United States Patent Application Publication 20250262738
Kind Code A1
Publication Date August 21, 2025
Inventor(s) Bumgarner; Ryan T. et al.

ATTACHMENT FOR POWERED HAMMER

Abstract

An attachment configured for use with a powered hammer to drive a rod into the ground includes a body and an impact portion defining an impact axis. The impact portion includes a bore configured to receive a drive shank that is coupled to the powered hammer. The impact portion is configured to receive repeated impacts from the powered hammer. The attachment also includes a driving portion in which the rod is receivable. The driving portion includes a side load driving portion defining a side load driving axis. The side load driving axis is non-parallel to the impact axis.

Inventors: **Bumgarner; Ryan T. (Milwaukee, WI), DuMez; Travis J. (Port Washington, WI), Haim; Katherine J. (Waukesha, WI)**

Applicant: **MILWAUKEE ELECTRIC TOOL CORPORATION** (Brookfield, WI)

Family ID: **1000008490014**

Appl. No.: **19/052384**

Filed: **February 13, 2025**

Related U.S. Application Data

us-provisional-application US 63554260 20240216

Publication Classification

Int. Cl.: **B25D17/00** (20060101)

U.S. Cl.:

CPC **B25D17/005** (20130101);

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application claims priority to U.S. Provisional Patent Application No. 63/554,260, filed on Feb. 16, 2024, the entire contents of which are incorporated by reference herein.

FIELD OF THE INVENTION

[0002] The present invention relates to powered hammers, and more particularly to attachments for use with powered hammers.

BACKGROUND OF THE INVENTION

[0003] Long metal ground rods are inserted into the ground to electrically ground various circuits. For example, a ground rod may be used near transmission line towers to electrically ground the transmission lines or near residential construction to electrically ground a residential circuit. To install, the rods are typically positioned vertically on the ground, and an operator subsequently applies downward impacts upon a top end of the rod to drive it into the ground.

SUMMARY OF THE INVENTION

[0004] The present invention provides, in one aspect, an attachment configured for use with a powered hammer to drive a rod into the ground. The attachment includes a body and an impact portion defining an impact axis. The impact portion includes a bore configured to receive a drive shank that is coupled to the powered hammer. The impact portion is configured to receive repeated impacts from the powered hammer. The attachment also includes a driving portion in which the rod is receivable. The driving portion includes a side load driving portion defining a side load driving axis. The side load driving axis is non-parallel to the impact axis.

[0005] The present invention provides, in another aspect, an attachment configured for use with a powered hammer to drive a rod into the ground. The attachment includes a body and an impact portion defining an impact axis. The impact portion includes a bore configured to receive a drive shank that is coupled to the powered hammer. The impact portion is configured to receive repeated impacts from the powered hammer. The attachment also includes a driving portion in which the rod is receivable. The driving portion is configured to engage the rod and transmit a driving force due to impacts from the powered hammer to the rod. The attachment further includes a retention device adjacent the bore of the impact portion. The retention device includes a locking mechanism configured to secure the drive shank in the bore. The locking mechanism allows axial movement of the drive shank within the bore along the impact axis.

[0006] The present invention provides, in another aspect, an attachment configured for use with a powered hammer to drive a rod into the ground. The attachment includes a body defining an aperture and an impact portion defining an impact axis. The impact portion is configured to receive repeated impacts from a drive shank of the powered hammer. The attachment also includes a driving portion including a one-way collet positioned at least partially within an aperture of the body and configured to transmit a driving force generated by the impacts from the powered hammer to the rod. The one-way collet defines a driving axis that is angled relative to the impact axis. The driving portion also includes an end cap coupled to the body and extending over a portion of the aperture. The driving portion further includes a biasing member disposed between the collet and the end cap.

[0007] Other aspects of the invention will become apparent by consideration of the detailed description and accompanying drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. **1**A is a top perspective view of an attachment for use with a powered hammer according to one embodiment of the present disclosure.

[0009] FIG. **1**B is a bottom perspective view of the attachment of FIG. **1**A.

[0010] FIG. **2** is a side view of the attachment of FIG. **1**A.

[0011] FIG. **3** is a cross-sectional view of the attachment of FIG. **1**A, taken along section line **3-3** in FIG. **1**A.

[0012] FIG. **4**A is a side view of an existing attachment in use.

[0013] FIG. **4**B is a side view of the attachment of FIG. **1**A in use.

[0014] FIG. **5** is a cross-sectional view of an attachment according to another embodiment.

[0015] FIG. **6** is a cross-sectional view of an attachment according to another embodiment and in a first position.

[0016] FIG. **7** is a cross-sectional view of the attachment of FIG. **6** in a second position.

[0017] FIG. **8** is a cross-sectional view of an attachment according to another embodiment and in a first position.

[0018] FIG. **9** is a cross-sectional view of the attachment of FIG. **8** in an intermediate position.

[0019] FIG. **10** is a cross-sectional view of the attachment of FIG. **8** in a second position.

[0020] FIG. **11** is a bottom perspective view of another attachment.

[0021] FIG. **12** is a cross-sectional view of the attachment of FIG. **11**, taken along section line **12-12** of FIG. **11**.

[0022] FIG. **13** is a side view of an end cap for use with the attachment of FIG. **11**.

