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(56) Documents Cited:
CA 002251902 A1 **US 6536322 B1**
US 5800079 A **US 20140027017 A1**
US 20130306775 A1 **US 20120024425 A1**
US 20090159155 A1

(58) Field of Search:
INT CL **A01G, B23D, B27B**
Other: **WPI & EPODOC; Internet**

(54) Title of the Invention: **Tree stump grinder**
Abstract Title: **A tooth for a tree stump grinder**

(57) A tooth **2** for use in a grinding wheel, the tooth comprising means for cooperating with a recess **6** of the grinding wheel **4** and means for locking the tooth in the recess of the wheel, and a grinding wheel comprising the tooth. The tooth may comprise a spigot **8** which may fit within the recess of the grinding wheel. The recess may be provided with a slot **10** of the grinding wheel.

Figure 4

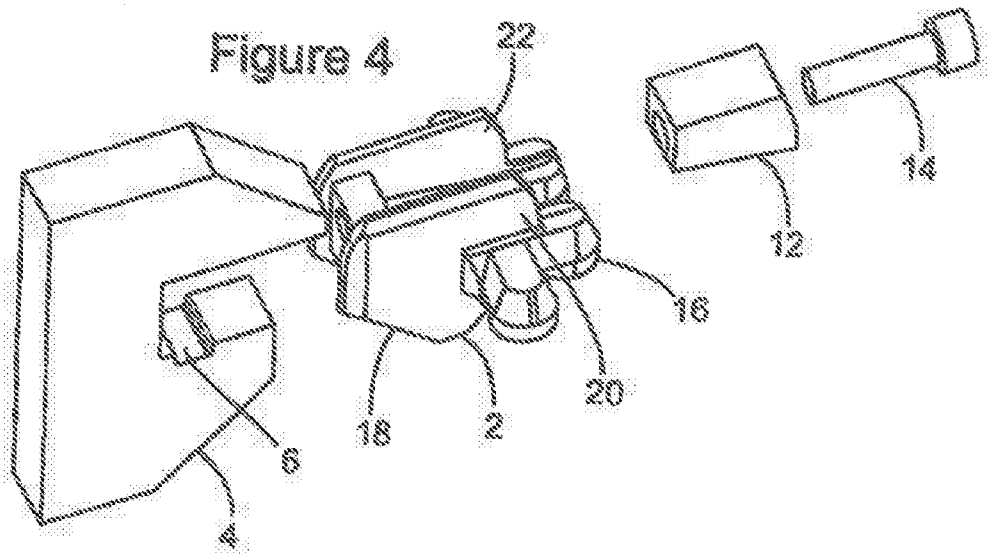

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Figure 1

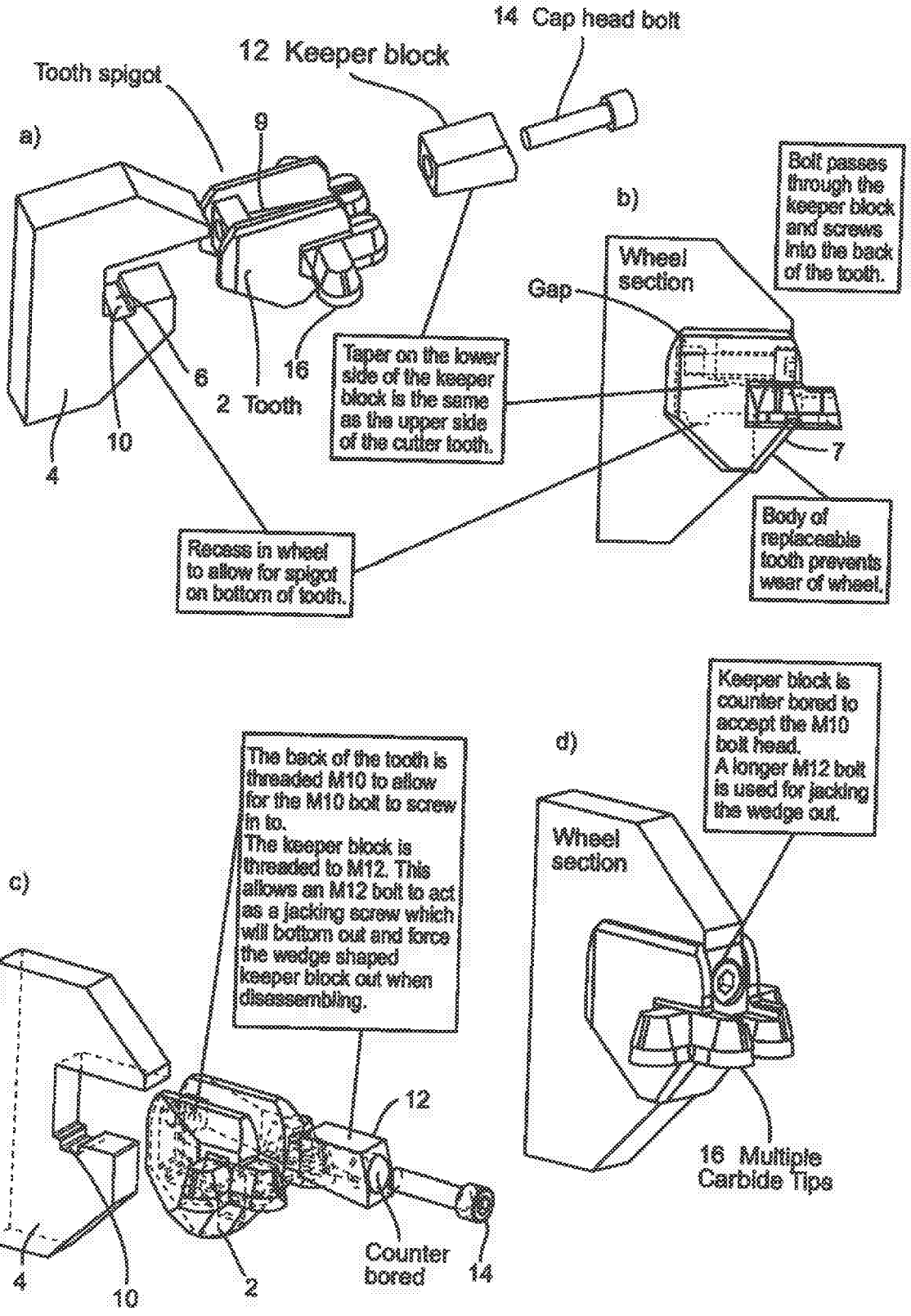


Figure 2

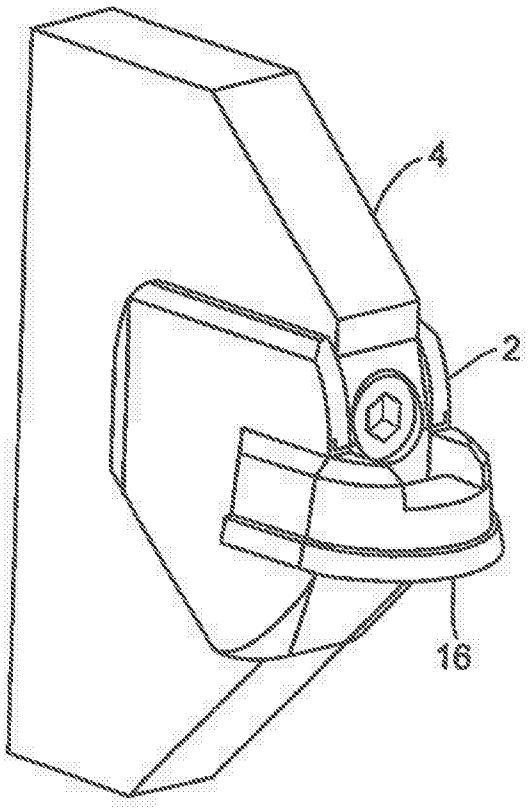


Figure 3

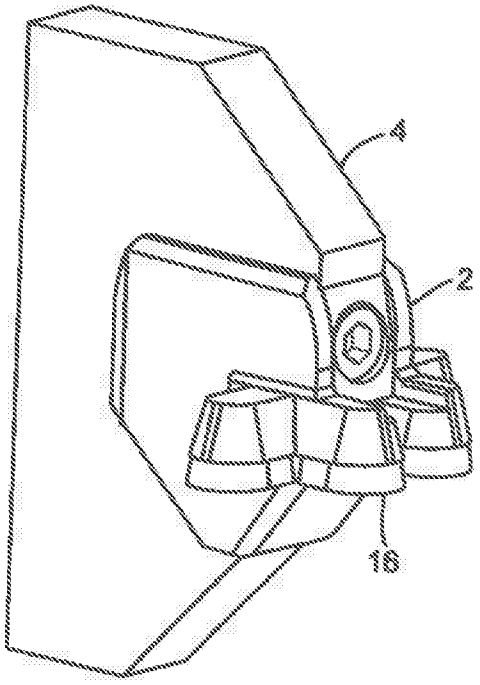


Figure 4

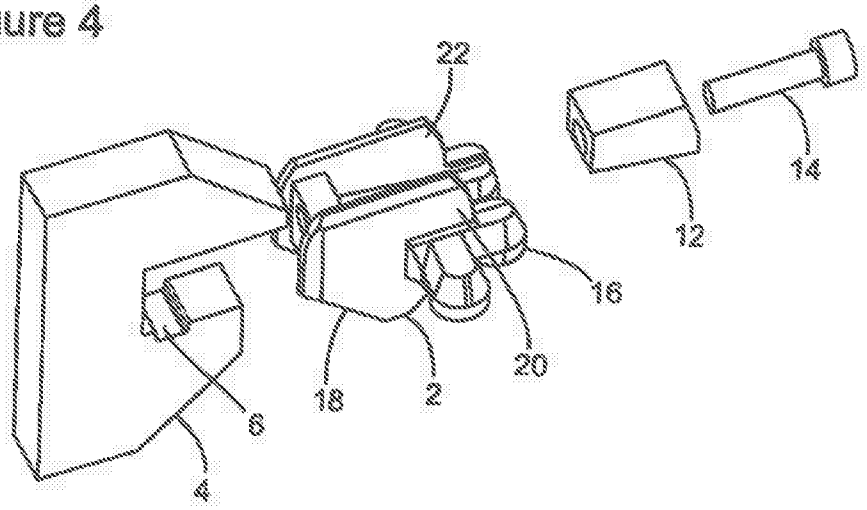


Figure 5

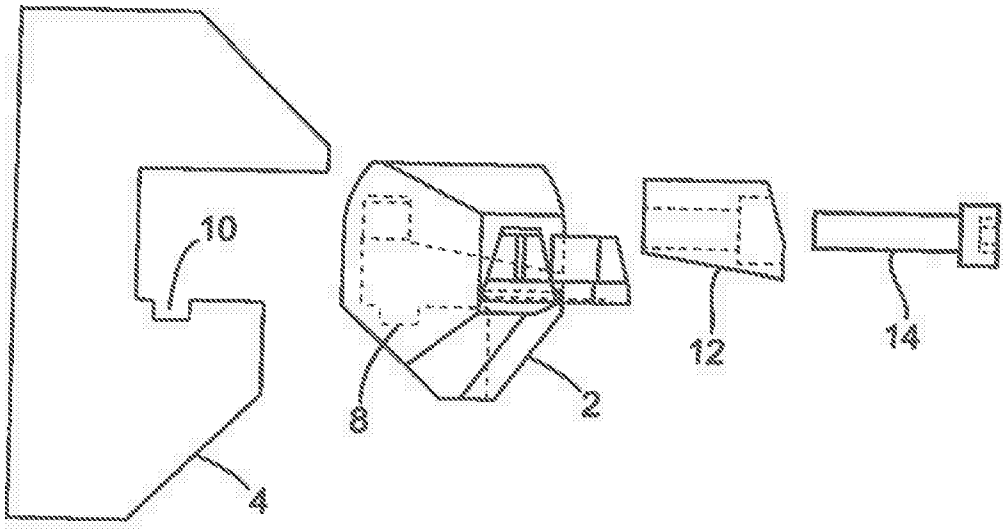


Figure 6

