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(54) IMPROVEMENTS IN OR RELATING TO AGRICULTURAL IMPLEMENTS

(71) We, C. VANDER LELY N.V., of 10, Weverskade, Maasland, The Netherlands, a Dutch Limited Liability Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

This invention relates to agricultural implements of the kind which comprise at least one working member arranged to be driven at different speeds by way of a gear wheel transmission.

In order to permit of bringing the driving speed of the working member(s) to a value suitable for different operative conditions, such as the kind of soil, the nature of the crop, the working rate or the substances to be spread, this driving speed should be variable in a simple manner without loss of time and, for example, without the need for replacing gear wheels.

According to the invention, there is provided an agricultural implement of the kind set forth, wherein two groups of gear wheels are provided, one group being mounted on a shaft and the other group being mounted on a further shaft, the construction and arrangement being such that a selected gear wheel of one group can be caused to drive the shaft upon which the other group is mounted *via* one gear wheel of that other group by slidable displacement of one of the shafts relative to at least one gear wheel of its group, at least one further gear wheel, and a housing of said transmission, and wherein said further gear wheel has internal splines which are arranged to co-operate with a set of external splines on the displaceable shaft, said internal splines having an axial length which is not less than the total axial length of the group of gear wheels that is mounted on the displaceable shaft.

In this way not only the speed of the working member can be readily changed,

but also the number of mechanical components involved in establishing different operative output speeds is minimized.

For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:-

Figure 1 is a plan view of an agricultural implement in accordance with the invention in the form of a soil cultivating implement or rotary harrow,

Figure 2 is a section, to an enlarged scale, taken on the line II-II in *Figure 1*,

Figure 3 is a plan view of a second implement in accordance with the invention,

Figure 4 is a section taken on the line IV-IV in *Figure 6*,

Figure 5 is a section taken on the line V-V in *Figure 6*,

Figure 6 is a plan view of a central region of the implement of *Figure 3* to an enlarged scale, and

Figure 7 is a view as seen in the direction of an arrow VII in *Figure 6*.

As one of the possibilities of application of the principle of this invention to many agricultural implements, *Figure 1* illustrates a soil cultivating implement in the form of a rotary harrow comprising a supporting hollow frame portion in the form of a gear box 1 that extends transverse, and usually substantially perpendicular, to the intended direction of operative travel A and that is arranged to be coupled with the three-point lifting device or hitch of a tractor or other operating vehicle by means of fastening points on a generally triangular coupling member or trestle 2. A crumbling roller 3 extends throughout the width of the implement behind the gear box 1, by means of which roller 3 the maximum depth of penetration of soil working or cultivating members of the machine into the soil can be

governed by upward or downward adjustment of the level of the supporting roller relative to the gear box 1. In this embodiment, the gear box 1 includes three pairs of gear wheels or pinions 4 which can be driven to rotate about parallel, upright rotary axes. The teeth of the successive gear wheels 4, formed in this embodiment as straight-toothed or spur-toothed gear wheels, are in mesh with one another so that the direction of rotation B (Figure 1) of each gear wheel 4 is opposite to that of the or each immediately neighbouring gear wheel 4.

In the direct proximity of a vertical plane of substantial symmetry of the implement that extends parallel to the direction A, there is disposed a gear wheel housing or gear box 6 arranged on the top of the gear box 1 and serving to drive the gear wheels 4 and hence the soil working members that are mounted at the lower ends of shafts 5 embodying their axes of rotation at different, selective, speeds whilst the input speed applied to an input shaft 31 of the gear wheel housing 6 remains the same.

As shown in the sectional view of Figure 2, the gear box 1 has a top plate 7 covering the whole width of the implement, the top plate 7 being provided with downwardly bent-over portions 8 along its front and rear edges, with respect to the direction A, said portions 8 having flanges 9. A bottom plate 10 of the gear box 1 is shaped in a symmetrically identical way and is fastened to the top plate 7 by bolts 11. Between the engaging flanges 9 of the top plate 7 and the bottom plate 10, a gasket strip 12 of flexible material is clamped both along the front edge and along the rear edge of the gear box 1. The row of six gear wheels 4 is located between the top plate 7 and the bottom plate 10 of the gear box 1, each gear wheel 4 comprising a hub having internal splines co-operating with matching external splines 13 on the outer surface of the upper end of each of the shafts 5. The external splines 13 extend axially around only the upper part of the outer circumference of each shaft 5. Only the portion of each shaft 5 having the splines 13 is located inside the gear box 1, whereas a further portion of each shaft 5 having approximately four times the length of the portion provided with the external splines 13 projects from the bottom of the gear box 1. For this purpose the bottom plate 10 is provided at regular intervals with bearing bushings 14 extending in a row that is transverse to the direction A, each bushing 14 having two spaced bearings 15 and 16 whose inner races engage the outer surface of the portion of the shaft 5 concerned, said portion projecting downwardly out of the gear box 1. The bearing bushings 14 are fixed in place at their upper ends by fitting those ends in rings 17 which are

secured by bolts 18 to the bottom plate 10. At their lower ends, the bearing bushings 14 are fastened to the gear box 1 by means of a supporting plate 19 that covers the whole width of the implement, said plate 19 being bent into the shape of a shallow flat-based V, as shown in the sectional view of Figure 2; near its free edges it is secured by bolts 11 to the flanges 9 of the gear box 1. At its centre, the supporting plate 19 has a row of holes through which the bodies of the bearing bushings 14 can be passed upwardly, the lower ends thereof having flanges which are secured by bolts 20 to the edges of the holes in the supporting plate 19.

