Utility vehicle lightweight chassis with build-in wheel alignment mechanism

Presented here is a rigid, non-driven lightweight chassis for utility vehicles that offers a significant weight advantage and suspension properties, and includes a build-in mechanism for cost-effective wheel alignment. The chassis is designed especially for trucks and trailers, as well as busses. Besides the significant weight advantage, it offers optimized suspension properties and allows for increased payload, due to its reduced tare weight. All without sacrificing stability.

Challenge

Rising energy costs demand improved transport sector efficiency. Efficiency improvements can be realized by application of lightweight construction technologies. As the maximum admissible total weight of utility vehicles is legally restricted, chassis weight savings directly allow increased potential payload capacity.
The construction design of chassis however, is tied to certain boundary conditions. As such, mechanical requirements, such as resilience to bending moments, especially at the trailing arms, have to be fullfilled. In addition, geometrical aspects, such as the placement of the suspension elements, have to be met to keep ride height at a miminum. Weight savings by use of modern materials such as composites, often fail due to high costs of such materials. In addition, current chassis designs are rather unsuitable for the use of carbon-fiber reinforced materials. Notch stress and bending moments are simply too high.
Further cost saving potential lies in minimizing production tolerances. Wheel alignment is key to driving stability and tire wear. However, production tolerances require post-production chassis corrections that bare significant additional costs. It is thus beneficial to minimize production tolerances that need costly adjustment of chassis alignment, or simplify the wheel alignment procedure.

Our Solution

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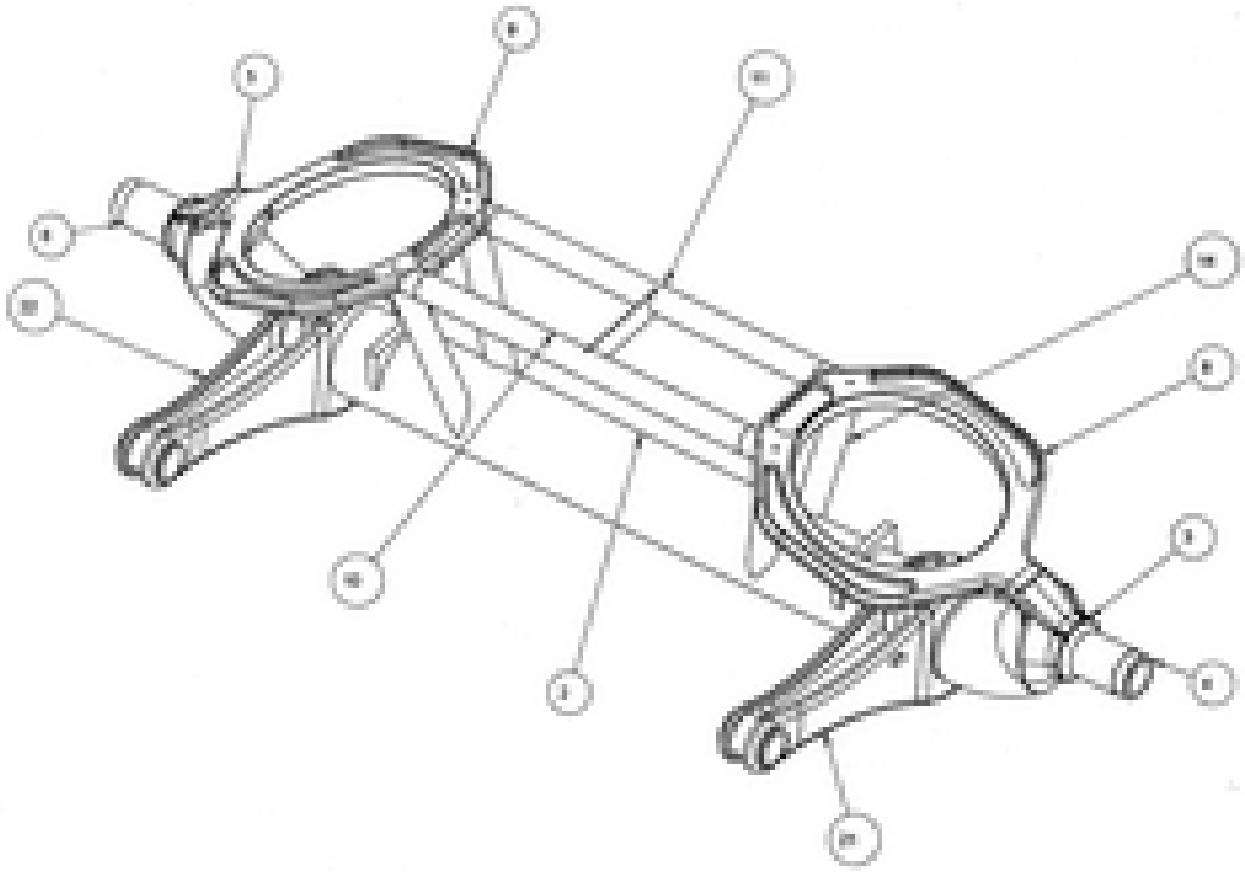