[0023] FIG. **14** is a perspective view of the end cap of FIG. **13**.

[0024] FIG. **15** is a side view of another end cap for use with the attachment of FIG. **11**.

[0025] FIG. **16** is a perspective view of the end cap of FIG. **15**.

[0026] FIG. **17** is a bottom perspective view of another attachment.

[0027] FIG. **18** is a cross-sectional view of the attachment of FIG. **17**, taken along section line **18-18** of FIG. **17**.

[0028] FIG. **19** is an enlarged cross-sectional view of a portion of the attachment shown in FIG. **18**.

[0029] FIG. **20** is perspective of an end cap for use with the attachment of FIG. **17**.

[0030] Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting.

DETAILED DESCRIPTION

[0031] FIGS. **1**A and **1**B illustrate an attachment **10** configured for use with a reciprocating power tool (e.g., a powered hammer, not shown) to drive a rod **13** (FIGS. **4**A, **4**B) into the ground. The attachment **10** includes a body **14** having a first end **15** and a second end **16** opposite the first end **15**. The attachment **10** further includes an impact portion **18** and a driving portion **22** disposed within the body **14**. The impact portion **18** is positioned on the first end **15** of the body **14** and receives impacts from the powered hammer, and the driving portion **22** transmits a driving force generated by the impacts to the rod **13** to drive the rod **13** into the ground. More particularly, the illustrated driving portion **22** includes a side load driving portion **26** and a top load driving portion **30** (FIG. **1**B). The side load driving portion **26** transmits the driving force to sides of the rod **13**, while the top load driving portion **30** is positioned on the second end **16** of the body **14** and transmits the driving force to a top end of the rod **13**. In operation, the side load driving portion **26** is used to drive the rod **13** into the ground until the rod **13** is nearly driven into the ground. When the rod **13** is nearly driven into the ground, an operator is able to switch to the top load driving portion **30** to complete driving the rod **13** into the ground. The attachment **10** of the present disclosure allows for efficient driving of the rod **13** into the ground, without the operator needing to switch attachments to complete the driving process.

[0032] With reference to FIG. **3**, the impact portion **18** is located on a first side of the body **14**. The illustrated impact portion **18** includes a bore **20**. More particularly, the bore **20** is a blind bore. A longitudinal axis of the impact portion **18** defines an impact axis A**1** (FIG. **2**). The impact portion **18** is shaped to receive a drive shank **31** of a powered hammer to couple the attachment **10** to the powered hammer. An interference fit may exist between the drive shank **31** and the impact portion **18** such that impacts from the powered hammer during operation secure the drive shank **31** within the impact portion **18** (e.g., the blind bore **20**). The impact portion **18** may include a sizing feature, such as an insert, adapted to adjust a diameter of the impact portion **18** to accommodate different size shanks. In some embodiments, the drive shank **31** is coupled to the body **14** via a quick-connect system, rather than an interference fit, so that the drive shank **31** is replaceable. The quick connect system may be similar to a chuck of the powered hammer. In yet other embodiments, the drive shank **31** is a post extending from the body **14** and integrally formed with the body **14**. The post is shaped to be received within the chuck of the powered hammer to received repeated impacts therefrom. Other attachment systems are described in more detail below.

[0033] With continued reference to FIG. **3**, the side load driving portion **26** includes a one-way collet **38** for selectively securing the rod **13** relative to the body **14** of the attachment **10** and transmitting the driving force from the powered hammer into the rod **13** to drive the rod **13** into the ground. A longitudinal axis of the side load driving portion **26** defines a side load driving axis A**2** (FIG. **2**). The collet **38** allows the attachment **10** to move relative to the rod **13** in a first direction DI along the side load driving axis A**2** and prevents relative motion between the rod **13** and the attachment **10** in a second direction D**2** along the driving axis A**2**. The second direction D**2** is the driving direction (e.g., into the ground). In operation, the one-way collet **38** prevents the attachment **10** from moving along the rod **13** towards the ground, thereby facilitating the driving of the rod **13**, while allowing the attachment **10** to be moved along the rod **13** away from the ground, thereby allowing the operator to re-position the attachment **10** along the rod **13** as the rod **13** is driven into the ground.

[0034] With continued reference to FIG. **3**, the body **14** defines an aperture **42** in which the collet **38** is received. In the illustrated embodiment, the aperture **42** is a frustoconical aperture. The aperture **42** narrows towards a top of the attachment **10** (e.g., proximate the powered hammer). The illustrated collet **38** includes a cylindrical portion **46**, a frustoconical portion **50**, and a central bore **54** extending a length of the collet **38** and adapted to receive the rod **13** therein. The cylindrical portion **46** is located at a top of the collet **38** and extends beyond the body **14** of the attachment **10** through the narrow portion of the aperture **42**. The frustoconical portion **50** is sized and shaped to fit within the frustoconical aperture **42** of the body **14**. For example, the frustoconical portion **50** of the collet **38** has a similar slope to the frustoconical aperture **42** of the body **14**. The slope of the illustrated embodiment is 5 degrees. In other embodiments, the slope of the collet **38** may be greater than or less than 5 degrees.

