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Stepe

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[54] **OPEN SIDE GROUND ENGAGING TIP**

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[52] **U.S. Cl.** ..... **37/142 R,** 172/702

[51] **Int. Cl.** **E02f 9/28**

[58] **Field of Search** ..... 37/142, 141; 287/103 R, 287/119; 172/702

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[57] **ABSTRACT**

A replaceable ground engaging tip for mounting on an adapter on the cutting edge of an excavating bucket has a wedge shaped body comprising the wear part of the point and a rearwardly extending straps at the top of the body and a rearwardly extending strap at the bottom of the body. The straps diverge from the body to the rearends of the straps to form an open-sided generally U-shaped opening for the reception of the nose of the adapter. Each strap has a key which extends laterally of the strap near the rearend of the trap. The keys project normal to the straps and engage respective keyways in the adapter. All loads on the tip are transferred to the adapter through the keys and keyways. The tip is a self-locking tip because of the friction produced between the keys and keyways. The loads on the tip are transmitted through the straps in tension-compression rather than in bending so that the straps can be made of quite thin sections. The tip is a high yield tip because the open-sided, thin section straps permit most of the weight of the tip to be concentrated in the wear part of the tip.

8 Claims, 6 Drawing Figures

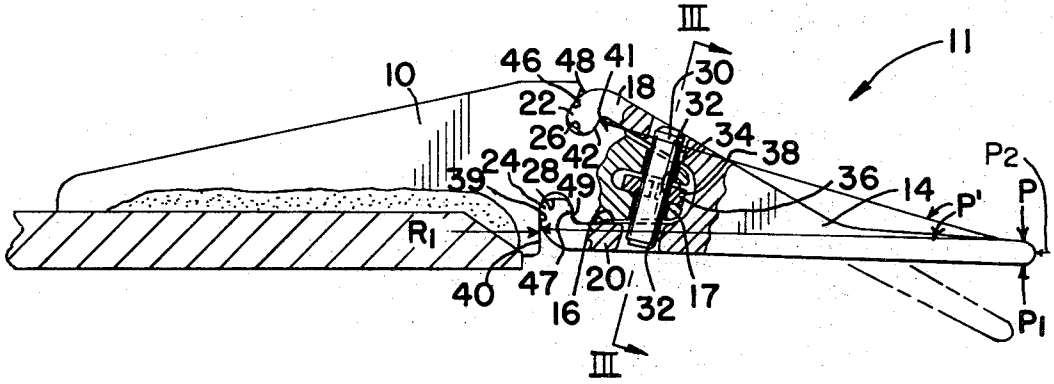


Fig. 2

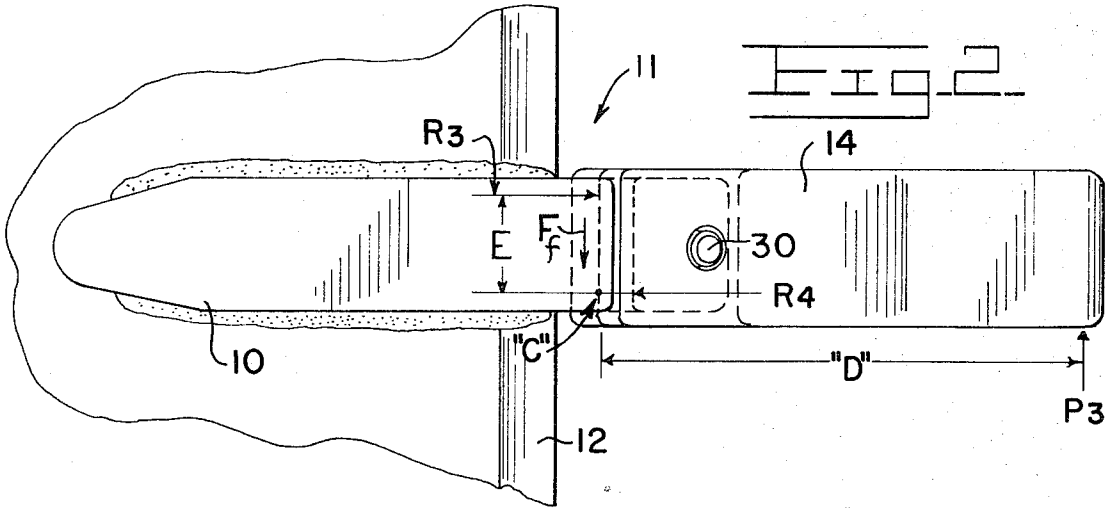
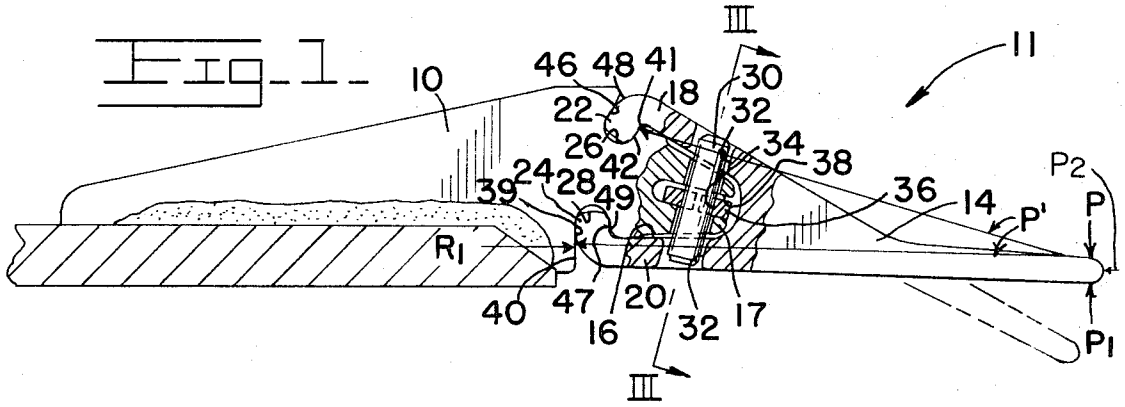