That portion of each shaft 5 which projects from beneath the supporting plate 19 is also provided with axial splines by which, together with a nut, a support 21 is secured to each shaft 5, said support having arms extending from the shaft 5 in a substantially radial direction but being bent over downwardly at a distance therefrom. Each bent-over end of each support 21 constitutes a rotary bearing for a corresponding cultivating tool 22 of the soil working member concerned. In this embodiment, each tool 22 has three tines 23 which are freely rotatable together about the axis of the bent over end of the associated support 21.

The gear wheel housing or gear box 6 comprises upper and lower portions 24 and 25. The lower portion 25 is directly secured to the top of the gear box 1; it is open at the top and is there provided with an uninterrupted flange 26 supporting the upper portion 24 to which it is fastened by bolts 27. The upper portion 24 of the gear wheel housing or gear box 6 is closed on top but is partly open at the bottom so that an open internal communication is established between the portions 24 and 25. The portion 24 has, at the front with respect to the direction A, a bearing holder 28, in which two spaced bearings 29 and 30 are arranged, the inner races of which bearings support the input shaft 31. The shaft 31 is provided at the front with axial splines 32 projecting from the bearing holder 28 and intended to fit internal splines at one end of an auxiliary telescopic transmission shaft by which the implement can be operated from a tractor or other vehicle. Such transmission shafts are known *per se* and have universal joints at their opposite ends. At its rear end, the shaft 31 also has axial splines 33 that are located inside the gear wheel housing or gear box 6 and that serve to receive the hub of a bevel gear wheel or pinion 34.

The top of the upper portion 24 of the gear wheel housing 6 is formed by a wall 35 which joins the bearing holder 28 at the front and merges at the rear into a wall portion 36 which is inclined downwardly and rearwardly away from the top wall 35 at an

angle of about 60° to the horizontal and which joins at its lower end a flange that directly engages the flange 26 of the lower portion 25 (Figure 2).

5 The open bottom of the upper portion 24 has two circular holes, whose respective centre lines or axes 37 and 38 are both parallel to the axes of the shafts 5. The edges of the two holes hold bearings 39 and 10 40 respectively that are located one behind the other in the direction A. The bearing 39 receives a driving shaft 41 whose axis coincides with the axis 37. The driving shaft 41 projects by part of its length above the bearing 39 and is provided along said part 15 with external axial splines by which a bevel gear wheel or pinion 42 is connected to the shaft 41. The centre line or axis 37 perpendicularly intersects the centre line or axis of the input shaft 31. The bevel gear wheel or pinion 42 is directly in mesh with the bevel gear wheel or pinion 34 on the input shaft 31. The driving shaft 41 projects throughout about 60% of its overall length beneath the bearing 39 and is provided over part of said 25 length with axially extending external splines 43. Between the splines holding the bevel gear wheel 42 on the shaft 41 and the external splines 43, the shaft 41 has a plain outer surface engaging the inner race of the bearing 39. Beneath the splines 43, the shaft 41 has an end portion serving as a stub shaft having a plain outer surface. This stub shaft is supported in a bearing 44 in a bearing 30 holder 45 secured in the bottom wall of the lower portion 25 of the housing or gear box 6.

35 Three straight-toothed gear wheels 46, 47 and 48 are mounted in superposed relationship on the driving shaft 41 by means of the external splines 43. The central gear wheel 47 has a pitch circle exceeding that of the upper gear wheel 46, whereas the lower gear wheel 48 has a pitch circle exceeding that of the central gear wheel 47. The diameter of the pitch circle of the gear wheel 46 is 60% to 70% of that of the gear wheel 47 and the diameter of the pitch circle of the gear wheel 48 is 150% to 160% of that of the gear wheel 47. The axial thickness of the gear wheel 47, measured in the direction of the axis 37, is about 5/6th of the thickness of the gear wheel 46, whereas the thickness of the gear wheel 48 is about 2/3rds of the thickness of the gear wheel 46. The gear wheels 46 to 48 each have at the centre a hole bounded by inner axial splines matching the external splines 43 of the shaft 41. Between the gear wheels 46 and 47 and between the gear wheels 47 and 48 spacing rings or washers 49 fit around the splines 43.

65 The centre line or axis 38 that is located behind the centre line or axis 37 relative to the direction A, is embodied in a side-shaft 50 which is held at the top by the bearing 40

and otherwise in bearings 51 and 52 surrounding the lower part of the shaft 50. The bearing 51 is arranged in a bearing holder 53 which is secured in the top plate 7 of the gear box 1. The bearing 51 is located at a level which is just beneath that of the bearing 44 since the bearing holder 45 is located just above the top plate 7. The distance between the bearings 51 and 52 is about 15% to 20% of the overall length of the shaft 50. The bearing 52 is arranged in a bearing holder 54 supported from the bottom plate 10 and, moreover, from the rear part of the supporting plate 19. The bearing 52 is thus located at the level of the bottom plate 10. The overall length of the shaft 43 is about 60% of that of the shaft 50, the upper ends of said shafts being located approximately at the same level.

