A SIMPLE AND NOVEL RETROFITABLE RETRACTABLE NON-TORQUE AIR SUSPENSION SYSTEM

ABSTRACT

The present invention relates to a simple and novel design of retrofitable retractable non-torque air suspension system. A non-torque reactive air suspension includes hanger brackets mounted to the L.H and R.H frames of a vehicle. Longitudinally extending arms are connected to the hanger brackets at leading end and extended parallel to the frame, the arms other ends interconnected by a cross bar extending laterally, also parallel to the vehicle axle center line. The ride air bellows one end connected to the top of the arms trailing end and the other end connected to the frame bottom. The arms having an axle pivot bore in between the ends in which an axle clamp assembly connected; this clamp assembly clamps the drive or non drive axle for the vehicle. A torque rod or control rod assembly connected at the center of the axle housing and the frame. Together with the arms, control rod assembly and brackets forms a parallelogram configuration wherein the arms form the lower link and the control rod forms the upper link. A pneumatically operated mechanism connected at the cross bar and the frame to lift the auxiliary axles in the multi axle vehicles during the vehicle running in un-laden. This pneumatic mechanism consists of a lift air bellow, mounting brackets, U-bolts and fasteners. The ride air bellows normally filled with air, if the air released from the ride air bellows and supplies the pressurized air into the lift air bellows which expands and lifts the axle-tire assembly from the road surface. When the air released from the lift air bellows and supplied to ride air bellows, the tires are lowered to the road surface and works as an air suspension system. This lifting mechanism can be retrofitable with the non-torque reactive air suspension, thus the truck tag axle and trailer axles can be made retractable.

DESCRIPTION

Field of invention

This invention relates a non-torque air suspension system for the vehicles such as trucks, trailers, buses and the like, and more in particular to such systems with simple
pneumatically operated retrofitable and retractable mechanism for lifting and lowering the auxiliary axle of a multi axle vehicle whenever necessary.

**Background of the Invention**

The purpose of the suspension systems to provide the vehicle's road holding / handling and braking for good active safety and for driving pleasure, comfortable ride, rolling stability and reasonably well isolated from road noise, bumps, vibrations, etc. The suspension also protects the vehicle itself and any cargo or luggage from damage and wear.

Various air suspensions are known to the art (US patent no 7900942B2, 7267348B1, 7178824B2). The term “air suspension” refers to a suspension equipped with air springs or air bellows for supporting a vehicle on an axle.

In heavy-duty trucks or vehicles, the rear axle experiences a high torque during acceleration and deceleration (braking). When increased torque applied to the air suspended rear axle, such as during acceleration, the truck frame rises up and away from the drive axle. This condition is known and referred as “frame rise”. Moreover, the driving torque leads driveline vibrations.

The various known air suspensions have not adequately managed the mobility versus stability. Most air suspensions that are adequately roll stable does not provide adequate mobility. Conversely, most air suspensions that provide mobility do not provide sufficient roll stability. Further, such suspensions have reduced the comfort and ride characteristics of the suspension.

Various non-reactive drive axle suspensions are known. The term “non-reactive” means, the suspension does not react appreciatively to the applied torque to axles, during acceleration and braking.

Various roll stable suspensions are also known. The term “roll stable” means that a suspension adequately resists the tendency of vehicle to roll when cornering or sharp turns.

These prior art non-torque reactive suspensions are also generally heavy and expensive to manufacture in terms of increased parts and they require lengthy installation and assembly time and complex connections, which further increases their manufacturing expense and also generally have low roll stability (US5588665, US55058917).
The present invention includes non-torque reactive suspension, in this the parallelogram geometry formed by the arm and torque rod or control rod maintains constant pinion angle where a trailing arm suspension does not. By doing this, the axle pinion angle more closely match the drive shaft angle and this minimizes driveline vibration. The cross bar interconnected between the arm trailing end, provides good roll stability, a novel and flexible connection made at this arm and the cross bar joint.