[0035] Spaced circumferentially about the frustoconical portion **50** are a plurality of ball bearings **58**. The ball bearings **58** partially extend radially into the central bore **54** to engage the rod **13** and transmit driving forces to the rod **13**. The collet **38** of the illustrated embodiment includes four rows of differently sized ball bearings **58**. Each row of bearings **58** is offset from the rows above and/or below. In the illustrated embodiment, the offset angle between each row is 45 degrees. Each bearing **58** within a row is of the same nominal size, while bearings **58** in adjacent rows have different nominal sizes. The difference between bearing sizes in adjacent rows corresponds to the slope of the frustoconical portion **50**. In other words, as the aperture **42** widens, the bearings **58** increase in size. This allows each bearing **58** to simultaneously engage the rod **13** when the rod **13** is inserted in the collet **38**. In other embodiments, the collet **38** may include more or fewer bearings

58 in each row, more or fewer rows of bearings **58**, and a greater or smaller offset between rows of bearings **58**, depending on the desired size of the attachment **10** and desired diameter of rods **13** to be driven by the attachment **10**. However, irrespective of the number or offset, the bearings **58** are sized to correspond to the slope of the frustoconical portion **50** to properly secure the rod **13**. Each bearing **58** equally engages the rod **13** to reduce marring during the driving operation. Marring can decrease the grounding capabilities of the rod **13** after it is driven, and therefore should be avoided.

[0036] The side load driving portion **26** further includes a biasing member **62** to bias the collet **38** against the aperture **42** and an end cap **64** to maintain the collet **38** within the aperture **42**. In other words, the biasing member **62** is configured to bias the collet **38** towards the first end **15** of the body **14**. The end cap **64** is located below the collet **38** (i.e., closer than the collet **38** to the second end **16** of the body **14**). The biasing member **62** is disposed between the end cap **64** and the collet **38**. In one embodiment, the biasing member **62** is a conical compression spring, and the end cap **64** is a washer secured within the aperture **42** by a snap ring **66**. The snap ring **66** is received in a groove **65** of the aperture **42**. The snap ring **66** has a thickness (measured parallel to the driving axis A**2**) that is equally or nearly equal to a height of the groove **65** (measured parallel to the driving axis A**2**). Such an arrangement helps eliminate relative movement of the snap ring **65** within the aperture **42**, reducing potential failures (e.g., breaking) of the snap ring **65**. In another embodiment, the biasing member **62** is a cylindrical compression spring, and the end cap **64** is a cup extending from a bottom of the aperture **42** and secured to the aperture **42** via a threaded connection.

[0037] The side load driving portion **26** is capable of driving rods of various diameters. For example, the attachment **10** can be used to drive rods **13** of ½″, ⅝″, or ¾″ diameters. In some embodiments, the attachment **10** can be used to drive rods **13** of ⅜″ or 1″ diameters. The slope of the frustoconical portions **42**, **50** dictates the size of rods **13** that can be driven. More particularly, the collet **38** is movable within the aperture **42**, against the force of the biasing member **62**, to accommodate larger diameter rods. As the collet **38** moves towards the end cap **66**, the aperture **42** widens and allows the bearings **58** to move radially outwards to accommodate a larger diameter rod **13**, while being able to contact both the body **14** and the rod **13**. The use of a conical spring as the biasing member **62** allows for a shorter overall attachment length (e.g., the washer end cap **64** rather than the cup), because the conical spring is compressible to a flatter shape than a cylindrical compression spring. In other words, the use of a cylindrical compression spring requires the cup-shaped end cap to provide clearance for the collet **38** to move within the aperture **42** and accommodate larger diameter rods **13**.

[0038] With reference to FIGS. **1**B and **3**, the top load driving portion **30** is illustrated as a blind bore **32** on a bottom side of the body **14** (e.g., the second end **16** of the body **14**). A longitudinal axis A**3** (FIG. **2**) of the top load driving portion **30** is parallel with the impact axis A**1**. In the illustrated embodiment, the longitudinal axis A**3** is coaxial with the impact axis A**1**. In some embodiments, the longitudinal axis A**3** of the top load driving portion is offset from the impact axis A**1** or non-parallel. Furthermore, in some embodiments, the top load driving portion **30** may be formed as a post extending below the body **14** and having the blind bore **32** therein.

[0039] In some embodiments, the body **14** includes an accessory receiving portion that is configured to receive an accessory that assists in the grounding operation. One such accessory is a step that can be fastened to the attachment **10**. The step may include, for example a bar or strap extending from a side of the attachment **10**. Another such accessory is a handle that can be fastened to the attachment **10** via fastener receiving holes. In operation, the step allows a user to apply a force to the attachment **10**, and thus the rod **13**, with their foot while driving the rod **13**. This force can steady the rod **13** during driving and may also increase the efficiency of the driving by applying a downward force (e.g., in the same direction as the driving force).

[0040] The attachment **10** of the present disclosure is optimized for efficient driving of the rod **13**. The optimization is in part due to decreasing the overall mass of the attachment **10**. Having less mass below the impact point of the powered hammer results in a greater driving force being transmitted to the rod **13**. To accomplish this, the overall size of the body **14** is decreased, and the body **14** is formed of lightweight and strong materials such as aluminum or magnesium. For example, compared to a similar attachment made of steel, an attachment made of aluminum may weigh about 65% less, while an attachment made of magnesium may weight about 80% less. In the illustrated embodiment, the impact portion **18** and the driving portion **22** of the body **14** are integrally formed as a single piece. In such embodiments, the impact portion **18** and the driving portion **22** may be formed of the same material. In other embodiments, the impact portion **18** and the driving portion **22** may be separate pieces that are secured (e.g., fastened, welded, etc.) together. In such embodiments, the impact portion **18** and the driving portion **22** may be formed of the same material or may be formed of different materials from each other.

