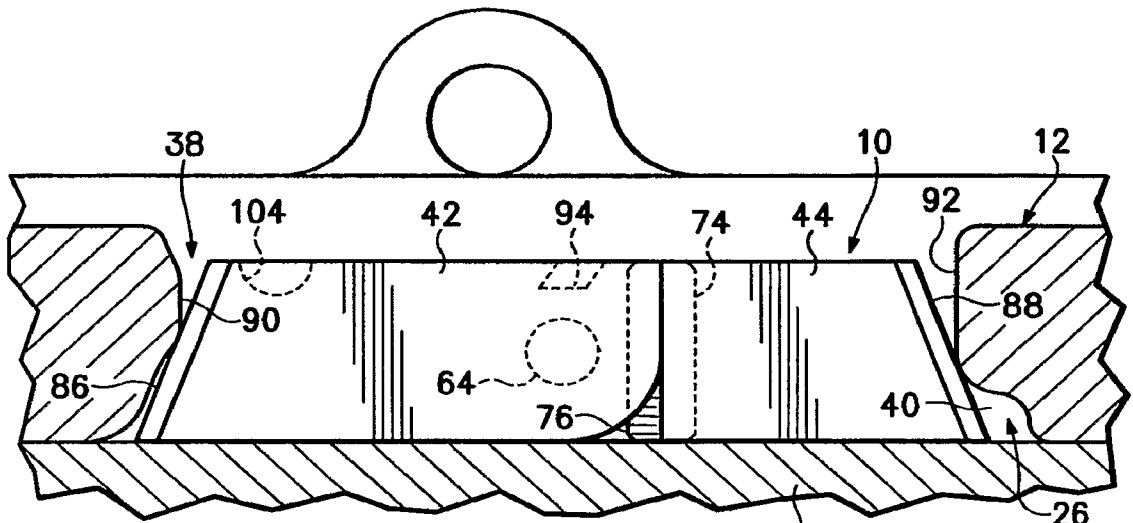


Figure 5

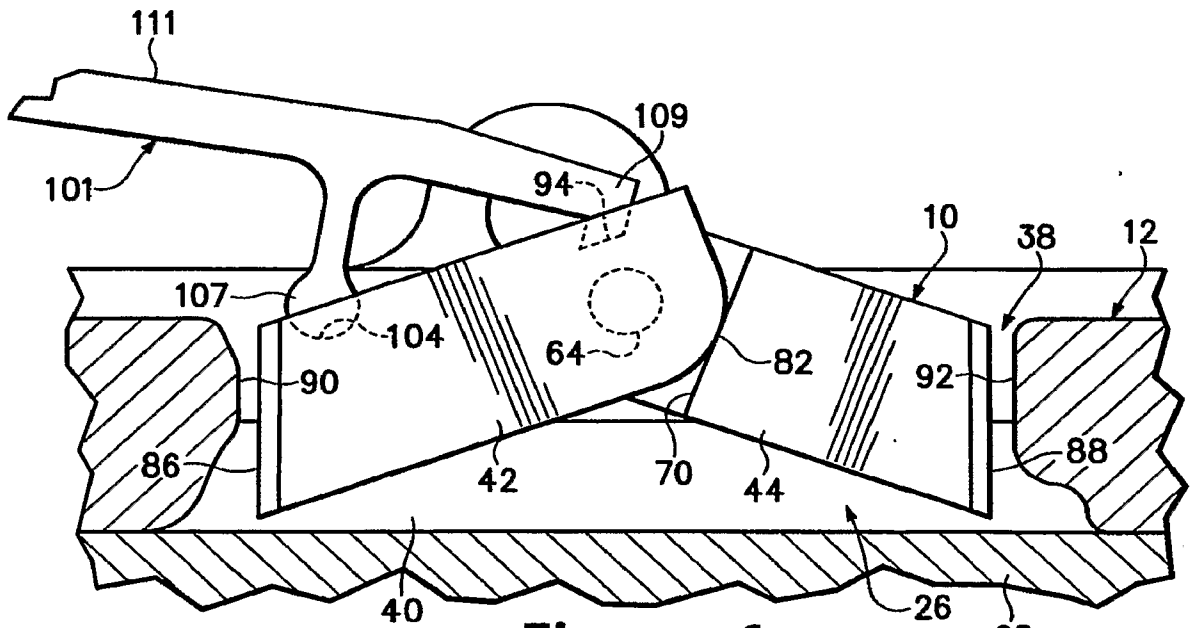


