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CONTROL MECHANISM FOR PIVOTABLE DEVICE

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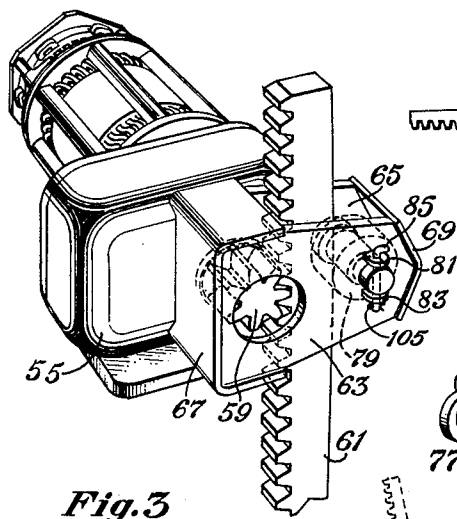


Fig. 3

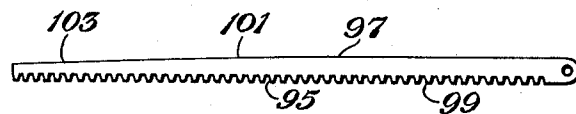


Fig. 6

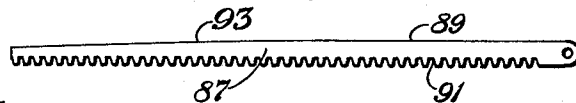


Fig. 5

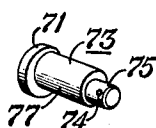


Fig. 4

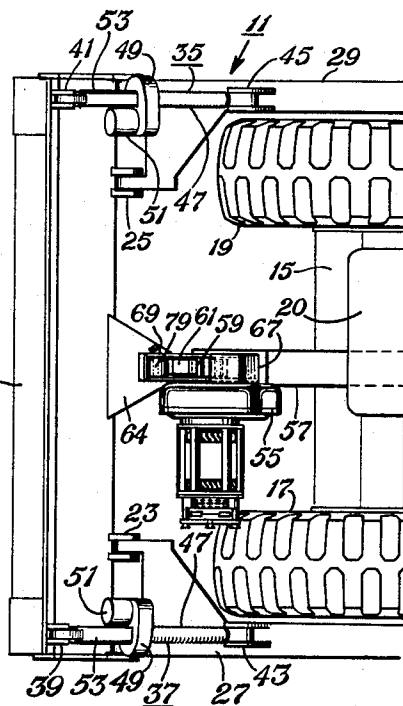


Fig. 1

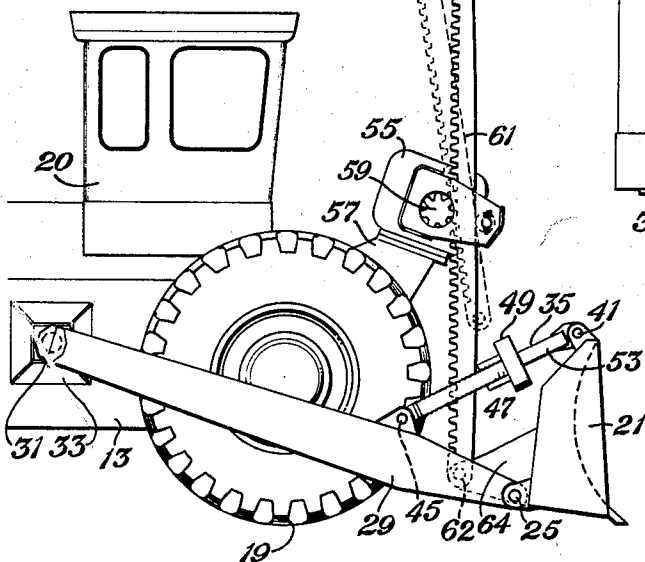


Fig. 2

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CONTROL MECHANISM FOR PIVOTABLE DEVICE

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My invention relates generally to improvements in control mechanisms and more particularly to a control mechanism for a pivotable device mounting a work tool and wherein a powered rack is employed.

