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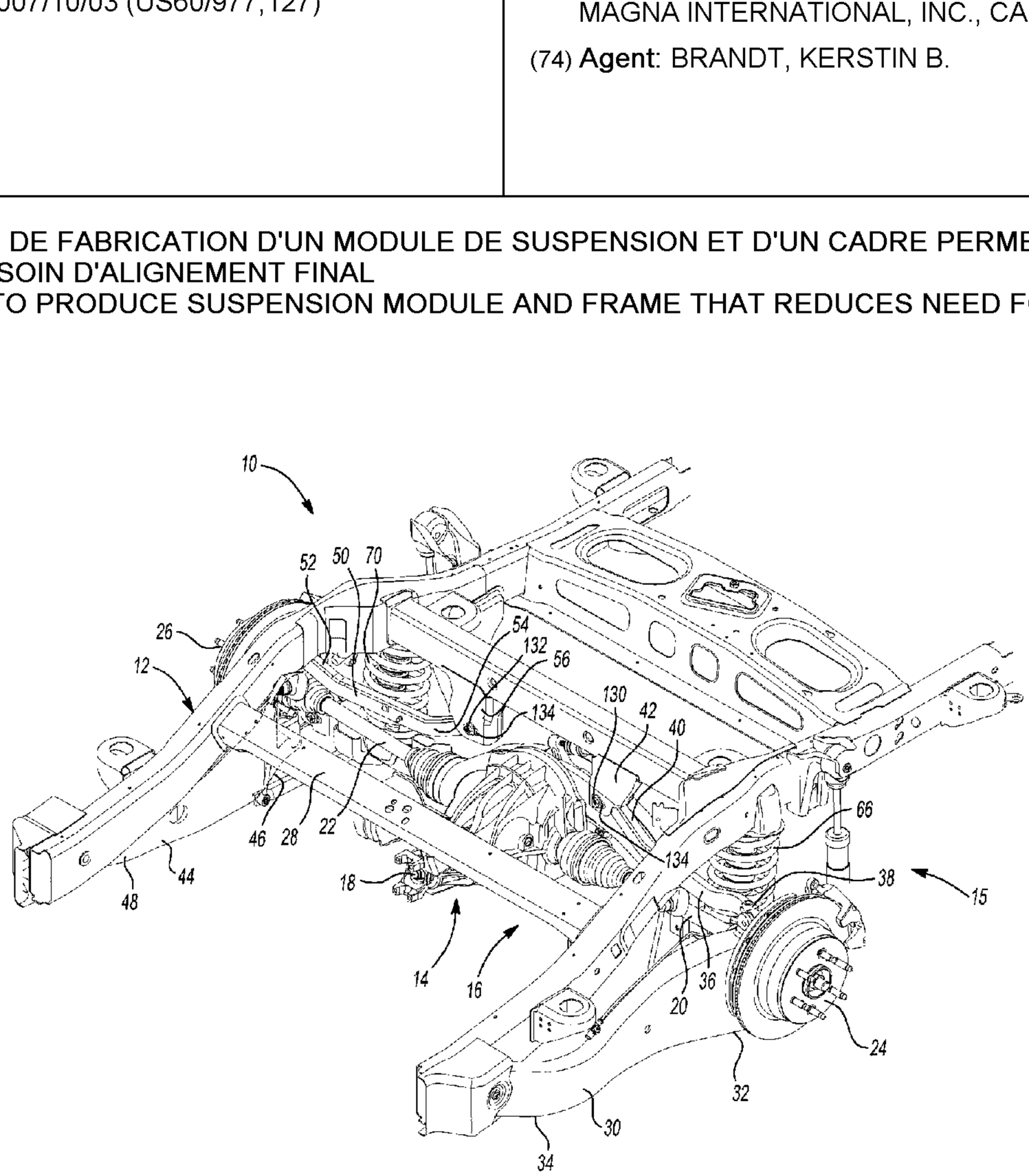
(54) Title: METHOD TO PRODUCE SUSPENSION MODULE AND FRAME THAT REDUCES NEED FOR FINAL ALIGNMENT



(57) Abrégé/Abstract:
A method of assembling a frame and suspension module includes determining locations of first and second suspension member supports on the frame. Target positions of first and second connections between the frame and third and fourth suspension members are defined based on the locations of the first and second suspension member supports. Target positions of third and fourth connections between a fifth suspension member and the first and second suspension members are defined based on the locations and the target positions of the first and second connections. The first and second suspension members are connected to the frame at the locations. The third and fourth suspension members are connected to the frame at the first and second target positions. The fifth suspension member is connected to the first and second suspension members at the third and fourth target positions.

