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(71) Applicant and Inventor: TOPHAM, Peter, Douglas, Temple (GB/GB); Caldecote Manor Farm, Abbotsley, ST Neots, Cambs PE19 4XQ (GB).

(74) Agent: WILLIAMS, Trevor, John; J A Kemp & Co, 14 South Square, Gray's Inn, London WC1R 5LX (GB).


(54) Title: IMPROVEMENTS IN OR RELATING TO TILLAGE ELEMENTS

(57) Abstract

This invention relates to an improved tillage element for use in a cultivator such as a plough, harrow or the like, which comprises a flat central portion (21) and a plurality of spaced teeth (22) projecting from the periphery of said flat central portion, the spaced teeth (22) being inclined out of the plane of the central portion to project to the same side of said central portion. The improved tillage elements are particularly suitable for use in wet or sticky soil conditions in assisting breaking up of the soil, without causing long peeled slivers of soil.
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"IMPROVEMENTS IN OR RELATING TO TILLAGE ELEMENTS"

This invention relates to improved tillage elements and to agricultural machines, for example ploughs and harrows, embodying such tillage elements.

Farmers are currently faced with the prospect of a complete ban on straw and stubble burning. This represents a considerable problem for arable farmers since the volume of straw produced by grain crops is far more than is required for animal bedding purposes and like uses. Moreover, the cost of transporting straw in bulk for other uses is prohibitive, even if such uses could be found. Accordingly, there is a need to incorporate the straw into the ground from which it has grown.

Many proposals have been made for straw incorporation, including the use both of ploughs and harrows. The success of these proposals depends very much on the conditions prevailing when the straw is to be incorporated into the soil. Generally speaking, problems are much less acute on light soil. In my co-pending British Patent Application No 91 15307.2, I discuss the use in tillage apparatus of an inversion wheel disc having a substantially planar portion and an inclined flange portion extending from the periphery of the central portion, an abrupt transition being provided from the central portion to the flange portion. This inversion wheel I have found to work efficiently over the wide range of ground conditions. Conventional tilling discs are of a concave shape and I have found that my prior inversion wheel with a frustoconical peripheral flange provides far better penetration in all soil types and conditions than the conventional concave disc plough.

A prime benefit arises from the use of the inversion wheel as compared with a conventional concave disc in that it is only the rear part of the concave disc which moves the soil, this being sharply sideways in an uncontrolled fashion. The soil inversion wheel’s front
and rear flat portion move the soil sideways providing a predictable and progressive rolling motion whereby the whole of the width of the inversion wheel is operating as compared with only half of the span of a conventional concave disc. Thus, as compared with the conventional concave disc, the inversion wheel provides, with its flat centre portion, for good soil transfer with a rolling action to bury straw and other material at the surface of the soil being worked and the peripheral edge portion of the inversion wheel provides better penetration than the edge of the curved concave disc.

WO 83/04158 provides a plough disc having a plurality of teeth or lugs radiating therefrom. This is an adaptation of a conventional concave disc with the consequent inability to give good soil transfer as with the use of an inversion wheel. Surprisingly, the present invention still provides good soil transfer and turning, despite the inversion wheel frustoconical flange having been replaced by a series of separate spaced teeth.

The present invention provides a tillage element for use in a cultivator, such as a plough, harrow or the like, which comprises a substantially flat central portion and a plurality of spaced teeth projecting from the periphery of said flat central portion, the spaced teeth being inclined out of the plane of the central portion to project to the same side of said central portion. This tillage implement is an inversion wheel which, instead of having a simple frustoconical flange as referred to in my previously mentioned co-pending application, has spaced teeth projecting out of the plane of the central planar portion. This provides good penetration in all types of soil conditions with the toothed edge cutting into the soil creating a good driving action with a very good momentum. As compared with the previous inversion wheel referred to in my abovementioned British Patent Application, the toothed construction provides better
penetration and also provides soil pulverisation. Because of the soil pulverisation, the actual soil inversion action is provided by the substantially flat central portion of the tillage element as the soil moves across it during ploughing. With this construction, there is less tendency for soil slivers to peel off in wet conditions and the teeth themselves can be simply replaceable when worn. This construction can be used either as harrow discs, as a simple rotary plough or for ploughing in combination with a leg and landslide to obtain additional penetration. A scraper can be fitted as required. The use of this toothed soil inversion wheel would have far less tendency to create a pan than conventional ploughing methods.