Figure 6

6/13

Figure 7

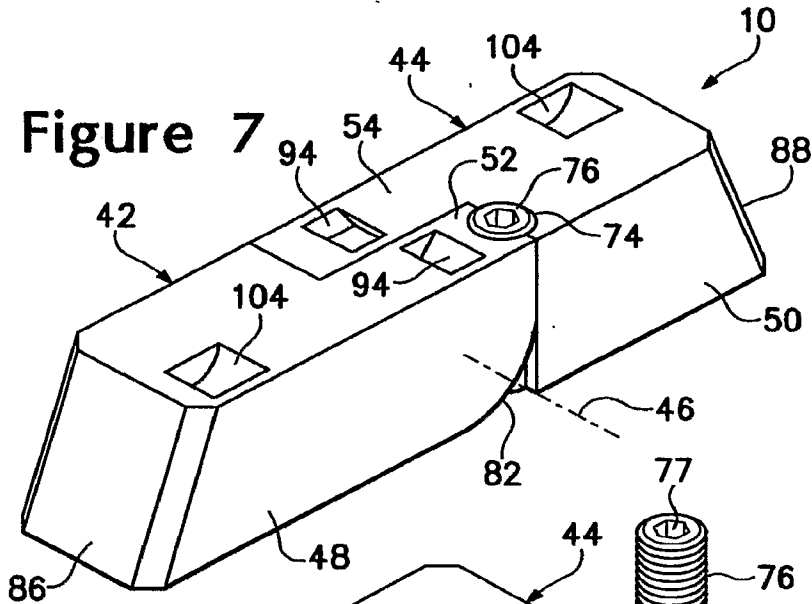


Figure 8