A heavy loaded vehicle rear axle normally takes about two thirds or more of the total load. In addition to the mechanical stress imposed on the vehicle’s suspension system, the subsoil stress distribution on the road for a single rear axle (Fig. 1a) will be considerably greater than that for a tandem or tridem rear axle (Fig. 1b) for similar payloads. Legislation in this country does not normally permit axle loads greater than ~10T per axle; this limit prevents rapid deterioration of the road surface and at the same time spreads the majority of load widely along the chassis by two or even more rear axles (Fig. 1b) (Patents US 6808035, US 8360451 B2, US 3918736, US 4165884).

However, high fuel consumption due to rolling forward resistance, road holding quality, poor tire and suspension parts life and low maneuverability are important issues associated with the multi axle vehicles at un-laden condition. Moreover, cornering of the vehicle is difficult (US 6769703 B1, US 6883813 B2, US 3285621). In order to reduce the above described problems associated with the multi axle vehicles, the auxiliary axles can be lifted off from the road surface during a partially loaded condition and/or un-laden condition (i.e., empty) of the vehicle, by using a suitable mechanism. FIG. 2a & 2b shows the schematic of a multi axle vehicle in which the auxiliary axle normal and lifted conditions, respectively.

A number of different types of hydraulically liftable auxiliary axles proposed in U.S Patents (US3936072, US20110175301A1, US8522933B2, and US3771812). This lifting system suffers from several problems such as heavy construction and relatively expensive and high operating cost. A problem associated with the liftable auxiliary axle is that the lifting mechanisms subjected to extremely high shock forces when the vehicle operated over undulated roads. The shock forces transmitted to all the components of lifting mechanism as well as the axle assemblies too. Such shock forces may damage the components of lifting mechanism, including hydraulic cylinders. It leads to high maintenances (US 4134604). Moreover, the all components lifting mechanism are also
subjected to side thrust forces (i.e., lateral forces) while the vehicle cornering. The side thrust forces produce a high strain on the cylinder seals, which leads to a premature failure of the hydraulic cylinder (US 4134604).

Implementation of lifting mechanism in the air spring suspension vehicle is relatively simple and also practically possible. Numerous types of lift axle suspension systems have been designed (US 6398236B1, US 6311993B1, US 7396028B2, US7854436B2, US 6435526B1, US 4342265, US 3771712, US 4171830, US3237957). In these air suspensions, an expandable and retractable air bellows used, in which one air bellows expanded to lower, while another air bellow to lift the auxiliary axle from road surface. These lifting systems required more lifting force and not simple for retrofit. In many liftable air suspensions does not sufficiently permit to lift the axle from the ground surface due to the interference of various vehicle frame elements.

The present invention includes a lifting mechanism, which proposes a simple, less lifting force, low cost, and retrofitable with the non-torque suspension for a multi axle trucks and trailers.

In this perspective, the present invention “liftable non-torque air suspension” proposes a simple, more flexible, low cost, retrofittable lifting and lowering mechanism for the vehicle axles. In this system without lifting mechanism, it can use as a non-torque air suspension system for both the drive and auxiliary axle.

**Summary of the invention**

The present invention directed to a non-torque reactive air suspension, exhibiting excellent ride and handling characteristics with simple retrofitable liftable mechanism. The suspension includes hanger brackets mounted to vehicle frame extending longitudinally on opposite sides of a vehicle. Longitudinally extending arms are connected to the hanger brackets at leading end and extended parallel to the frame, the other end connected with the cross bar which extending laterally across the vehicle centerline by a novel joint. The arm having axle pivot bore at the middle to connect the axle by the axle clamp assembly. A V-shaped torque rod or control rod assembly connected at middle of the axle housing and frame. Together with the arms, control rod assembly and brackets forms a
parallelogram configuration. A simple pneumatically operated system connected at the center of the cross bar and frame for lifting and lowering the auxiliary axle for a multi axle vehicle. The mechanism can be mounted in retrofitable manner with the above said non-torque air suspension system (Fig. 32). The lifting mechanisms have few parts and consume relatively less space. The operator or driver of the vehicle can lift and lower the auxiliary axle from cabin itself by a simple control switch. The present invention applicable for buses trucks and trailer.