A top portion of the shaft 50, forming a stub shaft 55, is surrounded by an annular setting member 56, a bore of which intimately receives the stub shaft 55, the member 56 having on its outer surface uninterrupted flanges 57 and 58 that are spaced apart from one another in an axial direction. The setting member 56 is secured to the shaft 50 by a transverse pin 59 passing through said member and through the stub shaft 55. On one side of the upper portion 24 of the gear wheel housing or gear box 6, when viewed in the direction A, there is journaled a pivotal shaft 60 to which a lever 61, located outside the gear wheel housing or gear box 6, is rigidly secured and which holds an arm 62 located inside the gear wheel housing 6, said arm 62 having, at the end remote from the shaft 60, a setting member formed by a cam or roller 63 that is located inside the groove formed between the two annular flanges 57 and 58 of the setting member 56. The lever 61 is arranged to move along an arcuate locking plate 64 which is located outside the housing or box 6 and which has a plurality of notches, any chosen one of which notches can receive the lever 61. The lever 61 is resiliently retained in the selected notch. The resilient retaining mechanism is not illustrated but may be provided by fastening the whole locking plate 64 resiliently to the gear wheel housing or gear box 6 or by using a resilient construction for the lever 61.

The portion of the side-shaft 50 which is just beneath the setting member 56 and the bearing 40 is provided with three straight-toothed gear wheels 65, 66 and 67 arranged so that the gear wheel 65 is constantly in mesh with the gear wheel 46, the gear wheel 66 with the gear wheel 47 and the gear wheel 67 with the gear wheel 48. The diameter of the pitch circle of the gear wheel 67 is equal to that of the gear wheel 46, that of the gear wheel 66 is equal to that of the gear wheel 47 and that of the gear wheel 65 is equal to that

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of the gear wheel 48. The axial thicknesses of the gear wheels 46, 65 and 47, 66 and 48, 67, measured in a direction parallel to the centre line or axis 38, are substantially equal to one another. At their lower sides, and near the shaft 50, the gear wheels 65 and 66 have annular projections the lower surfaces of which are supported from the subjacent gear wheels 66 and 67 respectively. The gear wheel 67, which does not have such a projection is, supported at its bottom face by a circular rib 68 forming part of the bottom portion of the lower part 25 of the gear wheel housing 6. The assembly of the three gear wheels 65 to 67 is enclosed in the gear wheel housing 6 in the direction of the centre line or axis 38 between the rib 68 and a ring 69 located between the inner race of the bearing 40 and the top of the gear wheel 65.

The gear wheels 65 to 67 each have internal splines 70, 72 and 74 respectively arranged around the shaft 50. The splines 70, 72, 74 extend axially parallel to the centre line or axis 38. The splines 70 of the gear wheel 65 cover only part of the thickness of the gear wheel 65 so that a portion 71 of the central bore of the gear wheel 65 is plain and does not have splines. The bore of the gear wheel 65 receives the side-shaft 50 along the plain portion 71 with an ample amount of clearance. In a similar manner the gear wheel 66 has the internal splines 72 over only part of its thickness, whereas a further part of its thickness 73 is plain and does not have splines, the side-shaft 50 being located therein with an ample amount of clearance. The gear wheel 67 also has the internal splines 74 over only part of its thickness, a further part 75 of the bore through the gear wheel 67 being plain and the shaft 50 being received therein with ample clearance. The internal splines 70, 72 and 74 have identical shapes and the sizes of the bores along the plain parts or portions 71, 73 and 75 around the shaft 50 are the same and substantially correspond to the axial lengths of the internal splines 70, 72 and 74. The plain part 71 of the gear wheel 65 is located between the ring 69 and the internal splines 70, the plain portion 73 of the gear wheel 66 is located between the internal splines 70 of the gear wheel 65 and the internal splines 72 of the gear wheel 66 itself, whereas the plain portion 75 of the gear wheel 67 is located between the internal splines 72 of the gear wheel 66 and the internal splines 74 of the gear wheel 67 itself. The axial heights of the plain portions 71, 73 and 75 are substantially equal to one another.

The side-shaft 50 has external splines 76 whose teeth extend in an axial direction. The axial height (length) of the splines 76 of the side-shaft 50 is at the most equal to the

height of one of the plain portions 71, 73 or 75 of the gear wheels 65, 66 and 67 respectively. The axially extending external splines 76 are provided at such a location on the side-shaft 50 that they mesh with the internal splines 74 of the lowermost gear wheel 67 when the bottom face of the setting member 56 engages the top of the bearing 40.

