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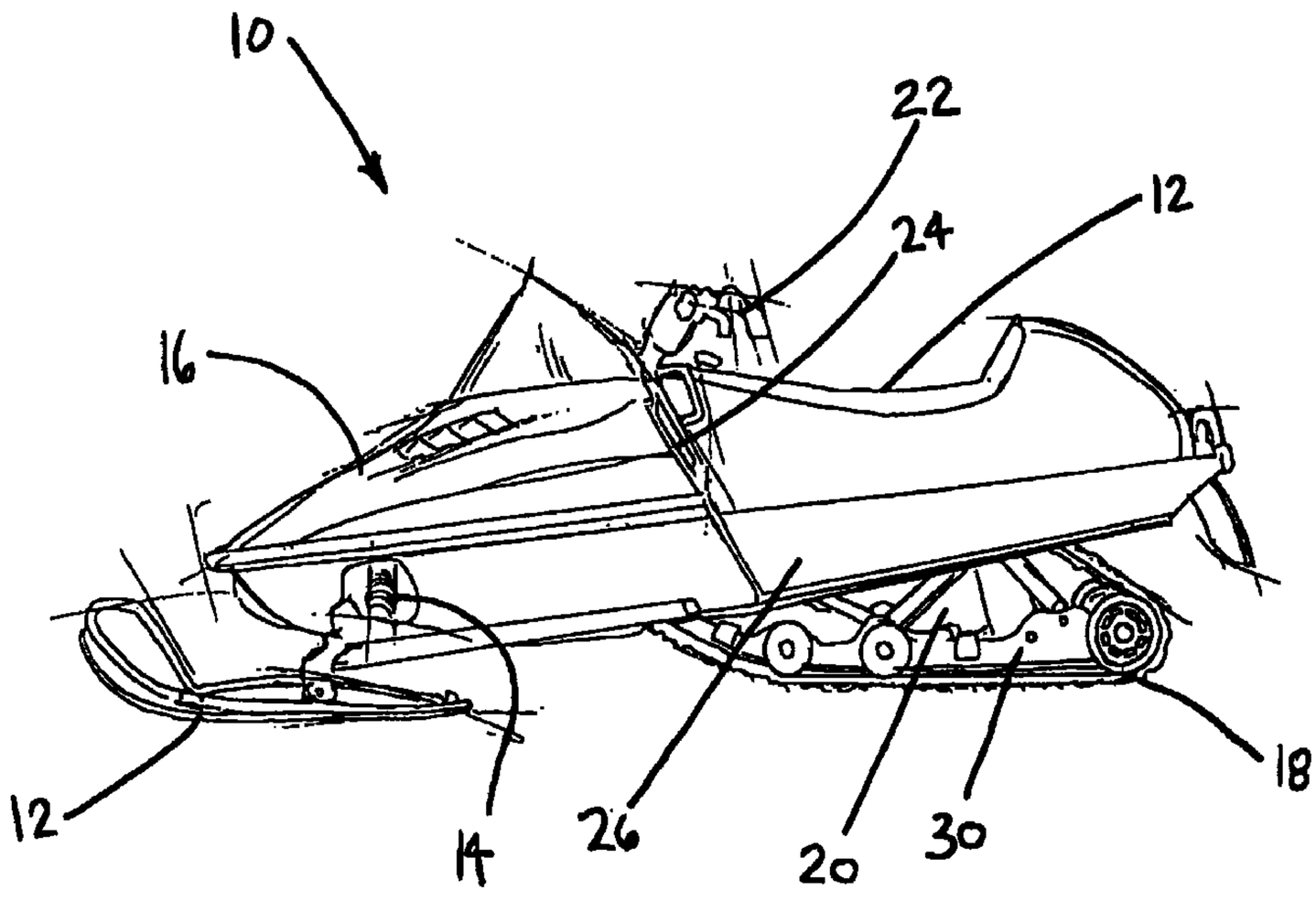
(54) **MECANISME DE SUSPENSION POUR MOTONEIGE**
(54) **SUSPENSION MECHANISM FOR A SNOWMOBILE**



(57) A suspension system for a snowmobile including a par of slide rails connected to each other by a plurality of supports to form a slide frame. Two suspension mechanisms connect the slide frame to the snowmobile chassis. The rear suspension mechanism consists includes a cradle, a pair of swing arms, and a pivot arm all of which are pivotably mounted to the slide frame. A rear suspension arm is pivotably mounted between the swing arms and the pivot arm. Finally, an air spring connected between the tear suspension arm and the credit supports the load placed on the rear suspension mechanism.

Abstract of the Disclosure

A suspension system for a snowmobile including a par of slide rails connected to each other by a plurality of supports to form a slide frame. Two suspension mechanisms connect the slide frame to the snowmobile chassis. The rear suspension mechanism consists includes a cradle, a pair of swing arms, and a pivot arm all of which are pivotably mounted to the slide frame. A rear suspension arm is pivotably mounted between the swing arms and the pivot arm. Finally, an air spring connected between the rear suspension arm and the cradle supports the load placed on the rear suspension mechanism.

SUSPENSION MECHANISM FOR A SNOWMOBILE

Field of the Invention

The present invention relates generally to all terrain vehicles. More particularly, the present invention relates to snowmobiles. Still more particularly, the present invention relates to mechanisms for snowmobile suspension systems.

Background of the Invention

Snowmobiling is a popular recreational activity in areas which receive snow during the winter. Local trail systems have been developed in areas in which snowmobiling is popular. It is not uncommon for a snowmobiler to cover one hundred (100) miles in a single outing. Unfortunately, it is also not uncommon for snowmobile trails to be in rough condition due to the volume of snowmobile traffic on weekends and other times when a large number of snowmobilers are using the trail. The trail conditions encountered by a snowmobiler can vary from a freshly groomed trail to sections of small washboard bumps to sections of very large bumps. The snowmobiler may also cross roads, cross icy lakes, or venture off the trail into powder snow all in a single excursion.

In order to fully enjoy the sport of snowmobiling, snowmobilers require a snowmobile suspension which gives them good ride quality and good control of the snowmobile. Ideally, this suspension system should be adjustable to accommodate changing trail conditions. Because snowmobile suspension systems are subjected to repeated shocks and intense vibration along with exposure to water, ice, snow, salt and dirt, it is important that snowmobile suspension systems be very durable.

Summary of the Invention

A suspension mechanism for a snowmobile comprising a pair of elongated side rails connected together by a plurality of supports to define a slide frame. A rear suspension mechanism is attached to the slide frame which includes an air spring. The air spring having a first end and second end, the first end of said air spring being pivotally connected to the chassis of the snowmobile. A cradle pivotally connected to the side frame. The second end of the air spring mounted in the cradle. The cradle is designed such that the pivot point of the cradle is located above the point at which the air spring is connected to the cradle. This mounting structure allows the cradle to rotate to accommodate changes in the angular orientation of the air spring.

