Aug. 27, 1963 D. E. WRIGHT 3,101,932

GRADING MACHINE HAVING ROTARY CUTTING DRUMS

Filed Jan. 16, 1962

Fig. 2

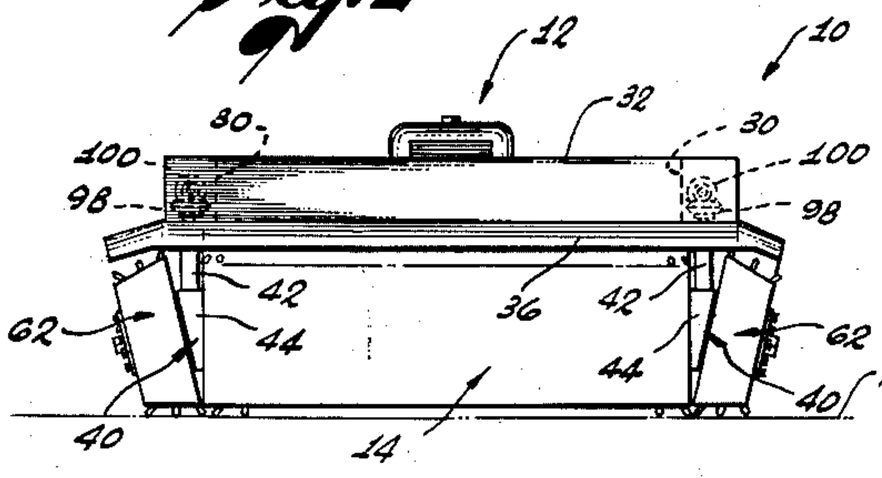
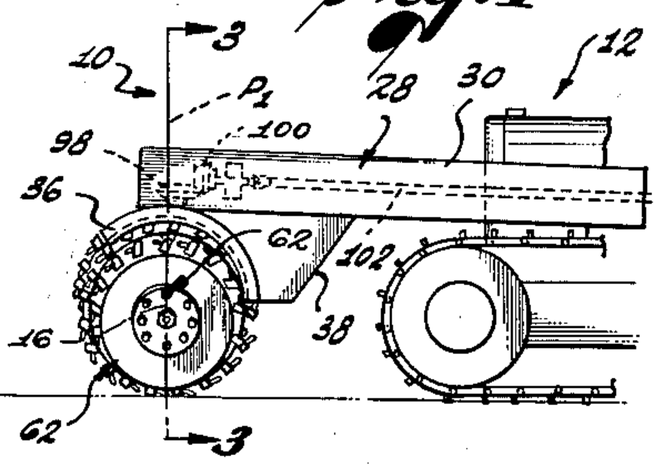


