Calculation of Reactive Gyroscopic Couple Due to Wheels

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Abstract— We saw a general problem in industry for transporting the goods from one to other location is ineffective. Here a vehicle this can transport goods and people quickly within any limitations. Vehicle can run on a single track and balancing problem is solved by gyroscope. From this invention we can save time and the cost of transportation in industry. This vehicle can effectively use in small and medium scale industries.

Key words: Reactive Gyroscopic Couple, Wheels

I. INTRODUCTION

The gyro monorail is a single rail land vehicle that works on the principle of gyroscopic action of a spinning wheel to reducing the essential instability of balancing on top of a rail.

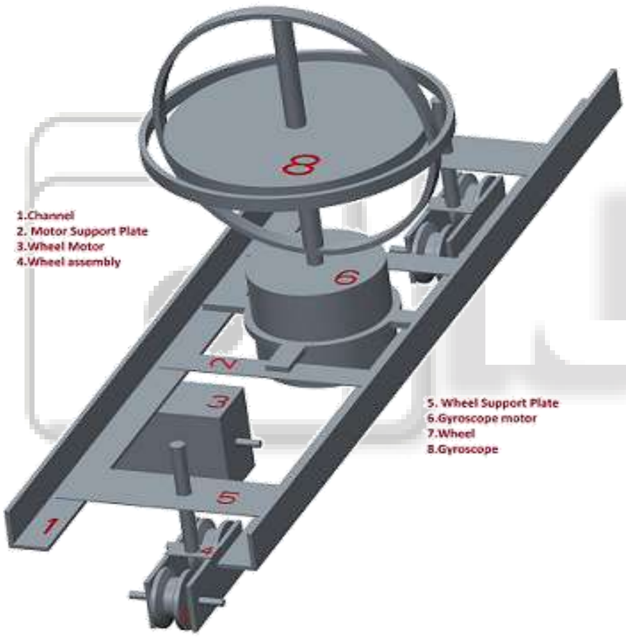

Fig. 1: Components of Vehicle

A. Components of Vehicle:

1) Gyroscopic Instrument
2) Wheels
3) Battery
4) Chassis & Frame
5) Brake & Chain Mechanism

A spinning wheel is located in a gimbals' frame whose axis of rotation is inclined perpendicular to the spin axis. The entire assembly is located on the vehicle chassis such that, at the stage of equilibrium, the spin axis and precession axis and vehicle roll axis are perpendicular with each other. By giving the force to the gimbals' which causes the wheel to process resulting in gyroscopic torques about the roll axis, so that there is a chance to right the vehicle when tilted from the vertical. The wheel shows a tendency to incline with its spin axis with the axis of rotation, and its action which rotates the entire vehicle about its roll axis.

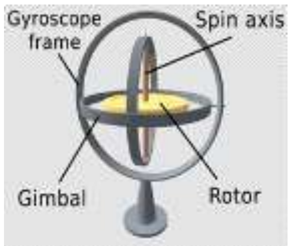

Fig. 2: Component of gyroscopic instrument

The equilibrium position is when the vehicle moving upward, so that any trouble from position decreases the height of the center of gravity(CG), by lowering the potential energy of the system. Whatever result given by the vehicle to equilibrium must be able to restoring the potential energy, and thus cannot take of passive elements alone.

II. FORCES ACTING ON GYRO TRAIN DURING ITS MOVEMENT

1) Cornering load
2) Side load
3) Offset load
4) Wind load

A. Side Loads:

If constant side forces were attracted by gyroscopic action alone, the gimbals' would rotate fastly on to the stops, and the vehicle would turn over. In fact, the mechanism tends to the vehicle to lean into the disturbance, resisting it with a part of weight, with the gyro near its undefeated position. An inertial side force, arising from cornering, tends to the vehicle to lean into the corner. A single gyro introduces nonsymmetrical plan which will cause the vehicle to lean, or not going further for the net force to remain in the plane of symmetry, so cornering forces will still be experienced on board. In order to ensure that the vehicle banks correctly upon corners, it is require reducing the gyroscopic torque arising from the vehicle rate of turn.