Brief Description of the Drawings

Figure 1 is a plan view of a snowmobile;

Figure 2 is a perspective view of a slide frame;

Figure 3 is a schematic representation of a snowmobile suspension system;

Figure 4 is a perspective view of a snowmobile suspension system;

Figure 5 is a perspective view of a rear suspension arm, a rear pivot arm, and a air spring cradle,

Figure 6 is a plan view of an air spring;

Figure 7 is a plan view of an alternate embodiment of an air spring; and

Figure 8 is a schematic representation of a system for adjusting the pressure inside an air spring.

Detailed Description of the Invention

Reference is now made to the drawings, in which like numbers refer to like elements throughout. Figure 1 illustrates a snowmobile 10 having a seat 12 to accommodate a snowmobile operator (not shown). The major components of snowmobile 10 include; a pair of skis 12, a ski suspension system 14, a hood 16, a track 18, a chassis 26, and a rear suspension 20. An engine 15 (not shown) and a twelve Volt battery 17 (not shown) are housed beneath hood 16. Snowmobile 10 also includes a steering arrangement 22 and a control panel 24. Both steering arrangement 22 and control panel 24 contain a plurality of controls (not shown) used by the snowmobile operator (not shown) to operate snowmobile 10. Rear suspension 20 includes a slide frame 30, which supports track 18 along its length.

Figure 2 is a perspective view of slide frame 30. Slide frame 30 includes a pair of slides 32A, 32B which are connected by a plurality of cross members 34A, 34B, 34C, and 34D. Slides 32A, 32B are also connected by a rear axle 36 which supports a plurality of idler wheels 38A, 38B, and 38C. A plurality of bogie wheels 40A, 40B, 40C and 40D are pivotably attached to slide frame 30.

Rear suspension system 20 of snowmobile 10 is schematically represented in FIG 3. The major components of rear suspension 20 are slide frame 30, a first suspension mechanism 104, and a second suspension mechanism 110.

First suspension mechanism 104 includes front suspension arm 140, spring assembly 144, and a pair of travel limiting straps 146. Front suspension arm 140 is pivotably connected to slide frame 30 at pivot point 106. Front suspension arm 140 is also pivotably connected to chassis 26 of snowmobile 10 at pivot point 108. Spring

assembly 144 is pivotably connected to slide frame 30 at pivot point 142, and pivotably connected to front suspension arm 140 at pivot point 108. Travel limiting straps 146 are pivotably connected to slide frame 30 at pivot point 148 and pivotably connected to front suspension arm 140 at pivot point 108.

Second suspension mechanism 110 includes rear suspension arm 120, pivot arm 122, and a pair of swing arms 124. Rear suspension arm 120 is pivotably connected to chassis 26 of snowmobile 10 at pivot point 114. Pivot arm 122 is pivotably connected to rear suspension arm 120 at pivot point 116 and pivotably connected to slide frame 30 at pivot point 112. Swing arms 124 are pivotably connected to rear suspension arm 120 at pivot point 114 and pivotably connected to slide frame 30 at pivot point 106. Although this embodiment of the present invention includes a pair of swing arms it should be understood that a single swing arm could be used without departing from the spirit or scope of the invention.

Second suspension mechanism 110 also includes an air spring 126 and an air spring cradle 128. Air spring 126 includes a first end 130 and a second end 132. First end 130 of air spring 126 is fixably attached to air spring cradle 128. Air spring cradle 128 is pivotably connected to slide frame 30 at pivot point 118. Pivot point 118 is located above the point at which air spring 126 is fixably attached to air spring cradle 128. Second end 132 of air spring 126 is fixably attached to first mounting 134. First mounting 134 is fixably attached (for example by welding) to rear suspension arm 120.

As described above, air spring 126 is fixably attached to air spring cradle 128 at a location below pivot point 118. This mounting arrangement allows air spring cradle 128 to rotate in order to accommodate changes in the angular position of the air spring 126.

Because air spring cradle 128 is essentially "floating", air spring 126 will be loaded along it's longitudinal axis. This is significant because forces perpendicular to the longitudinal axis of air spring 126 may cause it to buckle.

Figure 4 is a perspective view of suspension system 20. In this view, it can be appreciated that spring assembly 144 includes a front spring 140 and a front shock absorber 152. Front spring 140 is disposed around the body front shock absorber 152 and the ends of front spring 140 are fixedly attached to the ends of front shock absorber 152. This method of mounting a spring onto a shock absorber is well known in the art. In Figure 4 front shock absorber 152 is shown pivotably mounted to both front suspension arm 104 and slide frame 30.

Suspension system 20 includes two shock absorbers, front shock absorber 152 and a rear shock absorber 150. Rear shock absorber 150 is pivotably mounted to both slide frame 30 and rear suspension arm 120.

Suspension system 20 also includes two springs, spring 140 and air spring 126, which both serve to support the weight of snowmobile 10. When snowmobile 10 encounters a bump spring 140 and air spring 126 both deflect. Rear shock absorber 150 and front shock absorber 152 both act to dampen the movement of the suspension system. Suspension system 20 also includes straps 146A and 146B which serve to limit the travel of first suspension mechanism 104.

Figure 5 is a perspective view illustrating rear suspension arm 120, rear pivot arm 122, and air spring cradle 128. Cradle 128 is comprised of a platform 161 having two ball joints 162A and 162B secured to either end. Ball joints 162A and 162B each include threaded rod portions (not shown) which are used to secure ball joints 162A, 162B to

platform 161. A pair of bolts 164A and 164B are threaded through ball joints 162A and 162B. Ball joints like those shown in Figure 5 are commercially available from McMaster-Carr Supply Company (Chicago, Illinois). Bolts 164A, 164B and ball joints 162A, 162B pivotably connect air spring cradle 128 to slide frame 30.

In the specific embodiment of Figure 5 bolt 164A passes through ball joint 162A, then through washer 166, block 168, and finally through slide frame 30 (not shown). A lock washer 170 and a nut 172 are tightened onto bolt 164A to complete the assembly. The preferred material for platform 161 is steel because of its high strength and because shapes like square tubing, round tubing, and U-shaped channels are readily available in steel. Other materials may be used without departing from the spirit and scope this invention, for example, aluminum and thermoplastic composites.

Pivot arm 122 is comprised of a tubular body 180 and two vertical support members 182A, 182B which extend from tubular body 180. The preferred material for pivot arm 122 is steel because of its high strength and ready availability, and because parts of this type can be easily fabricated from steel by machining and welding. Other materials may be used without departing from the spirit and scope this invention, for example, aluminum and thermoplastic composites.