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(54) **Title:** METHOD TO PRODUCE SUSPENSION MODULE AND FRAME THAT REDUCES NEED FOR FINAL ALIGNMENT

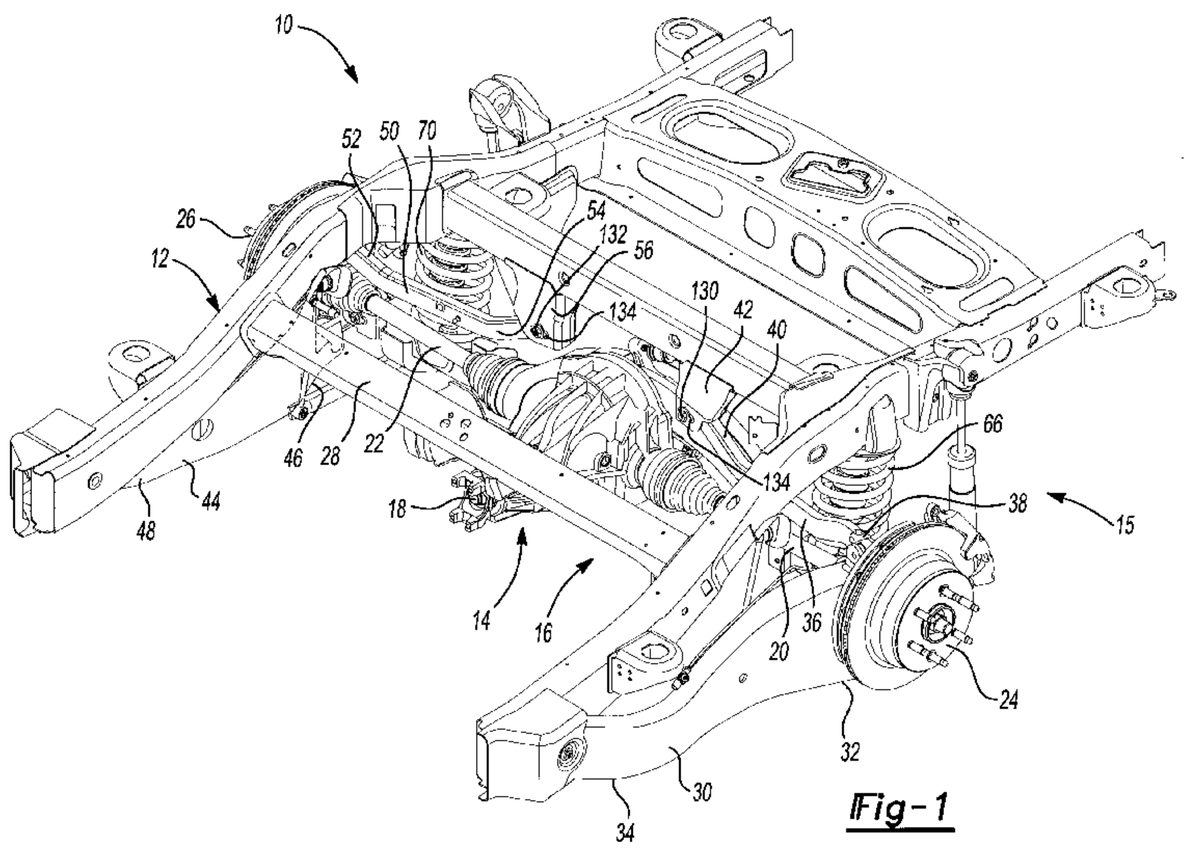

Fig-1

(57) **Abstract:** A method of assembling a frame and suspension module includes determining locations of first and second suspension member supports on the frame. Target positions of first and second connections between the frame and third and fourth suspension members are defined based on the locations of the first and second suspension member supports. Target positions of third and fourth connections between a fifth suspension member and the first and second suspension members are defined based on the locations and the target positions of the first and second connections. The first and second suspension members are connected to the frame at the locations. The third and fourth suspension members are connected to the frame at the first and second target positions. The fifth suspension member is connected to the first and second suspension members at the third and fourth target positions.

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METHOD TO PRODUCE SUSPENSION MODULE AND FRAME THAT REDUCES NEED FOR FINAL ALIGNMENT

BACKGROUND

[0001] Vehicle assembly typically includes interconnecting many components supplied from various manufacturers. Each of the components may include a number of geometrical features, such as size, shape and position, that may vary and still be within an acceptable tolerance range. To predict the dimensional characteristics of the completed vehicle after assembly, the interrelation or "stack-up" of the tolerances of the various components must be addressed.

[0002] For example, many vehicles are equipped with suspensions rotatably mounting vehicle wheels to a frame. To obtain optimum vehicle performance, it may be desirable to set the angular orientation of one or more wheels relative to the frame. A desired wheel position may be indicated by measuring camber, caster and toe. At least one known vehicle suspension includes special cam fasteners that vary the camber, caster and/or toe of an individual wheel by rotating the cam. Once the wheel alignment is properly adjusted, the cam may be fixed at a desired location by a retention mechanism such as a threaded fastener. To accurately set wheel alignment, the vehicle assembly manufacturing facility may be equipped with relatively large and costly alignment machines used to accurately measure the camber and caster of the vehicle wheels. Operators may be required to operate the alignment machine and adjust the cam fasteners until each wheel is within a desired specification range. At this time, the suspension components may be fixed at the adjusted position.

[0003] Accordingly, it should be appreciated that great cost and time may be expended to align vehicle wheels to account for the manufacturing tolerances of the various components. In particular, special cam bolts and/or other fasteners may be required at a number of component joints within the vehicle suspension to allow adjustment of the camber, caster and toe of each wheel. Specialty equipment may be required for measuring the position of the wheels and allowing measurement before and after alignment procedures are

conducted at the manufacturing plant. Additional burden related to the floor space, operation and manning the alignment equipment also exists. Certain warranty costs may also be associated with vehicles that may be improperly aligned at the manufacturing plant.

