

A RESEARCH PAPER ON IMPROVEMENT OF FLYWHEEL RING GEAR WITH STARTER MOTOR PINION GEAR SI ENGINE

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Abstract: - This Study examines methods to expand and progress which flywheel ring gear and starter motor bendix drive pinion gear of three wheelers four stroke petrol engine by investigation through comment, field complaints and discovery root cause of both gears' teeth failure. The problem arises during starting due to failure of Bendix gear mechanism teeth damage. While starting vehicle, due to excessive starter switch pressing, teeth meshes and damage occurs between flywheel ring gear and starter motor bendix drive pinion gear, starting issue with high disturbing noise while engine starting mechanism in engine of petrol engine. Profound enhancement targeting in describing the technique for improvement to sustain bendix pinion wrt. flywheel ring gear. Flywheel ring gear & starter motor pinion gear design modified & altered by accumulation extra slope in contacting surfaces position. The flywheel starter ring gear and pinion teeth wears issue, as the unusual engagement of ring gear with pinion gear. The tooth tip deforms at higher rate as major failure since sudden contact with rotor ring gear and bendix pinion gear. This statement concentration the development of rotor ring gear with starter motor pinion gear and attentive on amendment in disappointment parts & extends the lifecycle of failure fragments. The impact of growth imitates on recitals and smooth engine starting. This study emphases on progress & modification in disappointment parts with additional working lifecycle of failure fragments.

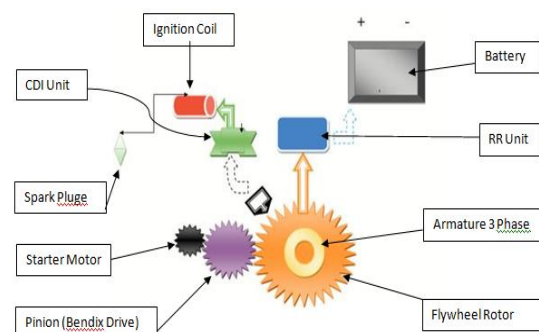
Keywords: - FEA, Design Analysis, Flywheel Ring Gear, Starter Motor Pinion, Design Calculation.

I. INTRODUCTION

ATUL AUTO LIMITED, foremost automobile industrial manufacturing industry in India. Vehicles manufactured & proposed different categories of model Gem, Gemin, Smart in addition Shakti model automobiles in multi-fuel range i.e. Petrol, CNG, LPG & Electronic in both traveler and goods transport vehicles. Atul Auto Limited, launched new model name Atul Gem Premium Traveler Vehicle consecutively in gasoline fuel. After some challenging on road testing, the problem of starting noise in vehicle and starting failure is re-counted. Factually number of vehicles are on thoroughfare testing and number of difficulties reports also enlarged [1].



Fig:1.1 Flywheel ring gear and pinion



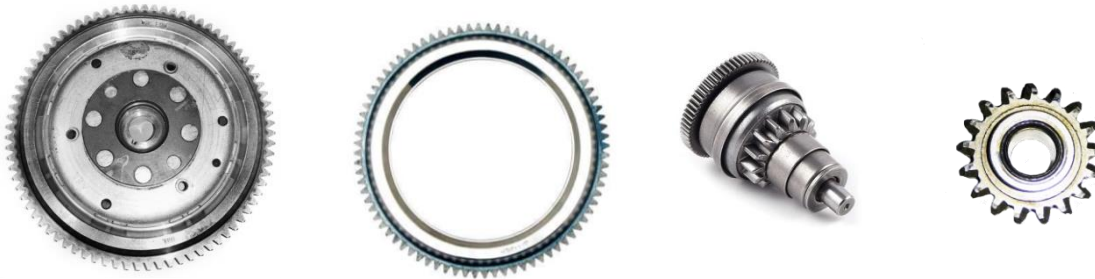


Fig:1.2 Flywheel rotor & starter motor bendix

- Starter Motor
- Starter motor Pinion gear
- Flywheel
- Flywheel Ring gear

The suitable investigation and right process growths is to be done to upsurge the starting gear lifespan and automobile sustainability in modest marketplace. In this broadside, an applied approach has been completed to design, enhancement and development of a conformist bendix and rotor ring gear, which will bounce recomences of using conformist design with up-to-date science. Conventional strategy will rigidity easiness and cost effectiveness.

