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Replacement Front Suspension System For Telescopic Forks On Sports Motorcycles.

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Abstract

Due to known performance deficiencies, it has long been accepted telescopic forks have reached the end of their development cycle as a means of front suspension for sports and race orientated motorcycles, yet a replacement design has never gained common acceptance.

The following performance criteria has made it difficult to replace telescopic forks: Feedback from the front wheel to the rider is optimized with telescopic forks; simplicity, with the fork legs being utilized as both springing/dampening units and as structural members; packaging, with telescopic forks being so structurally compact; and, a low polar moment of inertia associated with steering motion.

Telescopic forks have issues from being poorly braced in the plane of greatest forces being subjected to, both with their structural design and for the overall motorcycle chassis design for (horizontally) incoming loads; react as leverage upon the steering-head, therefore the main frame has to be overly braced to support them; can only operate at a 1:1 springing ratio, which is not ideal for optimum suspension action; have a structural design that is nearly impossible to design lateral flex into the fork legs of; and, for race orientated motorcycles, they do not operate sufficiently after an inclination steeper than 19.5 degrees of steering-head angle when the optimum steering-head angle should be around 15 degrees [1] of rearwards inclination, further, the optimum front wheel travel path is around 11 degrees [2] of rearwards inclination.

The issue of ratio between un-sprung and sprung weight does not usually apply, with the components of whatever front suspension system is being utilized, because the mass of components is similar from most designs.

The five common alternative front suspension systems to replace telescopic forks, are: - leading link (Earles forks), girder forks, parallelogram (Hossack), hub-center, and, trailing link. All other designs utilizing telescopic members structurally are basically a continuation of telescopic fork design thereby can be instantly dismissed as a replacement design.

Leading link (Earles forks) front suspension has a fundamental flaw [explained in the main text] therefore is considered dangerous on modern race orientated motorcycles, thereby is instantly dismissed as a replacement for telescopic forks.

Girder forks designs of front suspension are slightly more complex than telescopic forks thereby reduce rider feedback due to having a more convoluted connection between the front wheel and the rider, though this design has gained popularity in recent years.

Parallelogram 'Hossack' type front suspension - Fior/Britten/Duolever (BMW) etc - requires careful structural consideration to function properly and reduces feedback to the rider due to its complex structure.

Hub-center designs offer a distinct braking advantage due to chassis stability, are most structurally suited for the loads placed upon them (although being overly complex), but, in general, lack rider feedback, and, in a general configuration of, suffer from front wheel clearance issues. Further, issues of the dynamic condition known as 'bump steering' can affect this design.

Trailing link - presently being pioneered in professional racing by Geco - offers simplicity, potential for increased rider feedback, a low polar moment of inertia with steering motion (the increase in steering polar moment of inertia from the forward pivot point of the fork can be offset by having the suspension dampening unit in-line with the steering axis plus other structural

components being positioned close to the steering axis), a low polar moment of inertia with suspension motion and reduced un-sprung mass, and possess the potential for a braking advantage. The trailing link design can also offer the possibilities of aerodynamic advantages, rider control advantages, handling advantages, and road-holding advantages once developed properly when being constructed as an integral part of the chassis and layout of the sports motorcycle. Such a prospect - not presently being accomplished - could assist the dynamic qualities of sports motorcycle performance.

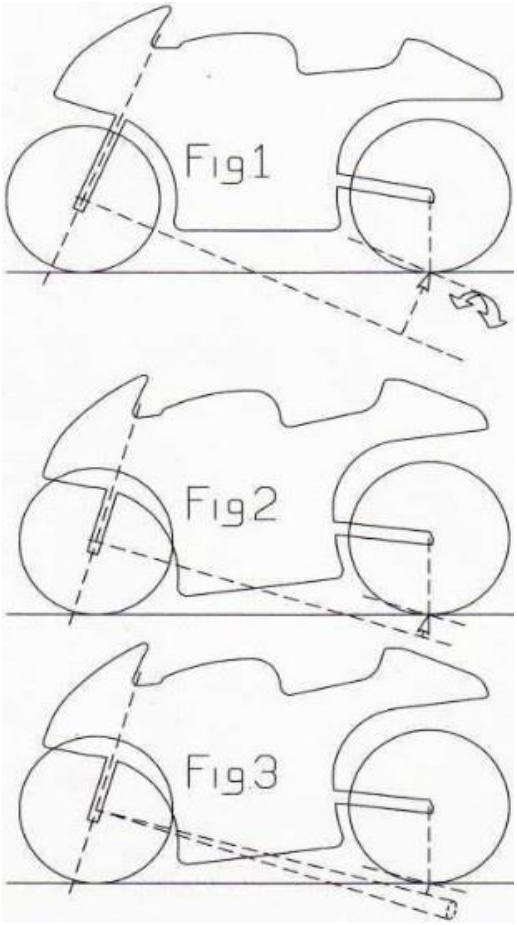

Figure 1. Depicts the original graphics from the theory devised circa 1992 that demonstrates the 'missing' theory in bike dynamics (and was extensively broadcast thereafter).

References

[1] Referenced from the theory that applies in **Figure 1** [an update of this theory is available in the text to correspond with how *'15 degrees rearwards inclination.'* is obtained].

[2] This is now an accepted value from within the automotive industry for the travel path of the auto-car front wheel with numerous examples and sources of.