In some embodiments the teeth may be made convex, preferably quite strongly convex, from the root to the tip. This gives an advantage of the soil peeling away quite easily from the convex surfaces as moving over them with a strong breaking action being provided by the very abrupt transition from the central planar portion to the convex teeth portion. With this construction, there is less tendency for soil slivers to be created in wet conditions, whilst in dry and wet conditions the construction has a shattering effect whilst inverting the soil. However, depending upon the soil condition, different embodiments may have teeth which are convex or concave or straight, from the root to the tip. The peripheral teeth can readily be replaceable when worn. Whilst the inversion wheel could be used for simple harrowing or disc-ploughing operations, preferably it is used in a plough with a leg having a point and a landslide for additional penetration. Preferably, when used in such wet conditions, especially with the additional penetration provided by a leg point and landslide, a scraper or rotational skimmer can be provided.

A further aspect of the invention provides a
machine comprising a plurality of tillage elements with
those tillage elements being according to one or both of
the first aspects of the invention.

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

Figure 1 compares a conventional disc with an
inversion wheel type disc tillage element with a convex
flange;

Figure 2 compares a conventional disc and the
inversion wheel type tillage element diagrammatically
illustrating their capabilities in operation;

Figure 3 is a plan view of a modified toothed
inversion wheel tillage element embodying the invention;

Figure 4 is a diagrammatic sectional view of the
tillage implement of Figure 3;

Figure 5 is a diagrammatic view similar to that
of Figure 3 but showing an alternative embodiment of
tillage element;

Figure 6 is a diagrammatic plan view of tilling
apparatus embodying the tillage element of Figure 3 for
use in a rotary plough;

Figure 7 is a view illustrating the manner in
which an inversion wheel type tillage element can be swung
between positions for left-hand and right-hand ploughing;

Figure 8 is a perspective view of use of the
tilling apparatus shown in Figure 7;

Figure 9 is a diagram to illustrate soil
movement during use of the tilling apparatus of Figure 8;

Figure 10 is a diagrammatic view showing how
tillage elements embodying the invention may be
incorporated for use as harrows;

Figure 11 is a diagrammatic illustration of how
a plurality of inversion wheel type tillage elements can
be arranged as tilling apparatus in a plough to provide a
series of side-by-side furrows;
Figure 12 is a diagrammatic sectional view illustrating a tillage element as used in the apparatus of Figure 8 but having a scraper mounted in relation thereto; and

Figure 13 is a view showing the incorporation of a secondary tillage element, indicated as a conventional concave disc, further to assist in inversion of soil during use of the inversion wheel plough.

Figure 1 illustrates, in side elevation, a conventional concave cultivating disc 10 as may be used in a conventional disc plough, harrow or other disc tilling apparatus and beside it a tillage element 20 which is in the form of a dish or inverter wheel comprising a generally flat planar central base portion 21 and a flanged portion 22 about the periphery of the base with an abrupt transition 23 being provided between the flange portion and the central planar portion. As shown, the angle of inclination of the flange portion 22 decreases progressively from its inner edge point of connection to the central planar base and its outer peripheral edge. Whilst the inclination of the inner edge of the flange may be between 70 and 90°, or less in some instances, it is preferably at least 80°. The peripheral edge of the flange should be preferably inclined at less than 60° to the plane of the central portion and is preferably more than 20°, perhaps in the range of 30 to 45°. This shape of the flange portion makes the tillage element particularly suitable for use in heavy sticky soils.

The flange 22 may itself be detachably secured to the central planar portion to enable its ready replacement when worn. The peripheral edge of the flange may be scalloped.

The tillage element 20, as can be seen in Figure 1, has a depth or width which can be half the width or less than the depth or width A of a conventional tilling disc. Whilst the smooth edge to the disc is illustrated
in this Figure, for some soil conditions, in the construction of the present invention, the flange is formed as a series of spaced teeth projecting from the periphery of the central disc portion. Generally, the teeth may be straight or convexly curved as illustrated in Figures 1, 2, 7 to 9 and 12 to 14. Also, apertures may be provided through the central portion to assist breaking of the soil.

Figure 2 illustrates the advantage of the additional width of cut which is obtainable with the inversion wheel tillage element 20 as compared with a conventional ploughing disc 10. Because of the improved efficiency, both the flange portion 22 cutting into the soil and better distribution of the soil across the tilling disc, a substantially wider cut 24 can be achieved with the tillage element 20 as compared with the narrow cut 25 obtained with the conventional tilling disc 10 under the same soil conditions. Typically, the maximum angle of operation of a conventional ploughing disc or disc harrow having a penetration similar to the tillage element used in the present invention is 35°, though in many cases they cannot operate as steeply as that. The tillage inversion wheel type element of the present invention can operate at very much greater angles, illustrated as 45 to 55° in Figure 2, although with a suitable construction, particularly for lighter soils, the angle could be as much as 70° although the more preferred range is 40 to 60°.