The lower end of the side-shaft 50 is surrounded by a sleeve 77, which is journalled in the bearings 51 and 52, the outer circumference of the sleeve 77 being provided, between the bearings 51 and 52, with external teeth 78 which are constantly in mesh with the teeth of one of the centre pair of gear wheels 4 in the gear box 1. The sleeve 77 has internal splines 79 covering its entire height and being constantly in mesh with external straight splines 80 on the outer circumference of the side-shaft 50. The region of the outer surface of the shaft 50 carrying the splines 80 is spaced from the external splines 76 by a distance which is such that, when the splines 76 are located in the plain portion 71 of the gear wheel 65, the splines 80 are still in mesh with the top parts of the internal splines 79 of the sleeve 77. The axial height of the external splines 80 is approximately equal to the axial height of each of the plain portions 71, 73 and 75 of the gear wheels 65 to 67.

During operation, the implement is driven by the aforementioned auxiliary telescopic transmission shaft which is powered from the tractor or other vehicle and operatively connected with the splines 32 of the input shaft 31. The rotation of the shaft 31 is converted by the identical bevel gear wheels or pinions 34 and 42 into rotation of the driving shaft 41. Since the gear wheels 46, 47 and 48 are mounted on the external splines 43 of the shaft 41, these three gear wheels constantly revolve with the shaft 41 so that the three gear wheels 65, 66 and 67, which are constantly in mesh with the gear wheels 46, 47 and 48 respectively, are also constantly driven. However, in the position of the parts that is shown in Figure 2, one of the gear wheels (i.e. the gear wheel 67) is coupled with the side-shaft 50 because the external splines 76 of the side-shaft 50 engage the internal splines 74 of the gear wheel 67. The driving torque transferred by the gear wheels 48 and 67 to the side-shaft 50 is transmitted by the external splines 80 of the shaft 50, via the internal splines 79 of the sleeve 77, the external teeth 78 of the sleeve 77 and the teeth of one of the neighbouring gear wheels 4 to all of the other intermeshing gear wheels 4 and thus to the rotary shafts 5 and to the supports 21 of the six soil working members. Each of those members is therefore positively rotated whilst its tools will rotate about the

centre lines of the bent-over ends of the corresponding supports 21, this latter ground-driven rotation being caused by ground contact of the tines 23. It may be desirable to drive the soil working members at different speeds in different kinds of soil. On heavy soil a more intensive crumbling can be achieved by driving the members with a higher speed of rotation whereas, on light soil, a lower driving speed may be advantageous. In this case the lever 61 is moved downwards along the locking plate 64 so that the cam or roller 63 moves upwards, the resulting force exerted on the flange 57 of the setting member 56 moving the shaft 50 upwardly in an axial direction. In this case the external splines 76 are displaced out of the internal splines 74 of the gear wheel 67, the external splines 76 thus becoming engaged with the plain unsplined portion 75 of the gear wheel 67. This results in a free run ("neutral" condition), in which the soil working members and their tools 22 remain at rest whilst the input shaft 31 is driven. Upon a further downward movement of the lever 61 along the locking plate 64, the splines 76 will engage the internal splines 72 of the gear wheel 66 which is thus coupled to the shaft 50 for rotation therewith. In this condition, the driving torque is transferred via the driving shaft 41 and the gear wheel 47 to the gear wheel 66 so that, with the same driving speed of the input shaft 31, a different speed of rotation of the side-shaft 50 is obtained. The gear wheels 65 and 67 are then not connected with the side-shaft 50 and are driven by the gear wheels 46 and 48 respectively so as to rotate freely around the side-shaft 50. The contact surface between the splines rotating loosely around the side-shaft 50 is formed by the innermost boundary surfaces of the internal splines of the gear wheels concerned, which boundary surfaces intimately fit around the locally plain and smooth outer surface of the side-shaft 50. When the lever 61 is moved still further downwards, the external splines 76 arrive at the plain portion 73 of the gear wheel 66 which again results in a free run ("neutral" condition). A further displacement of the side-shaft 50 in an upward direction brings the external splines 76 into engagement with the internal splines 70 of the gear wheel 65 which then transmits the driving torque to the side-shaft 50, the gear wheels 66 and 67 rotating idly around the side-shaft 50. When the side-shaft 50 is shifted even further upwardly, the external splines 76 arrive at the plain portion 71 of the gear wheel 65 so that again a free run ("neutral" condition) results. In the latter position the external splines 80 still mesh with an upper region of the internal splines 79 of the sleeve 77.

The plain portions 71, 73 and 75 prevent

the external splines 76 from ever simultaneously engaging the internal splines of two different gear wheels 65, 66 or 66, 67. During the upward displacement of the side-shaft 50 by the lever 61, the engagement of the splines 76 with one of the internal splines of the gear wheels surrounding the side-shaft 50 can sometimes be facilitated, when the machine is lifted by the tractor or other operating vehicle, by manually turning one of the soil working members and its tools 22 through a few degrees so that the splines will mesh correctly with one another.

When the driving torque is transferred via the gear wheels 46 and 65, the side-shaft 50 of this embodiment will rotate with a speed amounting to about 0.64-times that of the shaft 41. If the gear wheels 47 and 66 transfer the torque, the rotary speeds of the shafts 41 and 50 are the same, whereas, during transfer of the torque by the gear wheels 48 and 67, the side-shaft 50 is driven in this embodiment with a rotary speed approximately equal to 1.57-times that of the shaft 41. If, with the rotary speeds of the shafts 31 and 41 remaining the same, the side-shaft 50 is driven more rapidly, the transferred torque is lower with the same power so that the gear wheels 47 and 66 and the gear wheels 48 and 67 may be axially thinner than are the superjacent gear wheels.