The main objective of this invention is a novel concept of attaching liftable mechanism with the cross bar, this simple mechanism to lift the auxiliary axle to a height of ~120mm to ~150 mm from the road surface at low cost, low maintenance and less lifting force.

Another objective of the invention is the shape or profile of the arm at the trailing end.

Another objective of this invention is a novel joint at cross bar and arm trailing end, exhibiting excellent roll stability characteristic during vehicle operation.

Another objective of this invention is a novel ride air bellows bottom mounting bracket also used as a joint for cross bar and arm.

Another objective of this invention is a liftable mechanism which can be retrofitable mounted to the cross bar and chassis frame with the air suspension system.

Another objective of this invention, the lifting mechanism can be attached with the rear drive axle cross bar to lift the rear drive axle of multi axle vehicle which is having a suitable coupling joint to disconnect from the drive axle while vehicle at un-laden.

Another objective of this invention, the lifting mechanism provides a simple mechanism which can be operated by normally available compressed air in a vehicle with an additional air storage cylinder.

Another objective of this invention is to provide a liftable mechanism can be easily mounted in the vehicle without modifying the existing components of the non-torque suspension system.

Another objective of this invention is to provide a simple liftable mechanism and suspension components that can be easily manufactured.
Another objective of this invention is a new shaped torque or control rod with I-shaped cross section leads high strength to weight ratio.

An objective, the top clamp for the axle clamp assembly includes a bump stop and the bottom clamp also preferably includes shock damper mounting features.

Yet another objective, inside the lift air bellows a rebound stop included.

**Application requirements:**

Air springs can operate over a very narrow bounce frequency with considerable changes in vehicle laden weight. Consequently the quality of ride with air springs maintained over a wide range of operating conditions.

The non-torque suspension system does not react appreciatively to the torque applied to a drive and non drive axles, during acceleration and braking. The suspension cross bar provides the high roll stability of vehicle when cornering or sharp turns.

When a vehicle carries a full load, a multi axle rear suspension meets the safety regulations, subsequently improved road holding and adequate ride comfort. If a multi-axle suspension operated below half of the maximum load (un-laden), the quality of road holding and ride deteriorates, and increased in wheel bounce causes tire wear. Lifting the auxiliary axle from the road surface extends tire life, reduces rolling forward resistance of the vehicle and therefore reduces the fuel consumption.

**BRIEF DESCRIPTION OF THE DRAWING:**

The following description refers the figure and drawing which describes the invention.

Fig. 1 shows the road stress distribution in four wheeled and multi-axle vehicle
Fig. 2 shows the auxiliary axle normal and lifted position in multi-axle vehicle
Fig. 3 is the schematic view drive axle non-torque air suspension and liftable axle suspension assembly in a multi axle vehicle
Fig. 4 is the schematic view drive and liftable axle suspension assembly with axle tires
Fig. 5 is the schematic of drive axle non-torque reactive air suspension
Fig. 6 & Fig. 7 shows the outside and inside view of arm

Fig. 8 & Fig. 9 shows the different views of hanger bracket with two different concepts

Fig. 10 shows bushing assembly for the joint at arm and hanger bracket

Fig. 11 shows the schematic disassembled view of arm with hanger bracket

Fig. 12 is the schematic of disassembled view of arm and axle pivot bracket

Fig. 13 & Fig. 14 shows pivot pin & axle pivot bracket 3D view

Fig. 15 & Fig. 16 shows ride air bellows bottom mounting bracket and its connector plate

Fig. 17 is the different views of ride air bellows bottom mounting bracket assembled with corner plate

Fig. 18 & 19 schematic view of cross bar & disassembled view of arm and cross bar joint

Fig. 20, Fig. 21 & 22 shows the different concepts for control rod or torque rod

Fig. 23 shows isometric view of ride air bellows

Fig. 24, 25, 26, 27, 28 & 29 are shoes the 3D view of shock absorber, ride inside top mounting bracket, ride air bellows top mounting bracket, axle top clamp, bump stop & drive axle

Fig. 30 & 31 shows the schematic of control rod big and small end brackets

Fig. 32 & 33 shows the schematic view and its side view of liftable air suspension assembly

Fig. 34 & 35 shows the schematic view of lifting mechanism with ride air bellows & its different views