Rear suspension arm 120 includes a first tubular member 190 and a second tubular member 192. Two support members 194 and 196 extend between first tubular member 190 and second tubular member 192. First mounting 134 is fixably attached to first tubular member 190 and is used to mount one end of air spring 126. A second mounting 198 is also fixably attached to first tubular member 190 of rear suspension arm 120 and is adapted to connect with one end of rear shock absorber 150. A third mounting

199A is fixably attached to rear suspension arm 120 for the purpose of connecting with one end of swing arm 124A. Likewise, a forth mounting 199B is fixably attached to rear suspension arm 120 for the purpose of connecting with one end of swing arm 124B. The preferred material for rear suspension arm 120 is steel because of its high strength and ready availability, and because parts of this type can be easily fabricated from steel by machining and welding. Other materials may be used without departing from the spirit and scope this invention, for example, aluminum and thermoplastic composites.

Figure 6 is a plan view of one embodiment of air spring 126. Air spring 126 includes a flexible sleeve 200 including a first end 202 and a second end 204. Flexible sleeve 200 consists of a flexible material such as rubber. First end 202 of flexible sleeve 200 is sealingly attached to a first end cap 206. In this embodiment, the seal between flexible sleeve 200 and first end cap 206 is maintained with an end cap clamping ring 208.

Second end 204 of flexible sleeve 200 is sealingly attached to a second end cap 210. The seal between flexible sleeve 200 and second end cap 210 is maintained with a piston clamping ring 212. With first end 202 and second end 204 sealed in the fashion described above, flexible sleeve 200 forms a fluid pressure chamber 214. In this embodiment, flexible sleeve 200 includes a roll 216 which allows air spring 126 to expand in length when the pressure inside fluid pressure chamber 14 is increased.

Air spring 126 also includes conduit connection 218 which allows a conduit such as a tube or a pipe to be placed in fluid connection with fluid pressure chamber 214 of air spring 126. In Figure 6 conduit connection 218 is shown as a male pipe thread, however it should be understood that fluid connection 218 could be one of several means for

attaching a fluid conduit which are well known in the art. For example, fluid connection 218 could be a male hose nipple, a male tube adapted to receive a compression fitting, or a female pipe thread. It should also be understood that air spring 126 would function equally well if fluid connection 218 was located on second end cap 210 rather than being located on first end cap 206.

First end cap 206 and second end cap 210 each include mountings 220 and 222 respectively. Mountings 220 and 222 may be threaded holes as depicted in Figure 6, or they may be another mounting means such as threaded studs or mounting brackets.

Figure 7 is a plan view of a second embodiment of air spring 126. Air spring 126 includes a flexible sleeve 300 including a first end 302 and a second end 304. Flexible sleeve 300 consists of a flexible material such as rubber. First end 302 of flexible sleeve 300 is sealingly attached to an end cap 306. Second end 304 of flexible sleeve 300 is sealingly attached to an end cap 310.

Flexible sleeve 300 and end caps 306, 310 combine to form a fluid pressure chamber 314. Flexible sleeve 300 includes a plurality of corrugations 316. Corrugations 316 allow air spring 126 to expand in length when the pressure inside fluid pressure chamber 314 is increased.

Air spring 126 also includes conduit connection 318 which allows a conduit such as a tube or a pipe to be placed in fluid connection with fluid pressure chamber 314 of air spring 126. In Figure 7 conduit connection 318 is shown as a female pipe thread, however it should be understood that fluid connection 318 could be one of several means for attaching a fluid conduit which are well known in the art. For example, fluid connection 318 could be a male hose nipple, a male tube adapted to receive a

compression fitting, or a male pipe thread. It should also be understood that air spring 126 would function equally well if fluid connection 318 was located on end cap 310 rather than being located on end cap 306.

End caps 306, 310 each include mounting 320 and 322 respectively. Mounting 320 and 322 may be threaded studs as depicted in Figure 7, or they may be another mounting means such as threaded holes or mounting brackets.

Air springs of the type shown in Figure 6 and Figure 7 are commercially available from Firestone Industrial Products Company (Carmel, IN) and Enidine Corporation (Orchard Park, NY). During operation of snowmobile 10, rear suspension system 100 is exposed to cold, wet, repeated shocks, vibration, dirt, and salt. Flexible walled air springs of this type have been found to be very durable when exposed to these types of adverse conditions.

Figure 8 is a schematic representation of a system for adjusting pressure 400 used to change the fluid pressure in air spring 126. Air spring 126 is in fluid communication with a compressor or air pump 402 and a relief valve 404 through conduits 401A and 401B. Relief valve 404 is a normally closed solenoid valve which is well known in the art. Relieve valve 404 and compressor 402 are connected via wires 406 to a control system 408. Control system 408 allows the snowmobile operator to selectively actuate the compressor and the relief valve. Control system 408 may include one or more electrical switches conveniently located for use by the snowmobile operator. For example, the switches may be located on steering means 22 or on control panel 24 of snowmobile 10. A battery 410 supplies the electrical energy required to activate relief valve 404 and compressor 402. A number of battery types known in the art are suitable

for use as battery 410. A lead acid battery, a nickel-cadmium battery, an alkaline battery, and others would all be suitable for use as battery 410. Battery 17 of snowmobile 10 may also be used to serve the function of battery 410.

When an increase in the stiffness of rear suspension 20 is desired, compressor 402 is selectively activated by the snowmobile operator using control system 408. When compressor 402 is activated it begins pumping air into conduit 401A. The presence of additional air raises the pressure inside both conduit 401A and air spring 126.

When a decrease in the stiffness of rear suspension 20 is desired, relief valve 404 is selectively activated by the snowmobile operator using control system 408. When relief valve 404 is actuated it allows air from conduits 401A, 401B and air spring 126 to escape into the atmosphere. The escape of air to the atmosphere results in a reduction in of the pressure inside air spring 126.

Numerous advantages of the invention covered by this document have been set forth in the foregoing description. It will be understood, however, that this disclosure is, in many respects, only illustrative. Changes may be made in details, particularly in matters of shape, size, and arrangement of parts without exceeding the scope of the invention. The inventions's scope is, of course, defined in the language in which the appended claims are expressed.

What is claimed is:

1. A suspension system for a snowmobile comprising:

a snowmobile chassis;

a pair of elongated slide rails;

a plurality of supports connecting said slide rails together and defining a slide frame for said suspension;

a cradle pivotably connected to said slide frame of said suspension system;

an air spring having a first end and a second end, said first end of said air spring being connected to said cradle; and

said second end of said air spring being pivotably connected to said snowmobile chassis.

