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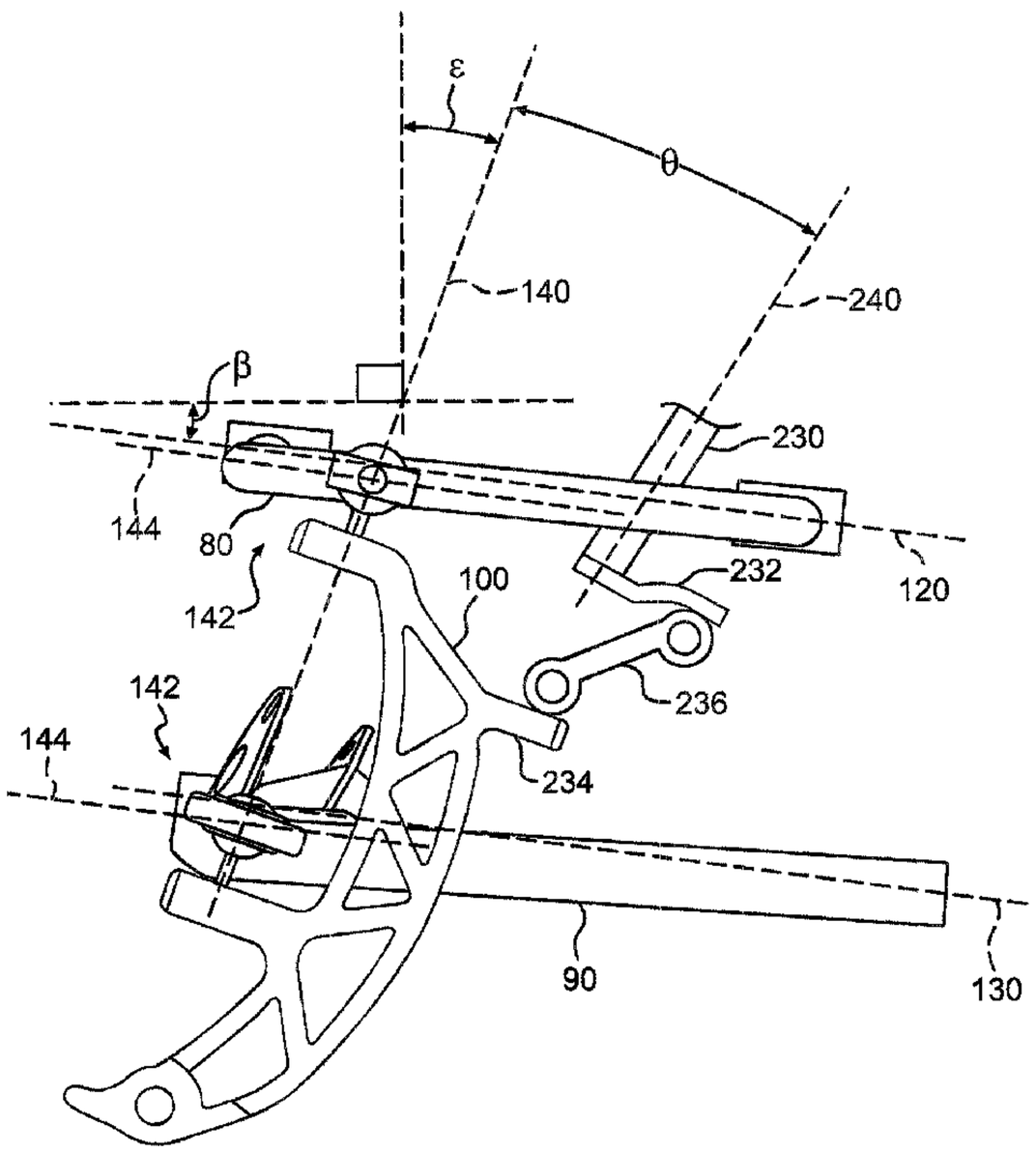

(57) Abrégé/Abstract:
A snowmobile has a double A-arm front suspension system that includes left and right pairs of A-arms that pivotally connect to the snowmobile's frame in an orientation that defines A-arm pivot axes. Steering skis pivotally mount to the outer ends of the A-arms for relative pivotal movement about steering ski pivot axes. A handlebar and steering column operatively connect to the steering skis and pivotally connect to the snowmobile's frame in an orientation that defines a steering column pivot axis. An angle formed between the steering ski pivot axes and the steering column pivot axis is preferably between about 12 and 16 degrees. As viewed from the side, an angle formed between the A-arm pivot axes and the steering column pivot axis is preferably between 68 and 74 degrees.

ABSTRACT

A snowmobile has a double A-arm front suspension system that includes left and right pairs of A-arms that pivotally connect to the snowmobile's frame in an orientation that defines A-arm pivot axes. Steering skis pivotally mount to the outer ends of the A-arms for relative pivotal movement about steering ski pivot axes. A handlebar and steering column operatively connect to the steering skis and pivotally connect to the snowmobile's frame in an orientation that defines a steering column pivot axis. An angle formed between the steering ski pivot axes and the steering column pivot axis is preferably between about 12 and 16 degrees. As viewed from the side, an angle formed between the A-arm pivot axes and the steering column pivot axis is preferably between 68 and 74 degrees.