SUMMARY

[0004] A method of assembling a frame and suspension module includes determining locations of first and second suspension member supports on the frame. Target positions of first and second connections between the frame and third and fourth suspension members are defined based on the locations of the first and second suspension member supports. Target positions of third and fourth connections between a fifth suspension member and the first and second suspension members are defined based on the locations and the target positions of the first and second connections. The first and second suspension members are connected to the frame at the locations. The third and fourth suspension members are connected to the frame at the first and second target positions. The fifth suspension member is connected to the first and second suspension members at the third and fourth target positions.

[0005] Another method of assembling a frame and suspension module includes defining a line based on locations of first and second suspension member supports on the frame. Target positions of first and second connections between the frame and third and fourth suspension members are defined based on the line. A surface is defined based on the line and the target positions of the first and second connections. Target positions of third and fourth connections between a fifth suspension member and the first and second suspension members are defined based on the surface. First and second suspension members are connected to the frame at the locations. Third and fourth suspension members are connected to the frame at the first and second target positions. The fifth suspension member is connected to the first and second suspension members at the third and fourth target positions.

[0006] Further areas of applicability will become apparent from the description provided herein. It should be understood that the description and

specific examples are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

DRAWINGS

[0007] The drawings described herein are for illustration purposes only and are not intended to limit the scope of the present disclosure in any way.

[0008] Figure 1 is a fragmentary perspective view of a frame and suspension module of a vehicle;

[0009] Figure 2 if a fragmentary perspective view of the frame depicted in Figure 1;

[0010] Figure 3 is a perspective view of the suspension assembly shown in Figure 1; and

[0011] Figure 4 is a perspective view of a compound link also depicted in Figures 1 and 3.

DETAILED DESCRIPTION

[0012] The following description is merely exemplary in nature and is not intended to limit the present disclosure, application, or uses. It should be understood that throughout the drawings, corresponding reference numerals indicate like or corresponding parts and features.

[0013] With reference to Figure 1, a portion of an exemplary vehicle 10 includes a frame 12 and a suspension assembly 14 coupled to one another to form a frame and suspension module 15. A driveline 16 includes a transaxle 18 having a first output shaft 20 and a second output shaft 22. First output shaft 20 drives a first wheel hub 24 and second output shaft 22 drives a second wheel hub 26. A cross member 28 is mounted to frame 12 and supports transaxle 18.

[0014] Suspension assembly 14 includes a first trailing arm 30 including a first end 32 supporting first wheel hub 24 for rotation. A second end 34 of first trailing arm 30 is rotatably coupled to frame 12. A first upper control arm 36 includes one end 38 rotatably coupled to first trailing arm 30. An opposite end 40 of first upper control arm 36 is rotatably coupled to a first upper control arm bracket 42. First upper control arm bracket 42 is mounted to frame 12. The opposite side of vehicle 10 is equipped with a second trailing arm 44

having a first end 46 and a second end 48, a second upper control arm 50 having ends 52 and 54 as well as a second upper control arm bracket 56. The "second" components are substantially mirror images of the previously discussed "first" components on the opposite side of vehicle 10.

[0015] Suspension assembly 14 also includes a compound link 60 having a first end 62 and a second end 64. A first spring 66 is positioned on a first spring seat 68 mounted to first end 62 of compound link 60. A second spring 70 is positioned on a second spring seat 72. Second spring seat 72 is fixed to second end 64 of compound link 60. First spring 66 and second spring 70 are each positioned between compound link 60 and frame 12. Accordingly, compound link 60 is movable relative to frame 12.

[0016] With reference to Figures 1-4, suspension assembly 14 also includes a pivot arm assembly 74 rotatably coupled to compound link 60. A first link 76 includes a first end 78 coupled to a first portion 80 of pivot arm assembly 74. A second end 82 of first link 76 is coupled to frame 12. In similar fashion, a second link 86 includes a first end 88 coupled to a second portion 90 of pivot arm assembly 74. A second end 92 of second link 86 is coupled to frame 12. During vehicle operation, compound link 60 may move relative to frame 12. In particular, first end 62 may move relative to frame 12 in the same or opposite direction and at the same or different magnitude as second end 64 moves relative to frame 12. Lateral movement of compound link 60 relative to frame 12 is limited by pivot arm assembly 74, first link 76 and second link 86.

[0017] Figure 2 depicts frame 12 having a number of components fixed thereto including first and second trailing arm mounting sleeves 102, 104 as well as first and second upper control arm brackets 42, 56. To obtain a vehicle 10 having properly aligned wheels at initial build, one particular frame 12 is designated for assembly with one particular suspension assembly 14 as depicted in Figure 3. Suspension assembly 14 is a subassembly including first trailing arm 30, second trailing arm 44, first upper control arm 36, second upper control arm 50, compound link 60, pivot arm assembly 74, first link 76, second link 86, transaxle 18, first output shaft 20 and second output shaft 22, among others. By implementing a method described hereinafter, suspension assembly

14 may be coupled to frame 12 without the use of special cam fasteners. Furthermore, after assembly of suspension assembly 14 to frame 12, vehicle 10 may not require a wheel alignment procedure due to the accuracy of wheel position obtained at initial assembly.