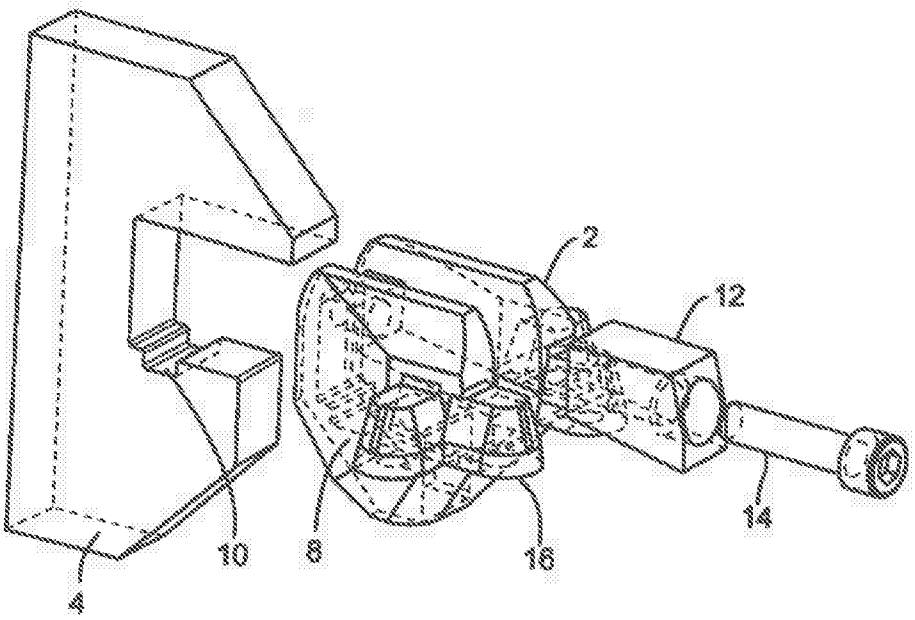


Figure 7

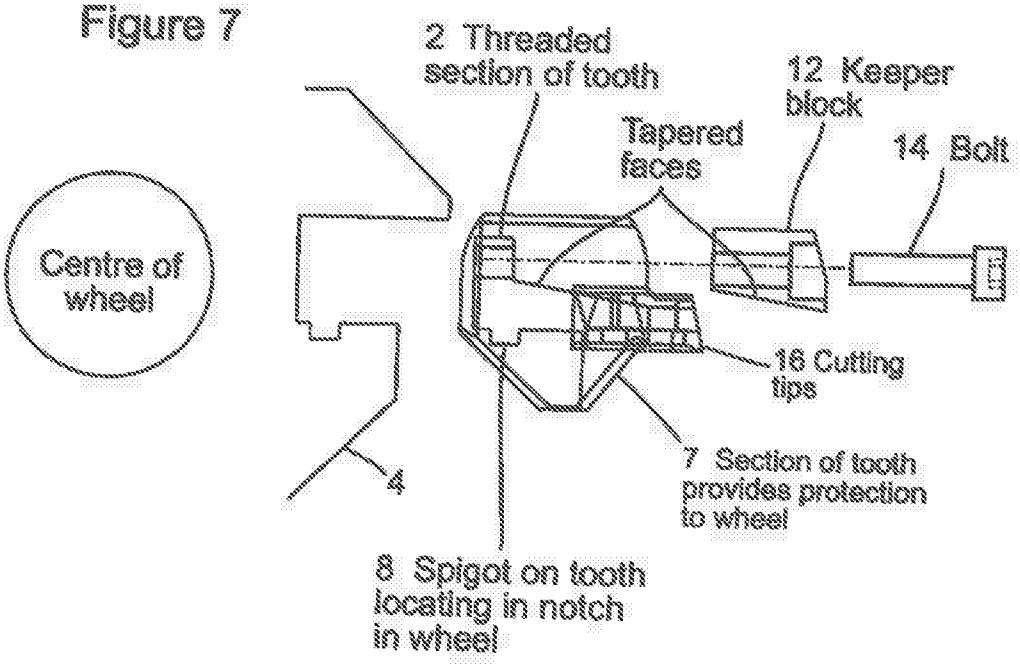


Figure 8

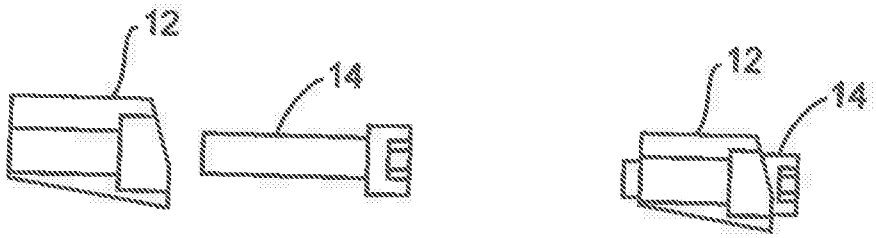
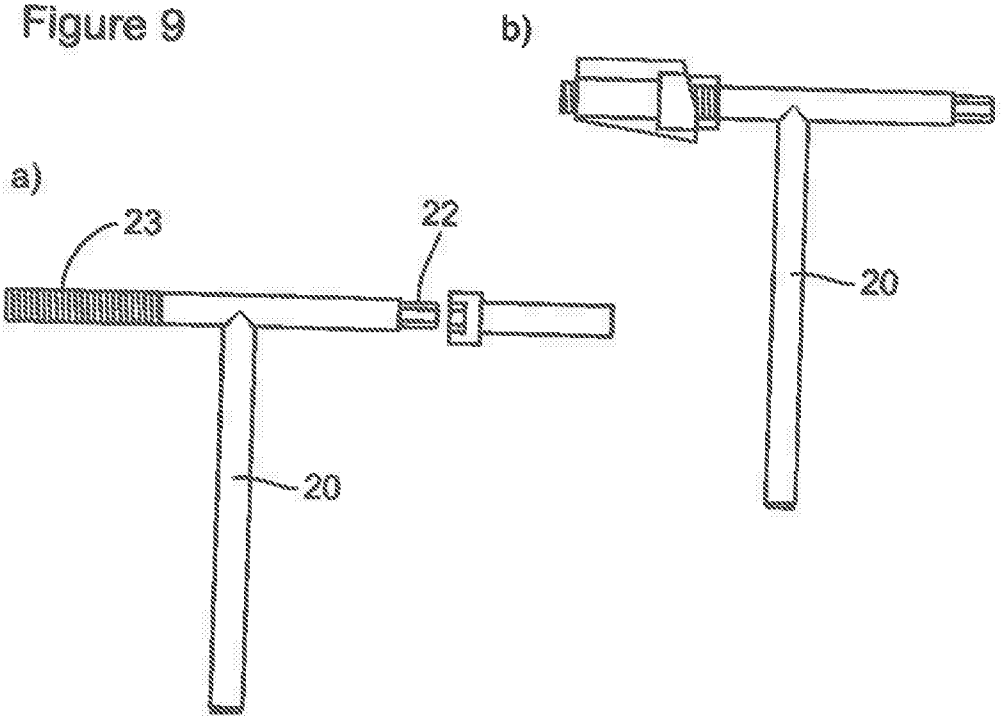


Figure 9



Tree Stump Grinder

The present invention relates to tree stump grinding machines and particularly to the grinding wheel of such a machine and the associated mechanism of engaging a tooth with the grinding wheel.