SNOWMOBILE SUSPENSION GEOMETRY

[0001] This application claims the benefit of priority to U.S. Provisional Patent Application Serial Number 60/417,387, entitled "Snowmobile Suspension Geometry" which was filed on October 10, 2002.

BACKGROUND OF THE INVENTION

2. Field of the Invention

[0002] The present invention relates to the construction of vehicles such as snowmobiles. More specifically, the present invention concerns the construction of front suspension and steering systems for such vehicles.

3. Description of Related Art

[0003] FIG. 4 illustrates a conventional snowmobile 1000, in which a rider 1010 sits toward the rear of the snowmobile 1000. The snowmobile 1000 has a frame 1020 that supports an engine 1030. The engine 1030 is positioned forwardly on the snowmobile 1000 and is operatively connected to an endless drive track 1040 to drive the snowmobile 1000. Two steering skis 1050 are supported by the frame via a swing arm suspension system 1060. Each steering ski 1050 pivots relative to the swing arm suspension system 1060 about a generally vertically extending steering axis 1065. A handlebar 1070 is operatively connected to the steering skis 1050 via a steering column 1080. To comfortably position the handlebar 1070 relative to the rider 1010, the handlebar 1070 is positioned rearwardly of the forwardly disposed engine 1030. To operatively connect the forwardly disposed steering skis 1050 to the rearwardly disposed handlebar 1070, the steering column 1080 extends over a substantial horizontal distance such that an angle α defined between a pivotal axis 1085 of the steering column 1080 and the steering axis 1065 is relatively large.

[0004] The steering column 1080 and steering skis 1050 both include arms 1090, 1100 that are connected to each other via tie rods 1110 that enable the steering column 1080 to transfer steering forces to the steering skis 1050. Unfortunately, the large angle α causes the angular steering paths of the arms 1090, 1100 to differ significantly from each other as the rider 1010 steers the snowmobile 1000, which results in the inefficient transfer of steering force from the handlebar 1070 to the skis 1050. In particular, with the steering column 1080 disposed at the large angle α, the operator must exert a substantial amount of force on the handblebar 1070 in the vertical direction to effectuate steering of the snowmobile 1000.

[0005] It is commonly understood that from a force transfer point of view, the ideal positioning of a handlebar 1070 is vertically above the point on a snowmobile at which the steering arms 1090, 1100 are connected. "Vertical" refers to the condition where the pivot point of the steering handlebar 1070 is disposed along the steering axis 1065. When disposed in this manner, the steering column 1080 extends vertically from the connection point between the steering arms 1090, 1100 and the handlebar 1070. As a result, to turn the skis 1050, only horizontal force needs to be applied to the handlebar 1070. This is the best arrangement from a design standpoint because virtually all of the force exerted on the handlebar 1070 is applied to the skis 1050. One significant problem with such a design is that the handlebar 1070 would be positioned such that it would be awkward for a rider to steer the snowmobile 1000. As a result, the steering columns in snowmobiles in the prior art are disposed at a rearwardly-extending, non-vertical angle.

[0006] As would be appreciated by those skilled in the art, as the steering column 1080 is tilted farther from vertical (and the related angle α increases), a greater amount of vertical force must be applied by the rider 1010 to push or pull on the handlebar 1070 to effect steering. Taken to the extreme, if the steering column axis 1085 extends horizontally, only vertically-

applied forces would be needed to steer the snowmobile 1000.

[0007] The design of the snowmobile 1000 is such that the angle α, which is generally related to the angle the steering column axis 1085 forms with a vertical axis, is large enough that the operator must exert a substantial amount of vertical forces to steer the skis 1050. While this is acceptable, a smaller angle α is preferred. The design of the snowmobile 1000, however, does not permit a significant decrease in the angle α.

[0008] The swing arm front suspension system 1060 does not absorb forward impacts as well as conventional A-arm type front suspensions. Consequently, as the snowmobile 1000 traverses bumps during forward operation, the rider experiences relatively significant impact forces.

[0009] In all, there are several issues associated with the steering arrangement and suspension for snowmobiles for which a solution is not forthcoming from the prior art.

SUMMARY OF THE INVENTION

[0010] Accordingly, one aspect of embodiments of the present invention provides a snowmobile with an efficient steering assembly.

[0011] An additional aspect of embodiments of the present invention provides a snowmobile with an A-arm type front suspension system and an improved steering assembly.

[0012] A further aspect of embodiments of the present invention provides a vehicle that includes a frame, a straddle type seat supported by the frame, a suspension A-arm pivotally connected to the frame in an orientation that defines an A-arm pivot axis, a steered device operatively supported by the A-arm, and a steering column pivotally connected to the frame in an orientation that defines a steering column pivot axis. The steering column operatively connects to the steered device to steer the vehicle. An angle formed between the A-arm pivot

axis and the steering column pivot axis is between about 68 and 74 degrees.

[0013] The vehicle may be a snowmobile that includes a power plant operatively connected to an endless track to drive the snowmobile. The steered device may be a ski. The vehicle may include a ski leg that operatively connects to the ski and pivotally connects to the A-arm in an orientation that defines a ski leg pivot axis. An angle formed between the ski leg pivot axis and the steering column pivot axis may be between about 12 and 16 degrees.

[0014] The vehicle may include a second A-arm that operatively connects to the steered device and pivotally connects to the frame in an orientation that defines a second A-arm pivot axis.