Fig. 1



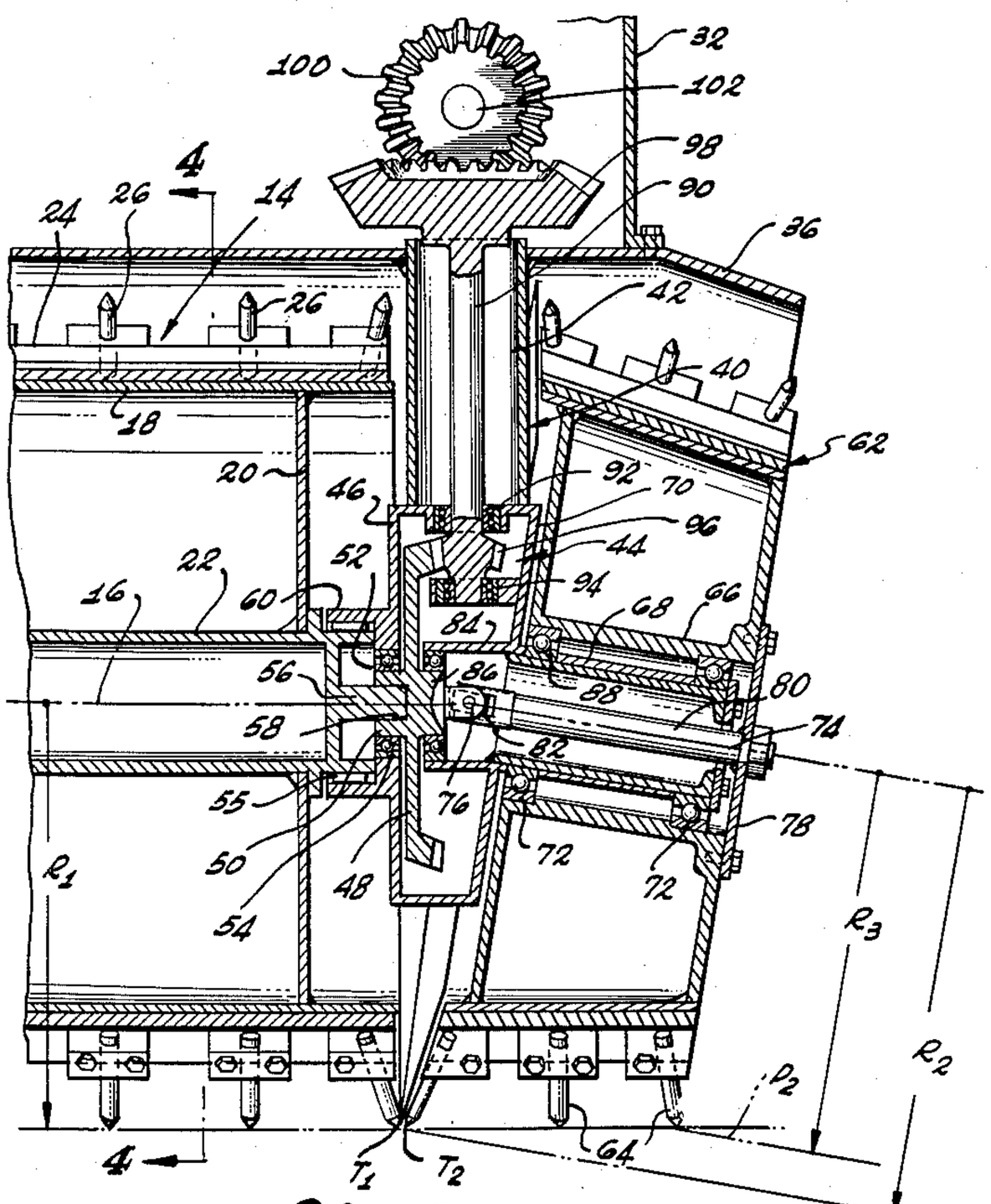


Fig. 3

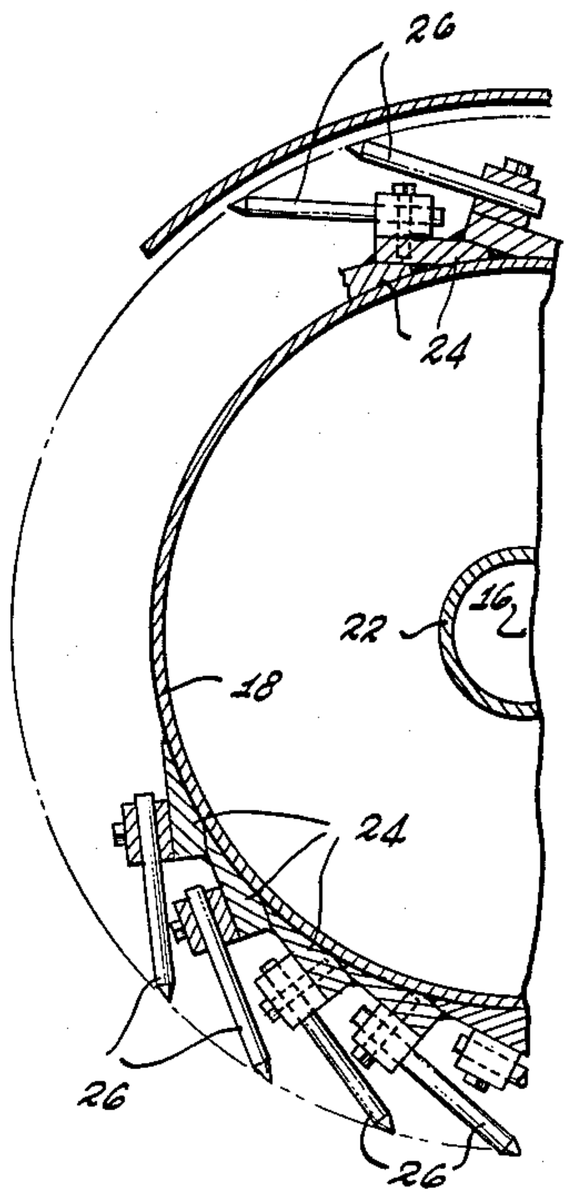


Fig. 4

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GRADING MACHINE HAVING ROTARY CUTTING DRUMS

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This invention relates generally to grading machines and, particularly, to improvements in grading machines of the type which utilize rotary grading or cutting drums.

Grading machines of the type with which this invention is concerned are used primarily for grading or leveling off ice fields to create aircraft runways, roads, building sites, storage areas, and so forth. The conventional grading machine for this purpose is equipped with a vehicle which may be self-propelled or towed over the ice field, a rotary, cylindrical cutting drum at the forward end of the vehicle, a frame on the vehicle for rotatably supporting the drum in a horizontal position out in front of the vehicle, and means for driving the drum in rotation. The drum carries spikes or other ice chipping or cutting means about its periphery which cut a path through the ice and its overlying blanket of snow wide enough to accommodate the following vehicle and plane the underlying ice surface.

The drum supporting frames on the existing grading machines of this character include supporting members which straddle and rotatably mount the ends of the cutting drum. These supporting members are located outboard of the ends of the drum and, therefore, limit the cutting depth of the drum. Thus, the cutting depth of the cutting drum on the existing grading machines is somewhat less than the cutting radius of the drum.

A general object of the present invention is to provide a grading machine of the character described embodying an improved cutting drum arrangement which is devoid of outboard drum supporting members and, therefore, capable of an appreciably greater maximum cutting depth than the rotary cutting drums on the existing grading machines.

A more specific object of the invention is to provide a grading machine of the character described in which the maximum cutting depth is substantially equal to the full cutting diameter of the cutting drums.

Other objects, advantages, and features of the invention will become readily apparent as the description proceeds.