It is known in the prior art to provide a tree stump grinding machine with a cutting wheel driven by a belt, a chain, shafts or hydraulic motors. Such machines are sometimes referred to as cutting machines. Current tree stump grinding machines typically consist of a circular wheel with a number of receiving brackets positioned around the rim. The receiving brackets have channels into which are fitted individual cutting teeth. Each tooth is individually mounted and a gauge is often required to set each tooth at the correct distance from the centre of the wheel. Each tooth is held in place by retaining bolts that are tightened to a very high degree in order to hold the teeth. The bolts and retaining brackets are required to take the full rotational force of the grinding action. The wheel is provided with a plurality of teeth, some of which are fitted to cut vertically, as the wheel moves along a horizontal and vertical axis. An example of such a grinding wheel is found in US 6,484,766.

The teeth and receiving brackets provided on the grinding wheels known from the prior art have to be changed regularly as a result of the considerable wear that they encounter in use. Changing the teeth and receiving brackets is time consuming because of the set up accuracy required, Each tooth is generally held in place using two bolts to secure the receiving bracket and the tooth. The task of changing the tooth is invariably complicated by the earth and mud that clogs the teeth, brackets and bolt threads which then require cleaning prior to fitting of a new tooth. As a result of the earth and mud, the receiving thread in the cutting wheel and the bolt or bolts may become cross-threaded and require repair before a new tooth can be fitted. In addition to the expense incurred in a long down-time to change the teeth, the teeth and receiving brackets themselves are expensive because of the number of heavy duty components.

US 6,550,504 shows an example of how a plurality of teeth can be attached to a rotor. Each tooth consists of a cutting tip and a body portion. The body portion includes two holes that allow the tooth to be attached to the rotor and the rotor is provided with corresponding pairs of holes for attaching the teeth by suitable fixing means, typically bolts, that pass through the tooth and

the rotor and is then secured, typically using a nut that screws onto the bolt. In this way the tooth is mounted on the rotor.

There are two forces acting on the tooth that are of importance in this context. The first is the sheer force that prevents the tooth from slipping around the rotor and that arises because the tooth is not in the plane of the rotor. The second force is the bending moment which is a function of the distance between the fixing means and the cutting tip. In the example shown in US 6,550,504, the cutting tips are positioned considerably out of the plane of the rotor and therefore the bolt will experience both the bending movement caused by the distance between the tip and the bolt and, in addition, the sheer force acting across the bolt.

US 6,546,977 discloses a stump grinding device that reduces the force on the bolt by providing a cutting unit that is disposed in the plane of the rotor. Therefore the bending moment is considerably reduced in comparison with the example shown in US 6,550,504. However, the sheer force across the bolt remains the means by which the force is transferred from the cutting tip to the rotor.

US 6,375,106 discloses a machine that is designed to reduce waste by grinding. Although this is not the same technical field as the other art, some similar problems will be encountered. The teeth are replaceable and, unlike the previously discussed prior art, the attachment device is in the plane of the rotor. However, the tortuous cross section of the attachment device and locking element result in considerable stresses on certain parts of the interface between the rotor and the cutting tip.

EP 1175735 relates to a tooth for use in a grinding wheel wherein the tooth is held within a slot of the grinding wheel by means of a bolt. This has the problems that: (1) the centrifugal force and/ or load of the assembly are entirely on the bolt. If the user over tightens the bolt, the bolt could stretch beyond its elastic capability and weaken, such that the bolt may break. Even though the instructions of a device of this arrangement may point the user to a recommended torque setting, in most cases the user doesn't pay attention to this and typically over tightens the bolt. (2) Contact with the soil eventually causes wear of the wheel just under the tooth slot. This eventually adversely affects the fit of the assembly, wherein the tooth does not fit as well as previously within the slot, thus putting extra stress onto the bolt. The typical life span of the wheel is 300 to 500 hours depending on the soil type. Expensive steel may be used to extend the

life span but this is harder to machine in production. (3) The assembly is not always at a fixed distance from the centre of the wheel. If the slot is subject to wear and/ or if the keeper and/ or tooth are not manufactured to an exact size, the distance of the assembly with respect to the centre of the wheel may vary. In some cases, there may be a build up of tolerances which may make this problem worse. The relationship of the distance between one tooth and the next on the wheel would have an effect on the performance of the assembly.

The present invention seeks to ameliorate the problems associated with the prior art described above.

According to a first aspect, there is provided a tooth for use in a grinding wheel, the tooth comprising means for cooperating with a recess of the grinding wheel and means for locking the tooth in the recess of the wheel.

Preferably, the tooth comprises a spigot which may be received within the recess. Preferably, the spigot of the tooth fits within the recess of the grinding wheel. Preferably, the recess is provided within a slot of the grinding wheel.