2. The suspension system of claim 1, wherein the pressure in said air spring is adjustable.

3. The suspension system of claim 1, wherein said air spring includes a flexible sleeve.

4. The suspension system of claim 1, further including a pressure source in fluid connection with said air spring.

5. The suspension system of claim 4, wherein said pressure source is an air pump.

6. The suspension system of claim 4, wherein said pressure source is an air pump powered by a 12 volt battery.

7. The suspension system of claim 1, further including a shock absorber with a first end and a second end, said first end pivotably connected to said first end of said suspension arm, and said second end pivotably connected to said slide frame of said suspension system.

8. The suspension system of claim 1, wherein the cradle is further defined as a platform having two ball joints secured to either end of the platform.

9. The suspension system of claim 8, wherein the cradle is pivotably connected to the slide frame of the rear suspension system by a securing element passing through said ball joints allowing pivoting rotation around said securing element.

10. The suspension system of claim 1, wherein the cradle pivots about a pivot axis, and the air spring extends generally perpendicularly to, and across the pivot axis.

11. A suspension system for a snowmobile comprising:

a pair of elongated slide rails;

a plurality of supports connecting said slide rails together and defining a slide frame for said suspension;

a swing arm having a first end and a second end, said first end pivotably connected to said slide frame of said suspension system;

a suspension arm having a first end and a second end, said first end pivotably connected to said second end of said swing arm;

a pivot arm having a first end and a second end, said first end pivotably connected to said suspension arm, and said second end pivotably connected to said slide frame of said suspension system;

an air spring having a first end and a second end, said first end of said air spring being connected to said first end of said suspension arm; and

a cradle pivotably connected to said slide frame of said suspension system, and further connected to said second end of said air spring.

12. The suspension system of claim 11, wherein the pressure in said air spring is adjustable.

13. The suspension system of claim 11, wherein said air spring includes a flexible sleeve.

14. The suspension system of claim 11, further including a pressure source in fluid connection with said air spring.

15. The suspension system of claim 11, wherein said pressure source is an air pump.

16. The suspension system of claim 14, wherein said pressure source is an air pump powered by a 12 volt battery.

17. The suspension system of claim 11, further including a shock absorber with a first end and a second end, said first end pivotably connected to said first end of said suspension arm, and said second end pivotably connected to said slide frame of said suspension system.

18. The suspension system of claim 11, wherein the cradle is further defined as a platform having two ball joints secured to either end of the platform.

19. The suspension system of claim 18, wherein the cradle is pivotably connected to the slide frame of the rear suspension system by a securing element passing through said ball joints allowing pivoting rotation around said securing element.

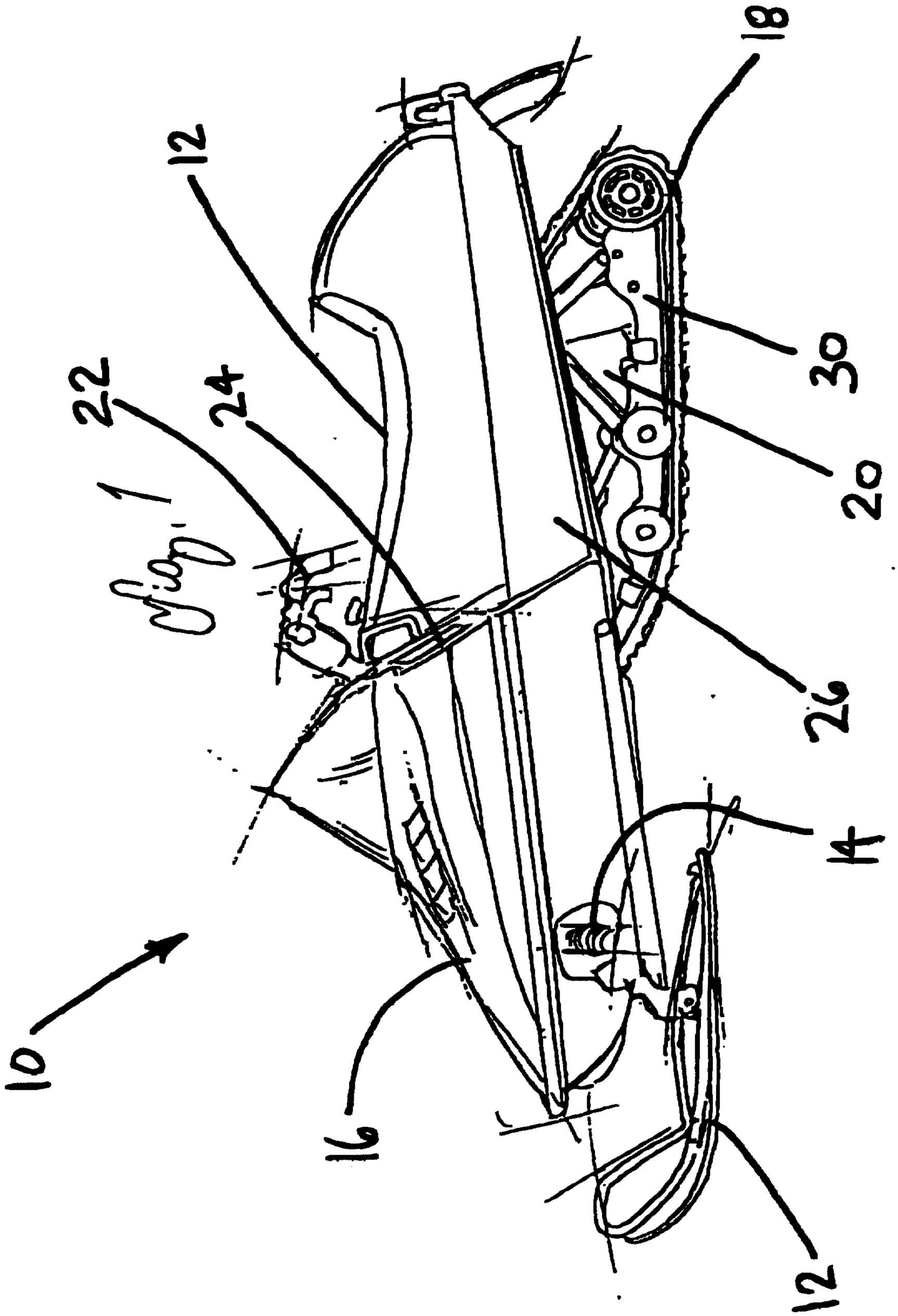

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Fig. 1
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14
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16
2