[0018] In particular, the method of assembling frame and suspension module 15 includes determining the location of first trailing arm mounting sleeve 102 and second trailing arm mounting sleeve 104. A line 106 is defined based on the locations of mounting sleeves 102 and 104. A target position is calculated for the interconnection of first upper control arm 36 with first upper control arm bracket 42 based on the locations of sleeves 102, 104 and/or line 106 that the sleeves define. Similarly, a target location for the interconnection of second upper control arm 50 and second upper control arm bracket 56 is determined based on the location of the trailing arm sleeves and/or the line data. Once the target joint positions have been determined, a first slot 108 is pierced through first upper control arm bracket 42 having the nominal position or center of the slot being located at the target location. In similar fashion, a second slot 110 is pierced through second upper control arm bracket 56 having a center of the slot positioned at the target location. At this time, the frame is identified so that this specific frame may be later coupled to a particular suspension assembly 14.

[0019] Using data representing the location of first trailing arm sleeve 102, second trailing arm sleeve 104, first slot 108, second slot 110 and a location of a center point 112 of compound link 60, a response surface 113 is defined. Target locations for first through fourth compound link slots 114, 116, 118, 120 are determined based on the response surface data. Slots 114 – 120 are pierced at the target locations.

[0020] Suspension assembly 14 is constructed using the specific compound link 60 previously pierced with slots 114 – 120. A first fastener 122 extends through slots 114 and 116 to pivotally interconnect compound link 60 and first trailing arm 30. A second fastener 124 extends through slots 118 and 120 to pivotally interconnect compound link 60 and second trailing arm 44.

Fasteners 122 and 124 may be tightened at the nominal or center position of slots 114 – 120.

[0021] Once the assembly of suspension assembly 14 has been completed, suspension assembly 14 is coupled to frame 12 to form frame and suspension module 15. At this time, second end 34 of first trailing arm is coupled to first trailing arm sleeve 102. Similarly, second end 48 of second trailing arm 44 is rotatably coupled to second trailing arm mounting sleeve 104. End 40 of first upper control arm 36 is rotatably coupled to first upper control arm bracket 42 by a threaded fastener 130 extending through slot 108. Fastener 130 may be located at the nominal or center position of slot 108. Likewise, end 54 of second upper control arm 50 is rotatably coupled to second upper control arm bracket 56 with a threaded fastener 132. Fastener 132 extends through slot 110 and may be tightened when located at the nominal or center position of slot 110. Various other components including first link 76 and second link 86 are interconnected to frame 12 to complete frame and suspension module 15.

[0022] After some period of vehicle use, it may be desirable to service or replace various suspension components or align the vehicle wheels. It is contemplated that fasteners 122, 124, 130 and/or 132 may be replaced with a traditional cam bolt. Bosses or "eyebrows" 134 are formed adjacent slots 108, 110, 114, 116, 118 and 120. Each boss 134 provides a seat for each cam bolt. Rotation of one of the cam bolts moves the pivot point between the interconnected components to a different location along the respective slot through which the cam bolt extends. Accordingly, a method and apparatus exists to set the proper wheel alignment after replacing or repairing various suspension components.

[0023] Furthermore, the foregoing discussion discloses and describes merely exemplary embodiments of the present disclosure. One skilled in the art will readily recognize from such discussion, and from the accompanying drawings and claims, that various changes, modifications and variations may be made therein without departing from the scope of the disclosure as defined in the following claims.

CLAIMS

What is claimed is:

1. A method of assembling a frame and suspension module, comprising:

determining locations of a first suspension member support and a second suspension member support on said frame;

defining first and second target positions on said frame of a first connection between said frame and a third suspension member and a second connection between said frame and a fourth suspension member based on said locations;

defining third and fourth target positions of a third connection and a fourth connection, each between a fifth suspension member and one of said first and second suspension members, based on said locations and said target positions of said first and second connections;

connecting said first and second suspension members to said frame at said locations;

connecting said third and fourth suspension members to said frame at said first and second target positions; and

connecting said fifth suspension member to said first and second suspension members at said third and fourth target positions.

2. The method of claim 1 further including forming apertures through said frame at said first and second target positions of said first and second connections.

3. The method of claim 2 further including forming apertures through said fifth suspension member at said target positions of said third and fourth connections.

4. The method of claim 3 wherein said apertures are formed at opposite ends of said fifth suspension member.

5. The method of claim 1 wherein said first and second suspension members extend substantially longitudinally relative to said frame.

6. The method of claim 5 wherein said third and fourth suspension members substantially transversely extend relative to said frame.

7. The method of claim 6 wherein said fifth suspension member substantially transversely extends relative to said frame.

8. The method of claim 1 further including engaging a spring with said fifth member and said frame.

9. The method of claim 1 further including rotatably connecting said third and fourth suspension members with said first and second suspension members.

10. The method of claim 1 further including connecting a rotatable pivot arm to said fifth suspension member.

11. The method of claim 10 further including interconnecting a first end of said pivot arm to said frame with a first link.