In the construction described, the number of components required for setting different speeds of the working members of the implement is minimized whilst, in contrast to an array of relatively slidable gear wheels, none of the teeth are exposed to a risk of damage during a gear change, which damage tends to become more serious in the course of operation, since the damaged teeth are moving continuously relative to co-operating initially undamaged teeth.

In the embodiment shown in Figure 2, the gear wheels 4 are driven by means of an intermediate gear wheel formed by the sleeve 77 with its external teeth 78, since the gear wheels 4 are comparatively large (diameter substantially 50 cms). If the machine has a larger number of smaller diameter gear wheels 81 (Figure 3), one of those smaller gear wheels 81 may be directly driven by the side-shaft. This is possible by shaping a gear wheel housing or gear box 82 in a form differing from that of the preceding embodiment. The gear wheels 81 each have a diameter of about 25 cms. and drive soil working members 83 (Figure 4) whose tines are rigidly secured to supports 84 in contrast to the preceding embodiment in which the ground driven tools 22 are used. Assuming the centre line of an input shaft 85 driven by the tractor or other operating vehicle to be located in the vertical plane of

substantial symmetry that extends parallel to the direction A, a line of connection between the axes of a driving shaft 86 and of a side-shaft 87 is at an acute angle to the direction A (Figure 6) in the embodiment shown in Figures 3 to 7, as viewed in plan. Contrary to the preceding embodiment, the side-shaft 87 is located obliquely in front of the driving shaft 86 with respect to the direction A. A lower portion 88 of the gear wheel housing or gear box 82, similar to the lower portion 25 in the preceding embodiment, is inclined to the front away from a region around the driving shaft 86, considered in the direction A. A lower portion of the side-shaft 87 directly carries the support 84 of one of the row of soil working members 83 without using an intermediate gear wheel as in the preceding embodiment.

In the embodiment of Figures 3 to 7, the driving shaft 86 (Figure 4) instead of the side-shaft 87 is axially displaceable by means of the arm 62, the cam or roller 63 being in co-operation with the setting member 56 (parts having essentially identical shapes and/or functions to those of the preceding embodiment are designated by the same reference numerals). The driving shaft 86 locally has external, axial splines 89 and 90 which are spaced from one another in an axial direction and comparable with the splines 76 and 80 of the first embodiment. The lower external splines 90 can come, by axial displacement of the driving shaft 86, into mesh with internal splines 91, 92 or 93 of gear wheels 94, 95 or 96 respectively in analogy with the co-operation of the external splines 76 with the internal splines 70, 72 and 74 of the gear wheels 65, 66 and 67 respectively of the first embodiment. In the construction shown in Figure 4, the axial displaceability of the shaft applies to the driving shaft 86 instead of the side-shaft 50 of Figure 2, since the side-shaft 87 directly drives the rotary soil working members 83. The gear wheels 95 and 96 do not have internal splines over plain portions 97 and 98 respectively of the heights of their bores. The lengths of said portions 97 and 98 correspond with those of the external splines 90 so that, as in the preceding embodiment, a free run of the driving shaft 86 ("neutral" condition) can be achieved whilst the splines 90 are prevented from simultaneously co-operating with two gear wheels. In this embodiment the gear wheel 94 has its internal splines 91 throughout its axial length.

In this embodiment, the hub of the bevel gear wheel 42 also has internal axial splines which co-operate with the external splines 89 of the driving shaft 96, the axial length of said hub being determined by the maximum distance over which the splines 90 have to be axially displaceable in order to couple the

shaft 86 with one of the gear wheels 94 to 96. For similar reasons the shaft 86 extends, in the position shown in Figure 4, over a predetermined distance beneath a lowermost bearing 99 in order to ensure that, in its uppermost position, in which it is coupled with the gear wheel 94, the shaft 86 is still held in the bearing 99. Near its top, the shaft 86 is journalled *via* the hub of the gear wheel 42 in two bearings 100 and 101 which are arranged side-by-side in an axial direction. The gear wheels or pinions 34 and 42 and the setting member 60, 62 are enclosed by an upper portion 102 of the gear wheel housing 82, which housing also supports the input shaft 85 and has a substantially cylindrical outer circumference whose bottom is bolted to the top of the lower portion 88 that is inclined to the direction A (see Figures 6 and 7).

The foremost part of said lower portion 88 encloses three gear wheels 103, 104 and 105 connected in superposed relationship to the side-shaft 87 and constantly being in direct mesh with the gear wheels 94, 95 and 96, respectively. The gear wheels 103 to 105 have internal splines fitting external splines 106 on part of the length of the side-shaft 87, said part corresponding to the total height of said three gear wheels 103 to 105. By means of a bearing 107, also capable of withstanding axial load, the shaft 87 is journalled in the top plate of the gear box 1 and again has, beneath said bearing 107, external splines 108 by means of which one of the gear wheels 81 is coupled to the side-shaft 87. The side-shaft 87 projects at the bottom of that gear wheel 81 beyond the bottom of the gear box 1 and is there provided with one of the supports 84.