[0015] Additional and/or alternative objects, features, and advantages of the present invention will become apparent from the following description, the accompanying drawings, and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] For a better understanding of the present invention as well as other objects and further features of embodiments thereof, reference is made to the following description which is to be used in conjunction with the accompanying drawings, where:

[0017] FIG. 1 is a side view of a snowmobile according to an embodiment of the present invention;

[0018] FIG. 2 is a partial side view of the front suspension and steering systems of the snowmobile of FIG. 1;

[0019] FIG. 3 is a partial side view of the handlebar adjustment mechanism of the snowmobile of FIG. 1; and

[0020] FIG. 4 is a side view of a conventional snowmobile.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0021] Before delving into the specific details of the present invention, it should be noted that the conventions "left," "right," "front," "rear," "longitudinal," "lateral," "upward," and "downward" are defined according to the normal, forward travel direction of the vehicle being discussed. As a result, the "left" side of a snowmobile is the same as the left side of the rider seated in a forward-facing position on the vehicle (or traveling in a forward direction on the vehicle). Furthermore, unless otherwise expressly stated, all dimensions, measurements, orientations, etc. are made when the vehicle is (a) resting on level ground, (b) full of all necessary fluids (fuel, oil, coolant, etc.), (c) and otherwise unloaded.

[0022] FIGS. 1-3 illustrate a snowmobile 10 according to an embodiment of the present invention. As shown in FIG. 1, the snowmobile 10 includes, among other elements, a frame 20, a drive system 25, two steering skis 60, a front suspension system 70, and a straddle-type seat 200.

[0023] The frame 20 includes a front engine supporting portion 22 and a rearward tunnel 24. The tunnel 24 is preferably made of sheet metal that is bent into an inverted U shape. The frame 20 may alternatively comprise a variety of alternative shapes and materials without departing from the scope of the present invention. For example, the frame 20 may comprise a tubular structure.

[0024] The drive system 25 comprises an engine 30 that operatively connects to an endless drive track 40 to drive the snowmobile 10. The engine 30 is supported by the front engine supporting portion 22 of the frame 20 and is disposed farther rearward on the snowmobile 10 than the engine 1030 on the conventional snowmobile 1000 (see FIG. 4). The endless drive track 40 is supported below the tunnel 24 via a rear suspension system 50 such as a

conventional slide rail suspension system.

[0025] The front suspension system 70 preferably comprises a double A-arm suspension system. Because the left and right sides of the snowmobile 10 are mirror images of each other, only the left side of the snowmobile 10 is described in detail. It is to be understood, however, that the description is equally applicable to the right side of the snowmobile 10.

[0026] The double A-arm suspension system 70 includes upper and lower A-arms 80, 90, a ski leg 100, and a shock absorber 110. The A-arms 80, 90 are not limited to "A" shapes. Rather, the term A-arm is intended to encompass any of a variety of shapes (e.g., U-shape, V-shape, irregular shape, triangular shape, etc.) without deviating from the scope of the present invention, as would be understood by those skilled in the art.

[0027] Laterally-inward ends of the A-arms 80, 90 are connected to the frame 20 for relative pivotal movement about generally parallel upper and lower A-arm pivot axes 120, 130. As shown in FIG. 2, the A-arm pivot axes 120, 130 angle downwardly slightly as they extend rearwardly such that an angle β is formed between the pivot axes 120, 130 and a horizontal plane. The angle β is preferably between 0 and 15 degrees, is more preferably between about 5 and 15 degrees, is even more preferably between about 8 and 12 degrees, and is even more preferably about 10 degrees. The downward angle β causes the outer ends of the A-arms 80, 90 to move rearwardly slightly as the suspension system 70 compresses during use. While the downward angle β is not required to practice the present invention, it is nonetheless preferred because it helps the front suspension 70 to absorb some of the longitudinal impact forces exerted on the snowmobile 10 during use. The A-arm axes 120, 130 preferably extend in a generally longitudinal direction such that they have little, if any, lateral component.

[0028] As shown in FIG. 2, the ski leg 100 connects to outer lateral ends of the A-arms 80, 90 at ball joints 142. In the illustrated embodiment, the ball joints 142 include ball ends

mounted to the ski leg 100 and associated eye ends mounted to the A-arms 80, 90. The relative positions of one or both sets of ball ends and eye ends may be switched without deviating from the scope of the present invention. The connection between the eye ends and ball ends of the ball joints 142 enable the ski leg 100 to pivot relative to the A-arms 80, 90 about (a) a ski leg pivot axis 140 and (b) outer suspension pivot axes 144 that are parallel to the A-arm pivot axes 120, 130. The ball joints 142 may be replaced by any other type of joint(s) that would enable the ski leg 100 to pivot relative to the A-arms 80, 90 about two axes. The ski leg pivot axis 140 extends slightly rearwardly as it extends upwardly such that an angle ε is formed between the ski leg pivot axis 140 and a vertical plane. The angle ε is preferably between 0 and 30 degrees, is more preferably between 15 and 25 degrees, and is even more preferably about 20 degrees.

[0029] The ski leg 100 operatively connects to the steering ski 60. The ski leg 100 (or steering leg) may alternatively be utilized in vehicles other than the snowmobile 10. For example, if the steering leg/ski leg were used on a wheeled vehicle, steering wheels could pivotally connect to the steering leg to facilitate vehicle steering.