12. The method of claim 11 further including interconnecting a second end of said pivot arm to said frame with a second link.

13. The method of claim 2 further including forming a boss adjacent to at least one of said apertures formed in said frame.

14. The method of claim 13 further including engaging a cam bolt with said boss.

15. A method of assembling a frame and suspension module, comprising:

defining a line based on locations of first and second suspension member supports on said frame;

defining first and second target positions on the frame of first and second connections between said frame and third and fourth suspension members based on said line;

defining a surface based on said line and said target positions of first and second connections;

defining third and fourth target positions on a fifth suspension member of third and fourth connections between said fifth suspension member and said first and second suspension members based on said surface;

connecting said first and second suspension members to said frame at said locations;

connecting said third and fourth suspension members to said frame at said first and second target positions; and

connecting said fifth suspension member to said first and second suspension members at said third and fourth target positions.

16. The method of claim 15 further including forming apertures through said frame at said target positions of said first and second connections.

17. The method of claim 16 further including forming apertures through said fifth suspension member at said target positions of said third and fourth connections.

18. The method of claim 17 further including connecting a rotatable pivot arm to said fifth suspension member.

19. The method of claim 18 wherein said surface is based on a location of a pivot point of said pivot arm.

20. The method of claim 15 wherein said first and second suspension members extend substantially longitudinally relative to said frame.