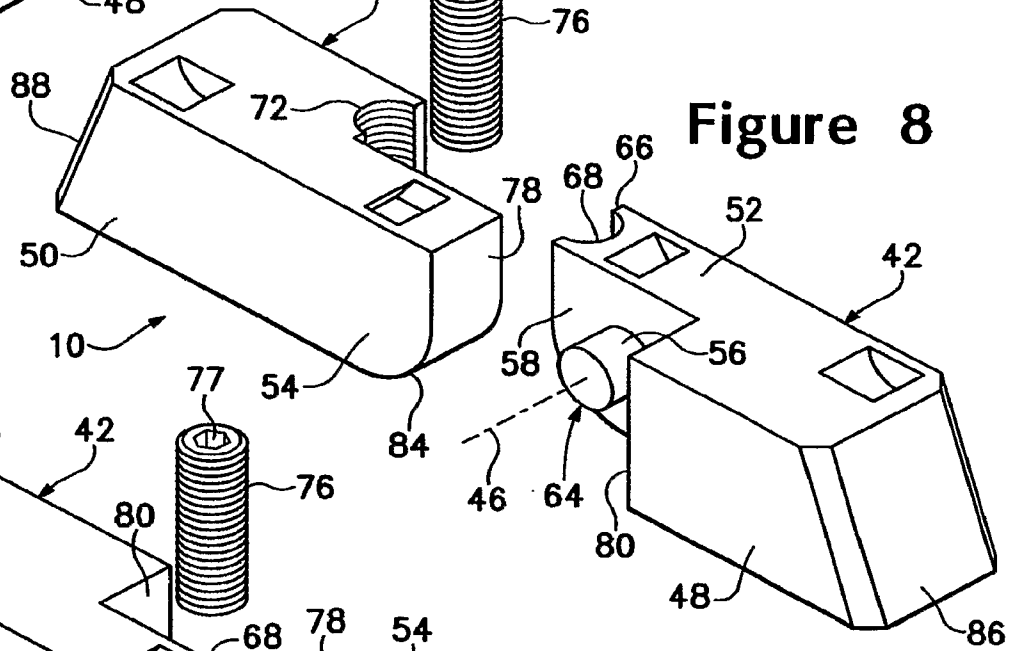
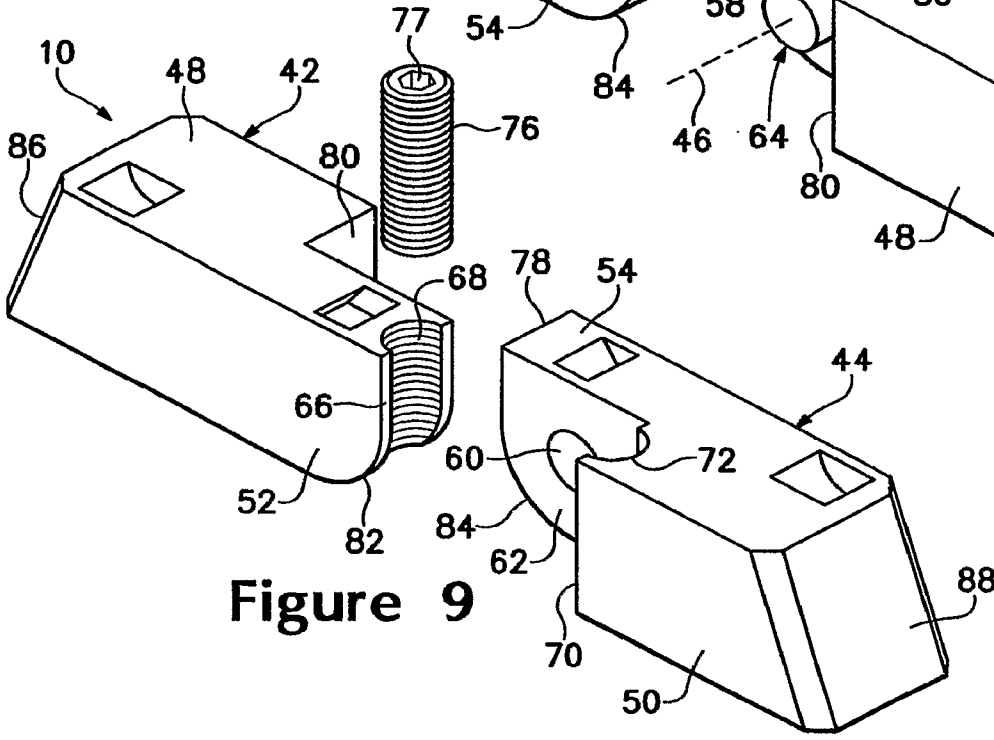