Briefly, the objects of the invention are attained by providing a grading machine equipped with a vehicle, and a normally horizontal, rotary, cylindrical cutting drum at the forward end of the vehicle. A drum supporting frame is mounted on the vehicle and includes supporting members which straddle and rotatably mount the ends of the cylindrical drum. A pair of rotary, conical cutting drums are located at the ends of the cylindrical drum, respectively, outboard of the drum supporting members and are rotatably supported at their inner ends on these members. The drums are driven in rotation by drive means including rotary power transmission mechanisms which extend between the opposing ends of the conical drums and the cylindrical drum.

The conical drums are rotatably mounted on the drum supporting members in such a way that all three drums are approximately tangent to a common plane passing below the drums. The point of tangency of the cutting radius of the large end of each conical cutting drum with this plane is proximate to the point of tangency of the cutting radius of the adjacent end of the cylindrical drum with this plane. Accordingly, the three drums cut and

plane three parallel paths across the ice which are so closely contiguous as to form one single path.

Since this cutting drum arrangement is devoid of any drum support members outboard of the outer, conical cutting drums, the drums can cut to a depth approximating their full diameter. There are, of course, upwardly widening gaps between the ends of the center, cylindrical drum and the two outer, conical drums in which are located the rotary drive mechanisms for the drums. Because these gaps are relatively narrow and taper downwardly to a point and because of the action of the rotating drums, however, ice and snow entering the gaps quickly crumble and, therefore, offer no appreciable resistance to forward movement of the drums.

A presently preferred embodiment of the invention will now be described by reference to the attached drawing, wherein:

FIG. 1 is a side elevation of the forward end of the illustrated grading machine;

FIG. 2 is a front elevation of the grading machine;

FIG. 3 is an enlarged section taken along line 3—3 in FIG 1; and

FIG. 4 is a partial section taken along line 4—4 in FIG. 3.