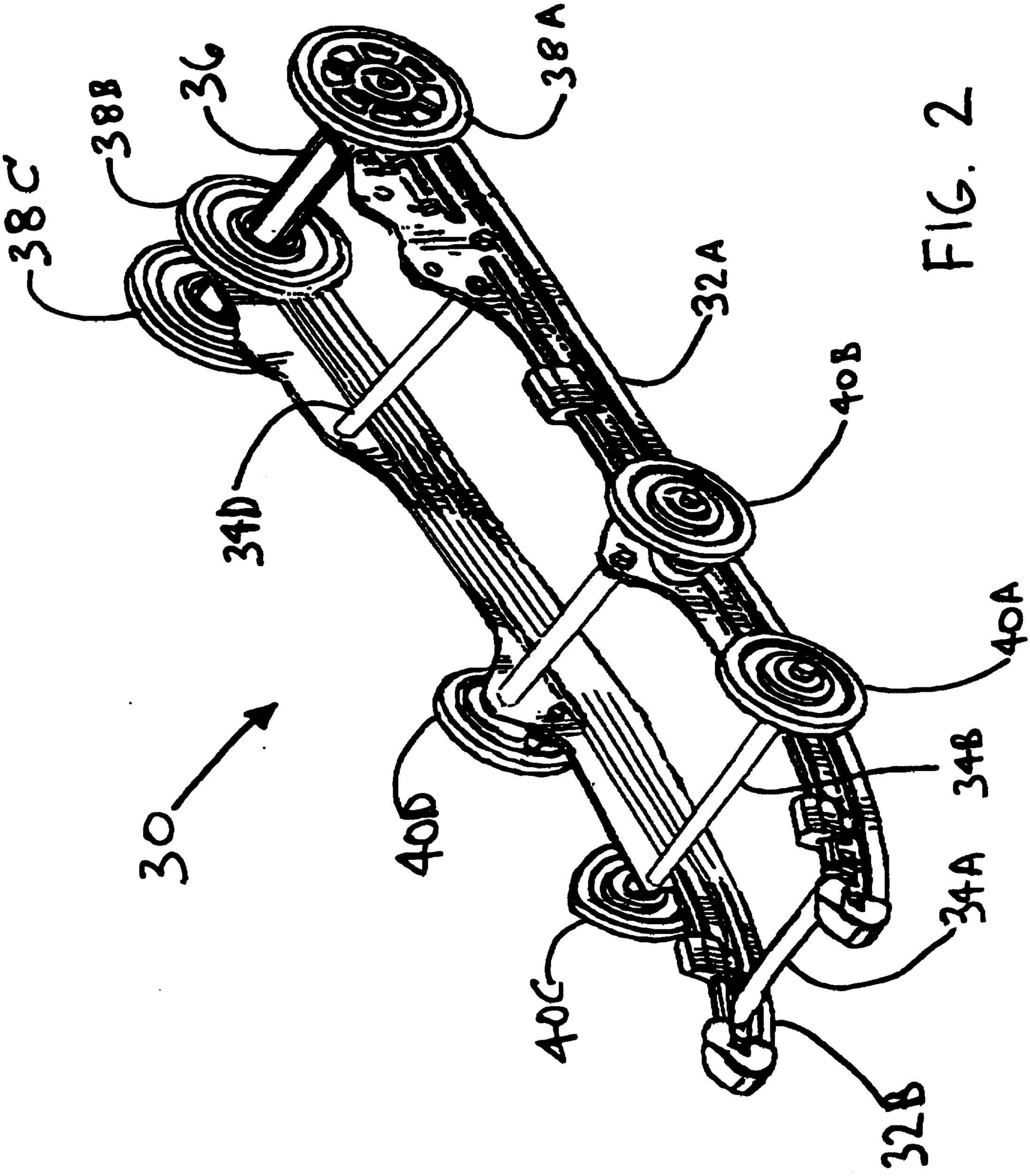
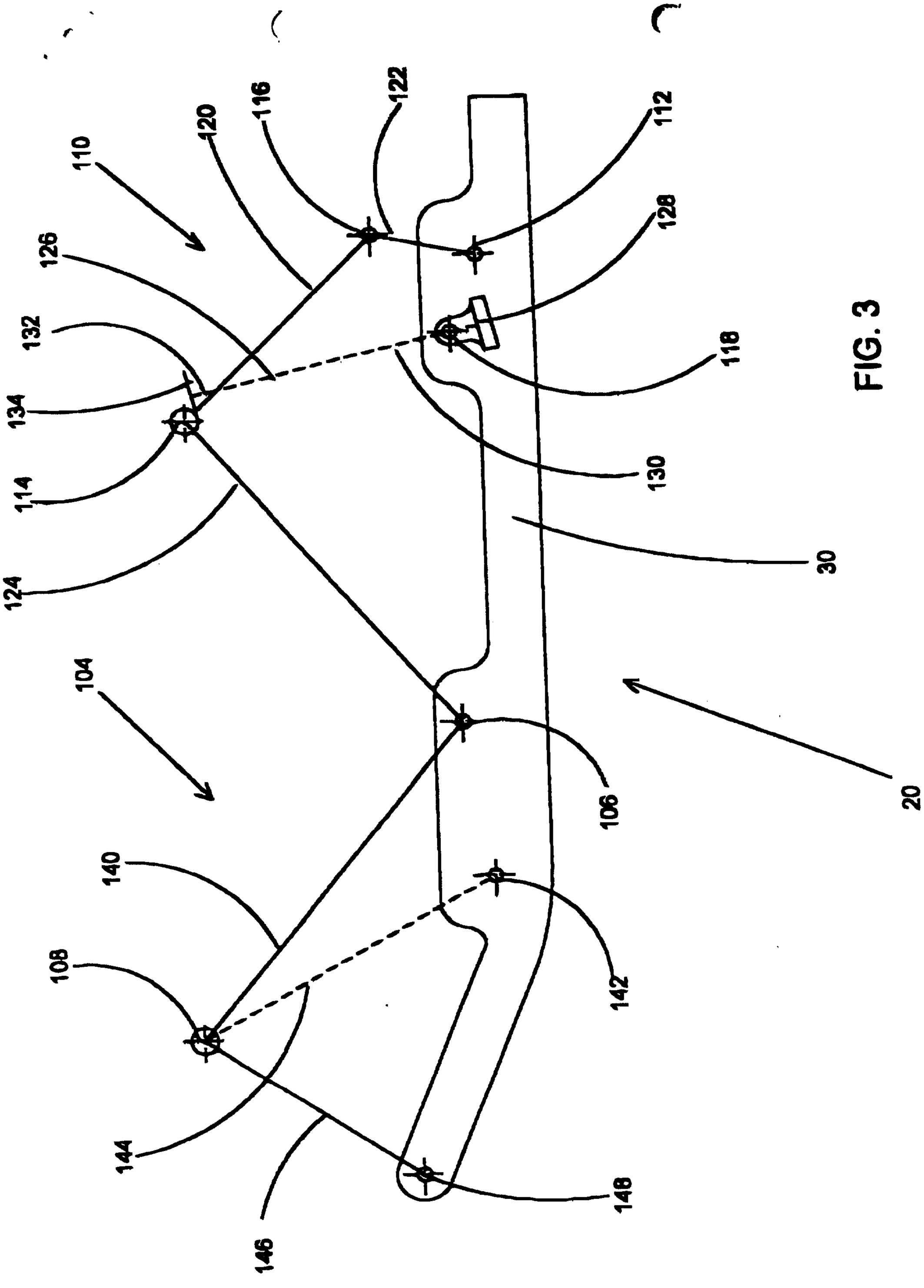