Fig. 36 & 37 is the ride air bellow bottom & top bracket & Fig. 38 shows the different views of lift air bellows

Fig. 39 & 40 shows the ride air bellows inside top bracket for liftable axle & U-Bolt

Fig. 41 & 42 is the schematic view of axle lifting mechanism & its disassembled view

Fig. 43 is the schematic view of auxiliary axle torque rod clamping assembly
DETAILED DESCRIPTION OF THE INVENTION:

Fig. 3 & 4 illustrate the components associated with a multi axle vehicle having non-torque reactive liftable air suspension system. The vehicle includes longitudinally extending preferred C-shaped LH (5) & RH (6) frame. The vehicle further includes a drive axle (2) & non-drive auxiliary axle (3) illustrated in fig. 3, 5 & 32. The drive axle (2) and non-drive axle (3) for the vehicle extends laterally across the vehicle and used to mount the tires (92) (Fig. 4). The vehicle rear suspension includes a non-torque reactive drive axle air suspension (Fig. 5) & non-torque reactive with liftable air suspension (Fig. 32) and forming a tandem axle assembly. It understood that a suspension system according to the present invention may be used with only a single axle assembly if desired.

The majority of the components in the suspension system (Fig. 3, 4, 5 & 32) positioned in one side (LH) of the vehicle will have the similar components positioned on the other side (RH). Accordingly, in this detailed description, when reference made to a particular suspension component, it will be understood that a similar component presented on the opposite side of the vehicle, unless otherwise specified.

Non-torque air suspension (Fig. 5) consists of hanger bracket (8) mounted on opposite sides of the frame (5 & 6), longitudinally extending arms (9) connected at one end to a hanger bracket (8) through a bushing assembly (Fig. 10) and a washer (34) at each sides of the bushing assembly, which allows axle adjustment for the suspension system. The bolt (35) used to connect the arm (9) with hanger bracket (8) through the bushing assembly (Fig. 10).

Uniquely designed different concepts of hanger brackets are shown in fig 8. Holes (29) provided to assemble this bracket to the frame at the surface 31, profile 26, 27, 28 & 30 to increase the strength. Inner view shows in fig. 9. Bracket inner also having rib or stiffener to increase the bracket strength, two legs (68) provided for holding the arm.

Bushing assembly (Fig. 10) having a sleeveless bushings and has an outer surface (33) trapped and compressed between the arm bore positioned at the leading end (20) and hollow sleeve shaft (32). The bushing outer surface (33) reacts against vehicle roll as the vehicle moves sharp turns and the trapped conical rate of the bushing provides additional roll stability. The arm (9) with bushing assembly positioned into the hanger
bracket holder (68), and connected by bolt (35) and nut (36) joints through the hollow shaft (32) (Fig 11).

The other end of the arms (11) (both the LH & RH) interconnected with cross bar (12), by an arm-to-cross bar connection assembly (Fig. 19). The cross bar welded (95) at each ends with two plates (45), the arm end (11) having a square shaped grooved bore (24) at the inner trailing end and four holes (22) provided for fastener. The cross bar (12) directly inserted into the arm (9) grooved bore (24), then the ride air bellow bottom bracket (42) inserted at the top, the closing plate (43) (fig 17) placed at the proper place (96), the bolts (46) inserted through the holes (22) and tightened with nuts (47). The bolt (46) can be inserted inward or outward direction. The arm (9) having I-shaped profile (23 & 25) for high strength to weight ratio.

The cross bar (12) forms an anti roll bar which lifts and rotates at cornering, and this cross bar is the primary component contributing to roll stability for air suspension system. The secondary component for the roll stability of the suspension is the bushing assembly (Fig. 10) which used to connect the arm (9) with hanger bracket (8) (Fig. 11).

The arm having an axle pivot bore (21) around the middle, through which the axle clamp (10) positioned by the pivot (37). The bolts (38) and nuts (39) used to tighten the pivot pin (37) with the axle pivot clamp (10) through the holes (40) provided in the pivot pin (Fig 12). The outside diameter of the pivot (37) smaller than the arm bore diameter (21), therefore the axle which connected with the axle pivot clamp (10) freely rotate about the arm bore (21). The axle top clamps (94) placed on the axle top housing to connect with the axle clamp pivot bracket (10) through the U-bolt (91) and nut joints.