Preferably, the tooth further comprises means for cooperating with a keeper block. Preferably, the keeper block is dimensioned to fit with the tooth within a slot of the grinding wheel. Preferably, the keeper block is attached to the tooth by means of a bolt. It is preferred that the bolt passes through the keeper block and attaches to a rear portion of the tooth. Preferably, the tooth comprises a threaded portion through which the bolt may pass. Preferably, the keeper block is counter bored to allow passage of the bolt through the keeper block. Preferably, the bolt is attached to the tooth by means of a threaded engagement. Preferably, the keeper block is shaped such that it corresponds with the shape of the tooth, such that the combination of the keeper block and tooth fit within a slot of the grinding wheel. Typically, the underside of the keeper block is provided with a tapered surface that interfaces with the surface of the tooth. Typically, the taper on the lower surface of the keeper block is approximately 11°. The keeper block and tooth advantageously fit together and are sized to fit within the slot of the grinding wheel. Advantageously, the keeper block and tooth move together relative to the slot provided within the grinding wheel.

Advantageously, the tooth is locked in place by pulling a wedged keeper block in and forcing the spigot on the lower part of the tooth into the recess in the wheel.

Advantageously, the engagement of the spigot of the tooth with the recess of the grinding wheel provides an interfitting, positive mechanical engagement. This is in contrast to previous systems which involved a fit under tension from a screw. Advantageously, the present invention uses forces in the radial, tangential and axial directions relative to the axis of rotation of the grinding wheel, wherein the force in the radial direction is provided by the reaction surfaces between the spigot and the recess, and the force in the tangential direction is provided by the tapered keeper block and the surfaces on either side thereof, and the force in the axial direction is provided by the walls of the slot within the tooth.

Preferably, the tooth comprises a main body including a slot comprising two substantially planar surfaces for, in use, engaging with the keeper block. Preferably, the tooth comprises a tapered channel on the upper surface thereof. Preferably, the tooth comprises one or more cutting face connected to and extending away from the main body.

Preferably, the cutting face includes one or more tips. In an embodiment wherein the tooth comprises two or more tips, the tips may be perpendicular to each other. In another embodiment, the multi-tipped tooth may have protruding transverse tips to facilitate lateral grinding, in addition to radial tips. Such a multi-tipped tooth allows for cutting in radial and lateral dimensions simultaneously.

Some advantages of embodiments of the present invention are: (1) the tooth may be quickly removed and replaced within the grinding wheel; (2) the tooth has good performance; (3) the only part of the assembly, excluding the wheel, that wears is the tooth: (4) the keeper block, threaded insert and bolt are protected by the tooth; (5) typically, only one relatively small bolt is required because all of the forces are taken up through the wheel. Previous systems had pockets on both side faces of the wheel which would hold the teeth; (5) typically, the bolt is not taking the centrifugal force of the whole assembly (typically approximately 0.74 kg), but instead has the centrifugal force of itself and the small keeper block; (6) typically, there are fewer components, or, in the case where the wheel has been drilled and tapped instead of using a threaded insert, extra machining is not required; (7) preferably, a section is included within the tooth that protects the wheel from wear, such that standard mild steel can be used within is cheaper and easier to

machine than the material used in conventional equipment, such that the wheel that may be used with the present invention may last up to ten times longer than previous wheels. Advantageously, the assembly of the present invention is at a fixed position relative to the centre of the wheel, such that the variability in performance found with previous wheels is minimised resulting in perfect performance every time.

Advantageously, the wheel absorbs a substantial proportion of the forces in the plane of the grinding wheel resulting from the grinding action. Advantageously, the means for cooperating with the recess of the grinding wheel and means for locking the tooth within the recess of the wheel provide for a secure attachment of the tooth within the wheel.

When the term "slot" is used in this specification, it is intended to refer to any physical configuration that provides two planar surfaces that enable the interlocking of a second piece. In particular, a simple slot may be provided in the circumference of the grinding wheel by cutting a substantially U-shaped gap in the periphery of the wheel thus providing two substantially planar surfaces into which a tooth may be slotted in use. Preferably, the slots may be arranged in diametrically opposed pairs wherein the slots in an opposing pair of slots are the same distance from the axis. Preferably, the slots are arranged in two diametrically opposed series, each successive slot in each series having an increased distance from the axis.

The number of slots is preferably 4, 6, 8, 10 or 12. Some or all of the slots may be angled either towards or away from the axis of rotation of the grinding wheel. If the slots are angled towards the axis of rotation, the teeth will protrude perpendicular to the rim of the grinding wheel and will therefore, dependent on the configuration of cutting tips of the teeth, the grinding wheel could be rotated in either direction.

The invention will further be described by way of example, with reference to the accompanying drawings, in which:

Figure 1(a) is an exploded perspective view of the apparatus according to the invention;

Figure 1(b) is an assembled side view of the apparatus of Figure 1;

Figure 1(c) is an exploded perspective view of the apparatus according to the invention;

Figure 1(d) is an assembled perspective view of the apparatus of Figure 3;

Figure 2 is an assembled view of apparatus according to an embodiment of the invention;

Figure 3 is a perspective view of apparatus according to another embodiment of the invention;

Figure 4 is an exploded perspective view of apparatus according to another embodiment of the invention;

Figure 5 is a plan side view of apparatus according to an embodiment of the invention;

Figure 6 is an exploded perspective view of apparatus according to an embodiment of the invention; and

Figure 7 is a plan side view of apparatus according to an embodiment of the invention;

Figure 8 is a side plan view of a part of apparatus according to an embodiment of the invention;

Figure 9(a) is a side view of a tool that may be used with part of the apparatus of the invention; and

Figure 9(b) is a side view of a tool in combination with part of the apparatus of the invention.