Many structures which are disposed to pivot about axes may be conveniently moved and controlled by rack and pinion mechanisms. It is not unusual in earthworking machinery, for example, to provide a powered gear reduction having an output pinion in engagement with a length of rack which is connected to a pivotable dozer blade or an apron for a scraper bucket, or the like. The length of rack is straight; that is, the pitch line of the teeth is a straight line and the back of the rack is usually parallel to the pitch line. In order to use such racks it is necessary to provide a pair of backup rollers to bear against the back surface of the rack, opposite the teeth thereof. Moreover, such an arrangement requires that the rollers be mounted so as to allow some pivoting movement when the blade or other pivotable device is being moved. Such usual rack and roller arrangements are not entirely satisfactory, and it is recognized that new and useful improvements may be made therein.

In my co-pending application entitled "Control Arrangements and Mechanisms for Pivotable Devices," Serial No. 227,877, filed October 2, 1962, there is disclosed an improved arrangement for controlling pivotable devices, utilizing an arcuate pivoted rack and a single backup roller, which is a new and useful improvement over existing prior art devices. The device of the present invention embodies additional development of the single backup roller concept of said co-pending application.

The general object of the present invention is to provide control mechanism for a pivotable device mounting a work tool and wherein a powered rack is employed.

Another object of my invention is to provide for a pivotable device, a control mechanism utilizing an improved form of rack.

Another object of my invention is to provide, for a pivotable device wherein a powered rack having a straight tooth pitch line is employed a control mechanism that employs only a single fixed back-up roller.

Another object of my invention is to provide, for a pivotable device, a mechanism employing a rack having a straight tooth pitch line that is simpler and more economical than those heretofore available.

More particularly, in accordance with the present invention, there is provided a pivotable device which is disposed to rotate about an axis. A length of rack, having teeth arranged along a straight pitch line, is connected at one end to the pivotable device. In a preferred embodiment of the invention, the back surface of the rack is curved convexly with respect to the pitch line substantially in the form of a cosine curve segment. A powered gear reduction, having an output pinion engaging the rack, is fixedly mounted on support means above the pivot axis. A single back-up roller is fixedly mounted in radial alignment with the pinion, so that the roller is in continuous rollable engagement with the back surface of the rack.

In accordance with a modification of the invention, the back surface of the rack, for a portion of its length near the connected end, is substantially parallel to the plane of the pitch line. The other portion of the back surface curves convexly, substantially in the form of a cosine curve segment, with respect to the plane of the pitch line.

In accordance with a further modification of the inven-

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tion, the back surface of the rack is convex and includes a plurality of angularly intersecting planar surfaces. The surface nearest the connected end of the rack is substantially parallel to the plane of the pitch line and the included angle between adjacent pairs of planar surfaces is slightly less than the angle of a straight line.

For a further understanding of my invention and further objects, features, and advantages thereof, reference may now be had to the following description taken in conjunction with the accompanying drawing in which:

FIG. 1 is a schematic fragmentary plan view of the front end portion of an earthworking machine including a pivotable device control mechanism in accordance with a preferred embodiment of my invention;

FIG. 2 is a schematic fragmentary side elevational view of the front end portion of the machine of FIG. 1;

FIG. 3 is a schematic perspective view of the rack operating mechanism;

FIG. 4 is a schematic perspective view showing a detail of the mechanism;

FIG. 5 is a schematic profile view of a rack in accordance with a modification of my invention; and

FIG. 6 is a schematic profile view of a rack in accordance with another modification of my invention.

Referring now to the drawing, FIG. 1 illustrates, in plan view, the front end portion of an earthworking machine 11 including a main frame 13 (see FIG. 2) which is supported by an axle 15 and a pair of electric motor-driven wheels 17, 19. An operator's cab and control station 20 is located centrally between the wheels and is elevated above the axle 15. A pivotable device, which in the drawing is shown as a dozer blade 21, extends transversely in front of the machine 11. It is pivotally connected at its extremities, as at 23, 25, to the front ends of a pair of support arms 27, 29. Each arm, also, is pivotally connected, by a ball and socket arrangement 31, to a support structure 33 extending outwardly from each side of the main frame 13 a sufficient distance to provide operative clearance between the arms and the perspective wheels. There is provided, also, a pair of adjustable pivotable screw devices 35, 37 which are connected both to the upper edge of the blade, as at 39, 41 and to the top surface of the support arms 27, 29, as at 43, 45. Each screw device comprises a threaded cylinder or screw 47 which is received by a nut (not shown) operating in a nut case 49. The nut is rotated by a motor 51 and worm gear, whereby the screw 47 advances into or withdraws from a hollow sleeve 53.