Figure 9



7/13

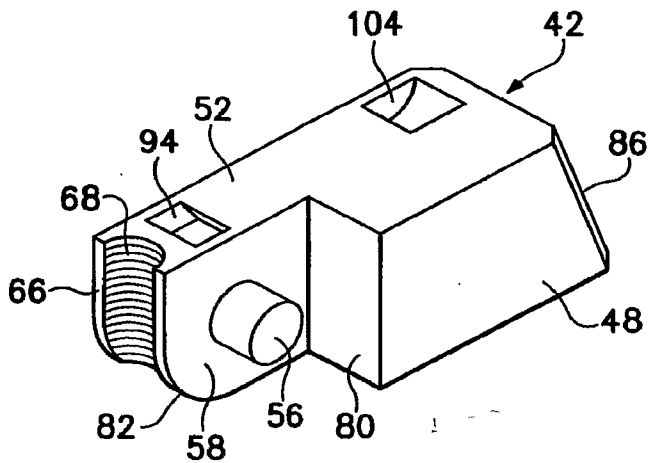


Figure 10

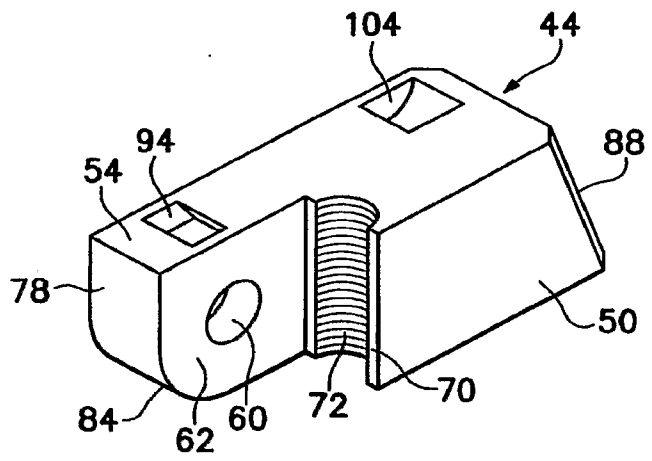


Figure 11