Figures 6 and 7 illustrate the disposition of the lower portion 88 of the gear wheel housing or gear box 82 with respect to the direction A, the centre line or axis of the input shaft 85 being located in the vertical plane of substantial symmetry of the gear box 1 and implement that extends parallel to the direction A. In the embodiment shown in Figures 3 to 7, the gear wheels 94 and 95 are thinner and/or lighter than is the subjacent gear wheel 96 having regard to the torque to be transferred thereby, which also applies to the gear wheels with which the wheels 94, 95 and 96 are constantly in mesh. In this embodiment, it is preferred to construct the straight-toothed gear wheels 94, 95 and 96 with 24, 19 and 14 teeth respectively and the gear wheels 103, 104 and 105 with 17, 22 and 27 teeth respectively so that, with a rotary input speed of 540 rev./min., the side-shaft 87 is driven, at will, with a speed of 157,253 or 413 rev./min.

It will be obvious that the constructions described may be used not only in soil cultivating implements but also in different

kinds of agricultural implements which involve the need for adapting the speed of rotation of a working member to the prevailing conditions and the nature of, say, the crop, purely for example, such implements as rotary mowers, drum tedders, forage harvesters, loading wagons, organic manure and artificial fertilizer distributors.

WHAT WE CLAIM IS:-

1. An agricultural implement of the kind set forth, wherein two groups of gear wheels are provided, one group being mounted on a shaft and the other group being mounted on a further shaft, the construction and arrangement being such that a selected gear wheel of one group can be caused to drive the shaft upon which the other group is mounted *via* one gear wheel of that other group by slidable displacement of one of the shafts relative to at least one gear wheel of its group, at least one further gear wheel, and a housing of said transmission, and wherein said further gear wheel has internal splines which are arranged to co-operate with a set of external splines on the displaceable shaft, said internal splines having an axial length which is not less than the total axial length of the group of gear wheels that is mounted on the displaceable shaft.

2. An implement as claimed in claim 1, wherein the working member of the implement is arranged to be driven from a gear wheel whose teeth are in driven mesh with those of said further gear wheel.

3. An implement as claimed in claim 1 or 2, wherein the displaceable shaft is externally splined throughout only at least one part of its length for selective co-operation with internal splines of at least one of its group of gear wheels.

4. An implement as claimed in claim 3, wherein each gear wheel with which said displaceable shaft co-operates is provided with matching internal splines.

5. An implement as claimed in claim 4, wherein the group of gear wheels which is mounted on the displaceable shaft are arranged in side-by-side relationship with parts of their outer surfaces in successive contact with one another.

6. An implement as claimed in claim 4 or 5, wherein boundary surfaces of the internal splines of each gear wheel of the group which is mounted on the displaceable shaft intimately fit at least a part or parts of the outer surface of that shaft.

7. An implement as claimed in any one of claims 4 to 6, wherein the internal splines of each gear wheel extend axially of that gear wheel throughout only a part of the thickness thereof.

8. An implement as claimed in claim 7, wherein that plain portion of each gear wheel which does not have internal splines is

not less in axial length than the externally splined portion of said displaceable shaft.

9. An implement as claimed in any preceding claim, wherein each gear wheel that co-operates with the displaceable shaft is axially fixed in place relative to said housing.

10. An implement as claimed in claim 9, wherein each gear wheel is fixed axially in position relative to bearings accommodated in said housing.

11. An implement as claimed in any preceding claim, wherein the displaceable shaft is displaceable axially with respect to a frame of the implement.

12. An implement as claimed in any preceding claim, wherein said further gear wheel is provided with internal splines throughout substantially the whole of its axial length.

13. An implement as claimed in any preceding claim, wherein the group of gear wheels which is mounted on the displaceable shaft have pitch circles of different diameters.

14. An implement as claimed in claim 13, wherein said gear wheels are of different axial thicknesses.

15. An implement as claimed in claim 14, wherein those gear wheels of smaller axial thickness have smaller pitch circles than do the gear wheels of larger axial thickness.

16. An implement as claimed in claim 14, wherein those gear wheels of greater axial thickness have pitch circles of smaller diameter than do those gear wheels of smaller axial thickness.

17. An implement as claimed in any preceding claim, wherein the displaceable shaft is displaceable with the aid of parts defining an annular groove around said shaft.

18. An implement as claimed in claim 17, wherein said groove co-operates with a setting member which is displaceable in a direction substantially parallel to the axis of the co-operating shaft.

19. An implement as claimed in claim 18, wherein the setting member is afforded by a cam or roller.

20. An implement as claimed in claim 18 or 19, wherein the setting member is displaceable by a lever which can be disposed in any chosen one of a plurality of different positions.

21. An implement as claimed in claim 20, wherein the setting member is arranged to be retained in any chosen position by resilient means.

22. An implement as claimed in claim 2 or in any one of claims 3 to 21 when read as appendant to claim 2, wherein said gear wheel has its teeth in driving mesh with those of additional gear wheels that corres-

pond to other working members of the implement.