Fig. 1



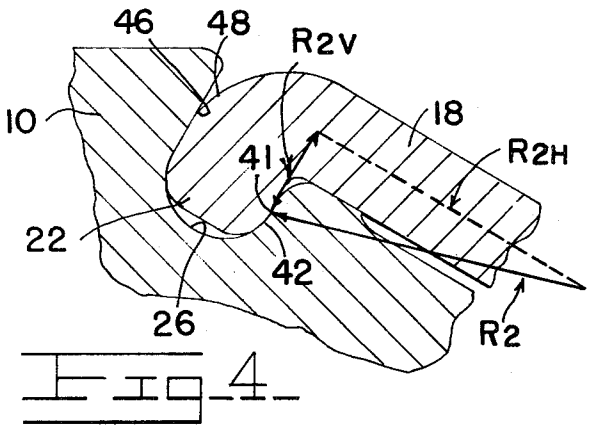


Fig. 4

Fig. 3

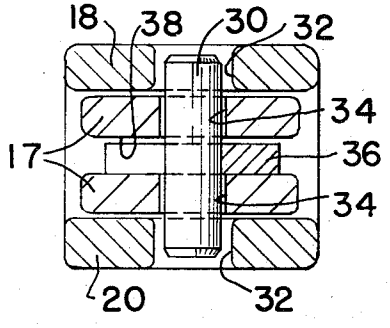
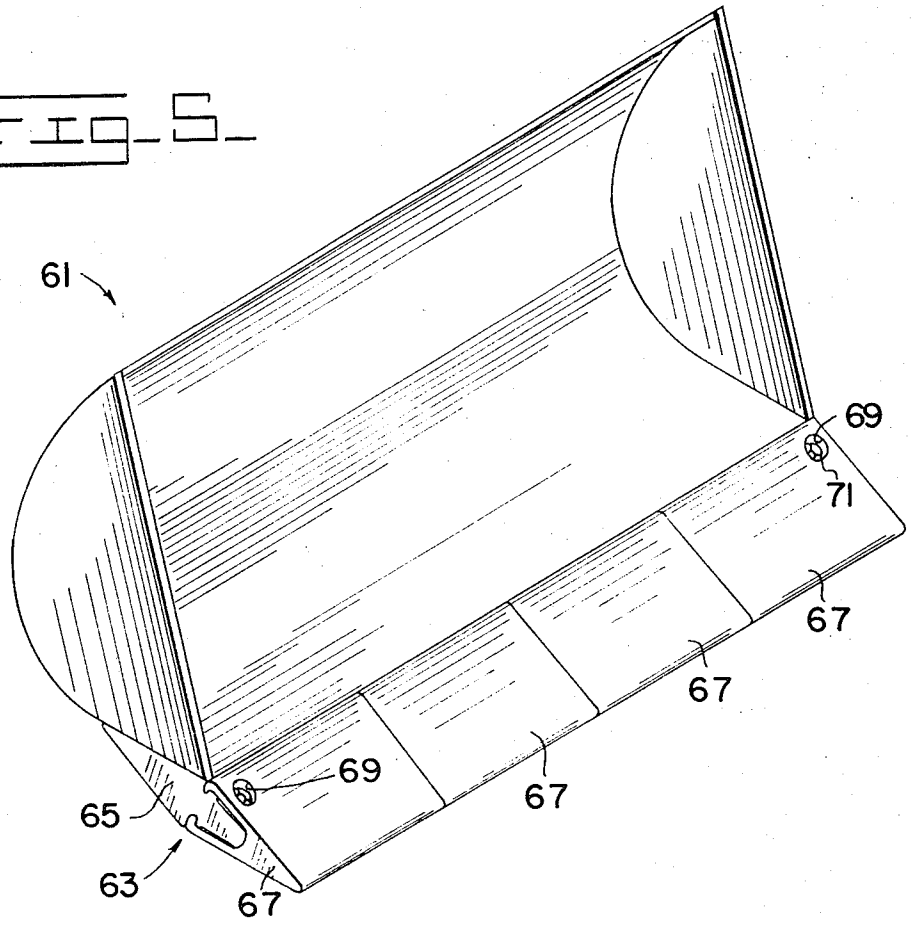