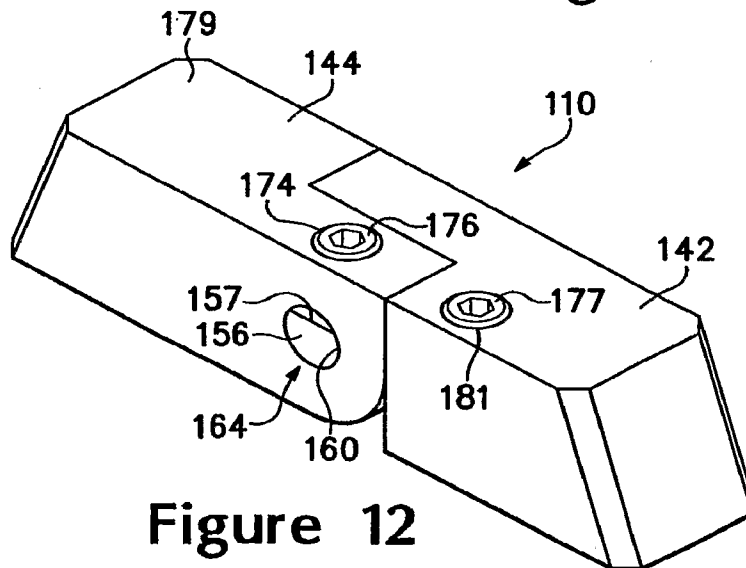


Figure 12

8/13

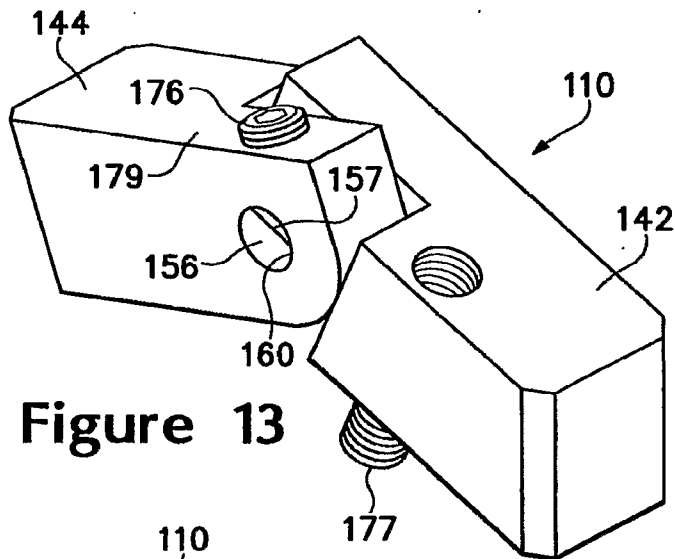


Figure 13