An electric motor-driven gear reduction 55 is suitably fixed adjacent the upper end of a support structure 57, which is rigidly connected at its lower end near the midpoint of the axle 15. The gear reduction 55 is provided with an output pinion 59 which engages the teeth of a rack 61. The lower end of the rack 61 is provided with a hole to receive a pivot pin 62 which is supported in a rack support structure 64 projecting outwardly from the blade 21. The rack is disposed to continuously engage the teeth of the output pinion 59. Both the rack and pinion operate within a housing having a pair of side plates 63, 65, and a pair of end plates 67, 69. One end plate 67 is formed as a channel member which is rigidly connected to the gear reduction 55. The side plates 63, 65 are provided with a pair of axially aligned holes which are of different sizes. In the plate 65, the hole is of a size large enough to receive the larger cylindrical end portion of a cam shaft 73, while the hole in the plate 63 receives the smaller cylindrical end portion 75 of the cam shaft 73. The smaller cylindrical end portion is provided with a hole 74 therethrough. Between the cylindrical ends 71, 75 of the cam shaft 73, there is another cylinder 77 which is disposed eccentrically and which supports a single backup-roller 79. A pair of opposed ears 81, 83

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project outwardly from the side plate 63, and each is provided with a hole. The hole 74 may be aligned with the holes in the ears 81, 83 and a keeper pin 85 inserted there-through. The purpose of the cam 73 and the keeper pin 85 will be explained hereinafter.

In FIG. 2 there is illustrated a rack 61 in accordance with a preferred embodiment of my invention. This rack comprises an elongated bar having a rectangular cross section. It is provided along one edge with a plurality of teeth, the pitch line of which is straight. The back surface of the rack is a curved surface which is generally cosinusoidal in shape. The distance from the pitch line of the teeth to the back surface is greatest at the mid-length point and least at the upper end. At the lower end, the back surface emerges with the rack structure surrounding the pivot pin 62.

FIG. 5 illustrates a modified rack structure 87 wherein the back surface 89 of the right end portion (as viewed in FIG. 5) is planar and substantially parallel to the pitch line 91. The back surface 93 of the left end portion, however, curves convexly and generally cosinusoidally, from the planar portion, so that the distance from the pitch line 91 to the back surface 93 is least at the left end of the rack.

FIG. 6 illustrates another modified rack structure wherein the back surface includes a plurality of angularly intersecting planar surfaces 97, 101, 103. The surface 97 which is nearest the right end portion (as viewed in FIG. 6) is substantially parallel to the plane of the pitch line. The included angle between adjacent pairs of planar surfaces such as, for example, surfaces 97, 101 and 101, 103, is slightly less than the angle of a straight line. This may be expressed another way by saying that the distance from the pitch line 99 to the planar surfaces 103 at the extreme left end is least and the distance from the pitch line to the line of intersection of the surfaces 101, 103 is greater than the least distance, but less than the distance to the back surface 97.

Now, in order to describe the manner in which the control mechanism operates, reference is made to FIGS. 2 and 3. First, the keeper pin 85 is removed from the holes in the ears 81, 83 and the cam shaft 73 is rotated to obtain maximum clearance between the pinion and the surface of the single back-up roller. Thereafter, the upper end of the rack 61 is inserted upwards between the side plates 63, 65 so that the rack teeth face the pinion. The lower end of the rack is then connected by the pivot pin 62 to the support structure 64 and the teeth of the rack and pinion are made to engage. The cam shaft 73 is then rotated until the back-up roller 79 engages the back surface of the rack. While the rack and pinion are in such a position, the keeper pin 85 is inserted in the holes in the ears and in the hole 74. If desired, a cotter pin 105, or other suitable device, may be inserted in a hole in the end of the keeper pin for locking purposes.