FIG. 2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148
146

FIG. 3

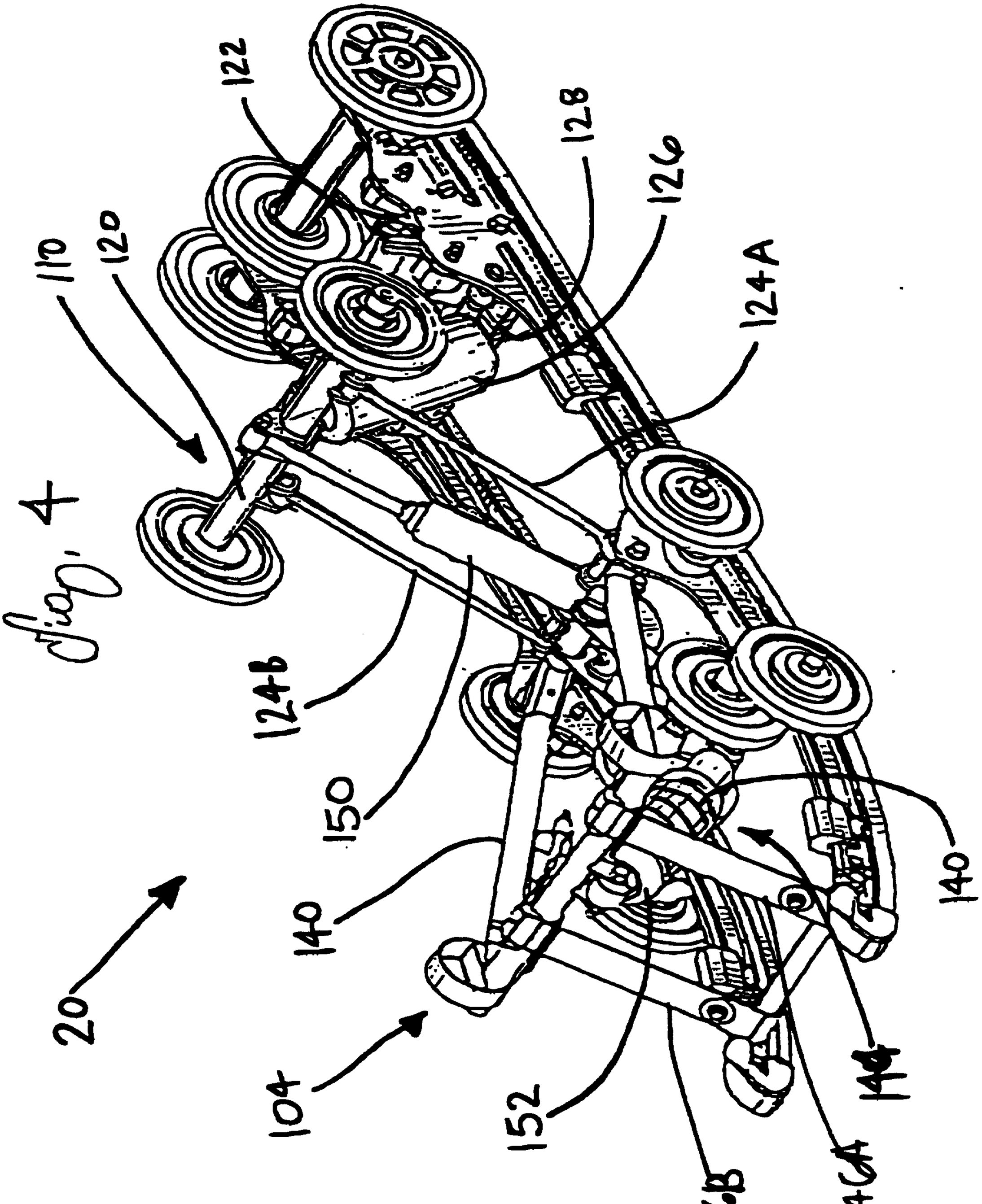
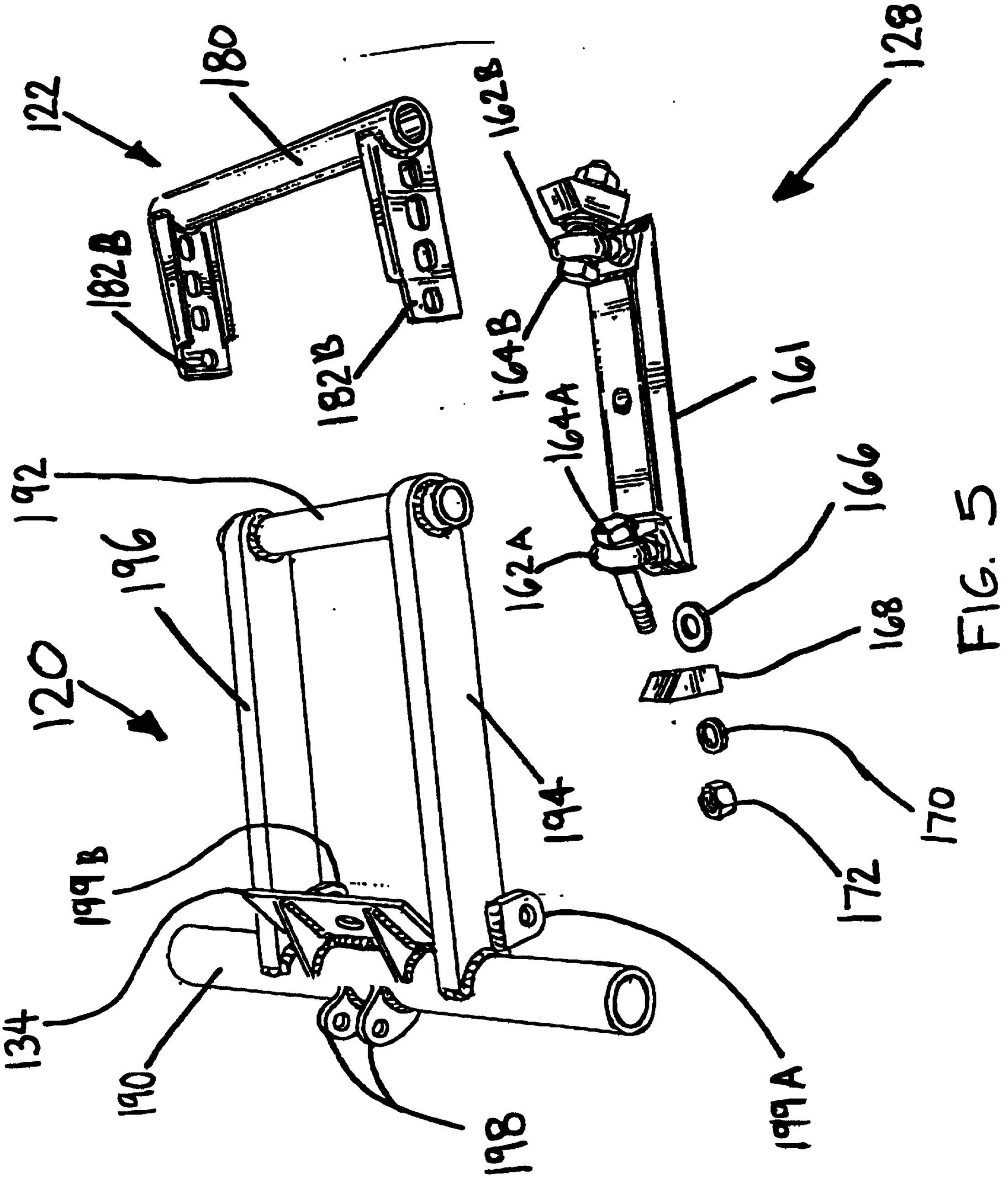