The grading machine 10 illustrated in this drawing comprises a vehicle 12. This vehicle has been illustrated as being a self-propelled vehicle, namely a Caterpillar tractor. It will become evident as the description proceeds, however, that other types of self-propelled vehicles, or vehicles which must be drawn over the ice field by an independent vehicle, may be used in the machine. At the forward end of the vehicle 12 is a normally horizontal, rotary, cylindrical cutting drum 14. The central axis 16 of this drum is disposed in a plane P_1 normal to the longitudinal axis of the vehicle 12. While various types of cutting drums may be used on the machine, the cutting drum 14 has been illustrated as comprising a cylindrical shell 18 rigidly joined at its ends to circular end plates 20. Extending axially through the shell 18 and joined to the end plates 20 is a cylindrical axle 22. A multiplicity of inclined, circumferentially spaced bars 24 are joined to the cylindrical shell 18 and to the end plates 20. These bars and shell 18 extend a distance beyond the end plates, as shown. Spikes 26 are rigidly attached to the bars 24. The spikes 26 on each bar 24 are offset in the axial direction of the drum with respect to the spikes on the adjacent bars.

Carried on the vehicle 12 is a drum supporting frame 28. Frame 28 comprises two arms 30 at the sides of the vehicle 12, the rear ends (not shown) of which are hinged to the vehicle in the well-known way to permit vertical swinging movement of the frame 28. The forward ends of the arms 30 are bridged and rigidly joined by a cross member 32 which is bolted or otherwise rigidly secured to a cylindrically curved shield 36 concentric with and located over the cutting drum 14. Reinforcing plates 38 (only one shown) are placed, as shown, and welded to the arms 30 and the shield 36 to lend rigidity to the supporting frame structure.

Rigidly joined to the shield 36 are a pair of generally vertical supporting members 40 for the drum 14. Each supporting member 40 includes an upper sleeve 42 which extends through an opening in and is firmly welded to the shield 36. Each drum supporting member 40 terminates at its lower end in a generally disc-shaped gear housing 44 which is firmly welded to the lower end of the respective sleeve 42.

Each gear housing 44 is approximately centered on the central axis 16 of the drum 14 and has one side wall 46 facing the drum and disposed in a plane normal to its axis 16. Within each gear housing 44 is a drive gear 48

having a hub 50 which extends through an opening 52 in the respective gear housing side wall 46 and is rotatably supported therein, for turning on the drum axis 16, by means of a bearing 54. Each end of the drum axle 22 projects beyond the adjacent drum end plate 20 and is provided with an axial stub shaft 56 which slidably fits in and is keyed against rotation in an axial opening 58 in the adjacent drive gear 48. Bearings 54, therefore, serve the dual function of rotatably supporting the drive gears 48 on their respective gear housings 44 and rotatably supporting the ends of the cutting drum 14 for rotation of the latter on its central axis 16. Extending from each gear housing side wall 46 is a cylindrical flange 60 which is centered on the drum axis 16 and serves as a dirt seal for the adjacent bearing 54.

Located at the ends of the cylindrical cutting drum 14, respectively, outboard of the drum supporting members 40, are two conical, rotary cutting drums 62. These conical drums are constructed in substantially the same way as the cylindrical drum 14 and mount a multiplicity of inclined spikes 64 about their peripheries. Each conical drum 62 has a tubular hub 66 which receives a tubular axle 68 rigidly joined at one end to and extending from a second side wall 70 of the adjacent gear housing 44. Each conical drum 62 is rotatably supported on and restrained against axial movement along its respective gear housing axle 68 by bearings 72.

The large end of each conical drum 62 is disposed proximate to the adjacent drum support 40 and the central axis 74 of each conical drum and its respective axle 68 is disposed approximately in the aforementioned plane P_1 of the cylindrical drum axis 16 and slopes downwardly as the respective axis 74 approaches the outer, small diameter end of the respective conical drum 62. Each conical drum axis 74 intersects the cylindrical drum axis 16 at a point 76 within the adjacent gear housing 44. The second side wall 70 of each gear housing 44 is disposed in a plane normal to the axis 74 of its adjacent conical drum 62. Each gearing housing, therefore, has a generally tapered configuration in vertical section, as illustrated.