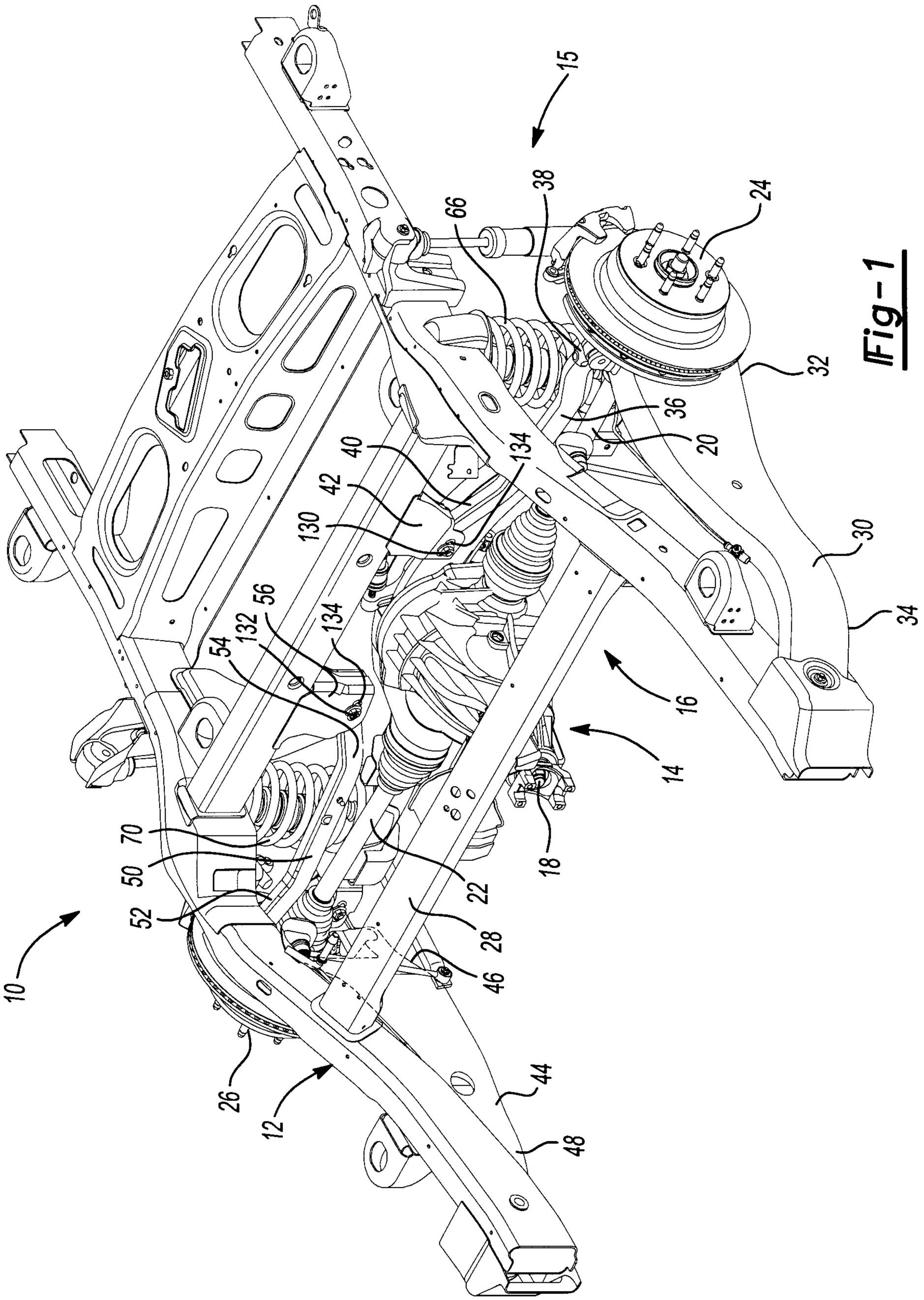
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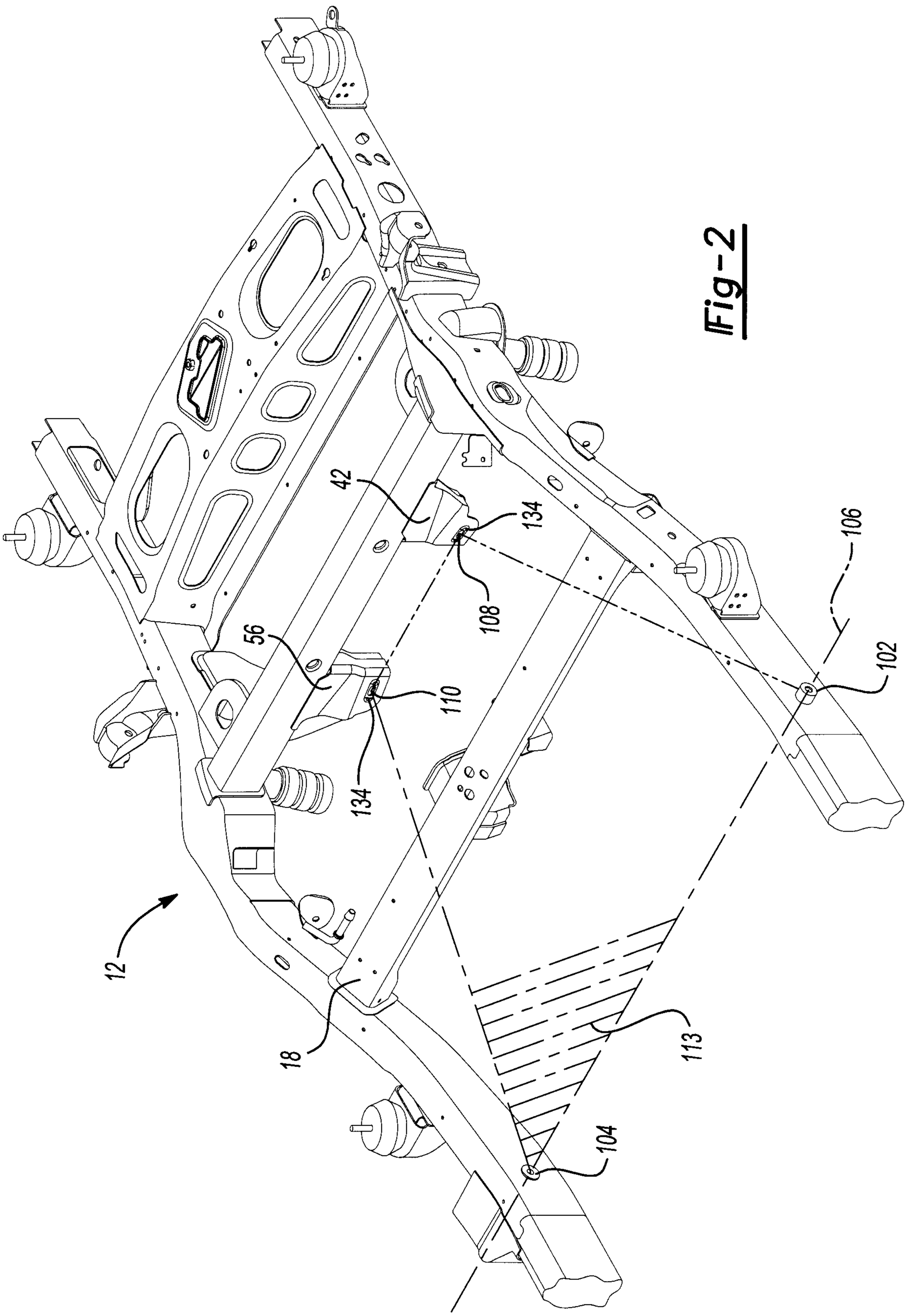
Fig-1