122
128
126
110
120
124A
124B
150
140
140
20
104
152
144
146B
146A

Fig. 4


120
122
128
134
161
162A
164A
164B
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168
170
172
180
182A
182B
190
192
194
196
198
199A
199B

FIG. 5

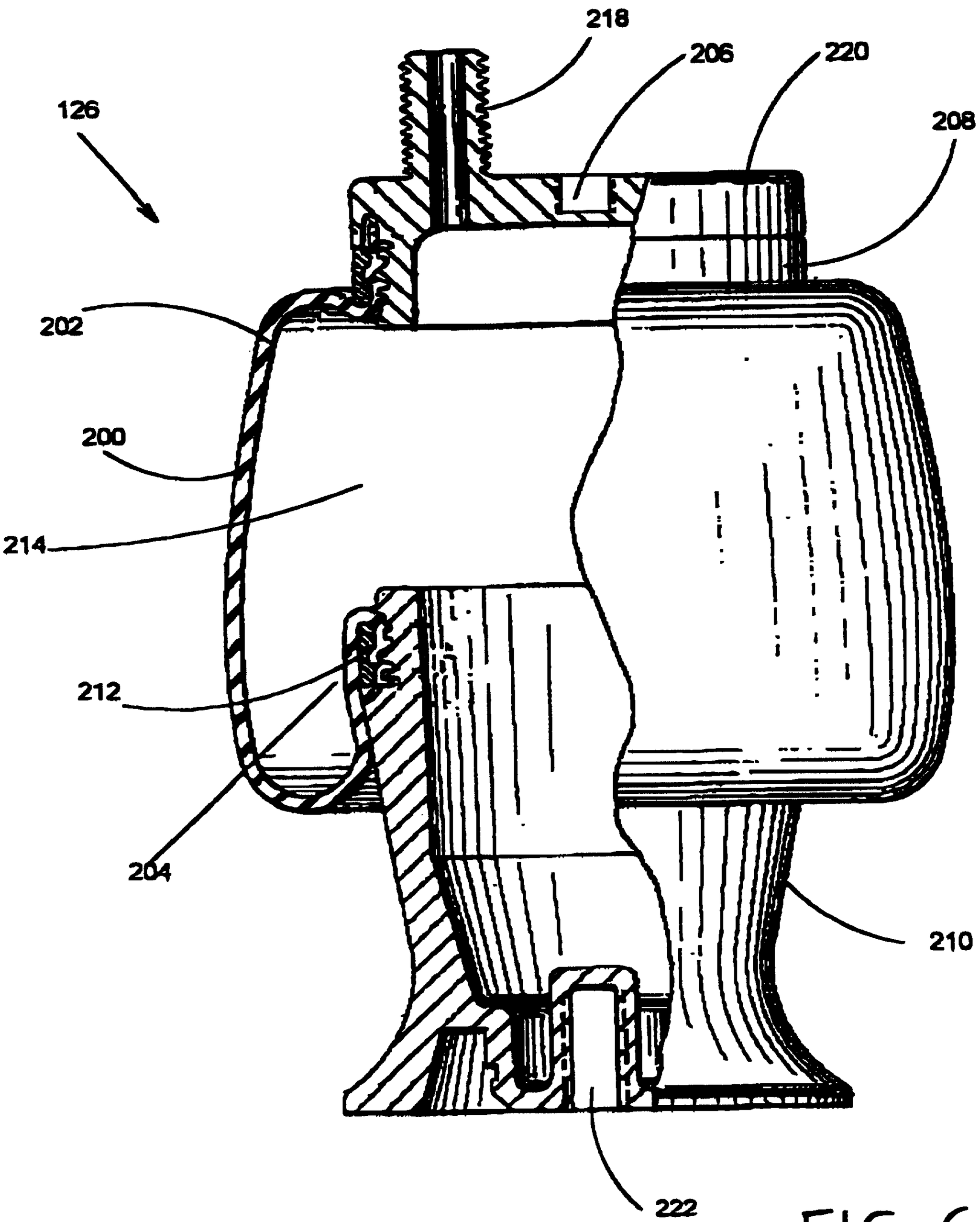

FIG. 6

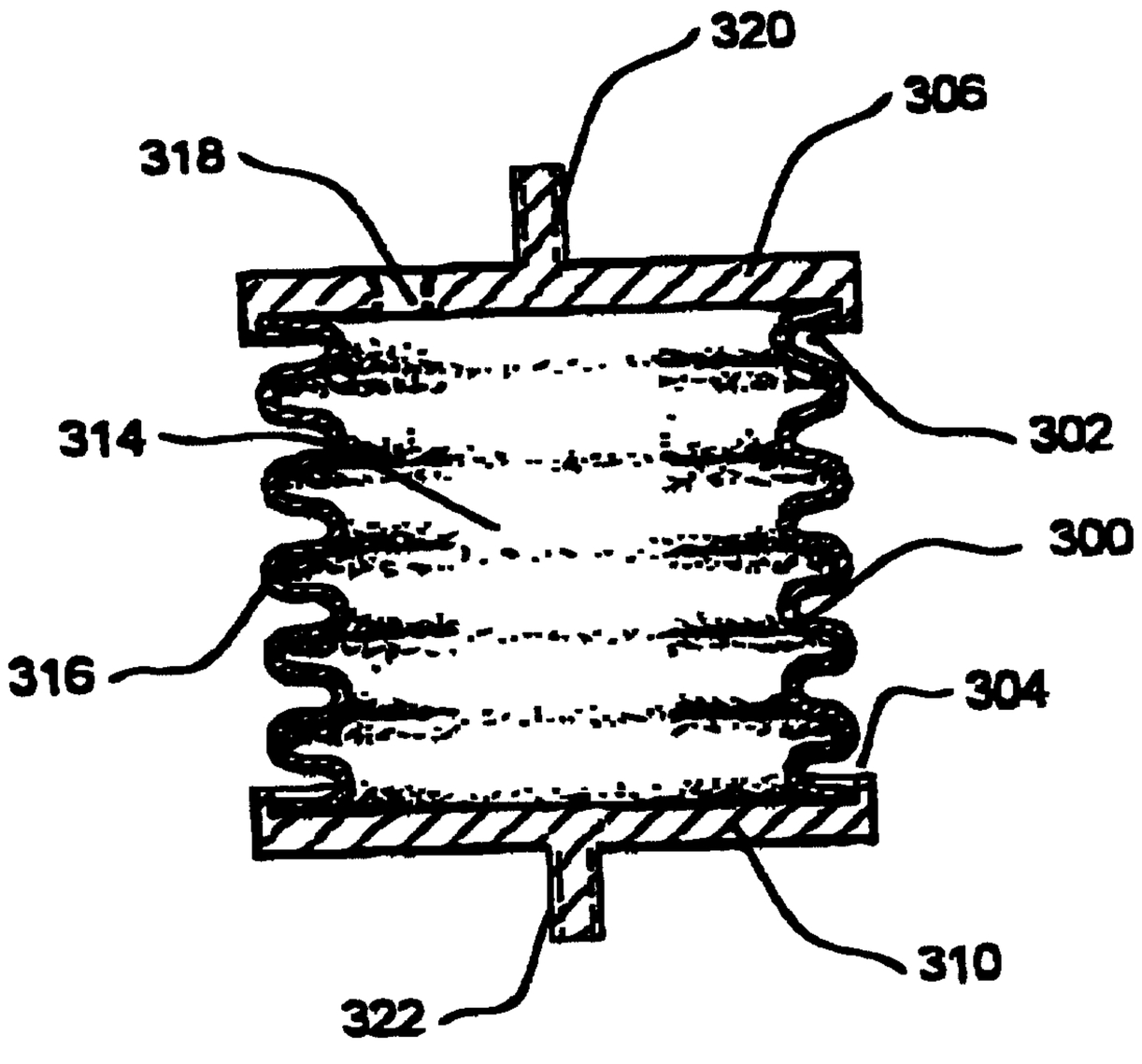

FIG. 7

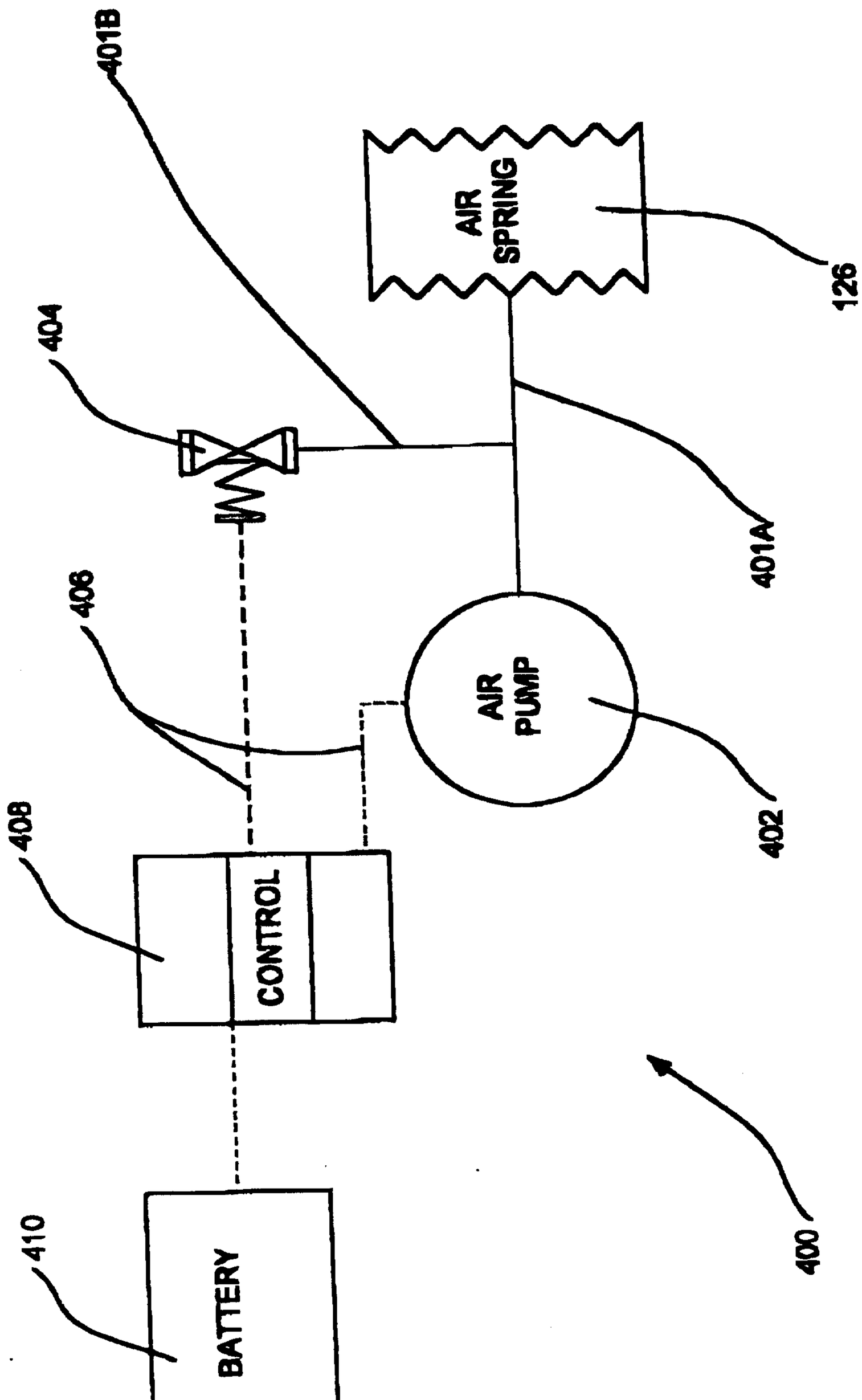
401B
AIR SPRING
126
404
406
AIR PUMP
401A
408
CONTROL
402
410
BATTERY
400

FIG. 8