Bolted to the outer end of each conical drum 62 and extending over the outer end of the respective drum axle 68 is a plate 78. Extending axially through each axle 68 is a drive shaft 80, the outer end of which is fixed to the adjacent plate 78. The inner end of each drive shaft 80 extends into the adjacent gear housing 44. The inner end of each drive shaft 80 is drivably coupled to the adjacent drive gear 48 by means of a universal joint 82, the pivot axes of which intersect at the point of intersection 76 of the respective drum axes 16 and 74. About each universal joint is a supporting sleeve 84 which is welded to the adjacent gear housing side wall 70 and extends over a second hub 86 on the adjacent drive gear 48. The second hub of each drive gear is rotatably supported in the adjacent sleeve 84 by means of a bearing 88.

Extending axially through the upper sleeve 42 of each drum support 40 is a drive shaft 90. The lower end of each shaft 90 extends through an upper opening in the gear housing 44 of the respective drum support and is rotatably supported in the opening by means of a bearing 92. The lower end of each shaft 90 is rotatably supported within its respective gear housing 44 by means of a second bearing 94. Rigid on each shaft 90, between its respective bearings 92 and 94, is a pinion 96 which meshes with the adjacent drive gear 48.

Drive shafts 90 extend beyond the upper ends of the drive support sleeves 42 and rigidly mount at their upper ends bevel gears 98. Each bevel gear 98 meshes with a second bevel gear 100 which is rotatably supported on the drum supporting frame 28, as shown, and is driven in rotation, from an engine (not shown) on the vehicle 12, through suitable drive shaft means generally denoted by the numeral 102. From this description, it is evident

that the rotary cutting drums 14 and 62 are driven in rotation through the rotary power transmission mechanisms, comprising the gears 48, 98 and 100, which extend through the upwardly widening gaps between the outer, conical cutting drums 62 and the inner, cylindrical cutting drum 14.

The spikes 26 on the cylindrical cutting drum 14 are disposed at a uniform cutting radius R_1. The cutting radii of the spikes 64 on each conical cutting drum 62 range between a maximum cutting radius R_2 for the spikes at the inner, large end of each conical drum and a minimum cutting radius R_3 for the spikes at the outer, small end of each conical cutting drum. The maximum cutting radius R_2 of each conical drum is approximately the same as the cutting radius R_1 of the cylindrical drum. The axes 74 of the conical cutting drums 62 slope downwardly at such an angle that the cylindrical drum 14 and both conical drums 62 are tangent, along substantially their entire length, to a plane P_2 passing under the drums normal to the plane P_1. The spikes on the drums are so arranged that the point of tangency T_1 of the cutting radius R_1 of each end of the cylindrical drum 14 with the plane P_2 is proximate to the point of tangency T_2 of the cutting radii R_2 of the conical drums 62 with the plane P_2, as clearly shown in FIG. 3.

From this description, it is evident that when the cutting drums 14 and 62 are driven in rotation and moved forwardly over an ice field by the vehicle 12, the drums cut and plane three parallel paths in the ice, which paths are so closely contiguous as to form a single path wide enough to accommodate the following vehicle. Since the supporting frame 28 for the cutting drums is devoid of support members outboard of the conical cutting drums 62, the drums can cut a path through an ice field with an overlying blanket of snow to a depth approximately the full diameter of the drums. It is obvious that as the rotary cutting drums are moved forwardly into a bank of ice and snow, some of the ice and snow passes into the gaps between the two outer, conical drums and the center, cylindrical drum. Because these gaps are relatively narrow at their upper, widest end and taper to a point at their lower end and because of the action of the rotating drums against the ice and snow, the latter crumble as they enter the gaps and, therefore, offer no appreciable resistance to forward motion of the drums.

Clearly, then, the invention herein described and illustrated is fully capable of attaining the objects and advantages preliminarily set forth.