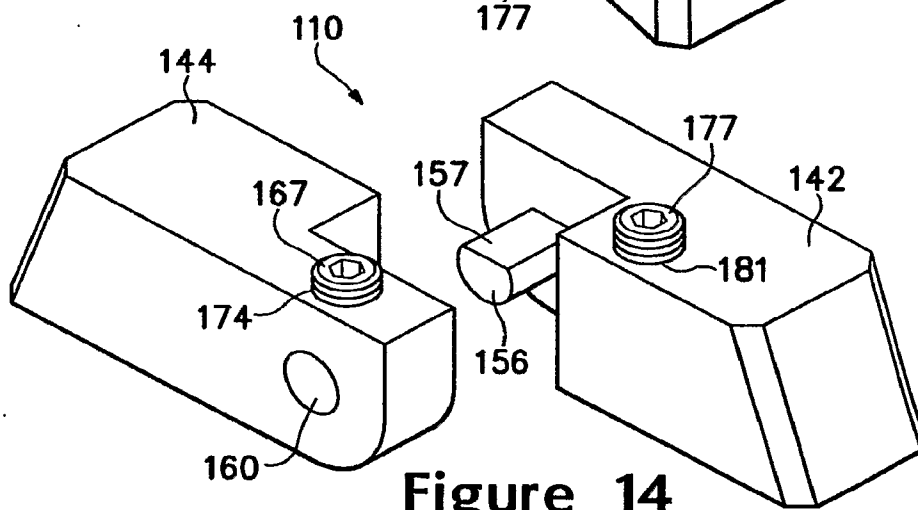


Figure 14

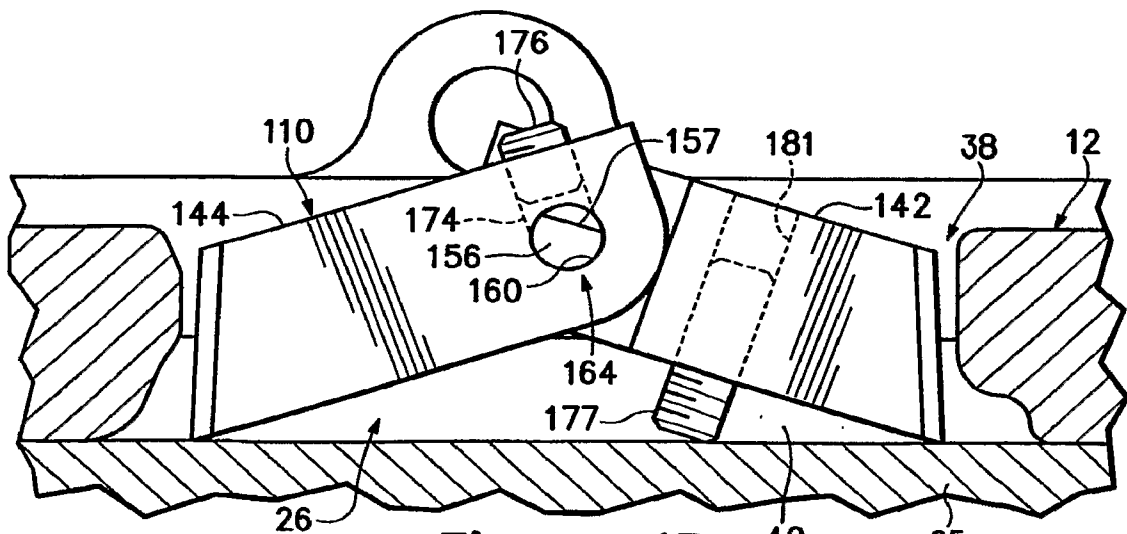


Figure 15

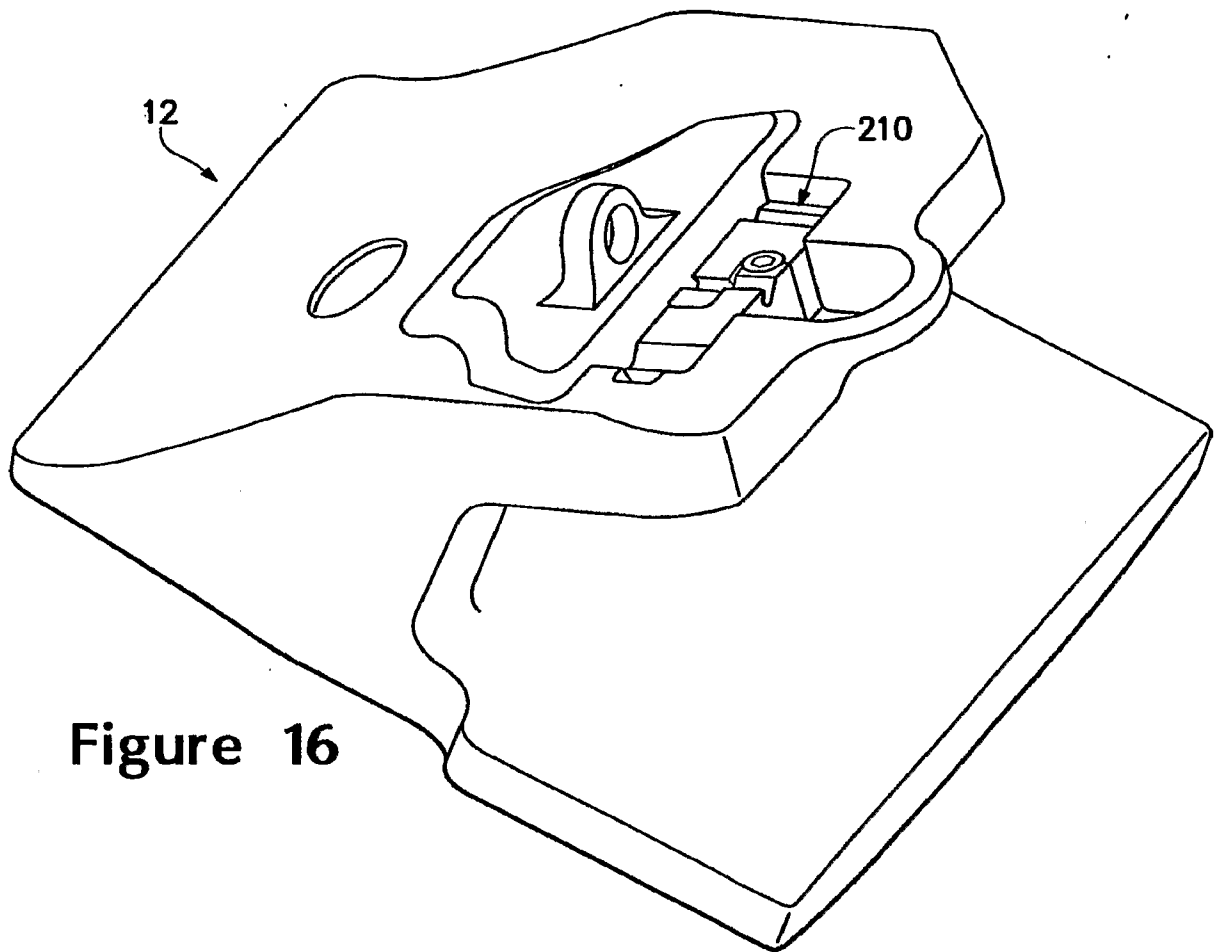