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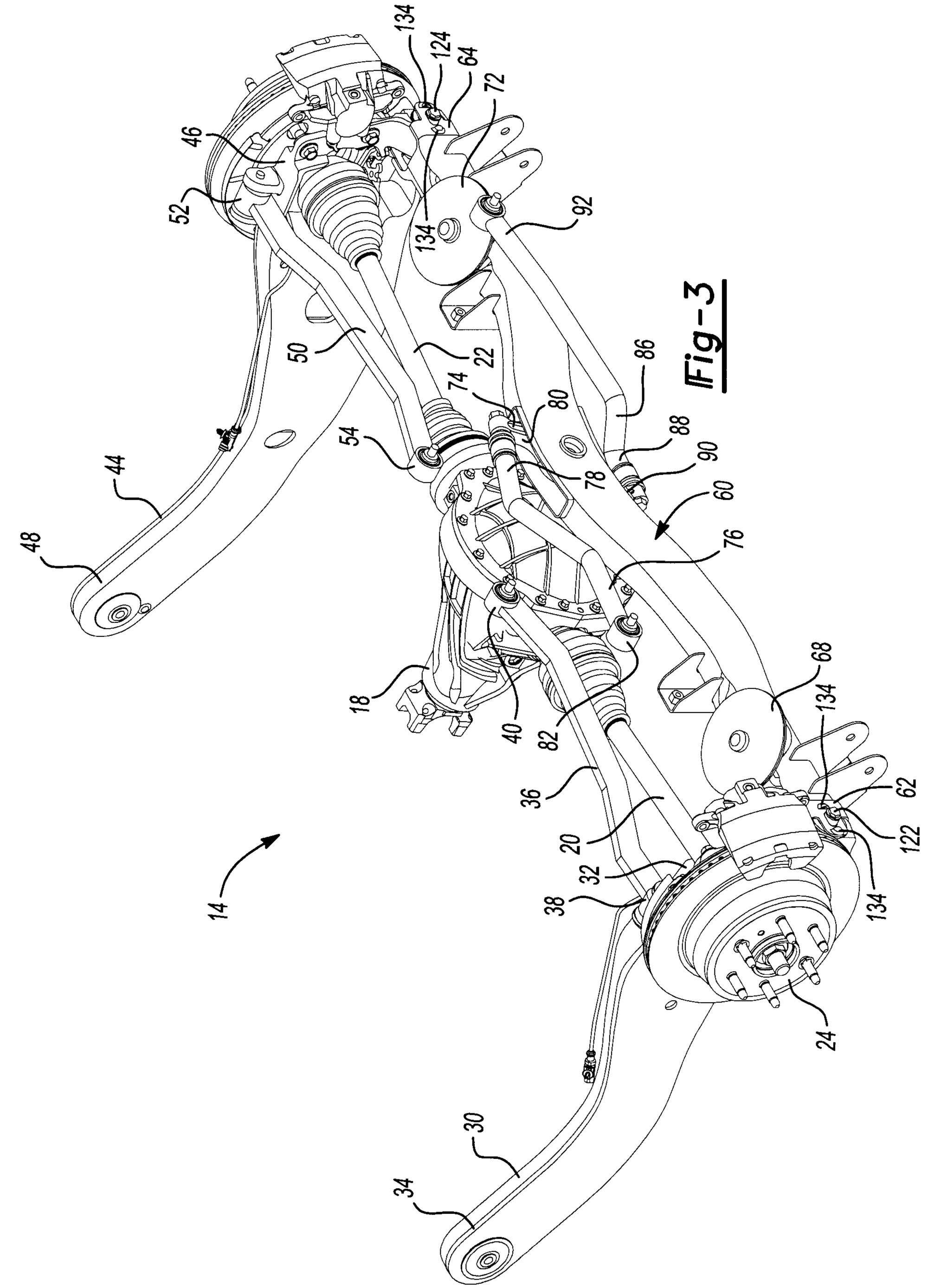
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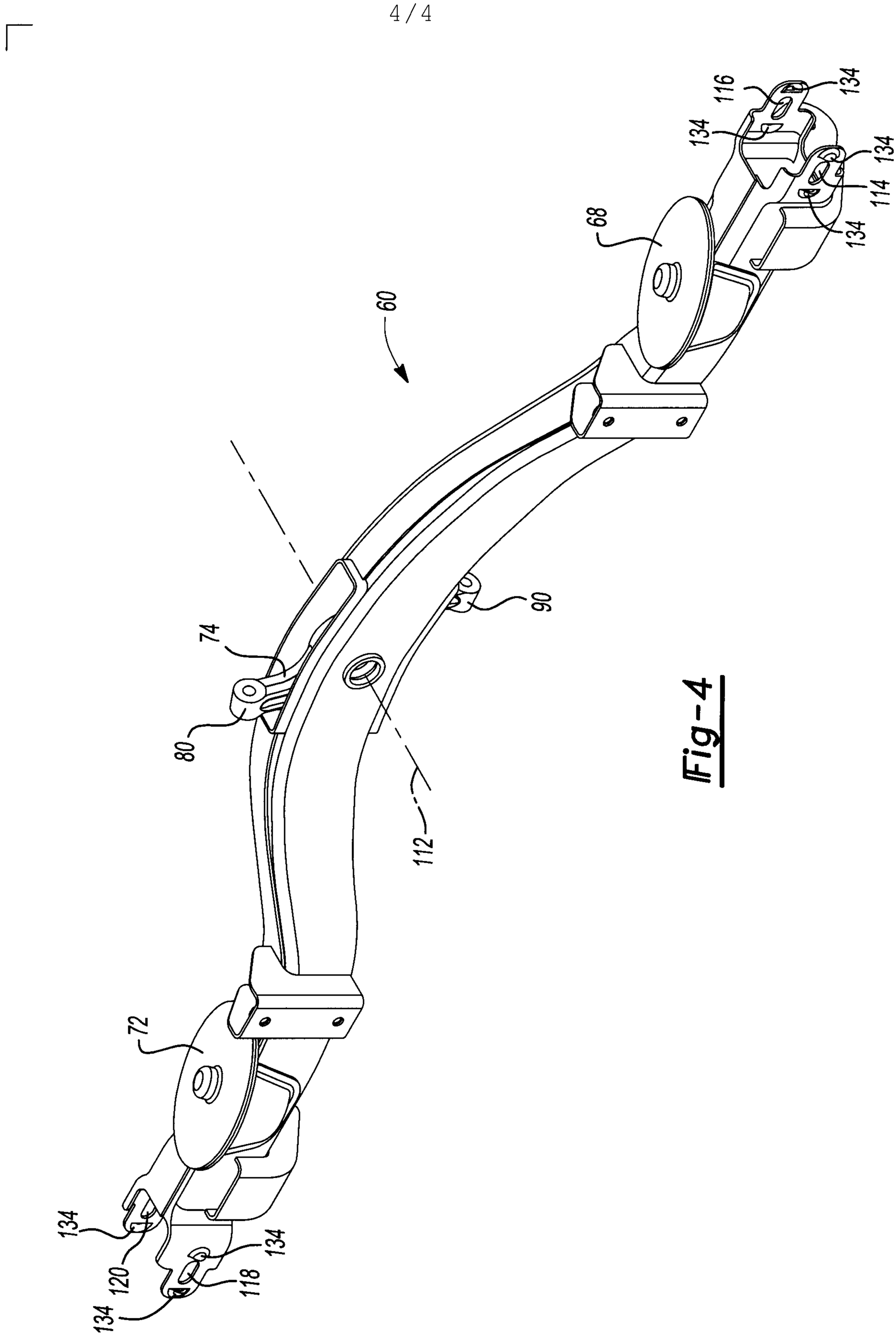
Fig-3