23. An implement as claimed in any preceding claim, wherein the further gear wheel has straight or spur teeth.

24. An implement as claimed in any one of claims 1 to 22, wherein said further gear wheel is a bevel pinion.

25. An implement as claimed in claim 24, wherein the displaceable shaft is arranged to be driven by the bevel pinion.

26. An implement as claimed in claim 24 or 25, wherein the bevel pinion is supported axially from a rotary input shaft of the implement.

27. An implement as claimed in any one of claims 23 to 26, wherein the further gear wheel is supported in axial directions by rotary bearings.

28. An implement as claimed in any preceding claim, wherein the displaceable shaft is substantially vertically disposed.

29. An implement as claimed in any preceding claim, wherein only one of the group of gear wheels which is mounted on the displaceable shaft is positively driven during operation of the implement, the or each further gear wheel of the group being arranged to revolve idly around said shaft.

30. An implement as claimed in any one of claims 1 to 24, wherein the displaceable shaft is arranged to be driven directly from a rotary input shaft of the implement.

31. An implement as claimed in any one of claims 1 to 24, wherein the displaceable shaft is arranged to be driven through the intermediary of a side-shaft.

32. An implement as claimed in any preceding claim, wherein the group of gear wheels with which the displaceable shaft slidably co-operates comprises three gear wheels.

33. An implement as claimed in any preceding claim, wherein said two shafts are in parallel relationship and each group comprises straight- or spur-toothed gear wheels.

34. An implement as claimed in any preceding claim, wherein the gear wheels of one group are connected to the corresponding shaft so as always to be rotatable therewith.

35. An implement as claimed in any preceding claim, wherein one of said shafts is substantially axially fixed in position relative to the gear wheels that are mounted thereon.

36. An implement as claimed in any one of claims 17 to 21, wherein the displaceable shaft is arranged to be driven from a tractor or other operating vehicle.

37. An implement as claimed in any one of claims 1 to 27, wherein, when the implement is viewed in plan, a line interconnecting the longitudinal axes of said two

shafts is disposed in non-perpendicularly inclined relationship with the intended direction of operative travel of the implement.

38. An implement as claimed in claim 37, wherein, as seen in side elevation, the displaceable shaft is located to the rear of a shaft which drives said working member with respect to the intended direction of operative travel of the implement.

39. An implement as claimed in any preceding claim, wherein an output shaft of said gear wheel transmission directly supports said working member.

40. An implement as claimed in any one of claims 1 to 38, wherein an output shaft of said gear wheel transmission is arranged to drive said working member through the intermediary of further gear wheels.

41. An implement as claimed in any preceding claim, wherein a plurality of working members are arranged so as to be positively rotated about corresponding non-horizontal axes.

42. An implement as claimed in any preceding claim, wherein a plurality of working members are provided, said members being disposed in a row or other group that extends transverse to the intended direction of operative travel of the implement.

43. An implement as claimed in claim 32 or in any one of claims 33 to 42 when read as appendant to claim 32, wherein the or each working member can be driven at any chosen one of three different speeds in response to a substantially constant input drive speed that is applied to the implement during its operation.

44. An implement as claimed in any preceding claim, wherein said gear wheel transmission forms part of a change-speed box that is disposed between a rotary input shaft of the implement and a plurality of working members thereof that are rotatable about corresponding non-horizontal axes.

45. An implement as claimed in any preceding claim, wherein an output shaft of said transmission is provided with a support to which a plurality of tines are rigidly fastened.

46. An implement as claimed in any one of claims 1 to 44, wherein an output shaft of the transmission is provided with a support, and wherein at least one tined tool is provided that is arranged so as to be rotatable relative to said support.

47. An implement as claimed in any preceding claim, wherein at least the top of said housing of the transmission is inclined downwardly and rearwardly with respect to the intended direction of operative travel of the implement.

48. An agricultural implement of the kind set forth, substantially as hereinbefore

described with reference to either of the
embodiments that are illustrated in the
accompanying drawings.