[0030] The illustrated ski leg 100 functions as a unitary component that directly, pivotally connects to the A-arms 80, 90 and the ski leg 100. While the unitary construction is preferred, the unitary ski leg 100 may be replaced by a conventional two-piece steering spindle and sleeve without deviating from the scope of the present invention. In such an embodiment, the sleeve pivotally connects to the A-arms 80, 90 for relative pivotal movement about the axes 144. The spindle pivotally connects to the sleeve for relative pivotal movement about the axis 140.

[0031] The shock absorber 110 connects between the lower A-arm 90 and the frame 20 to bias the skis 60 downwardly relative to the frame 20 of the snowmobile 10. The shock absorber 110 may alternatively connect between the upper A-arm 80 and the frame 20 without

deviating from the scope of the present invention.

[0032] The straddle-type seat 200 mounts to the frame 20. A rider 210 sits on the seat 200 in a position that is farther forward than on the conventional snowmobile 1000 illustrated in FIG. 4. The forward positioning of rider 210 improves the comfort of the rider 30 and the maneuverability of the snowmobile 10. To accommodate this rider 210 positioning, the handlebar 220 is positioned farther forward on the snowmobile 10 than on the conventional snowmobile 1000.

[0033] The handlebar 220 operatively connects to the skis 60 via a steering column 230. The steering column 230 pivotally mounts to the frame 20 in an orientation that defines a steering column pivot axis 240. The steering column 230 is disposed in front of the engine 30 and may include an arch, a curve, or an irregular shape that gives the steering column 230 sufficient clearance in front of the engine 30. The steering column 230 and ski leg each include arms 232, 234 that operatively connect to each other via a tie rod 236. The tie rod 236 preferably pivotally connects to each of the arms 232, 234 via ball joints.

[0034] As shown in FIG. 2, as viewed from the side, the steering column pivot axis 240 forms an angle θ with the ski leg pivot axis 140. The angle θ is preferably between 5 and 20 degrees, and is more preferably between 12 and 16 degrees. Because the geometry of the front suspension system 70 may be designed such that the angle θ varies slightly as the front suspension system 70 compresses and expands, the angle θ is measured when the snowmobile 10 is in an unloaded position. The related paths of the arms 232, 234 helps the steering assembly efficiently transfer steering forces from the handlebar 220 to the steering ski 60 through the steering column 230, arms 232, 234, and tie rod 236.

[0035] As shown in FIG. 3, the handlebar 220 and steering column 230 are preferably connected to the frame 20 via a handlebar adjustment mechanism 250. The adjustment

mechanism 250 enables the handlebar 220 to selectively move in a forward/rearward direction to accommodate variously sized riders 210. The illustrated adjustment mechanism 250 includes upper and lower brackets 260, 270 mounted to the frame 20. The upper end of the steering column 220 is selectively movable forwardly and rearwardly within the upper bracket 260. The lower bracket 270 mounts to the frame 20 for relative pivotal movement about a laterally extending adjustment mechanism pivot axis. The steering column 220 pivotally mounts to the brackets 260, 270 to allow the steering column 220 to freely pivot about the steering column pivot axis 240 relative to the brackets 260, 270. A rearward position of the handlebar 220 is shown in solid lines while a forward position of the handlebar 220 is shown in dotted lines. The illustrated adjustment mechanism pivots the steering column 230 and handlebar 220 relative to the lower bracket 270 in order to longitudinally move the handlebar 220. This pivotal movement modifies the angle θ. The handlebar adjustment mechanism 250 preferably varies the angle θ by 4 to 10 degrees.

[0036] Various other types of handlebar adjustment mechanisms may alternatively be used without departing from the scope of the present invention. Furthermore, the adjustment mechanism 250 may alternatively be omitted altogether such that the steering column pivot axis 240 is permanently disposed at a fixed angle relative to the frame 20.

[0037] The foregoing illustrated embodiments are provided to illustrate the structural and functional principles of the present invention and are not intended to be limiting. To the contrary, the principles of the present invention are intended to encompass any and all changes, alterations and/or substitutions within the spirit and scope of the following claims. For example, while the illustrated embodiments are incorporated into a snowmobile 10, the present invention could alternatively be incorporated into other types of vehicles such as all-terrain vehicles.

What is claimed is:

1. A snowmobile comprising:

a frame including a tunnel;

an engine supported by the frame;

an endless track operatively connected to the engine propel the snowmobile;

a seat supported by the frame, the seat being constructed and arranged to be straddled by a rider;

a suspension A-arm pivotally connected to the frame in an orientation that defines an A-arm pivot axis;

a ski leg pivotally connected to the A-arm in an orientation that defines a ski leg pivot axis;

a ski operatively connected to the ski leg; and

a steering column pivotally connected to the frame in an orientation that defines a steering column pivot axis passing over the engine, the steering column being operatively connected to the ski to steer the snowmobile, wherein an angle formed between the ski leg pivot axis and the steering column pivot axis is between 12 and 16 degrees

2. The snowmobile of claim 1, wherein an angle formed between the A-arm pivot axis and the steering column pivot axis is between about 68 and 74 degrees.

3. The snowmobile of claim 2, wherein an angle formed between the ski leg pivot axis and a vertical plane is between 15 and 25 degrees.