Figures 3 and 4 illustrate a tillage element, embodying the invention, suitable for use with heavy wet soils, in which instead of having the continuous flange 22, a series of teeth 22' are provided around the periphery of the central disc portion. These teeth also, as shown, have a sharp transition with the outer edge of the disc to which they are attached and may be considered as lying on an imaginary frustoconical surface. The teeth
as shown in Figure 3 have their side edges at right angles to the peripheral edge of the central portion although these side edges may be inclined to the peripheral edge portion circumference as shown in the teeth 22" in the alternative embodiment of Figure 5. The sides of the teeth need not be parallel, one with the other. In one embodiment, they may be mutually inclined and symmetric about a radius of the disc to provide the tilling element with a similar performance regardless of the direction of rotation. A wear strip 26 can be attached to the disc so as to extend adjacent the periphery of the central disc portion and at the roots of the teeth 22' in order to provide a renewable wear strip. The teeth themselves are preferably detachably secured to the central portion so that they can be replaced when worn. In an alternative construction, the disc itself may be replaceably detachably mounted to a backing support disc carried for rotation by the plough.

While preferably, as shown, the central disc is planar, it may be slightly convex or concave, although necessarily still having an abrupt transition from the central portion to the roots of the teeth.

While the teeth are illustrated in Figure 3 as being substantially equal in width to the gaps in between, it should be noted that the width of the teeth and the relative width of teeth and interdigital spacing can be varied depending upon the type of soil to be tilled. Thus, for lighter or drier soils, the gap between each pair of teeth should be smaller than when one is tilling heavy or wetter soils. A particularly useful arrangement for medium to lighter soils has been found to comprise a disc in which the teeth are approximately twice as wide as the gap therebetween, one particular embodiment having gaps of approximately 5 cm between teeth which are approximately 10 cm wide.

Figure 6 illustrates tilling apparatus in the
form of part of a plough in which the tilling element 20' with its base 21 and teeth 22' is rotatably mounted on a shaft 44 which is pivoted, at 30, to a frame comprising a landslide 15 and a point 18 which projects forwardly of the leading edge of the tilling element 20' where it penetrates the grounds.

As can be seen in Figure 7, the pivot 30 enables the tillage element 20 to be swung between alternative positions, allowing left- or right-hand ploughing. The construction of the tilling apparatus can possibly be better understood from the showing of Figure 8 where a frame comprising an upright portion 14 carries the point 18 and the rearwardly extending landslide 15. Preferably, a frame member, not shown, will extend across from the upper end of the frame member 14 and carry the support for the pivotal connection of the shaft 44. The support for the pivotal connection can, if desired, and as is preferred, be extended down to be secured to the landslide 15 in order to obtain greater rigidity. The frame comprising the members 14 and 15 preferably is pivotally secured to a plough beam so as to trail from that beam when the plough is in operation.

Figure 9 illustrates the manner of flow of earth when being inverted by use of the tillage element provided with the flange 22 with the direction of movement of the plough being shown in this Figure, as in the others, by an arrow marked DT. In this diagram, the soil level is shown as SL and soil can be shown as being moved initially by action of the flange 22 with the convex surface of the flange preventing removal of the soil, particularly when it is wet and sticky with the soil then being broken up and inverted as it changes direction and slides over the centre of the inversion wheel. Using a series of inversion wheels in a plough as diagrammatically illustrated in Figure 11, it can be seen how the soil lifted and leaving the inversion wheel is dropped into the
furrow which has been left by a preceding inversion wheel.

Figure 10 illustrates how the tillage element of the present invention may be used as a harrow. The upper part of Figure 10 shows flanged tillage elements being arranged in series on a shaft to provide a harrow which is particularly effective when dragged at an angle to the direction of movement. Also shown in this Figure is a diagrammatic illustration of a harrow provided with the toothed tillage elements. Although this harrow could be used at an angle, the tooth elements are particularly effective in penetrating and in breaking up the already turned heavy soil in the parallel formation shown. Whilst these different types of harrows could be used individually, it is also possible for them to be used in the format as illustrated in Figure 10 with one diagonally arranged flanged tilling element harrow being followed by the toothed tillage element harrow, so that soil is broken up and displaced by the initial harrow and then the turned earth is then further broken up by the toothed tillage elements of the second harrow portion.