It has been found practically desirable to locate the centers of the pinion 59, and the single back-up roller 79, along a line which is angled downward slightly from a horizontal line through the center of the pinion. The pinion and roller should be disposed, for practical reasons, also, within the arc described by the pivot pin 62, as the blade 21 and arms 27, 29 pivot about their respective ball and socket joints 31. It is recognized that, for any given pivotable device, the length of the arms 27, 29 and the location of the pivot pin 62 are generally fixed. With respect to the pivot axis, the pinion and roller arrangement may be variously located and disposed. An ideal location and disposition is one that allows the rack, as well as the arms and the blade, to move with the least frictional and flexural resistance. It may not be possible always to locate and dispose the pinion and roller in an ideal manner. It is recognized that practical considerations often-times control the arrangement which is finally selected as a compromise to the ideal arrangement. FIG. 2 illustrates an arrangement of a rack and pinion and back-up roller

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which, while not ideal, is a practical and effective compromise arrangement, in accordance with a preferred embodiment of my invention.

In a preferred embodiment of my invention, the back surface of the rack 61 is convexly curved in a substantially cosinusoidal manner with respect to the straight pitch line. This may be more readily comprehended by noting that as the rack moves upward (or downward) between the fixed pinion and back-up roller, it tilts backward or forward respectively. Now, the distance between the pinion and back-up roller is fixed because the back-up roller cannot pivot. Therefore, in order for the rack to be able to tilt backward (or forward), it is necessary to gradually reduce in some regular manner the distance between the back surface and the pitch line. A back surface having a cosinusoidal shape is one that will allow backward (or forward) tilting movement with a practical minimum of frictional and flexural resistance. FIG. 2 shows phantasmally the rack 61 with the cosinusoidal back in another upward and backward tilted position. The principles of my invention will be apparent to those skilled in the art from the explanation set forth herein and from FIG. 2.

Those skilled in the art will recognize that the maximum height, or amplitude, of the cosinusoidal back surface above a chordal plane of the surface connecting the extremities of the rack is quite small. The height or amplitude depends on the relative location of the pinion with respect to the pivot axis and the disposition of the back-up roller with respect to the pinion. It will be observed that, in situations where the pinion is located close to and within the arc described by the pivot pin 62 (see FIG. 2) and the pivot pin approaches closely the fixed location of the pinion, the back surface may be substantially parallel to the plane of the pitch line for some distance from the pivot pin 62. This distance depends, of course, upon the relative locations of the pivot axis and the pinion as noted before. The parallel planar portion merges with a cosinusoidal portion extending to the other extremity of the rack. Such a modified form of rack is illustrated in FIG. 5.

It has been mentioned hereinbefore that the height or amplitude of the cosinusoidal back surface is generally small. And so, as a practical matter, the modified form of FIG. 5 may be further modified by substituting for the one continuous cosinusoidal surface 93 of FIG. 5, a pair of angularly intersecting planar surfaces 101, 103 of FIG. 6. These surfaces are, in reality, chordal planar surfaces subtending portions of an arc such as the continuous arc 93. If desired, there may be several chordal surfaces such as 101, 103.

While the principles of my invention have been shown as applicable to a dozer blade, which is one form of pivotable device, it is apparent that my invention is applicable to other pivotable devices, such as adjustable angularly disposable blades of roadgraders, or the apron of an earth carrying bucket and the like. Such applicability is not necessarily restricted to earthworking machines.

While I have shown my invention in several forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof.

I claim:

1. In an earthworking machine having a main frame and an earth engaging structure pivotally mounted thereon, a movement control mechanism for said earth engaging structure which comprises: a powered gear reduction fixedly mounted on said frame above said earth engaging structure and having an output pinion; a rack having an arcuate convex back surface and teeth engaging said output pinion, which teeth are so arranged that the pitch lines of the faces thereof lie in a common plane; a single back-up roller journally mounted in a fixed position adjacent said pinion for rollable engagement with said back sur-

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face; and means for connecting one end of said rack to said earth engaging structure.

2. In an earthworking machine having a main frame and a structure pivotably mounted thereon for movement about an axis, a movement control mechanism for said structure which comprises: a powered gear reduction fixedly mounted on said frame above said structure and having an output pinion; a rack having output pinion-engaging teeth so arranged that the pitch lines of the faces thereof lie in a common plane, said rack having a back surface comprising a planar surface portion adjacent one end thereof that is substantially parallel to said common plane, and an arcuate convex surface portion merging with said parallel planar surface portion; a single back-up roller mounted in a fixed position with respect to said pinion for rollable engagement with said back surface; and means for connecting the said one end of said rack to said pivotable structure.