4. The snowmobile of claim 1, wherein an angle formed between the A-arm pivot axis and a horizontal plane is between 5 and 15 degrees.

5. The snowmobile of claim 4, wherein the angle formed between the A-arm pivot axis and the horizontal plane is between 8 and 12 degrees.

6. The snowmobile of claim 1, further comprising a second A-arm that operatively connects to the ski leg and pivotally connects to the frame in an orientation that defines a second A-arm pivot axis.

7. The snowmobile of claim 6, wherein the A-arm and second A-arm are generally parallel to each other.

8. The snowmobile of claim 7, wherein an angle formed between the A-arm pivot axis and a horizontal plane is between 5 and 15 degrees.

9. The snowmobile of claim 8, wherein the angle formed between the A-arm pivot axis and the horizontal plane is between 8 and 12 degrees.

10. The snowmobile of claim 6, wherein the ski leg pivotally connects to the second A-arm in an orientation defined by the ski leg pivot axis.

11. The snowmobile of claim 10, wherein an angle formed between the ski leg pivot axis and a horizontal plane is between 65 and 75 degrees.

12. The snowmobile of claim 10, wherein an angle formed between the A-arm pivot axis and a horizontal plane is between 5 and 15 degrees.

13. The snowmobile of claim 10, wherein the connection between the ski leg and the A-arm comprises a ball joint, and the connection between the ski leg and the second A-arm comprises a ball-joint.

14. The snowmobile of claim 10, wherein the ski leg directly pivotally connects to the A-arm and second A-arm.

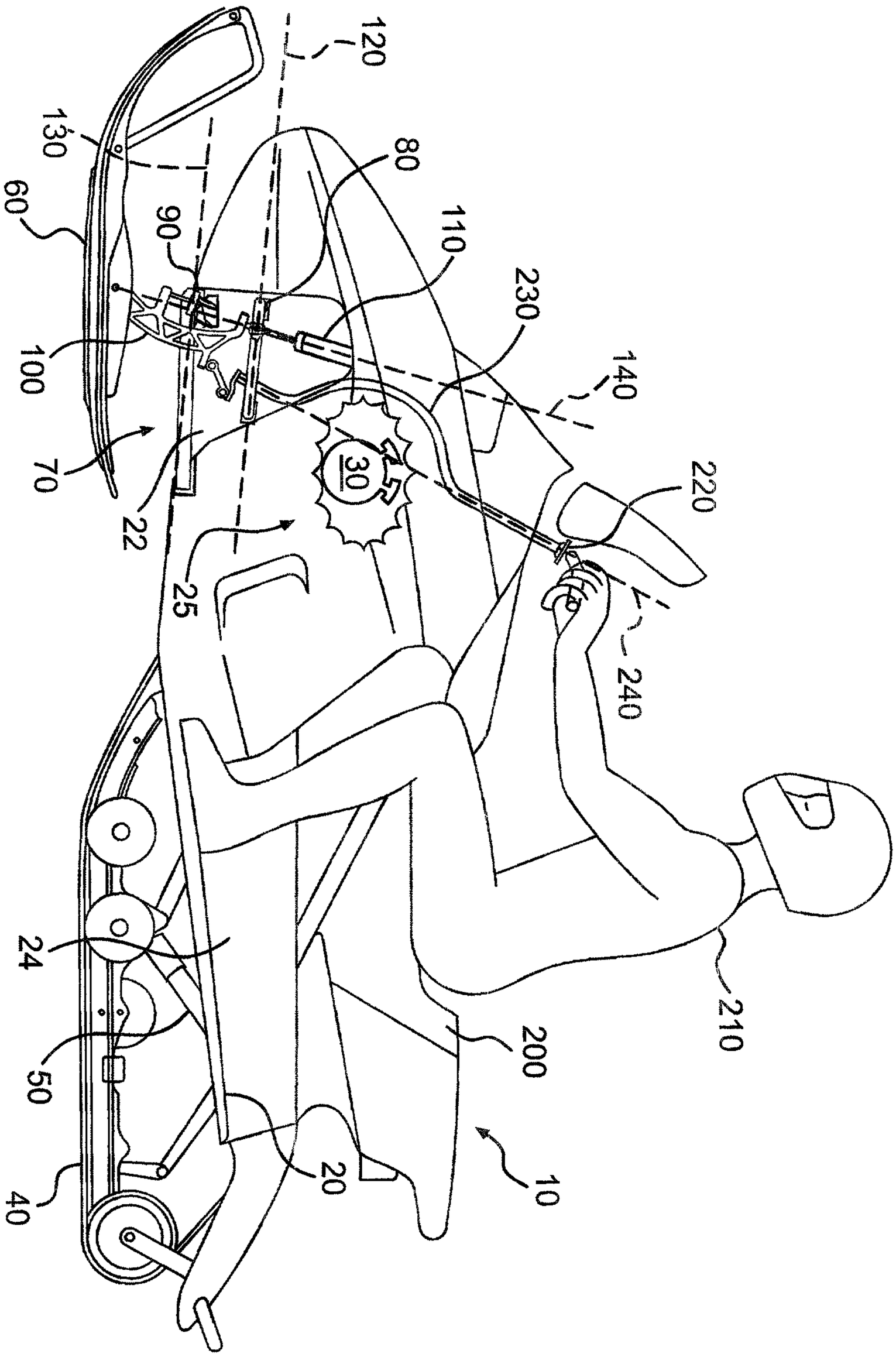
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FIG. 1