Presented here is a rigid, non-driven lightweight chassis for utility vehicles that offers a significant weight advantage and improved suspension properties. In addition it includes a build-in mechanism for cost-effective wheel alignment.
The presented chassis, even when build with standard steel components, offers a significant weight advantage over conventional chassis designs. The key advantage of this new design is that primarily pressure and tensil forces are being transmitted, bending moments are mostly avoided. Thus, this new chassis could also be produced from carbon-fiber reinforced materials, which would result in enormous weight savings. However, even as a standard steel construction, the chassis is significantly lighter then conventional constructions. The ring-shaped upper braces allow placement of the suspension elements close, or even directly above the axle, which leads to direct force transmission into the suspension, while the dropped lower brace keeps the overall height low. Taken together, this design significantly improves suspension properties and helps constructing weight-optimized trailing arms. The adjustable upper cross braces furthermore allow easy and cost-effective wheel alignment and compensation of production tolerances.
Together, reduced height, weight advantage and thus increased payload, cost-effective production and minimized tire wear result in substantial cost savings. In addition, the specific construction design allows for easy integration of electric motors close to wheel hubs, which makes it particularly attractive for the increasing e-mobility sector.

Advantages

- Energy savings due to weight advantage (fuel consumption)

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- cost savings due to cost effective wheel alignment
- increased payload due to low height and tare weight
- optimized suspension properties through direct force transmission into suspensions
- reduced wear due to minimized unsprung mass

Applications

- rigid non-driven axles of trucks and trailers, as well as bus axles
- additionally well suited for e-mobility, due to easy integration of electric motors close to wheel hubs

Development Status

Mechanical stability was tested by simulations and CAD-drawings of all parts exist. A demonstrator was constructed.

Specifications of a prototype:

Achslast	9 t
Radspur	2040 mm
Lenkermitte	1300 mm
Balgmitte	1200 mm
Abstand Achsmitte/Drehpunkt	500 mm
Luftbalgdurchmesser max.	360 mm
Fahrhöhe	> 300 mm
Fahrwerk komplett (fahrbereit)	< 350 kg mit 19,5" Bremse (Stahlvariante)
davon Fahrwerk-Tragwerkstruktur	ca. 95 kg (s. Abb. 1)
2 g Vertical load Test	dauerschwingfest
Roll Test	Betriebsfest (> 100.000 Zyklen)
Vorspur/Sturz	einstellbar < 0,1°
Nabe/Räder	19,5" /22,5"
Bremse	19,5" /22,5"

Patent Status

Disclosed patents and patent applications:

US patent granted: US1220663B2
European patent application: EP3257691A1
Chinese patent application: CN107521300A

Patent holder:
University of Applied Sciences and Arts Hildesheim/Holzminden/Goettingen (HAWK)

References

Press release (in german) including video: "Light axle: less fuel consumption, lower production costs"
Direct link to the video (youtube): "Lightest 9to axle ever built"
Flyer IAA Commercial Vehicles 2018: "Lightest 9to Axle Ever Built"
World premiere at IAA Commercial Vehicles 2018: "HAWK presents lightest 9to truck axle of its kind"

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