Fig. 5



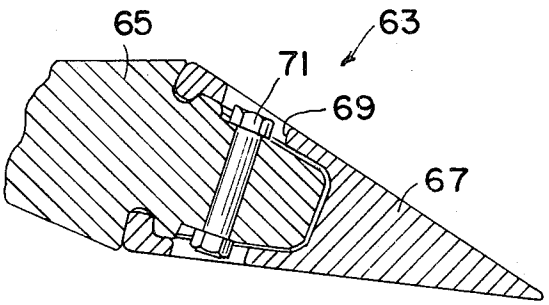


Fig. 6

OPEN SIDE GROUND ENGAGING TIP

BACKGROUND OF THE INVENTION

This invention relates to a replaceable ground engaging tip for mounting on an adapter on the cutting edge of an excavating bucket.

This invention relates particularly to a tip with open sides, a pair of straps extending rearwardly from the top and bottom of the wear part of the tip, and a key on each strap which extends laterally of the strap and which projects normal to the strap. The keys engage respective keyways in the adapter to transfer all loads to the adapter through the keys.

The tip of the present invention is unique in construction and in the manner by which the loads on the tip are carried and transferred into the supporting adapter. The tip is self-locking on the adapter because of the friction developed between the keys and keyways under load. A retainer is used, however, to prevent walking off of the tip during vibratory motion under no load.

THE PRIOR ART

Substantial gains have been made in recent years in the ground engaging tip art.

New configurations, new material and improved load distribution have all resulted in increased wear life and economy.

The majority of the ground engaging tips are of wedge-shaped configurations.

The prior art tip usually has an internal socket cavity which telescopically mates on an adapter. The tips are secured to the adapters by retaining pins.

In the conventional design of ground engaging tips only about fifty percent of the total weight of the tip is located in the forward end of the tip. The remaining 50 percent of the weight of the tip is required for adequate support of the tip on the adapter. As a result, in a conventional design of ground engaging tip, the tip must be replaced after approximately 50 percent of its total weight has worn away. Since conventional tips have only approximately 50 percent yield, they do not provide a truly economical tip.

SUMMARY OF THE INVENTION

It is therefore a primary object of the present invention to construct a ground engaging tip that adequately and efficiently transfers the tip loads into the supporting adapter while providing a tip that has high yield.

In accordance with the present invention a ground engaging tip has a wedge-shaped body with a point at the forward end of the wedge.

An upper strap and a lower strap extend rearwardly from the wedge-shaped body, and the straps diverge with distance from the body to form an open-sided, generally U-shaped opening for the reception of the nose of the adapter.

A key extends laterally of each strap near the rearend of the strap and projects normal to the strap for engagement in a respective keyway in the adapter.

The tip does not contact the forward part of the nose of the adapter.

Instead, all loads are transferred from the tip to the adapter through the interengaged keys and keyways.

The vertical loads are transmitted in tension or compression through the straps, with substantially no bending stresses in the strap; so the straps can be made of quite thin sections.

Because the tip has open sides and has thin section straps, the bulk of the weight of the tip can be concentrated in the wedge-shaped body, which is the wear portion. The tip of the present invention therefore permits a high yield (up to approximately eighty-six percent yield) to be realized.