Figure 16

10/13

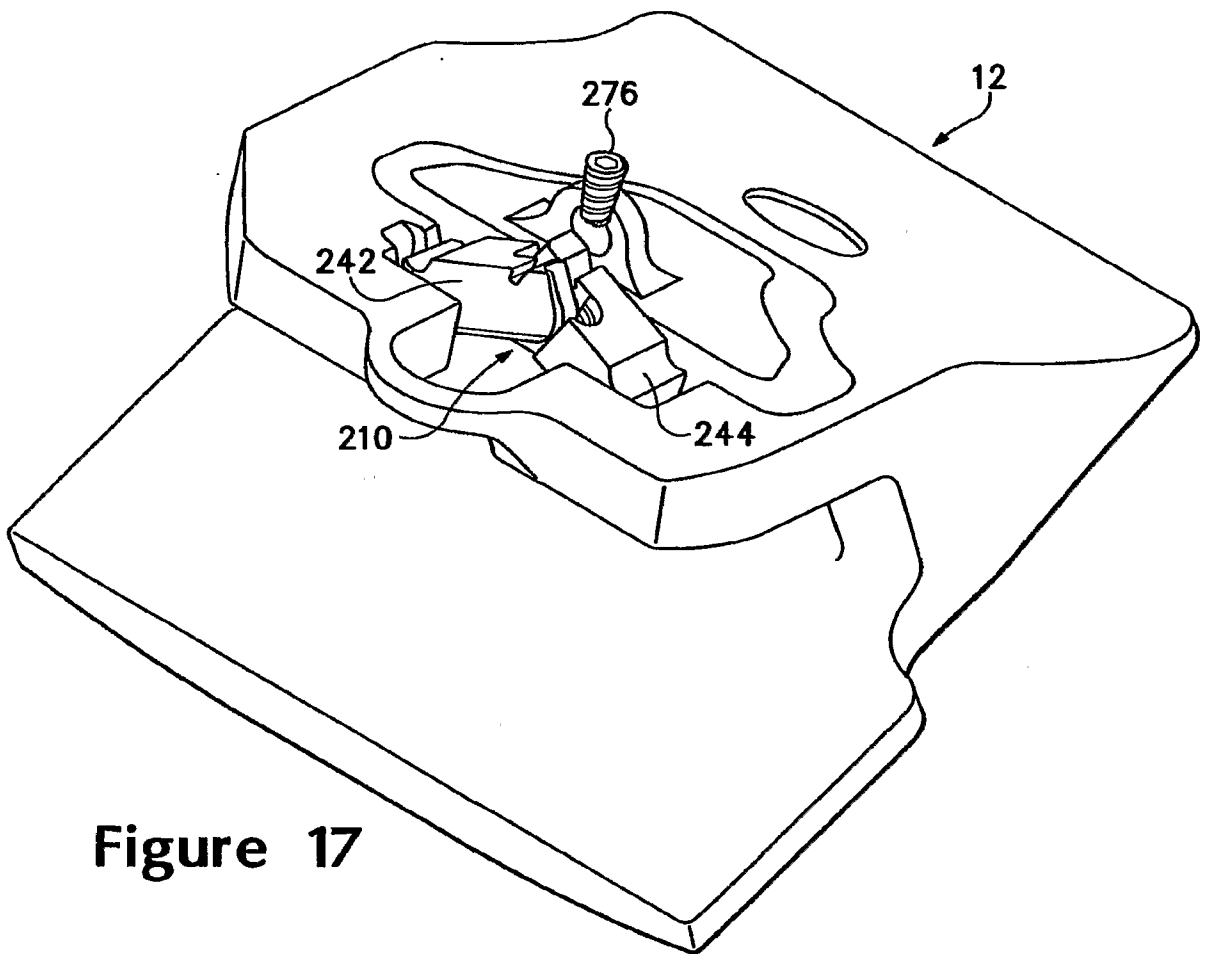


Figure 17

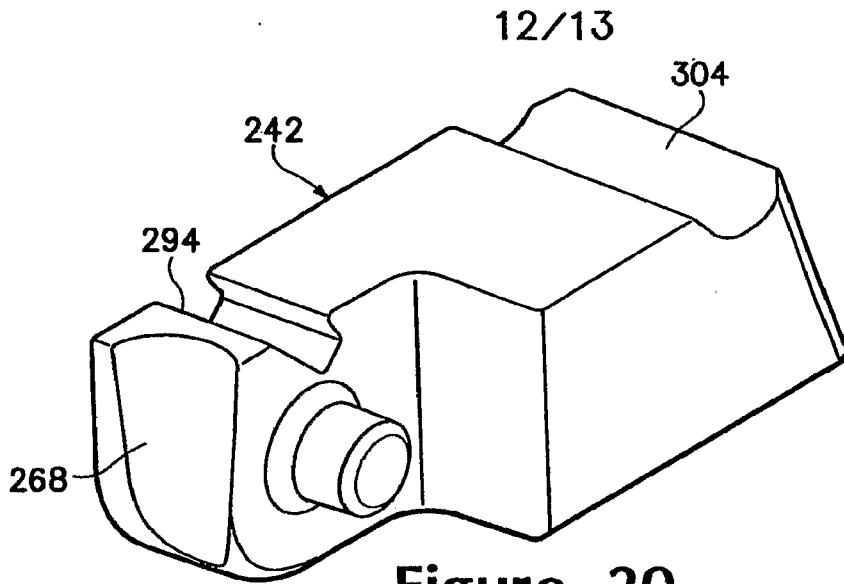