[0041] Referring now to FIG. **3**, the side load driving axis A**2** is angled relative to the impact axis A**1**. In other words, the side load driving portion **26**, the aperture **42**, and the collet **38** are angled relative to the impact axis A**1**. The side load driving axis A**2** and the impact axis A**1** define an angle θ. The illustrated angle θ is an acute angle. In some embodiments, the angle θ is less than 20 degrees. Preferably, the angle θ is 4.5 degrees. In other embodiments, the angle θ may be greater than 20 degrees. In further embodiments, the side load driving axis A**2** and the impact axis A**1** are offset and parallel. Having the side load driving axis A**2** angled relative to the impact axis A**1** increases the rod driving efficiency by decreasing an offset distance D**3** (FIG. **4**B) between the impact axis A**1** and the side load driving axis A**2**. A shorter offset distance between the impact axis A**1** and the side load driving axis A**2** decreases the bending moment arm applied to the rod **13** during impacts and allows more of the force from the impact to be transferred to the rod **13** to drive the rod **13** linearly into the ground. For example, as shown in FIG. **4**A, an offset distance D**3** is defined between the rod **13** and the impact axis A**1** at a position where the rod **13** contacts the ground. The offset distance D**3** is measured in a direction that is parallel to the ground or perpendicular to the rod **13**. As illustrated in FIG. **4**A, the offset distance D**3** is generally going to be the offset distance between the impact axis A**1** and the side load driving axis A**2**. However, as shown in FIG. **4**B, by angling the side load driving axis A**2** relative to the impact axis A**1**, the offset distance D**3** can be reduced further or completely reduced to zero. In addition, by having the angle e be small, the horizontal force vector applied to the rod **13** during operation is negligible allowing the vertical vector force provided to the rod **13** to be nearly the full force applied by the power tool to the impact portion **18**.

[0042] In the illustrated embodiment, the side load driving portion **26** and the side load driving axis A**2** are angled relative to the impact portion **18** and impact axis A**1** so that the impact axis A**1** remains generally parallel with the outside edge of the body **14**. In other embodiments, the impact portion **18** and impact axis A**1** may be angled relative to the side load driving portion **26** and side load driving axis A**2** so that the side load driving axis A**2** is generally parallel to the outside edge of the housing.

[0043] To drive a rod **13** with the above-described attachment **10**, the operator first couples the attachment **10** to the powered hammer via the impact portion **18**. In the illustrated embodiment, the drive shank **31** is inserted into the chuck of the powered hammer. If the attachment **10** has not been used before (e.g., the drive shank **31** is not secured within the impact portion **18**), the operator also inserts the drive shank into the blind bore **20** of the impact portion **18**. Next, the rod **13** is inserted into the side load driving portion **26** from above the attachment **10**. The insertion direction corresponds to the direction DI in which the collet **38** allows for relative movement of the rod **13** and the attachment **10** (e.g., opposite the driving direction D**2**). At this point, the rod **13** can be aligned with the ground at a desired location and the operator can actuate the powered hammer to begin driving the rod **13**. As the rod **13** is driven, the operator adjusts the position of the attachment **10** relative to the length of the rod **13** until the rod **13** is nearly driven into the ground. At this point, the operator will release the side load driving portion **26** from the rod **13** and insert a top of the rod

13 into the top load driving portion **30** to complete driving the rod **13** into the ground. While the steps of a driving operation have been described in a particular order above, one or ordinary skill in the art will understand the ability to perform the steps in a different order.

[0044] Table 1 below illustrates the average time in seconds to complete driving rods **13** of different lengths into the ground using various attachments. As evidenced by the table, the attachment **10** with the side load driving axis A**2** angled relative to the impact axis A**1** reduced the driving time by over half compared to attachments that are not angled.

TABLE-US-00001 TABLE 1 Average Time (seconds) to Complete Driving Operation Sample Rod Size (feet) 3 4 5 6 Attachment #1 (not angled) 75.95 107.24 136.53 201.89 Attachment #2 (not angled) 80.66 120.17 156.34 185.95 Attachment 10 (angled) 36.34 53.38 68.07 89.48

[0045] In some embodiments, hardened steel may be included to increase the strength of high wear areas of the body **14**. For example, a hardened steel sleeve may be applied to the top load driving portion **30** so that the bore **32** is not overly worn during operation. Similarly, the collet **38** and the end cap **64** can be formed of high strength steel, and a different steel sleeve may be applied to the aperture **42** so that the bearings **58** do not mar the body **14** of the attachment **10** during use.