Loads applied to the tip cause frictional engagement of the keys in the keyways to cause the tip to be a self-locking tip.

A tip constructed to have the specific structural features noted above and effective to function in the ways described above constitutes a further, specific object of the present invention.

Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawings which, by way of illustration, show preferred embodiments of the present invention and the principles thereof and what are now considered to be the best modes contemplated for applying these principles. Other embodiments of the invention embodying the same or equivalent principles may be used and structural changes may be made as desired by those skilled in the art without departing from the present invention and the purview of the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevation view, partly broken away to show details of construction, of a tip-adapter combination constructed in accordance with one embodiment of the present invention;

FIG. **2** is a top plan view of the tip-adapter combination shown in FIG. **1**;

FIG. **3** is an elevation view taken along the line and in the direction indicated by the arrows III—III in FIG. **1**;

FIG. **4** is a fragmentary enlarged front elevation view in cross-section showing details of the key and keyway mounting connection of the tip-adapter combination shown in FIG. **1**;

FIG. **5** is an isometric view of an excavator bucket having a tip-adapter combination constructed in accordance with another embodiment of the present invention; and

FIG. **6** is a side elevation view in cross-section through the tip adapter combination of FIG. **5** showing a bolt retaining pin.

TECHNICAL DISCLOSURE OF THE INVENTION

A tip adapter combination constructed in accordance with one embodiment of the present invention is indicated generally by the reference numeral **11** in FIGS. **1** and **2.**

The tip adapter combination includes an adapter **10** which is secured to a bucket cutting edge **12** by welding, as illustrated, or by bolts.

The ground engaging tip or tooth **14** is removably secured on the forward leading edge on the adapter **10.** The tip **14** is of generally wedge-shaped configuration in the body part of the tip which is subjected to the greatest wear. This wedge-shaped body of the tip has a point at the forward end of the wedge.

The tip **14** has an upper strap type wall **18** and a lower strap type wall **20** extending rearwardly from the wedge-shaped body.

The straps **18** and **20** diverge to define an open-sided, generally U-shaped opening **16** for the reception of the wedge-shaped nose **17** of the adapter **10.**

The upper strap **18** has a key **22** near the rearend of the strap.

The lower strap **20** has a key **24** near the rearend of the strap.

The keys **22** and **24** engage with lateral keyways **26** and **28** in the adapter.

The tip is installed on the adapter from the side.

A substantial amount of clearance is provided between the forward portion of the wedge-shaped nose **17** of the adapter and the U-shaped opening **16** of the tip. As a result, regardless of the loads which act upon the tip and produce deflection in the tip, contact will not occur between the forward portion of the adapter nose and the U-shaped cavity in the tip.

The tip of the present invention is self-locking on the adapter under load. It requires no retaining pin to hold the tip on the adapter under load, since all loads applied to the tip (other than a true side load applied near the end of the tip and exactly balanced between the straps) would tend to cock the tip. This would cause binding of the retaining keys **22** and **24** in their respective key slots. This would prevent the tip from being removed.

There is, however, a possibility that the tip could disengage itself (walk-off) from the adapter during vibrations of the tip on the adapter when the tip is in an unloaded condition.

To eliminate this possibility, a cylindrical retaining pin **30** is installed in aligned holes **32** and **34** in the tip and adapter.

The pin is retained in the installed position by engagement with a split ring collar **36,** which is located in a longitudinal slot **38** in the adapter nose. See FIG. **3.** The retaining pin is of relatively small size since it is not a load carrying member. The retaining pin merely prevents "walking-off" of the tip.

The tip of the present invention is unique in the way the tip loads are transmitted into the adapter.

A clockwise load P applied near the forward end of the tip places, by design, the bottom strap in compression with the resisting force R_1 occurring between surface **39** of the adapter and the rearmost surface **40** of the tip (See FIG. **1**). It is noted that these surfaces are normal to the bottom strap **20**; therefore, there is no vertical force component. Load P is also resisted by a reaction force R_2 occurring between the surface **41** of keyway **26** and the surface **42** of the key **22.** It is noted that the surfaces **41** and **42** are normal to the top strap **18.** The direction of the resisting force R_2 is easily found since this is a three force system — and in such a system, if the intersection of the line of action of any two forces is found, the line of action of the third force and pass through the intersection point.