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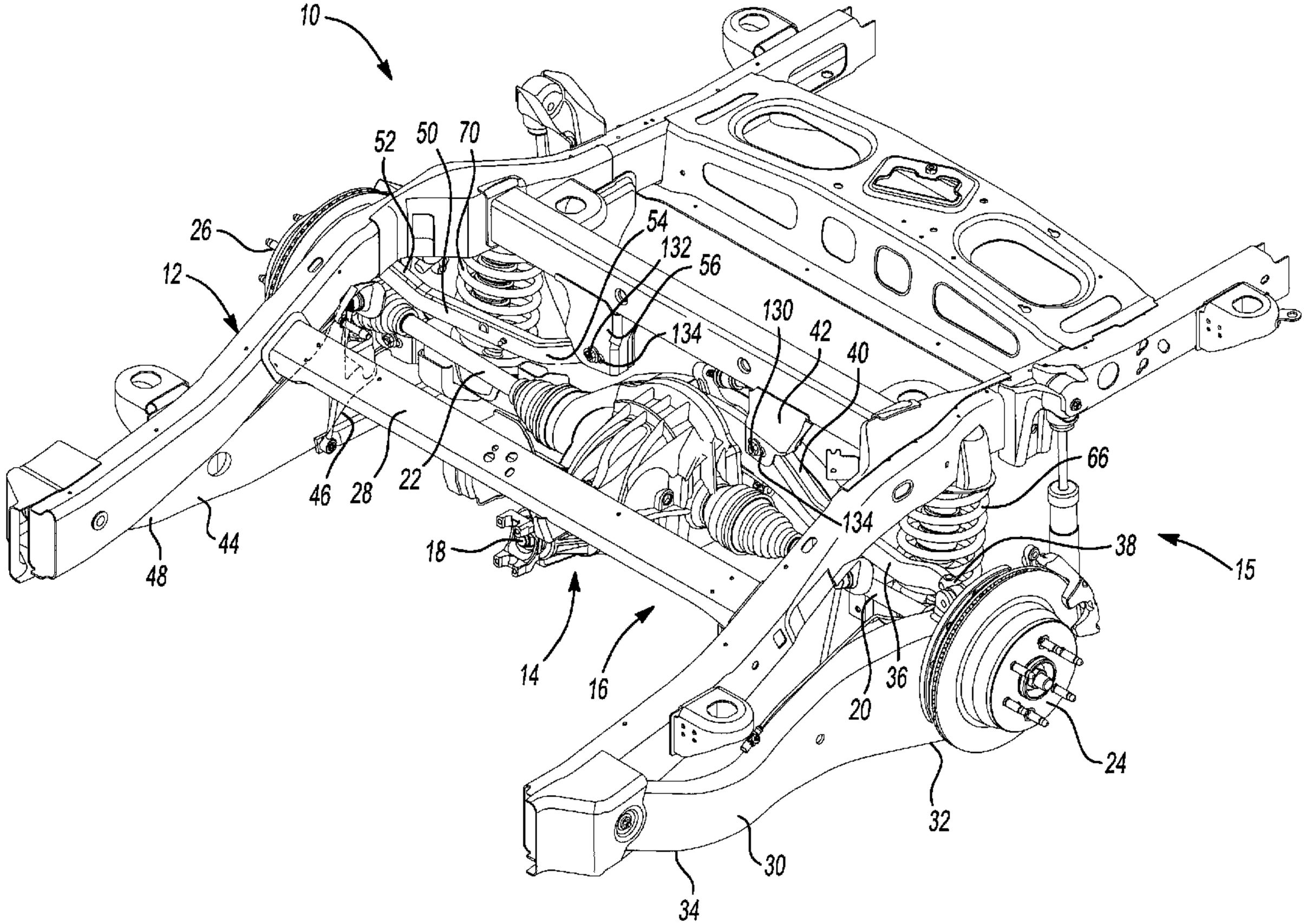
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