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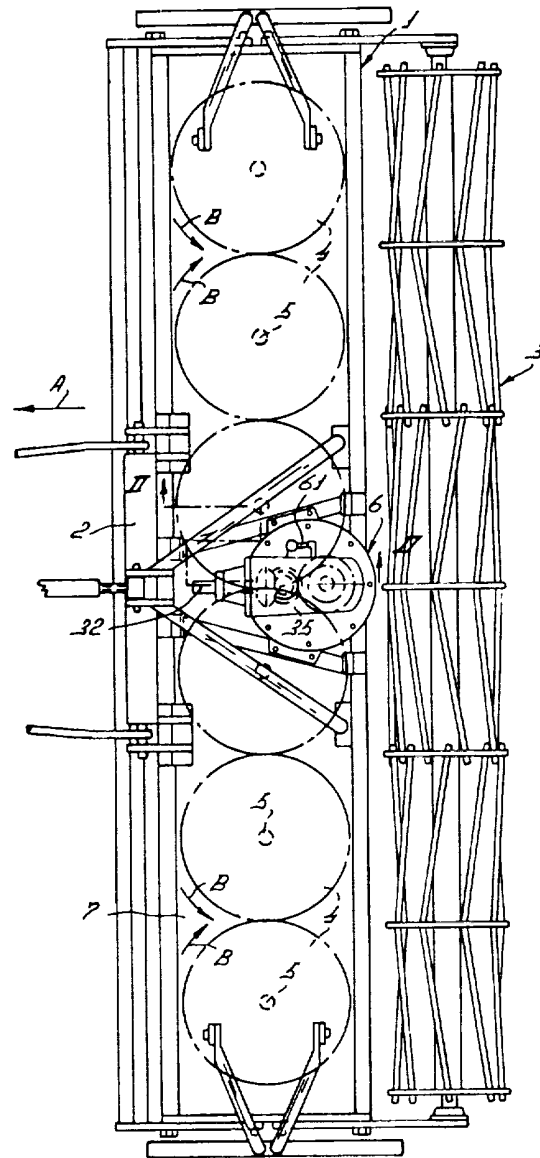
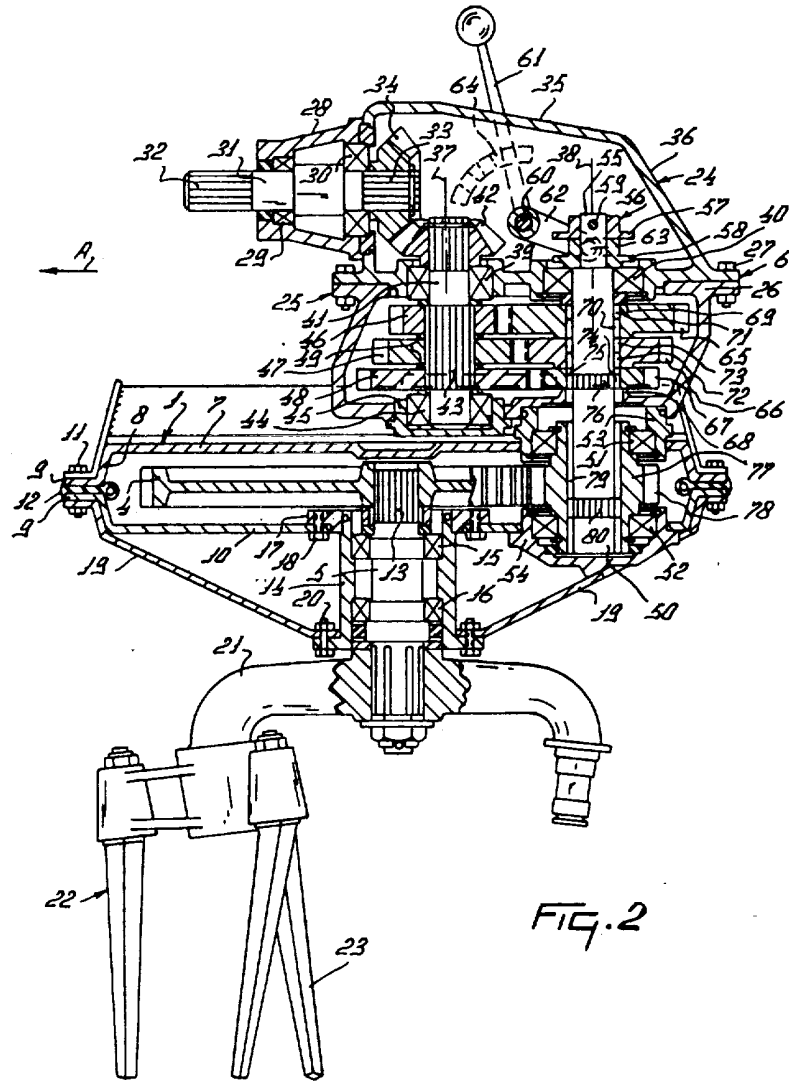


FIG. 1



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Sheet 3*

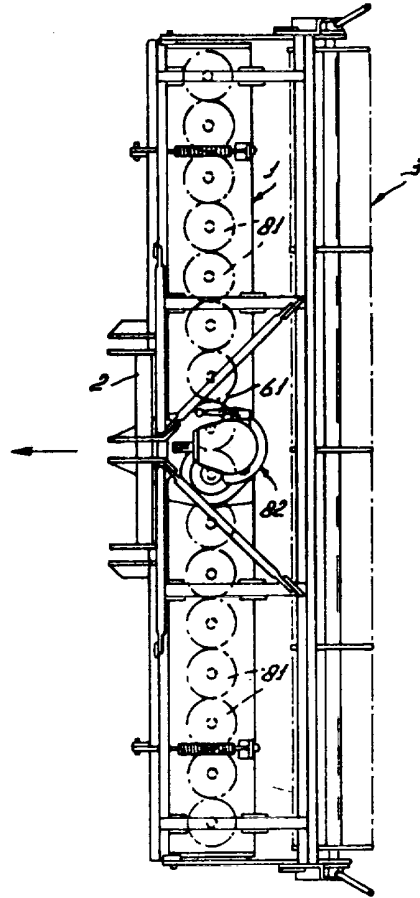


FIG. 3