[0046] FIG. **5** illustrates an attachment **110** according to another embodiment of the invention. The attachment **110** is similar to the attachment **10** described above with like features being represented with like reference numbers. The illustrated attachment **110** includes a retention device **114** to selectively secure the shank **31** within the bore **20** of the impact portion **18**. As mentioned above, the attachment **10**, **110** may include a dedicated drive shank **31** that is removably coupled to the bore **20** of the impact portion **18**. The retention device **114** includes a locking mechanism **118** that is received in an opening **122** in the body **14**. In the illustrated embodiment, the locking mechanism **118** is a fastener, such as a set screw. In other embodiments, the locking mechanism **118** may include other types of threaded or non-threaded fasteners or inserts. For example, the locking mechanism **118** may include a pin, a spring-loaded detent, a clevis pin, a spring pin, a quick-release pin, a through bolt with a nut, or the like. The opening **122** extends to the bore **20** of the impact portion **18**. The drive shank **31** includes a recessed or flat surface side **126** that the locking mechanism **118** engages when the drive shank **31** is received within the bore **20**. The flat surface side **126** defines a groove **128** in the drive shank **31**. To couple the shank **31** to the attachment **110**, an operator may place the drive shank **31** in the bore **20** and insert (e.g., thread) the locking mechanism **118** into the opening **122** to secure the drive shank **31** in place. Conversely, an operator may remove the locking mechanism **118** from the opening **122** in order to remove the drive shank **31** from the bore **20**.

[0047] The engagement of the locking mechanism **118** and drive shank **31** provides a sufficient force to retain the drive shank **31** within the bore **20**. However, due to the flat surface side **126** on the drive shank **31**, the drive shank **31** is allowed to minimally move axially along the impact axis A**1**. In particular, the locking mechanism **118** has a dimension D (e.g., a diameter) measured parallel to the impact axis A**1** that is less than a length L measured parallel to the impact axis A**1** of the groove **128**. As such, the drive shank **31** is allowed to float within the bore **20**. During operation of the attachment **110**, large compressive forces are transferred to the attachment **110** through the drive shank **31** that is coupled to a percussive power tool. Allowing the drive shank **31** to float in the bore **20** during a drive operation lets the compressive force from the power tool transfer to the drive shank **31** and rod **13** without a resultant tensile force. As a result, fatigue failures to the drive shank **31** and attachment **110** are reduced. In addition, allowing the drive shank **31** to float in the bore **20** dampens the percussive force reducing user fatigue during a driving operation. Further, the retention device **114** allows a user to change a drive shank **31** that has broken without needing to buy a completely new attachment.

[0048] FIGS. **6** and **7** illustrate an attachment **210** according to another embodiment of the invention. The attachment **210** is similar to the attachment **10** described above with like features being represented by like reference numbers. The illustrated attachment **210** includes a retention device **214** to selectively secure the drive shank **31** to the attachment **210**. The retention device **214** includes an external sleeve **218**, an internal sleeve **222**, and a locking mechanism (e.g., ball bearings **226**). The external sleeve **218** is coupled to the body **14** adjacent the bore **20** and includes a channel **230** extending along the impact axis A**1**. The external sleeve **218** also includes an end cap **234** at one end and a pair of lips **238** extending from an interior surface of the channel **230** in a direction radially inward. The internal sleeve **222** is positioned within the external sleeve **218** and includes a portion that extends into the bore **20**. A first snap ring **242** secures the internal sleeve **222** within the bore **20**, and a second snap ring **246** assists in securing the internal sleeve **222** within the external sleeve **218**. A biasing member (e.g., compression spring **250**) is positioned within the channel **230** of the external sleeve **218** between the lips **238** and the second snap ring **246**. The lips **238** and the second snap ring **246** act as spring seats for the biasing member **250**. The biasing member **250** biases the external sleeve **218** axially towards the body **14**. The ball bearings **226** are positioned within respective openings **254** in the internal sleeve **222**. In the illustrated embodiment, the retention device **214** includes two ball bearings **226**. In other embodiments, the retention device **214** may include fewer or more ball bearings **226**.

[0049] In a locked position (FIG. **6**), the lips **238** of the external sleeve **218** are positioned adjacent the openings **254** and the ball bearings **226**. In the locked positioned, the lips **238** force the ball bearings **226** to partly extend into a channel **256** defined by the internal sleeve **222** to engage grooves **258** on the drive shank **31**. Similar to the locking mechanism **118**, each ball bearing **226** has a dimension D (e.g., a diameter) measured parallel to the impact axis A**1** that is less than a length L of the corresponding groove **258**. The ball bearings **226** retain the drive shank **31** during a driving operation.

[0050] To remove or replace the drive shank **31** from the attachment **210**, a user can pull up on the end cap **234** away from the body **14** and against the bias of the biasing member **250** to an unlocked position (FIG. **7**). As the external sleeve **218** moves away from the body **14** of the attachment **210**, the lips **238** on the inside surface of the channel **230** are removed from the openings **254** in the internal sleeve **222**, allowing the ball bearings **226** to travel into pockets **262** of the external sleeve **218**. With the ball bearings **226** removed from the internal channel **256**, the drive shank **31** is allowed to be removed from the bore **20** of the impact portion **18**. Conversely, a user can lift the end cap **234** away from the body **14** in order to couple the drive shank **31** to the attachment **210**. Similar to the attachment **110** above, the ball bearings **226** allow the drive shank **31** to minimally move axially or float within the bore **20** in order to reduce fatigue to the drive shank **31** and attachment **210**.