With reference to Figure 1, there is provided a tooth 2 for use in a grinding wheel 4, the tooth comprising means 8 for cooperating with a recess 6 within the grinding wheel 4 and means for locking 14 the tooth in the recess of the wheel.

The tooth comprises a spigot 8 which fits within the recess 6 of the grinding wheel 4. The recess 6 is provided within a slot 10 of the grinding wheel.

The tooth further comprises means for cooperating with a keeper block 12, wherein the keeper block is dimensioned to fit with the tooth 2 within a slot 10 of the grinding wheel 4. As shown in Figure 2, the keeper block 12 is attached to the tooth 2 by means of a bolt 14, wherein the bolt

14 passes through the keeper block 12 and attaches to a rear portion of the tooth 2. Preferably, the bolt 14 is attached to the tooth 2 by means of a threaded engagement. Preferably, the bolt 14 passes through the keeper block 12 and screws into the back portion of the tooth 2. Advantageously, the tooth of the present invention does not require a bolt 14 to be attached to the grinding wheel 4, thus preventing wear of the wheel over time. Advantageously, the locking mechanism allows for replacement of the tooth 2 and keeper 12 components instead of the wheel 4 during wear. Preferably, the keeper block is counter bored and tapped to M12. The bolt is preferably an M10 socket cap which typically passes directly through the tapped hole and screws into a threaded M10 hole in the tooth. Advantageously, the head of the bolt sits in and is protected by the counter-bored section of the keeper block (see Figure 8).

With reference to Figure 1, the keeper block 12 is shaped such that it corresponds with the shape of the tooth 2, such that the combination of the keeper block 12 and tooth 2 fit within a slot of the grinding wheel 4. The underside of the keeper block is provided with a tapered surface that interfaces with the surface of the tooth. Typically, the taper on the lower surface of the keeper block is approximately 11°. The keeper block 12 and tooth 2 advantageously fit together and are sized to fit within the slot 10 of the grinding wheel 4. Advantageously, the keeper block 12 and tooth 2 move together relative to the slot 10 provided within the grinding wheel 4. Advantageously, the attachment of the keeper block of the present invention to the tooth by means of a bolt allows for a shorter bolt to be used than in previous assemblies.

The tooth 2 comprises a main body 18 including a slot comprising two substantially planar 20, 22 surfaces for, in use, engaging with the keeper block 12. The tooth 2 comprises one or more cutting face 16 connected to and extending away from the main body, wherein the cutting face includes one or more tips 16. In the embodiment wherein the tooth 2 comprises two or more tips 16, the tips may be perpendicular to each other. In another embodiment, the multi-tipped tooth may have protruding transverse tips to facilitate lateral grinding, in addition to radial tips. Such a multi-tipped tooth allows for cutting in radial and lateral dimensions simultaneously. The tips 16 may comprise a carbide material. Advantageously, the tooth 2 may comprise a region 7 comprising replaceable components to prevent wear of the wheel.

In the embodiment shown in Figure 1(c), the rear of the tooth 2 is provided with a threaded M10 to allow for a corresponding M10 bolt to screw into the tooth. The keeper block 12 is preferably threaded to M12. This allows an M12 bolt 14 to act as a jacking screw which will bottom out

and force the wedge shaped keeper block out when disassembling. Preferably, the keeper block 12 is counter bored to allow the bolt 14 to pass therethrough, as shown in Figure 1(d).

In the embodiment shown in Figure 1(d), the keeper block 12 is counted bored to accept an M10 bolt head. A longer M12 bolt is used as a jacking screw which will force the wedge shaped keeper block out when disassembling. In the embodiment shown in Figure 1(d), the tooth comprises multiple tips 16, wherein the tips provide the cutting face of the tooth. In this embodiment, each of the tips comprises carbide material. Advantageously, the hard carbide tips reduce wear of the assembly and allow the teeth to last longer, especially when the teeth come into contact with soil.

Advantageously, only one tool 20 is required to drill the bolt into the keeper block and tooth, as shown in Figure 9. One end 22 of the tool typically has an 8 mm hex head which fits into the M10 bolt head for tightening. The other end 23 of the tool is typically tapped to M12. This is used for extracting the keeper block. Once the bolt has been removed, the threaded end screws into the keeper block and bottoms out on the back of the tooth. Continuing to wind the thread in will push the keeper block out. Then the tooth can be removed freely. This is in contrast with previous systems where two tools are typically required, an allen key and a hammer. In previous systems, the hammer is used to knock the tooth out of the slot after the bolt has been removed.

In the embodiment shown in Figure 2, the tooth 2 comprises a single tip 16. The locking mechanism of this embodiment is the same as that described above in relation to Figure 1.