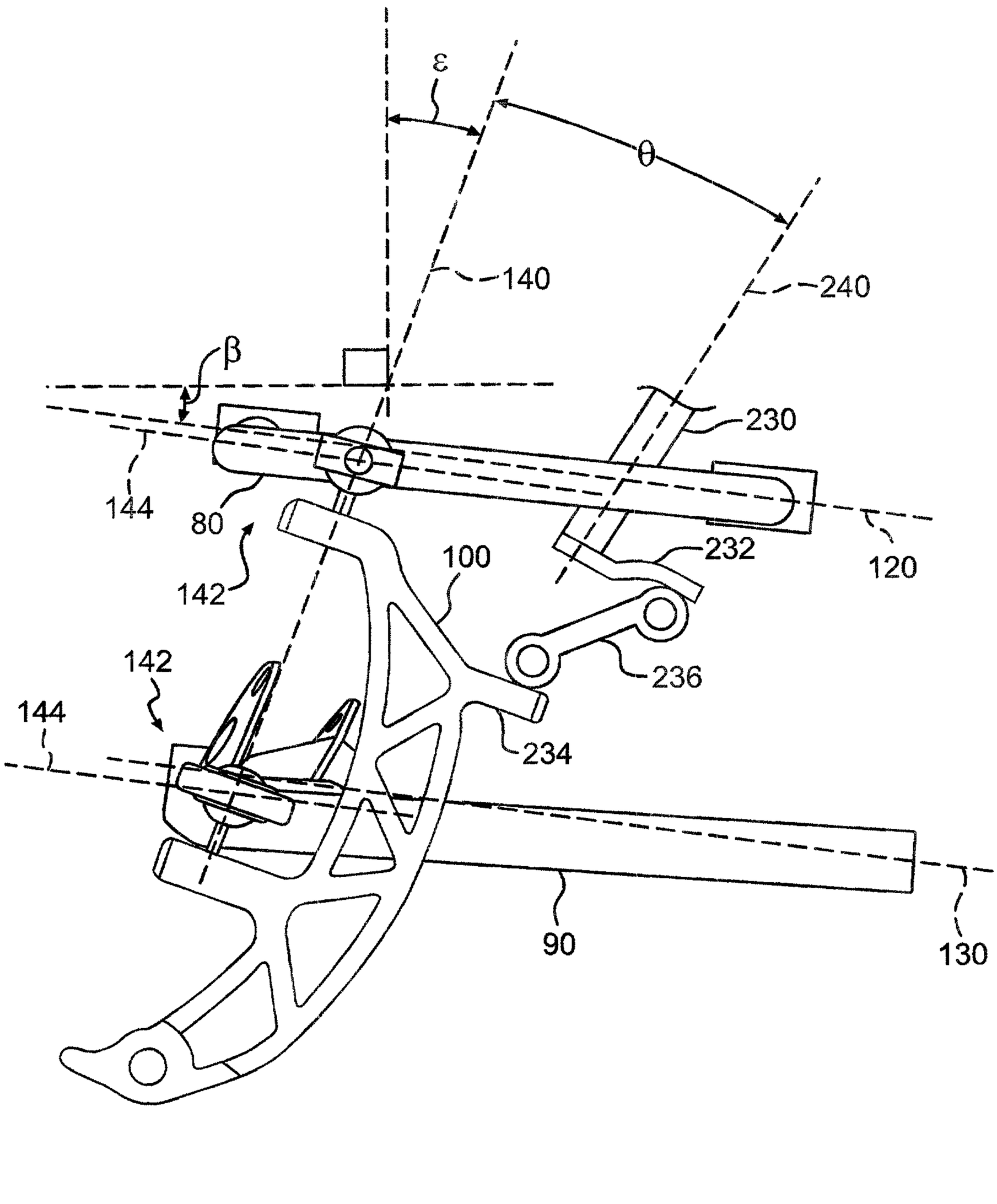


FIG. 2

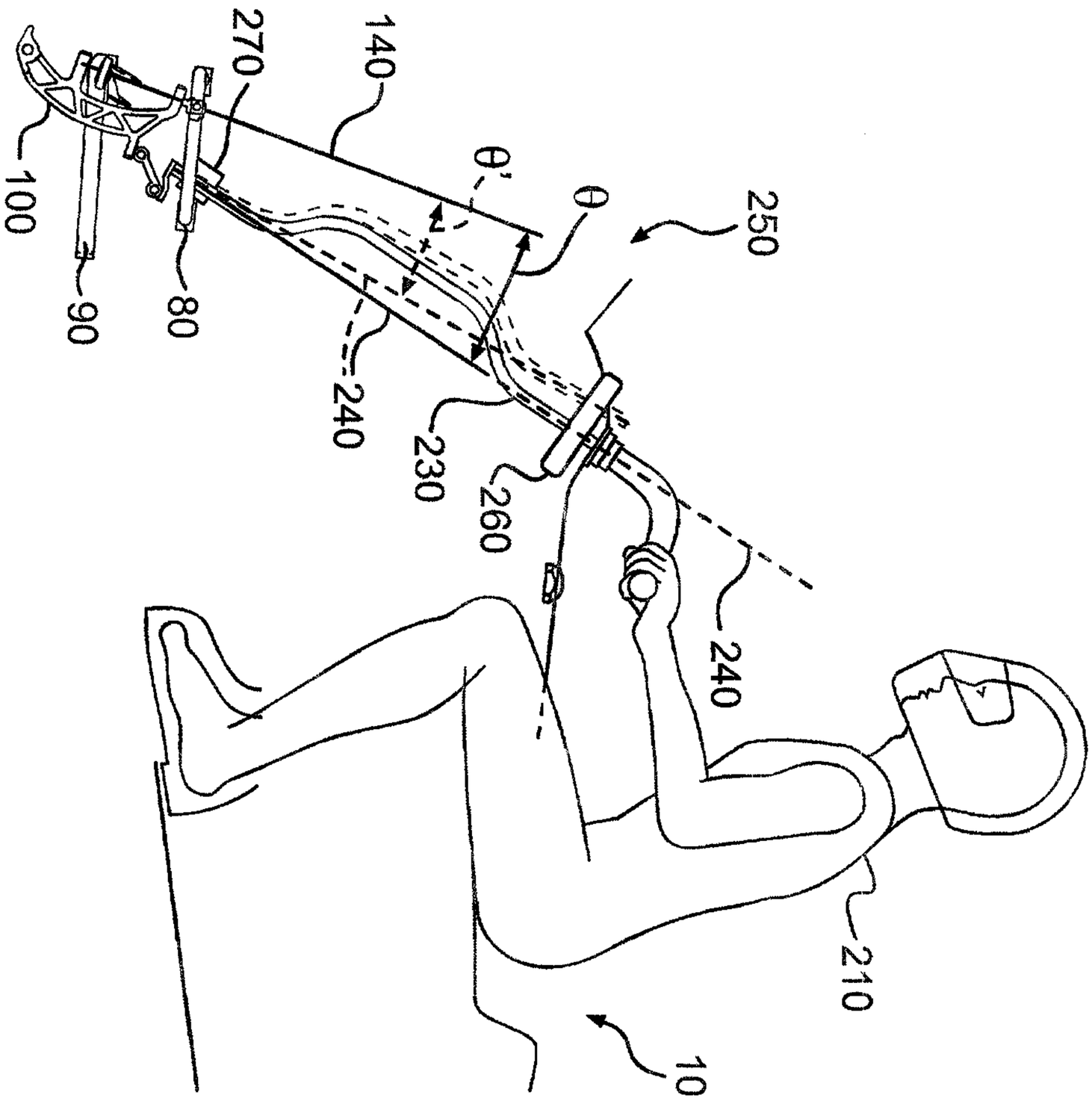