While a presently preferred embodiment of the invention has been described and illustrated, it is obvious that numerous modifications in the design, arrangement of parts, and instrumentalities of the invention are possible within the spirit and scope of the following claims.

What is claimed is:

1. A grading machine comprising:

a vehicle,

a normally horizontal, rotary, cylindrical cutting drum at the front end of said vehicle having its central axis in a plane approximately normal to a longitudinal axis of the vehicle,

a supporting frame on said vehicle including a pair of supporting members straddling the ends of said drum and means supporting the ends of said drum on said supporting members for rotation of the drum on its central axis,

a pair of rotary, conical cutting drums at the ends of said cylindrical drum, respectively, outboard of said supporting members, the large ends of said conical drums being located proximate to said supporting members and the central axes of said conical drums sloping downwardly as the axes approach the small, outer ends of said conical drums,

means rotatably supporting said conical drums on said supporting members for rotation of said conical drums on their central axes, the cutting radii of

said drums being approximately tangent along substantially the entire length of each drum to a plane passing below the drums normal to said first plane and the point of tangency of the cutting radius of the large end of each conical drum with said latter plane being proximate to the point of tangency of the cutting radius of the adjacent end of said cylindrical drum with said latter plane, and

means including a rotary power transmission mechanism extending between the large end of each conical drum and the adjacent end of the cylindrical drum for driving said drums in rotation.

2. A grading machine comprising:

a vehicle,

a normally horizontal, rotary, cylindrical cutting drum at the front end of said vehicle having its central axis in a plane approximately normal to a longitudinal axis of the vehicle,

a supporting frame on said vehicle including a pair of supporting members straddling the ends of said drum and means supporting the ends of said drum on said supporting members for rotation of the drum on its central axis,

a pair of rotary, conical cutting drums at the ends of said cylindrical drum, respectively, outboard of said supporting members, the large ends of said conical drums being located proximate to said supporting members and the central axes of said conical drums sloping downwardly as the axes approach the small, outer ends of said conical drums and being disposed in a plane approximately parallel to said first plane,

means rotatably supporting said conical drums on said supporting members for rotation of said conical drums on their central axes, the cutting radii of said drums being approximately tangent along substantially the entire length of each drum to a plane passing below the drums normal to said first plane and the point of tangency of the cutting radius of the large end of each conical drum with said latter plane being proximate to the point of tangency of the cutting radius of the adjacent end of said cylindrical drum with said later plane, and

means including a rotary power transmission mechanism extending between the large end of each conical drum and the adjacent end of the cylindrical drum for driving said drums in rotation.

3. A grading machine comprising:

a vehicle,

a normally horizontal, rotary, cylindrical cutting drum at the front end of said vehicle having its central axis in a plane approximately normal to a longitudinal axis of the vehicle,

a drum supporting frame on said vehicle including a pair of supporting members straddling the ends of said drum and means rotatably supporting the ends of said drum on said supporting members for rotation of the drum on its central axis,

a pair of rotary, conical cutting drums at the ends of said cylindrical drum, respectively, outboard of said supporting members, the large ends of said conical drums being located proximate to said supporting members and having approximately the same cutting radius as said cylindrical drum and the central axes of said conical drums sloping downwardly as the axes approach the small, outer ends of said conical drums and being disposed in planes approximately parallel to said first plane,

means rotatably supporting said conical drums on said supporting members for rotation of said conical drums on their central axes, the cutting radii of said drums being approximately tangent along substantially the entire length of each drum to a plane passing below the drums normal to said first plane and the point of tangency of the cutting radius of the large end of each conical drum with said latter plane being proximate to the point of tangency of the cutting radius of the adjacent end of said cylindrical drum with said latter plane, and

means including a rotary power transmission mechanism extending between the large end of each conical drum and the adjacent end of the cylindrical drum for driving said drums in rotation.