[0051] FIGS. **8-10** illustrate an attachment **310** according to another embodiment of the invention. The attachment **310** is similar to the attachment **210** described above, with like features being represented with like reference numbers. The illustrated attachment **310** includes a retention device **314** similar to the retention device **214** described above, however, the retention device **314** includes dowel pins **318** instead of ball bearings **226**. In the illustrated embodiment, the retention device **314** includes two dowel pins **318**. In other embodiments, the retention device **314** may include fewer or more dowel pins **318**. The dowel pins **318** are resilient and cylindrical shaped so that the pins **318** are allowed to rotate within the openings **254** and compress within the openings **254**. In addition, the pockets **262** of the external sleeve are sized to receive the dowel pins **318** instead of the ball bearings **226**. Similar to the locking mechanism **118** and the ball bearings **226**, each dowel pin **318** has a dimension D (e.g., a length) measured parallel to the impact axis A that is less than a length L of the corresponding groove **258**.

[0052] In the locked position (FIG. **8**), the pockets **262** are offset circumferentially from the openings **254** of the internal sleeve **222** so a user also rotates the external sleeve **218** to release the drive shank **31**. The pockets **262** may be offset from the openings **254** by up to 90 degrees. As such, to release the drive shank **31**, the user first lifts the external sleeve **218** away from the body **14** as shown in FIG. **9**. Next, a user rotates the external sleeve **218** in a first direction to align the pockets

262 with the openings **254**, allowing the pins **318** to retreat from the channel **256** of the internal sleeve **222** and the grooves **258** on the shank **31** (FIG. **10**). The user can then remove the drive shank **31** from the bore **20**. Similar to the attachment **110** above, the dowel pins **318** allow the drive shank **31** to minimally move axially or float within the bore **20** in order to reduce fatigue to the drive shank **31** and attachment **310**.

[0053] FIGS. **11** and **12** illustrate an attachment **410** according to another embodiment of the invention. The attachment **410** is similar to the attachment **10** described above with like features being represented by like reference numbers plus "**400**." The illustrated attachment **410** includes a body **414** having a first end **415** and a second end **416**. The attachment **410** further includes an impact portion **418** and a driving portion **422** disposed within the body **414**. Similar to the attachment **10**, the illustrated driving portion **422** is a side load driving portion including a one-way collet **438** positioned at least partially within an aperture **442** of the body **414**. The one-way collet **438** includes ball bearings **458** and is configured to transmit a driving force generated by the impacts from a powered hammer to the rod **13**. As shown in FIG. **12**, the one-way collet defines a driving axis A**4** that is angled relative to an impact axis A**5** of the impact portion **418**. The driving portion **422** also includes a biasing member **462** to bias the collet **438** against the aperture **442** and an end cap **466**, **466**′ to maintain the collet **438** within the aperture **442**. The end cap **466**, **466**′ is located below the collet **438** (i.e., closer than the collet **438** to the second end **416** of the body **414**). The biasing member **462** is disposed between the end cap **466**, **466**′ and the collet **438**.

[0054] In the illustrated embodiment, the aperture **442** includes a threaded section **470** adjacent the second end **416** of the body **414**. The aperture **442** also includes a side bore **468** extending from a side of the body **414** to the threaded section **470** of the aperture **442**. The side bore **468** is configured to receive a set screw or other suitable fastener **472**. For example, in some embodiments, the fastener **472** may be a dowel pin. The dowel pin may be press-fit into the aperture **422**. In such embodiments, the aperture **442** may not be threaded. The threaded section **470**, the side bore **468**, and the fastener **472** couple the end cap **466**, **466**′ to the body **414**.

[0055] FIGS. **13** and **14** illustrate one example of the end cap **466**. The illustrated end cap **466** includes a base **478** and a sidewall **474** extending from the base **478**. As such, the end cap **466** is generally cup-shaped. The base **478** engages the biasing member **462**. A central bore **480** is formed in the base **478** to allow the rod **13** to pass through the end cap **466** as the rod **13** is driven into the ground. The base **478** also defines one or more holes **482**. The holes **482** are configured to receive a suitable tool or other object (e.g., a bolt, a screw, a pin, etc.) to help rotate the end cap **466** during installation and removal of the end cap **466** into and from the body **414**.

[0056] The sidewall **474** includes a threaded segment **475** and an unthreaded segment **476**. The threaded segment **475** is positioned adjacent the base **478** and configured to threadedly couple or engage the threaded section **470** of the aperture **442**. The unthreaded segment **476** is positioned opposite from the base **478** and has a smaller outer diameter than the threaded segment **475**. As such, the unthreaded segment **476** does not engage the threaded section **470** of the aperture **442**. Rather, the illustrated unthreaded segment **476** includes one or more planar wall segments or flats **477**. In the illustrated embodiment, the unthreaded segment **476** includes a plurality of flats **477** spaced continuously around an outer surface of the sidewall **474**. In other embodiments, the unthreaded segment **476** may only include a single flat **477** or may include a few flats **477** space sporadically around the outer surface of the sidewall **474**. The flats **477** are configured to be engaged by the fastener **472** to secure the end cap **466** in the body **414**.