During rotation, the wheel 4 absorbs a substantial proportion of the forces in the plane of the grinding wheel resulting from the grinding action. The locking mechanism of the invention assists in retaining the tooth 2 in place within the slot 10 as the grinding wheel 4 rotates.

When the term "slot" is used in this specification, it is intended to refer to any physical configuration that provides two planar surfaces that enable the interlocking of a second piece. In particular, a simple slot may be provided in the circumference of the grinding wheel by cutting a substantially U-shaped gap in the periphery of the wheel thus providing two substantially planar surfaces into which a tooth may be slotted in use. Preferably, the slots may be arranged in diametrically opposed pairs wherein the slots in an opposing pair of slots are the same distance

from the axis. Preferably, the slots are arranged in two diametrically opposed series, each successive slot in each series having an increased distance from the axis.

The number of slots is preferably 4, 6, 8, 10 or 12. Some or all of the slots may be angled either towards or away from the axis of rotation of the grinding wheel. If the slots are angled towards the axis of rotation, the teeth will protrude perpendicular to the rim of the grinding wheel and will therefore, dependent on the configuration of cutting tips of the teeth, the grinding wheel could be rotated in either direction.

Thus, preferably the tooth of the invention comprises one or more cutter tips, a spigot in the underside of the channel which locates in a recess provided within a slot of the wheel, a tapered channel on the upper side of the tooth, and/ or a threaded section at the back of the tooth. Preferably, the keeper block is tapered on the underside and/ or comprises a counter-bored hole from the front to the back. The apparatus of the invention preferably further comprises a bolt.

In use, it is preferred that the tooth 2 is fitted by locating the spigot 8 in the recess 10 of the wheel 4. The keeper block 12 preferably comprises a tapered surface which slides into a tapered channel 9 provided on an upper surface of the tooth 2. The bolt 14 preferably passes through the keeper block 12 and screws into the back of the tooth 2. As the keeper block 12 is pulled in, it typically pushes the spigot 8 on the underside of the tooth 2 firmly into the recess 10 in the wheel 4 and locks the assembly tightly in place.

CLAIMS

1. A tooth for use in a grinding wheel, the tooth comprising means for cooperating with a recess of the grinding wheel and means for locking the tooth in the recess of the wheel.

2. The tooth of claim 1, wherein the tooth comprises a spigot.

3. The tooth of claim 2, wherein the spigot fits within the recess of the grinding wheel.

4. The tooth of claim 2 or 3, wherein the recess is provided within a slot of the grinding wheel.

5. The tooth of any preceding claim, further comprising means for cooperating with a keeper block.

6. The tooth of claim 5, wherein the keeper block is dimensioned to fit with the tooth within a slot of the grinding wheel.

7. The tooth of claim 5 or 6, wherein the keeper block cooperates with the tooth by means of a bolt.

8. The tooth of claim 7, wherein the bolt passes through the keeper block and attaches to a rear portion of the tooth.

9. The tooth of claim 7 or 8, wherein the bolt is attached to the tooth by means of a threaded engagement.

10. The tooth of any one of claims 5 to 9, wherein the keeper block is shaped such that it corresponds with the shape of the tooth, such that the combination of the keeper block and tooth fit within a slot of the grinding wheel.

11. The tooth of any one of claims 5 to 10, wherein the underside of the keeper block is provided with a tapered surface that interfaces with the surface of the tooth.

12. The tooth of claim 11, wherein the taper on the lower surface of the keeper block is approximately 11°.

13. The tooth of any one of the preceding claims, comprising a main body including a slot comprising two substantially planar surfaces for, in use, engaging with the keeper block.

14. The tooth of any one of the preceding claims, comprising one or more cutting faces connected to and extending away from the main body.

15. The tooth of claim 14, wherein the cutting face includes one or more tips.

16. A grinding wheel comprising a tooth according to any one of claims 1 to 15.

17. A tooth as defined herein and with reference to the accompanying drawings.

18. A grinding wheel as defined herein and with reference to the accompanying drawings.

Intellectual Property Office

Application No:	GB1619723.8	**Examiner:**	Bryony Barceló
Claims searched:	1-16	**Date of search:**	11 May 2017

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1, 5-10, 13-16	US2012/024425 A1 Leonardi et al; see figure 10
X	1, 14, 15, 16	US2014/027017 A1 Green et al; see figure 2
X	1-7, 10, 13-16	US2009/159155 A1 Watts; see figure 7
X	1, 5-9, 14-16	US6536322 B1 Butler et al; see figure 2a
X	1, 13, 16	CA2251902 A1 Tigercat; see figures 1 and 3
X	1, 5, 6, 10-12, 16	US5800079 A Qvarth; see figure 1
X	1-7, 9, 16	US2013/306775 A1 Cairns; see figure 1a

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

A01G; B23D; B27B

The following online and other databases have been used in the preparation of this search report

WPI & EPODOC; Internet

International Classification:

Subclass	Subgroup	Valid From
A01G	0023/06	01/01/2006
B27B	0033/02	01/01/2006
B27B	0033/08	01/01/2006
B27B	0033/12	01/01/2006