3. A control mechanism for a pivotable device mounted for movement about an axis, which comprises: a length of rack connected at one end to said pivotable device and having teeth so arranged that the pitch lines thereof lie in a common plane and having a convex back surface comprising a plurality of angularly intersecting planar surfaces; support means fixed relative to said rack; a powered gear reduction fixedly mounted on said support means and having an output pinion engaging said rack; and a single back-up roller journaledly mounted in a fixed position relative to said pinion for rollable engagement with the back surface of said rack.

4. A control mechanism for a pivotable device mounted for movement about an axis, which comprises: a length of rack connected at one end to said pivotable device and having teeth so arranged that the pitch lines thereof lie in a common plane and having a convex back surface comprising a plurality of angularly intersecting planar surfaces; support means fixed relative to said rack; a powered gear reduction fixedly mounted on said support means and having an output pinion engaging said rack; and fixed means for maintaining said rack in continuous engagement with said pinion.

5. In an earthworking machine having a main frame and a structure pivotably mounted thereon for movement about an axis, a movement control mechanism for said structure which comprises: a powered gear reduction fixedly mounted on said frame above said structure and having an output pinion; a length of rack connected at one end to said pivotable device and having teeth so arranged that the pitch lines thereof lie in a common plane, said rack having in the region of said connected end a planar back surface portion substantially parallel to said common plane and having in the region of the other end an arcuate convex back surface portion merging with said parallel planar portion; and fixed means for maintaining said rack in continuous engagement with said pinion.

6. In a machine having a main frame and a pivotable device mounted thereon for movement about an axis, a movement control mechanism for such pivotable device which comprises: a powered gear reduction fixedly mounted on said frame relative to said pivotable device and having an output pinion; a length of rack connected at one end to said pivotable device and having teeth so arranged that the pitch lines thereof lie in a common plane, said rack having a convex back surface comprising

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a plurality of angularly intersecting planar surfaces; and a single back-up roller mounted in a fixed position with respect to said pinion for continuous rollable engagement with said convex back surface.

7. In a machine having a main frame and a pivotable device mounted thereon for movement about an axis, a movement control mechanism for such pivotable device which comprises: a powered gear reduction fixedly mounted on said frame relative to said pivotable device and having an output pinion; a length of rack connected at one end to said pivotable device and having teeth so arranged that the pitch lines thereof lie in a common plane, said rack having a convex arcuate back surface; and a single back-up roller mounted in a fixed position with respect to said pinion for continuous rollable engagement with said convex back surface.

8. In a machine having a main frame and a pivotable device mounted thereon for movement about an axis, a movement control mechanism for such pivotable device which comprises: a powered gear reduction fixedly mounted on said frame relative to said pivotable device and having an output pinion; a length of rack connected at one end to said pivotable device and having teeth so arranged that the pitch lines thereof lie in a common plane, said rack having in the region of said connected end a planar back surface portion substantially parallel to said common plane, and having in the region of the other end a convex back surface substantially in the form of a cosinusoidal curve segment merging with said parallel planar portion, and a single back-up roller mounted in a fixed position with respect to said pinion for continuous rollable engagement with said back surface.

9. A control mechanism for a pivotable device mounted for movement about an axis, which comprises: a length of rack connected at one end to said pivotable device and having teeth so arranged that the pitch lines thereof lie in a common plane, said rack having in the region of said connected end a planar back surface portion substantially parallel to said common plane and having in the region of the other end an arcuate convex back surface portion merging with said parallel planar portion; support means fixed relative to said rack; a powered gear reduction fixedly mounted on said support means and having an output pinion engaging said rack; and a single back-up roller journaledly mounted in a fixed position relative to said pinion for rollable engagement with the back surface of said rack.

10. A control mechanism for a pivotable device mounted for movement about an axis, which comprises: a length of rack connected at one end to said pivotable device and having teeth so arranged that the pitch lines thereof lie in a common plane, said rack having a convex back surface substantially in the form of a cosinusoidal curve segment; support means fixed relative to said rack; a powered gear reduction fixedly mounted on said support means and having an output pinion engaging said rack; and a single back-up roller journaledly mounted in a fixed position relative to said pinion for rollable engagement with the back surface of said rack.

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