[0057] To install the end cap **466**, the end cap **466** is inserted into the aperture **442** through the second end **416** of the body **414**. When the threaded segment **476** of the end cap **466** reaches the threaded section **470** of the aperture, the end cap **466** is then rotated to thread the end cap **466** into the threaded section **470**. In some embodiments, the end cap **466** is threaded into the aperture **442** until an outer or bottom surface **479** of the base **478** is flush or near flush with an outer surface of the body **414**. That is, the bottom surface **479** may be slightly recessed relative to, or extend slightly beyond, the outer surface of the body **414**. Once the end cap **466** is inserted a suitable distance into aperture **442**, the fastener **472** is tightened (e.g., rotated or press-fit). As the fastener **472** is tightened in the side bore **468**, the fastener **472** extends into the aperture **442** and engages one of the flats **477**. The fastener **472** may be tightened until a firm, frictional contact is established with the upper wall segment **476**. The contact between the fastener **472** and the upper wall segment **476** secures the end cap **466** in place and inhibits the end cap **466** from reversing out from its threaded connection with the body **414**.

[0058] FIGS. **15** and **16** illustrate another example of the end cap **466′**. The illustrated end cap **466′** is similar to the end cap **466** described above and includes a base **478′** with a central bore **480′** and holes **482′**, and a sidewall **474′** with a threaded segment **475′** and an unthreaded segment **476′**. In the illustrated embodiment, however, the unthreaded segment **476′** of the sidewall **474′** defines a plurality of notches **486′** rather than the plurality of flats **477**. In the illustrated embodiment, the unthreaded segment **476′** defines eight notches **486′** spaced circumferentially around a circumference of the sidewall **474′**. In other embodiments, the unthreaded segment **475′** may define fewer or more notches **486′**, such as a single notch **486′** or more than eight notches **486′**, and/or the notches **486′** may be unevenly spaced around the circumference of the sidewall **474′**. Each notch **486′** is formed between a pair of adjacent protrusions **488′** and is configured to receive the fastener **472**. In the illustrated embodiment, the notches **486′** extend through an upper edge of the sidewall **474′**. In addition, the notches **486′** are through holes that extend through the sidewall **474′**. In other embodiments, the notches **486′** may be spaced from the upper edge of the sidewall **474′** (i.e., the notches **486′** may be bounded on all sides by the sidewall **474′**). Additionally or alternatively, the notches **486′** may be depressions that do not extend entirely through the sidewall **474′**.

[0059] Once the end cap **466′** is inserted a suitable distance into the aperture **442** (e.g., in a manner similar to the end cap **466**), the fastener **472** is tightened (e.g., rotated or press-fit). As the fastener **472** is tightened in the side bore **468**, the fastener **472** extends into the aperture **442** and is received in one of the notches **486′** between a respective pair of protrusions **488′**. The fastener **472** thereby engages the pair of protrusions **488′** such that the end cap **466′** is secured in place and inhibited from reversing out from its threaded connection with the body **414**.

[0060] FIGS. **17** and **18** illustrate an attachment **510** according to another embodiment of the invention. The attachment **540** is similar to the attachment **10** described above with like features being represented by like reference numbers plus “**500**.” The illustrated attachment **410** includes a body **514** having a first end **515** and a second end **516**. The attachment **510** further includes an impact portion **518** and a driving portion **522** disposed within the body **514**. Similar to the attachment **10**, the illustrated driving portion **522** is a side load driving portion including a one-way collet **538** positioned at least partially with an aperture **542** of a body **514**. The one-way collet **538** includes ball bearings **558** and is configured to transmit a driving force generated by the impacts from the powered hammer to the rod **13**. As shown in FIG. **18**, the one-way collet **538** defines a driving axis A**6** that is angled relative to an impact axis A**7**. The driving portion **522** also includes a biasing member **562** to bias the collet **538** against the aperture **542** and an end cap **566** to maintain the collet **538** within the aperture **542**. The end cap **566** is located below the collet **538** (i.e., closer than the collet **538** to the second end **516** of the body **514**). The biasing member **562** is disposed between the end cap **566** and the collet **538**.

[0061] As shown in FIG. **19**, in the illustrated embodiment, the aperture **542** includes a groove **570** adjacent the second end **516** of the body **514**. The aperture **542** also includes a plurality of recesses or cavities **572** that are formed in an inner surface of the body **514** between the groove **570** and the second end **516** of the body **514**. The cavities **572** connect to the groove **570** and form smooth transitions from a larger diameter section of the aperture **542** to the groove **570**. In addition, the cavities **572** are spaced apart from each other to define ledges **574** between adjacent cavities **572**. In the illustrated embodiment, the aperture **542** includes at least three cavities **572**. In other embodiments, the aperture **542** may include fewer or more cavities **572**.

[0062] FIG. **20** illustrates the end cap **566**. The illustrated end cap **566** includes a plate **575** having a plurality of lobes **576**. In the illustrated embodiment, the end cap **566** includes three lobes **576**. In other embodiments, the end cap **566** may include fewer or more lobes **576**. The lobes **576** are shaped and sized to fit and slide within the cavities **572** when the end cap **566** is inserted into the aperture **542** to reach the groove **570**. Once the end cap **566** is aligned with the groove **570**, the end cap **566** is rotated (e.g., a quarter turn) such that the lobes **576** engage or rest on the ledges **574**. A central bore **580** is formed through the plate **575** to allow the rod **13** to pass through the end cap **466** as the rod **13** is driven into the ground. The plate **575** also defines one or more holes **582**. The holes **482** are configured to receive a suitable tool or other object (e.g., a bolt, a screw, a pin, etc.) to help rotate the end cap **566** during installation and removal of the end cap **566** into and from the body **514**. Although the illustrated holes **482** are threaded, in other embodiments the holes **482** may not be threaded.