Since the resisting force R_2 in this particular design is not exactly parallel with the top strap **18,** the reaction force R_2 can be broken up into components acting parallel and perpendicular to the top strap (See FIG. **4**). This perpendicular force R_2V would theoretically tend to put the top strap **18** in bending. However, the friction force between the key **22** and the keyway **26** can be larger than reaction R_2V — and hence, no bending occurs. The friction force can be found by the formula — $F_f = R_2H \times f$. F_f is the friction force — R_2H is the horizontal component of R_2 — and f is the co-efficient of friction.

$R_2H = R_2 \text{ Cos } 14°$

$R_2H = 33{,}500 \times .9703$

$R_2H = 32{,}500 \text{ lbs.}$

$R_2V = R_2 \sin 14°$

$R_2V = 33{,}500 \times .2419$

$R_2V = 8{,}100 \text{ lbs.}$

$F_f = R_2H \times f$

$F_f = 32{,}500 \times .25$

$F_f = 8{,}125 \text{ lbs.}$

Furthermore, since the reaction R_2V is relatively small, the top strap section can be made heavier than the bottom strap if it is not desired to depend on friction to prevent bending.

If a counterclockwise reverse load P_1 (see FIG. **2**) is applied from the bottom of the tip, the reaction forces will act substantially perpendicular to the surfaces **46** and **47** of keyways **26** and **28,** the surfaces **48** and **49** of the tip **14.** The direction of the reaction force will be determined by the intersection of the reaction force on the top and bottom straps and the load P' lines of action. Any vertical component of the reaction forces tending to bend the top and bottom straps **18** and **20** would be insignificant due to the higher friction forces between the surfaces in contact.

An axial load P_2 (FIG. **1**) would merely tend to put a bending moment on the nose of the tip and to put the top and bottom straps **18** and **20** substantially (slight bending in top strap) in compression.

When a side load P_3 (see FIG. **2**) is applied (can be applied from either side), the top and bottom keys **22** and **24** are subjected to the reactions R_3 and R_4. These two reactions result in friction loads F_f on the key, which resists P_3. As P_3 gets larger, R_3 and R_4 get larger, and since the friction force is larger, the tip is in effect self-locking on the adapter.

$$F_f = (R_3 + R_4) \times f$$

There is a point somewhere along the length of the tip where the friction load is in balance by some applied load. The location is close to the keyway since only when P_3 is applied here, R_3 and R_4 will become sufficiently small so that the resulting friction load would also be small. If the moments about point C are summed, R_3 can only be reduced by making the D dimension small. E represents dimension between R_3 & R_4.

$$\Sigma M = 0$$

$$P_3 \times D = E \times R_3$$

$$R_3 = P_3 \times D/E$$

R_4 has to equal R_3 since forces in a horizontal direction must add up to zero. As can be seen, if P_3 was applied at point C, R_3 and R_4 would become zero and the tip would come off; but since there are two keys, the same kind of jamming occurs in a plane **90°** from the one discussed. So with the two keys, the tip would come off due to P_3 only if applied at a point C and applied equally on the top and the bottom keys. This is an almost impossible situation on a bucket.

The tip of the present invention with the open sides and the relatively thin sections is a high yield tip. Approximately 86 percent of the total tip weight can be worn away before the tip needs to be replaced. This is possible because of the unique utilization of the struc-

tural components as load carrying members. These straps are mainly in compression or tension.

The tip of the present invention can be made by forging, casting, or by extrusion.

It should also be noted that the tip can be reversed on a shank, providing either a runner or a digger tip (see the broken line position in FIG. 1).

It should be recognized that the keys at the rear of the tip could be arranged to project outwardly from the top and bottom walls instead of inwardly as shown in FIG. 1. This would change slightly the manner by which the loads are transferred into the adapter by the tip.

It would also be possible to have one key projecting outwardly and one key projecting inwardly.

FIGS. 5 and 6 show an embodiment of the present invention in which the open sided tip construction (illustrated and described above with reference to FIGS. 1–4) is embodied in a continuous cutting edge section for a bucket.

In FIG. 5 a bucket having a cutting edge incorporating this construction is indicated generally by the reference numeral 61.

The bucket 61 has an adapter 65 secured to the bottom of the bucket.

A plurality of cutting edge sections 67 are mounted on the adapter.

Each cutting edge section 67 incorporates the construction of the tip 14 illustrated and described in reference to FIGS. 1–4. That is, each cutting edge section 67 has an upper rearwardly extending strap and a lower rearwardly extending strap which define an open sided generally U-shaped opening for the reception of the nose of the adapter.