FIG. 3

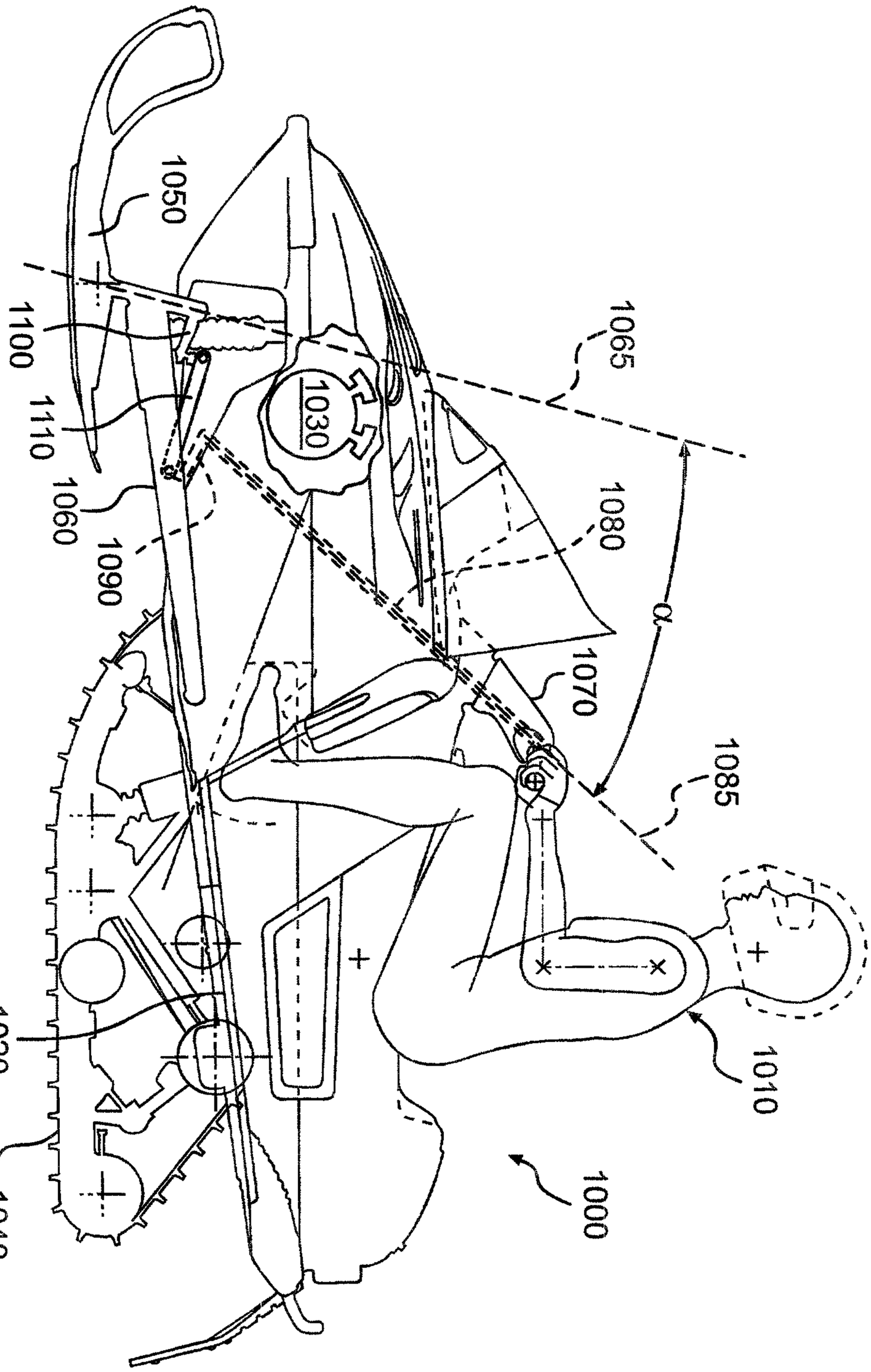
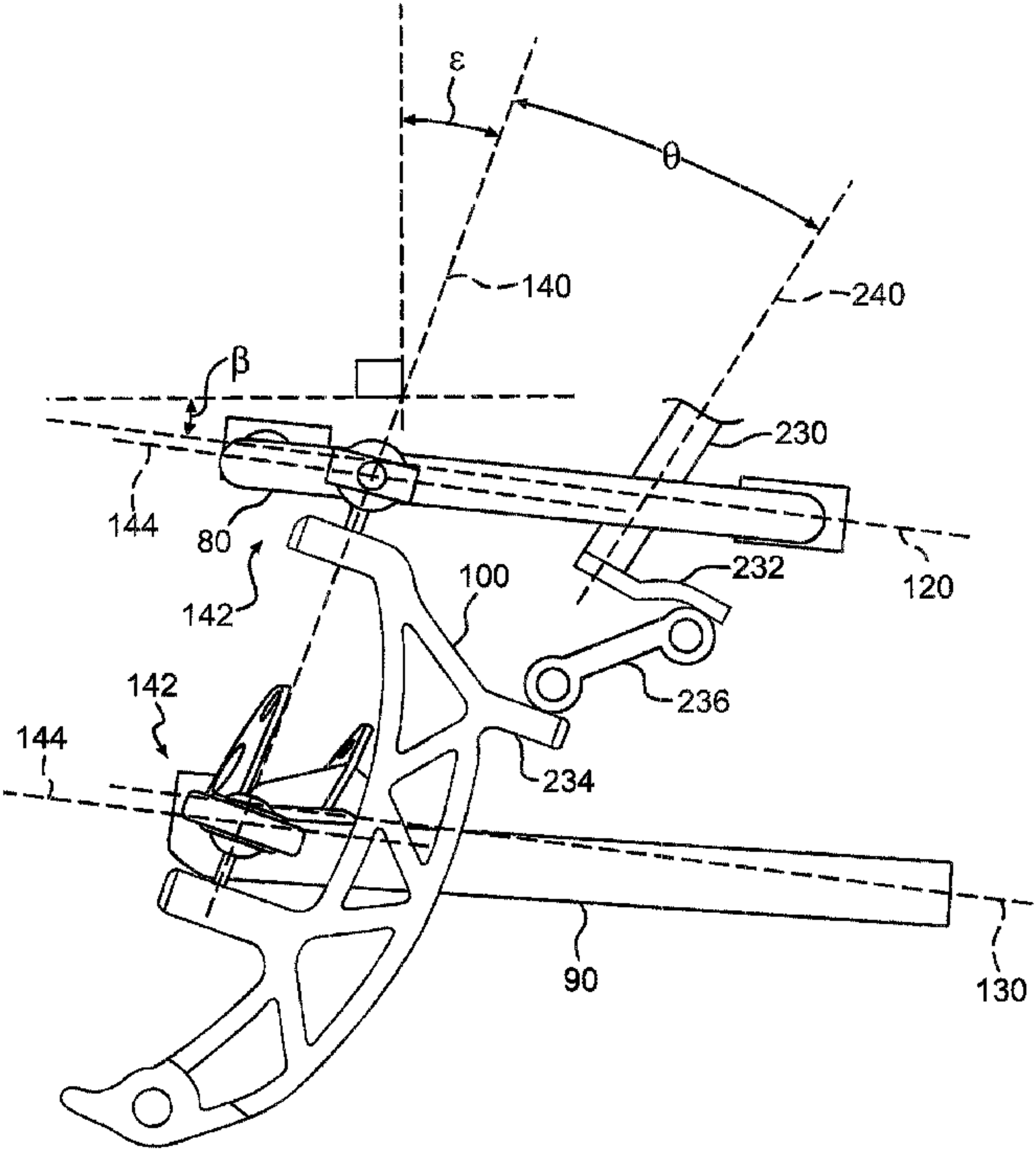


FIG. 4
PRIOR ART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