[0063] The attachments **10**, **110**, **210**, **310**, **410**, and **510** have been described with respect to driving electrical ground rods **13**. However, one of ordinary skill in the art will understand that the attachment **10** can be used for driving other rods and stakes as well.

[0064] Although not illustrated together, the features described above may be used together in any combination in a single attachment. For example, any of the end caps **466**, **466′**, **566** may be used with any of the retention devices **114**, **214**, **314** described above. As such, an attachment may have a driving portion that is angled relative to an impact portion, a retention device that allows a drive shank to float, and an end cap that securely maintains a collet within the driving portion.

[0065] Although the invention has been described in detail with reference to certain preferred embodiments, variations and modifications exist within the scope and spirit or one or more independent aspects of the invention as described.

Claims

1. An attachment configured for use with a powered hammer to drive a rod into the ground, the attachment comprising: a body; an impact portion defining an impact axis, the impact portion including a bore configured to receive a drive shank that is coupled to the powered hammer, the impact portion configured to receive repeated impacts from the powered hammer; and a driving portion in which the rod is receivable, the driving portion including a side load driving portion defining a side load driving axis, the side load driving axis being non-parallel to the impact axis.

2. The attachment of claim 1, wherein the impact axis and the side load driving axis are orientated at an acute angle relative to one another.

3. The attachment of claim 2, wherein the acute angle is less than 20 degrees.

4. The attachment of claim 3, wherein the acute angle is 4.5 degrees.

5. The attachment of claim 1, wherein the side load driving portion includes a one-way collet configured to transmit a driving force generated by the impacts from the powered hammer to a side of the rod, wherein the one-way collet is configured to allow the attachment to move relative to the rod in a first direction and to prevent relative movement between the attachment and the rod in a second direction, opposite the first direction.

6. The attachment of claim 5, wherein the one-way collet includes a frustoconical portion, and wherein the body defines a frustoconical aperture in which the one-way collet is received.

7. The attachment of claim 6, wherein the one-way collet includes a plurality of bearings disposed about the frustoconical portion, the plurality of bearings configured to engage the rod.

8. The attachment of claim 7, further comprising a biasing member that biases the one-way collet toward a position corresponding to a minimum rod diameter.

9. An attachment configured for use with a powered hammer to drive a rod into the ground, the attachment comprising: a body; an impact portion defining an impact axis, the impact portion including a bore configured to receive a drive shank that is coupled to the powered hammer, the impact portion configured to receive repeated impacts from the powered hammer; a driving portion in which the rod is receivable, the driving portion configured to engage the rod and transmit a driving force due to impacts from the powered hammer to the rod; and a retention device adjacent the bore of the impact portion, the retention device including a locking mechanism configured to secure the drive shank in the bore, the locking mechanism allowing axial movement of the drive shank within the bore along the impact axis.

10. The attachment of claim 9, wherein the drive shank defines a groove having a length measured parallel to the impact axis, and wherein the locking mechanism has dimension measured parallel to the impact axis, and wherein the dimension of the locking mechanism is less than the length of the groove.

11. The attachment of claim 9, wherein the locking mechanism is a fastener.

12. The attachment of claim 9, wherein the locking mechanism is a ball bearing or a dowel pin.

13. The attachment of claim 9, wherein the retention device further includes a sleeve that is moveable between a first position, in which the shank is secured within the bore, and a second position, in which the shank is removable from the bore.

14. The attachment of claim 13, wherein when in the first position, the sleeve forces the locking mechanism to engage the drive shank, and wherein when in the second position, the sleeve allows the locking mechanism to move away from a drive shaft.

15. An attachment configured for use with a powered hammer to drive a rod into the ground, the attachment comprising: a body defining an aperture; an impact portion defining an impact axis, the impact portion configured to receive repeated impacts from a drive shank of the powered hammer; and a driving portion including a one-way collet positioned at least partially within the aperture of the body and configured to transmit a driving force generated by the impacts from the powered hammer to the rod, the one-way collet defining a driving axis that is angled relative to the impact axis, an end cap coupled to the body and extending over a portion of the aperture, and a biasing member disposed between the collet and the end cap.

16. The attachment of claim 15, wherein the end cap is a threadedly coupled to the body.

17. The attachment of claim 16, wherein the driving portion also includes a fastener to secure the end cap within the aperture.

18. The attachment of claim 17, wherein the end cap includes a base that engages the biasing member and a sidewall that extends from the base and engages an inner surface of the body, and wherein the sidewall includes a flat that is engaged by the fastener.

19. The attachment of claim 17, wherein the end cap includes a base that engages the biasing member and a sidewall that extends from the base and engages an inner surface of the body, and wherein the sidewall defines a notch that receives the fastener.

20. The attachment of claim 15, wherein the aperture defines a groove and a plurality of cavities connected to the groove, and wherein the end cap includes a plate having a plurality of lobes received in the groove through the plurality of cavities.