The axle top clamp (94) having ribs (62) to hold the bolt (91) at top surface (60) and also having metal surface (61) to touch with the bump stop bracket (58) to act as stopper while the axle moving bumps.

The axle pivot clamp (10) having the provision (41) to mount the shock absorber (19) at one end (54), the other end (53) mounted with the bracket (18) by fasteners.

The ride air bellows (67) bottom end connected with bracket (42) by screws (87); the top end (50) connected at the ride air bellow top mounting bracket (17) which is
mounted at the frame (5 & 6) outer and with top mounting bracket (16) or bracket (69) for liftable air suspension system (Fig. 32) which mounted at the frame (5 & 6) inner by screws (87). The bracket (16) having holes (55) to mount with frame inner, holes (56) provided to mount the air bellows (67) & holes (57) to mount the air bellows adaptors to supply the air into the air bellows.

Axle connected with torque rod or control rod or V-rod (13) big end which having a big end (48) and two small ends (49). Different shaped control rods shows in Fig 20, 21 & 22. These I-cross section shaped control rods interconnected, these interconnection also I-shapes or circular shapes and forms different concepts. Any one of these control rods big ends (48) connected in the drive axle through the mounting bracket (15) through holes (66) and the other ends connected at the torque rod bracket (14) holes (97) which connected at the frame inside through the holes (67) by fasteners. For the liftable non-torque air suspension system (Fig. 32), torque rod (13) big end mounted in the v-rod mounting bracket assembly (Fig. 43) which mounted in the middle of the non drive axle (3). This auxiliary axle clamping assembly (Fig. 43) consists of axle top (74) and axle bottom (88) brackets, both the brackets are connecting the auxiliary axle by U-bolts (89) and nuts (90). The combination of arm, torque rod and brackets makes the parallelogram configuration to prevent the axle from turnover and act non-reactive to the torque.

The bump stop (58) mounted at the both sides of the frame (5 & 6), to stop the upward axle movement from some extent when the axle experiences any bump. The rubber bumper will be mounted at the bump stop bottom (98) and top of the axle top clamp (61). When the axle experience any jounce or bump the axle top clamp (94) will strike the bump stop (58) bottom surface and the vertical load will pass through the top clamp (58) directly into the clamped axle (2 & 3). As a result, the axle jounce travel limited. The amount of axle travel during jounce can be tuned by changing the vertical position of the bump stop (58), or by changing the axle top bracket height (61).

The lifting mechanism (Figs. 34, 35, 41 & 42) for the auxiliary liftable axle (3) will be mounted at the middle of the cross bar (12). Fig 35 shows the front, top and side view of the lifting mechanism (60), with ride air bellows.

The lifting mechanism (Figs. 41 & 42) consists; lift bellows top (70) and bottom (75) brackets, a single lift air bellow (73), U-bolts (71) for connecting the cross bar (12).
The top and bottom brackets (Fig 36 & 37) consists of two plates (81 or 82) & (80 or 85) welded together around the corner and in this one plate (80 or 85) bended at middle and forms U-shapes. The bottom lift bellows mounting bracket (75) connected with the specially designed inside ride bellow top mounting bracket (69) with the bots (76) and nuts (77) through the holes (79). The brackets (69) & (74) need to be interchanged with brackets (16) & (15) and the bump stop (58) removed from the non-torque air suspension system to retrofit the lifting mechanism (Fig. 42). The maximum lift height controlled by rubber stop which mounted inside the lift air bellow (73). The lift air bellows (73) bottom mounted at the bottom bracket (75) with screws (87) through holes (78) on the bracket; the top side attached with the top bracket (70) with screws (87) through holes (83) on the bracket. The lifting U-Bolts (71) are inserted to the top mounting bracket holes (84) from the bottom of the auxiliary axle (3). Wire rope or chain can be used instead of lifting U-bolts (71). The lifting mechanism connected at the rear most end of the suspension, therefore less lifting force enough to lift the auxiliary axle at un-laden.