B. Force and Couple Acting on two Wheel Vehicle Moving in Curved Path:

Centrifugal force F_C
Weight of vehicle M_g
Reactive gyroscopic couple C
Mass of vehicle with rider M
I_W Mass moment of inertia each wheel
I_E Mass moment of inertia of rotating parts of engine
R radius of wheel
V linear velocity of vehicle
ω_w =angular velocity of wheel=V/r
ω_e =angular velocity of engine
ω_p =angular velocity=V/R
G=gear ratio
θ=angle of inclination
Calculation of gyroscopic couple
Reactive gyroscopic couple due to two wheels is:
$C_w=2I_w\omega_w\cos\theta.\omega_p$

Reactive gyroscopic couple:
$C_e=I_E\omega_E\cos\theta.\omega_{p\backslash}$
Total gyroscopic couple: $C=C_w+C_E$
$C=\cos\theta\,\omega_p\omega_w(2I_w\pm GI_E)$

Positive sign is used when wheels and engine rotate in same direction. Negative sign is used when wheel and engine rotate in opposite direction.

NO	r(m)	R(m)	V(m/s)	Iw	ω.w =V/r	ωp =V/R	cosθ	Cw	ANGLE
1	0.015	0.5	2.77	1.4E-05	184.67	5.54	1	0.058	0
2	0.015	0.5	2.77	1.4E-05	184.67	5.54	0.999	0.057	2
3	0.015	0.5	2.77	1.4E-05	184.67	5.54	0.998	0.057	4
4	0.015	0.5	2.77	1.4E-05	184.67	5.54	0.995	0.057	6
5	0.015	0.5	2.77	1.4E-05	184.67	5.54	0.99	0.057	8
6	0.015	0.5	2.77	1.4E-05	184.67	5.54	0.985	0.057	10
7	0.015	0.5	2.77	1.4E-05	184.67	5.54	0.978	0.056	12
8	0.015	0.5	2.77	1.4E-05	184.67	5.54	0.97	0.056	14
9	0.015	0.5	2.77	1.4E-05	184.67	5.54	0.961	0.055	16
10	0.015	0.5	2.77	1.4E-05	184.67	5.54	0.951	0.055	18
11	0.015	0.5	2.77	1.4E-05	184.67	5.54	0.94	0.054	20

Table 1: Reactive Gyroscopic Couple Calculation for Model Train

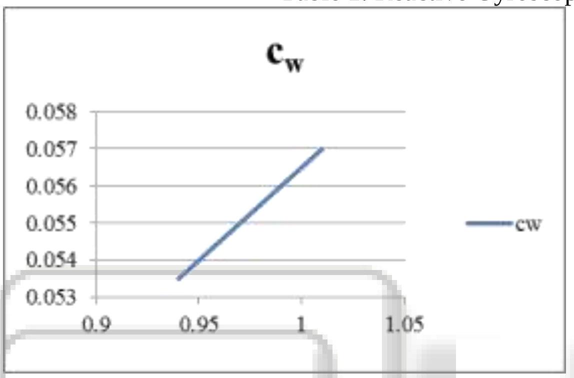

Fig. 3: Graph of angle v/s couple:

III. Conclusion

We conclude that angle of inclination is inversely proportion to radius of curvature. The monorail can travel on a straight path even without use of gyroscope but while talking turn it is necessary for stability. Through experiment it is found that present model is stable up to 67cm radius of curvature & 44.5° angle of inclination.

Reference

[1] www.alibaba.com
[2] Hamill, P.A (dec-1972) et.al." comments on a gyro stabilized monorail proposal" LTR-CS -77(Canada control system laboratory).
[3] "Monorail vehicle" engineering 794. June 14, 1907.
[4] The scherl gyroscopic mono rail car" scientific American. January 22 1910.
[5] schilovosky, p p (1922). The gyroscope, its construction and practical application. E spon publication.
[6] www.google.com
[7] http://en.wikipedia.org/wiki/Gyroscopic_monorail