Figure 11 illustrates how, with the inversion wheel type tilling elements used as a plough, the earth dug out inverted by the first tillage element leaves a furrow which is filled by the earth turned over by the second tillage element and so forth.

Figure 12 shows how the flanged tillage element 20 can have a rearward stub mounting portion which is mounted by a bearing 41 on a non-rotatable shaft 44 with a scraper 42 mounted on the end of the shaft 44 by a bolt 43 which extends through a hole at the centre of the tillage element. The scraper will remain stationary so as to ensure that any soil sticking to the tillage element will be broken away therefrom in use of the apparatus.

Figure 13 shows a further rotary tillage element 52, here shown as a conventional disc shape, mounted for rotation at the centre of the main tillage element 20 but
at an angle thereto. The further, smaller, tillage element serves to remove or invert an initial sliver of the soil surface to be buried by the main soil inversion action of the main tillage element 20. Both the main and the further tillage elements have their leading edges so positioned as to follow into soil initially opened by the point 18. The secondary element 52 instead of being in the form of a curved disc could also, as is preferred, be formed as an inversion wheel tillage element whether of the flanged type or toothed type embodying the invention. In a variation of this embodiment, instead of having the further tillage element as a rotary element, a fixed plough skimmer could be used, possibly shaped as half a small ploughshare, to move the initial surface sliver.

In general, the tillage element may be formed with the central portion and flanged or toothed portion being readily removable as a unit from a central hub for replacement purposes or, as indicated above, the teeth, the parts which are most subject to wear, may themselves be replaceably mounted on the central portion, with the central portion then possibly being more heavily built so that there is never any normal need to remove it from the central hub which supports it for rotation.
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C L A I M S

1. A tillage element for use in a cultivator, such as a plough, harrow or the like, which comprises a central disc portion (21) and a plurality of spaced teeth (22') projecting from the periphery of said central disc portion (21), the spaced teeth (22') being inclined away from the central disc portion (21) to project all to the same side of said central portion, characterised in that the central disc portion (21) is flat and there is a sharp transition (23) between the roots of the teeth (22') and the plane of the flat central portion (21).

2. A tillage element according to claim 1, wherein the teeth (22') are curved along their length to vary the angle of inclination to the plane of the central disc portion (21).

3. A tillage element according to claim 2, wherein the angle of inclination of the teeth (22') to the central disc portion (21) decreases from the inner edge to the outer peripheral tips of said teeth.

4. A tillage element according to claim 3, wherein the inner edge of the teeth intersects the plane of the central portion at an angle of between 70 and 90°, preferably at least 80°.

5. A tillage element according to claim 3 or 4, wherein at the periphery the teeth tips are at an angle of less than 60° to the plane of the central portion.

6. A tillage element according to claim 5, wherein the angle at the periphery is more than 20°.

7. A tillage element according to claim 6, wherein the angle is between 30 and 45°.

8. A tillage element according to any preceding claim, wherein the side edges of the teeth (22') are substantially at right-angles to the periphery of the central portion.

9. A tillage element according to any one of claims 1 to 7, wherein the side edges of the teeth (22'
are inclined in a direction circumferentially of said central portion.

10. A tillage element according to any one of claims 1 to 9, wherein the sides of the teeth are not parallel with each other.

11. A tillage element according to any preceding claim, wherein each tooth is symmetrical about a respective radius of the disc.

12. A tillage element according to any preceding claim, wherein the teeth (22') are detachably mounted to the central portion (21).

13. An agricultural machine, comprising a plurality of tillage elements as claimed in any preceding claim.

14. A machine according to claim 13, wherein a scraper (42) is mounted in relationship to the tilling element to assist removal of soil therefrom.

15. A machine according to claim 13, wherein the scraper (42) is mounted to the end of a shaft (44) mounting the disc through a central aperture through the tillage element.

16. A machine according to claim 13, wherein a secondary tillage element (52) is provided in association with the main tillage element (20), initially to move a surface portion of the soil before the full deflection of the soil by the main tillage element (22) in use of the machine.

17. A machine according to claim 16, wherein the secondary tillage element is itself a rotary element.

18. A machine according to claim 17, wherein the secondary tillage element has a shape similar to that of the primary tillage element.