OPERATION OR WORKING PRINCIPLE OF THE INVENTION:

Fig. 3 & 4 shows the schematic of dive axle non-torque air suspension (Fig. 5) and auxiliary axle non-torque liftable air suspension (Fig. 32) attached with the vehicle frame. For the operation of suspension (Fig. 5), the air from the air compressor supplied to the ride air bellows (67) through the leveling and unloading valve (not shown). The leveling valve used to maintain the constant ride height i.e. the distance between the axle top to frame bottom. The air pressure actually reaching the spring may vary from 5.5 bars at fully laden to 2.5 bars with empty vehicle to maintain the constant ride height.

The above said same operation involved in the liftable non-torque air suspension system (Fig. 32) whiles the vehicle at full laden condition. When the vehicle became empty or partial loaded condition the lifting mechanism operates thus the auxiliary axle will be lifted from the ground surface. The load sensing valve mounted in the frame (not shown) used to sense the vehicle load, when the vehicle load reduced to predetermined stage the air from the ride air bellows (67) removed and supplied to the lift air bellow (73) at ~6 to 8.2 bar by a switch which mounted in the driver front panel through the lift axle control kit (not shown), thus the axle lifted. The maximum axle lifting distance controlled
by rubber stop and this rubber stop mounted inside the ride air bellows. When the vehicle loaded above the predetermined load, the air supplied to the ride air bellows (67) and removed from the lift air bellow (73). Thus the auxiliary axle (3) lowered to the ground or road surface.

CLAIMS:

What is claimed as new is as follows:

1. I claim this Non-torque liftable air suspension system for vehicles comprises:
   a. an axle with tire assembly (2 or 3, 92);
   b. hanger bracket (8) attached to said axle outside of the frame,
   c. arms (9) connected at the hanger bracket (8) with the holder and bussing assembly (fig. 11), and extending parallel to the frame;
   d. specially designed cross bar (12), to interconnect the trailing ends of said arms (LH & RH) with novel joint (fig. 19) to provide suspension rolling stability;
   e. torque rod (13) connected at frame inner with brackets (14) and the axle at middle with brackets (15 or 74);
   f. ride air bags (67) mounted said arm to vehicle frame with suitable brackets (16) (17) (69),
   g. A simple lifting mechanism, which consists of brackets (70) (75), lift air bag (73), lifting U-bolt (71) and frame mounting bracket (69).

2. The lifting mechanism according to the claim 1, attached at the middle of the cross bar (12) and having only one lift air bags (73) to lift the axle.

3. According to the claim 1, the lifting mechanism mounting brackets are simple, the lift air bag bottom mounting bracket (75) directly attached with specially designed ride air bag inside top bracket (69).

4. This claims the lift air bag top and bottom mounting brackets (70 & 75), brackets having two plates welded together around the corner in this one plate formed U-shaped bend at the middle. Holes provided to mound the air bellows.

5. This claims the ride air bellow inside top bracket (69). This bracket specially designed to connect the lift air bag bottom bracket (75), a simple U shaped base plate bended at each ends forms L shapes to connect with vehicle frame, one more U-
shaped plate inserted with steel tube and welded at middle with U shaped base plate, plate with tubes welded at the tip of the bracket to connect the bottom lift bracket (75) with fasteners.

6. This invention claim according to the claim 1, the lifting special shaped U-bolts (71) attached with lift air bellow top bracket (70).

7. This invention claim Lifting U-bolts (71) according to the claim 6 can be replaced with steel wire or steel chain.

8. According to the claim 7, if the cross bar connected with lifting U-Bolt, maintained gap in between the cross bar bottom surface to the inner surface of U-Bolt for suspension rebound.

9. This invention claims the shape of the arm, the arm having I-cross section and specially designed trailing end. Rectangular grooved profile (24) makes at the trailing end to connect the cross bar, 4 holes provide to insert the long bolt.

10. This invention claims the shape of the cross bar said in claim 1, having hollow rectangular or circular or elliptical cross section. Each ends are welded with two bended plates and its act as a lock.