Each strap has a laterally extending and inwardly projecting key which is received in a corresponding keyway in the adapter 65.

The interior of the U-shaped opening in the cutting edge section 67 is spaced from the wedge shaped nose of the adapter 65 except at the rearward ends of the upper and lower straps as illustrated.

The two end cutting edge sections 67 have openings 69, and a retaining bolt 71 is positioned in the openings as illustrated in FIG. 6. As illustrated in FIGS. 5 and 6, just the outside edges of the outside cutting edge sections 67 have holes for the bolts 71. However, for commonality of parts, all of the sections 67 may have holes in them at each corner of each cutting edge section so that any section can be used at any location on the bucket and so that each individual section may be reversed.

A pin arrangement similar to that shown in FIG. 1 could be employed to secure the section 67 in place.

As illustrated in FIGS. 5 and 6, the cutting edge can be made in sections to reduce the weight and to facilitate installation on the bucket. Making the cutting edge in sections offers several additional advantages. One such additional advantage is obtaining greater wear life from the total cutting edge by switching worn sections with less worn sections. Another advantage of the multiple section cutting edge is the ability to assemble the shorter sections onto the adapter if the adapter should become bent or distorted.

Alternate sections of the cutting edge can also be made longer than the others to act as tips and/or a serrated edge. In this event, an odd number of sections, such as five or seven, would be used rather than the four as shown in FIG. 5.

For scraper applications the center sections can be longer to serve the purpose of a stinger bit.

In all cases the transfer of loads on the cutting edge sections to the adapter is accomplished through the interengaged keys and keyways in exactly the same manner as described above with reference to FIGS. 1–4.

While I have illustrated and described the preferred embodiments of my invention, it is to be understood that these are capable of variation and modification, and I therefore do not wish to be limited to the precise details set forth, but desire to avail myself of such changes and alterations as fall within the purview of the following claims.

I claim:

1. A replaceable ground engaging tip-adapter combination for mounting on the cutting edge of an excavating bucket, said adapter comprising a nose having upper and lower inclined surfaces extending rearwardly from a forward portion and providing a generally wedge shape, a recessed laterally extending keyway in the upper surface, and a recessed laterally extending keyway in the lower surface, and tip comprising, a wedge shaped body having a sharpened edge at the forward end of the wedge, a rearwardly extending strap at the top of the body, a rearwardly extending strap at the bottom of the body, said straps diverging from the body to form an open-sided, generally U-shaped opening receiving the nose, a key extending laterally of the top strap near the rear end of the strap and projecting normal to the strap and engaged in the keyway in the top surface, a key extending laterally of the lower strap and projecting normal to the strap and engaged in the keyway in the lower surface, said adapter nose and U-shaped opening defining a substantial clearance between the forward portion and the base of the U-shaped opening whereby the only contact between the nose and the body is at the extreme rearward ends of the top and bottom straps and the interengaged keys and keyways so that all loads which are applied to the body are transferred into the adapter by the keys.

2. A replaceable ground engaging tip-adapter combination as defined in claim 1 further including locking means comprises aligned openings in the nose and body and a locking pin extending therethrough.

3. A replaceable ground engaging tip-adapter combination as defined in claim 2 wherein the forward portion of the nose has an upper section and a lower section defining a space therebetween and a retention means disposed in the space in alignment with the nose opening and engaging the pin for locking the same in place.

4. The replaceable ground engaging tip-adapter combination of claim 3 wherein the retention means is a split washer.

5. A replaceable ground engaging tip-adapter combination as defined in claim 2 wherein the open sides of the body permit side mounting of the body on the nose, and the top and bottom straps are thin members loaded substantially only in tension-compression with little or no bending load, whereby the majority of the weight is located in the wedge shaped portion of the body.

6. A replaceable ground engaging tip-adapter combination as defined in claim 2 wherein frictional engagement of the keys and the keyways produces a self-locking body under steady state load conditions and including a locking means for preventing walking off of the body due to vibrations.

7. A replaceable ground engaging tip-adapter combination as defined in claim 2 wherein the sharpened edge is angled with respect to the body and the body can be reversed on the nose to provide a runner tip and a digger tip.

8. A replaceable ground engaging tip-adapter combination as defined in claim 2 further including a plurality of adapters mounted on said cutting edge and extending the width of the bracket and a plurality of said wedge shaped bodies mounted on the adapters in side by side relation to form a forwardly extending cutting edge.

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