19. A machine according to any one of claims 13 to 18, which is in the form of a plough with each tillage element (20) being associated with a point (18) arranged to penetrate the ground in front of the forwardmost edge.
of the teeth with the tillage element being rotatable with its plane of rotation inclined to the direction of movement of the plough.

20. A machine according to claim 19, when appendant to claim 16, wherein the secondary tillage element (52) also has a forwardmost edge following the point (18).

21. A plough according to claim 19 or 20, wherein the point (18) is provided on a frame which also carries a landslide (15) extending rearwardly of the tillage element.

22. A plough according to claim 21, wherein the tillage element is rotatable on a shaft (44) which is pivotally mounted to the frame for swinging movement to reverse its direction of inclination relative to the direction of movement of the plough to permit leftwards or rightwards turning of the soil.

23. A plough according to claim 21 or 22, which comprises a beam from which a plurality of said frames trail from pivotal connections.
AMENDED CLAIMS

[received by the International Bureau on 19 August 1993 (19.08.93);
original claims 1-23 replaced by amended claims 1-20 (3 pages)]

1. An agricultural machine comprising a plurality of tillage elements each of which comprises a central disc portion (21) and a plurality of spaced teeth (22') projecting from the periphery of said central disc portion (21), the spaced teeth (22') being inclined away from the central disc portion (21) to project all to the same side of said central portion, the central disc portion (21) being flat with a sharp transition (23) between the roots of the teeth (22') and the plane of the flat central portion (21), characterised in that a secondary tillage element (52) is provided in association with the main tillage element (20), initially to move a surface portion of the soil before the full deflection of the soil by the main tillage element (22) in use of the machine.

2. A machine according to claim 1, wherein the secondary tillage element is itself a rotary element.

3. A machine according to claim 2, wherein the secondary tillage element has a shape similar to that of the primary tillage element.

4. A machine according to claim 1, wherein the secondary tillage element comprises a fixed plough skimmer.

5. A machine according to claim 4, wherein the plough skimmer is shaped as half a small ploughshare.

6. A machine according to any preceding claims, wherein the teeth (22') of each tillage element are curved along their length to vary the angle of inclination to the plane of the central disc portion (21).

7. A machine according to claim 6, wherein the angle of inclination of the teeth (22') to the central disc portion (21) decreases from the inner edge to the outer peripheral tips of said teeth.
8. A machine according to claim 7, wherein the inner edge of the teeth intersects the plane of the central portion at an angle of between 70 and 90°, preferably at least 80°.

9. A machine according to claim 7 or 8, wherein at the periphery the teeth tips are at an angle of less than 60° to the plane of the central portion.

10. A machine according to claim 9, wherein the angle at the periphery is more than 20°, preferably between 30 and 45°.

11. A machine to any preceding claim, wherein the side edges of the teeth (22′) of each tillage element are substantially at right-angles to the periphery of the central portion.

12. A machine according to any one of claims 1 to 10, wherein the side edges of the teeth (22") of each tillage element are inclined in a direction circumferentially of said central portion.

13. A machine according to any one of claims 1 to 9, wherein the sides of the teeth of each tillage element are not parallel with each other.

14. A machine according to any preceding claim, wherein each tooth is symmetrical about a respective radius of the disc.

15. A machine according to any preceding claim, wherein the teeth (22′) of each tillage element are detachably mounted to the central portion (21).

16. A machine according to any preceding claim, which is in the form of a plough with each tillage element (20) being associated with a point (18) arranged to penetrate the ground in front of the forwardmost edge of the teeth with the tillage element being rotatable with its plane of rotation inclined to the direction of movement of the plough.

17. A machine according to claim 16, wherein the secondary tillage element (52) also has a forwardmost
edge following the point (18).

18. A plough according to claim 16 or 17, wherein the point (18) is provided on a frame which also carries a landslide (15) extending rearwardly of the tillage element.

19. A plough according to claim 18, wherein the tillage element is rotatable on a shaft (44) which is pivotally mounted to the frame for swinging movement to reverse its direction of inclination relative to the direction of movement of the plough to permit leftwards or rightwards turning of the soil.

20. A plough according to claim 18 or 19, which comprises a beam from which a plurality of said frames trail from pivotal connections.
**INTERNATIONAL SEARCH REPORT**

**I. CLASSIFICATION OF SUBJECT MATTER**

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.C1. 5 A01B15/16

**II. FIELDS SEARCHED**

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**III. DOCUMENTS CONSIDERED TO BE RELEVANT**

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**IV. CERTIFICATION**

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<td>09-07-1993</td>
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WALVOORT B.W.