11. According to the claim 10, if the cross bar hollow circular or elliptical cross section, the ends are rectangular cross section at outer by welding the casted block instant of bend plate said in claim 11.

12. This invention claims the shape or profile of the ride air bag bottom mounting bracket (42) and connector plate (43) according to the claim 1, used as a joints for cross bar and arm.

13. According to the claim 1, rubber stop mounted at the bottom side of the lift air bellow bottom bracket and inside the ride air bag, which controls the maximum lifting height.

14. According to the claim 1, rebound rubber stop mounted inside the lift air bellow for liftable suspension.

15. This invention claims the different configurations of torque rod or control rod (fig. 20, 21 & 22) according to the claim 1, with I-shaped cross section for high strength to weight ratio.
According to the claim 1, this invention claims the shape or design of the hanger bracket (8) at inside and outer surfaces (fig. 8 & 9). Holes (29) provided to assemble this bracket into the frame in the surface 31, profile 26, 27, 28 & 30 to increase the strength, inside view shown in fig. 9. Rib or stiffener provided at the inside of the bracket to increase the strength, two legs (68) provided for holding the arm.

According to the claim 1, this invention claims the novel bracket profile (74) for mounting torque rod with auxiliary axle for liftable suspension system.

According to the claim 1, suspension sub-assembly, comprising: An arm (9) extending in longitudinal direction, hanger bracket (8), axle connector (15) or (74) and torque rod (13) forms a parallelogram mechanism.

According to the claim 1, lifting mechanism can be retrofitable with the non-torque air suspension system.

FIGURES:

(a) Four wheeled (2 axle) vehicle

(b) Multi-axle vehicle

Fig. 1 Road stress distribution in (a) Four wheeled and (b) multi-axle vehicle
(a) Auxiliary axle in normal position

(b) Auxiliary axle in lifted position

Fig. 2 Auxiliary axle normal and lifted position in multi-axle vehicle

Fig. 3 Schematic view Drive and Liftable axle suspension assembly in MAV
Fig. 4 Schematic view Drive and Liftable axle suspension assembly with axle tires

Fig. 5 Schematic of drive axle non-torque reactive air suspension in vehicle
Fig. 6 View of outside of the Arm

Fig. 7 View for inner side of the arm

Fig. 8 Hager bracket outside with two different concept
Fig. 9 Hanger bracket inside view

Fig. 10 Bushing Assembly

Fig. 11 Schematic of assembly of Arm with Hanger bracket
Fig. 12  Schematic of disassembled view of Arm and Axle pivot bracket

Fig. 13  Pivot pin

Fig. 14  Axle pivot clamp

Fig. 15  Ride air bellows bottom mounting bracket

Fig. 16  Connector plate
Fig. 17 Different views of Ride air bellows bottom mounting bracket

Fig. 18 Schematic view of cross bar

Fig. 19 Disassembled view of Arm & Cross bar joint
Fig. 20 Control rod or torque rod – concept 1

Fig. 21 Control rod or torque rod – concept 2

Fig. 22 Control rod or torque rod – concept 3
Fig. 23 Isometric view of ride air bellows

Fig. 24 Shock absorber

Fig. 25 Ride inside top mounting bracket

Fig. 26 Ride air bellow top mounting bracket

Fig. 27 Axle top clamp bracket

Fig. 28 Isometric view bump stop

Fig. 29 Isometric view of drive axle
Fig. 30 Control rod big end bracket  
Fig. 31 Control rod smaller end bracket  

Fig. 32 Schematic view of liftable air suspension assembly
Fig. 33 Schematic side view liftable air suspension assembly

Fig. 34 Schematic view of lifting mechanism with ride air bellows

Fig. 35 Different views of lifting mechanism
Fig. 36 Ride air bellow bottom bracket

Fig. 37 Ride air bellow top bracket

Fig. 38 Different views of Lift air bellows

Fig. 39 Ride air bellows inside top bracket for liftable axle

Fig. 40 U-Bolt
Fig. 41 Schematic view of axle lifting mechanism

Fig. 42 Lifting mechanism disassembled view
Fig. 43 Schematic view of auxiliary axle torque rod clamping assembly