4. A grading machine comprising:

a vehicle,

a normally horizontal, rotary, cylindrical cutting drum at the front end of said vehicle having its central axis in a plane approximately normal to a longitudinal axis of the vehicle,

a drum supporting frame on said vehicle including a pair of supporting members straddling the ends of said drum and means rotatably supporting the ends of said drum on said supporting members for rotation of the drum on its central axis,

a pair of rotary, conical cutting drums at the ends of said cylindrical drum, respectively, outboard of said supporting members, the large ends of said conical drums being located proximate to said supporting members and having approximately the same cutting radius as said cylindrical drum and the central axes of said conical drums sloping downwardly as the axes approach the small, outer ends of said conical drums and being disposed approximately in said first plane,

means rotatably supporting said conical drums on said supporting members for rotation of said conical drums on their central axes, the cutting radii of said drums being approximately tangent along substantially the entire length of each drum to a plane passing below the drums normal to said first plane and the point of tangency of the cutting radius of the large end of each conical drum with said latter plane being proximate to the point of tangency of the cutting radius of the adjacent end of said cylindrical drum with said latter plane, and

means including a rotary power transmission mechanism extending between the large end of each conical drum and the adjacent end of the cylindrical drum for driving said drums in rotation.

5. A grading machine comprising:

a vehicle,

a normally horizontal, rotary, cylindrical cutting drum at the front end of said vehicle having its central axis in a first plane approximately normal to a longitudinal axis of the vehicle,

a drum supporting frame on said vehicle including a pair of hollow supporting members straddling the ends of said drum and means rotatably supporting the ends of said drum on said supporting members for rotation of the drum on its central axis,

a pair of rotary, conical cutting drums at the ends of said cylindrical drum, respectively, outboard of said supporting members, the large ends of said conical drums being proximate to said supporting members and having approximately the same cutting radius as said cylindrical drum and the central axes of said conical drums sloping downwardly as the axes approach the small, outer ends of said conical drums and being disposed approximately in said first plane,

means rotatably supporting said conical drums on said supporting members for rotation of said conical drums on their central axes, the cutting radii of said drums being approximately tangent along substantially the entire length of each drum to a plane passing below the drums normal to said first plane and the point of tangency of the cutting radius of the large end of each conical drum with said latter plane being proximate to the point of tangency of the cutting radius of the adjacent end of said cylindrical drum with said latter plane, and

means for driving said drums in rotation including a

gear rotatably mounted in each supporting member for turning on the central axis of one of the adjacent drums, means drivably connecting each gear and said one adjacent drum, means including a universal joint drivably connecting each gear and the other adjacent drum, a drive shaft rotatably supported in each supporting member and mounting a pinion meshing with the adjacent gear, said drive shafts extending beyond the peripheries of said drums, and means on said vehicle for driving said shafts in rotation.

6. A grading machine comprising:

a vehicle,

a normally horizontal, rotary, cylindrical cutting drum at the front end of said vehicle having its central axis in a first plane approximately normal to a longitudinal axis of the vehicle,

a drum supporting frame on said vehicle including a pair of hollow supporting members straddling the ends of said drum and means rotatably supporting the ends of said drum on said supporting members for rotation of the drum on its central axis,

a pair of rotary, conical cutting drums at the ends of said cylindrical drum, respectively, outboard of said supporting members, the large ends of said conical drums being located proximate to said supporting members and having approximately the same cutting radius as said cylindrical drum and the central axes of said conical drums sloping downwardly as the axes approach the small, outer ends of said conical drums and being disposed approximately in said first plane,

means rotatably supporting said conical drums on said supporting members for rotation of said conical drums on their central axes, the cutting radii of said drums being approximately tangent along substantially the entire length of each drum to a plane passing below the drums normal to said first plane and the point of tangency of the cutting radius of the large end of each conical drum with said latter plane being proximate to the point of tangency of the cutting radius of the adjacent end of said cylindrical drum with said latter plane, and

means for driving said drums in rotation including a gear rotatably mounted in each supporting member for turning on the central axis of said cylindrical drum, means slidably connecting each gear and said cylindrical drum, means including a universal joint drivably connecting each gear and the adjacent conical drum, a drive shaft rotatably supported in each supporting member and mounting a pinion meshing with the adjacent gear, said drive shaft extending beyond the peripheries of said drums, and means on said vehicle for driving said shafts in rotation.

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