Figure 20

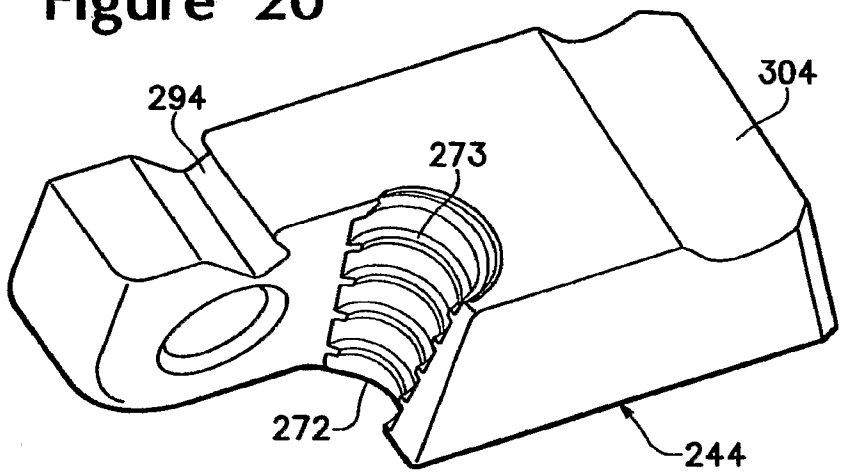


Figure 21

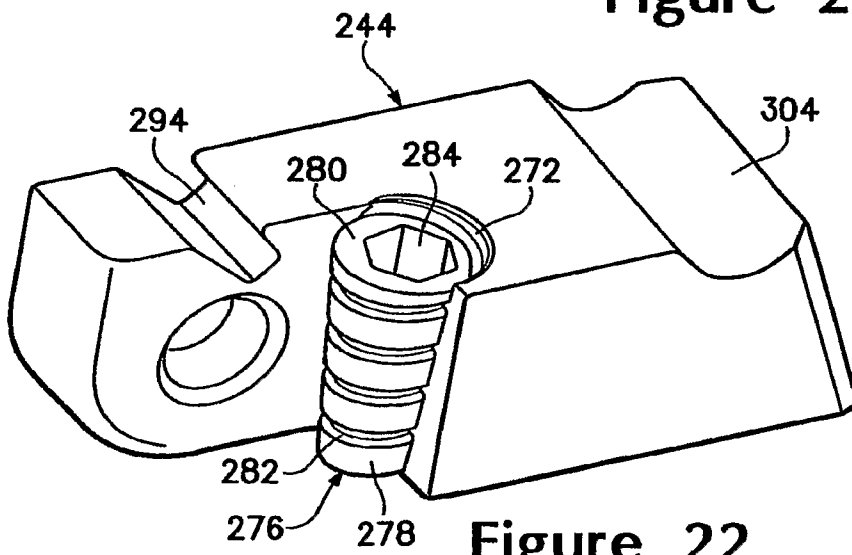


Figure 22