Table 1.1 Starting components

Part No	Part Name	Part Function
1	Flywheel	Required to store energy & reduces fluctuations.
2	Rotor	Part of flywheel having ring gear to start engine
3	Ring Gear	Torque transfer from Bendix pinion to the flywheel ring gear
4	Stator (Armature)	Produce electric charges to recharge battery
5	Regulator/Rectifier	Regulate the voltages and convert AC to D for battery storage
6	Pulsar coil	Sense the signal and send to CDI unit for spark
7	CDI Unit	Sends signal for exact time spark to ignite
8	Starter Motor	Starts engine by rotating ring gear
9	Bendix Drive	Engage and disengage Pinion and ring gear

Amongst power transmission, switch and distributed in all other stock from third stroke i.e. Power stroke. While starting Engine through starter motor, the bendix gear transmitting power exchanged to flywheel ring gear through interfacing bendix gear to ring gear. Starter motor bendix, the principle transmission of torque on ring gear from bendix gear assembly. The ring gear attached on rotor magneto assembly of flywheel which rotates the engine crankshaft connected with piston assembly. As a result, engine starts and power transmission from crankshaft chain to cam shaft which is assembled on housing of engine head assembly. Due to regular cranking the engine, the teeth of bendix gear and ring gear teeth damages. As a result, harsh noise with more time consuming during starting cause negative impact.

During vehicle preliminary due to starter motor bendix get-up-and-go gear mesh through flywheel ring gear that period proper meshing and not identical teeth damage amid together gear tooth, due to these kinds of explanations to between gear are frictional force entertainment and damaged out and ring gear thru pinion are scrape and wear approximately tooth are breakdown. Bendix drive gear teeth not properly competition so between backless and unsuitable meshing flanked by frictional force generate to fail gear indentation. The flywheel ring gear in addition pinion both gear interconnecting due to dissimilar forces acting in cooperation gear and wear, set in opposition too disruption the flywheel ring gear false teeth the magneto assembly impairment reasons is the rotor cutting-edge magnet on suffering very thin thinness magnet cover plate. This plate impact to armature and in conclusion fragmented the magnetic body cover plate and to end broken the magnet the woodruff key harm reasons the both gear on different forces act and appropriately not interconnecting both gear and this stretch collision to produce the shudders on rotor and counterattack in between crankshaft in addition woodruff key opening and woodruff key are impairment and broken and squeals in between rotor innermost side besides crankshaft. The starter motor Bendix drive be situated wear and damaged out the immobilize pinion gear with the reasons is the indecorous interconnecting on flywheel ring gear also meshing time fluctuate types consignment act on starter pinion gear, besides this failure and injury issue is expression by some 6000 to 7500 kilometer in automobiles.

The suitable analysis with progression developments is vital to intensification the starting gears lifespan and sustainability in up-to-date competitive market. The followings field grievances that are renowned while on road difficulties faced on vehicle.

- 1) Ring gear broken disappointment.
- 2) Bendix gear teeth damage.
- 3) Battery consuming by more cranking.
- 4) Ring gear coming out from magneto assembly from welding part by excess vibration.
- 5) Engine starting by more cranking issue.

2. OBSERVATION

Above all problems arises due to bendix pinion gear and ring gear failure. On road vehicle, damages on teeth when meshes at starting occurs at bendix pinion gear and ring gear. Due to which engine does not twitch and automobile not consecutive. As a negative impact of damaged teeth disturb basic alignment of engine starting. Due to excess vibration during meshing of bendix and ring gear, ring gear breaks apart in two parts as a big failure. Moving component ring gear with play, damaged and vibration disappoints further engine structure, results to Continuing Interaction Fatigue which occur since of the reverberation the gear cyclical force on false teeth created amid task and fragments that comprise in arrangement disappointment of descending component [1]. Static force investigation, oil burden, shifting gear working, wear design of gear, key construction, ring gear pendulous, stuck over load on ring gear etc. remained the probabilities to bargain the failure of bendix pinion gear and prevent on damages [2]. During comment, following belongings had been recognized,

- Engine starting time excessive noise produce.
- Engine not starting by self-start or electric start.
- Flywheel ring gear teeth worn out.
- Starter pinion gear teeth deep cuts and damage.
- Magneto assembly damage with armature.
- Woodruff key of crank shaft damage, woodruff key slot and crankshaft scratches.
- Power consumption more with battery charging issue.
- Huge Vibration in Engine at starting.

3. ROOT CAUSE

Due to sudden impact of forces, sudden load besides stress technologically advanced at Bendix pinion gear, Flywheel ring gear and certain connecting cycles, deep cuts are generated on Bendix pinion gear along with ring gear worn out. Owing to these deep scratches, cuts & worn out in parts, pinon gear and damaged ring gear freely moves on engine crankshaft [5]. Resulting more failure and fragment damage transpires and last ring gear from flywheel broke apart. At high torque and rpm, the pinion gear will become free and unstable which billets more teeth damage & other parts of flywheel assembly.

In vehicle, engine ignition case by electronically ignition switch case, push button is provided for direct starting of the starter motor pinion to contract with flywheel ring gear. While meshing and starting in many running many cycles, wear and scratch occurs between ring gear and pinion because of which the flywheel assembly getting vibration and consequences in play amongst crank shaft connecting key to flywheel. Due to improper fitment, flywheel produces vibration besides this condition, when the gear meshes, its teeth come to be damaged with destructive flywheel and crankshaft. While starting, pinion gear shifts from idle location to flywheel ring gear through starter motor starting mechanism, bringing it in standard condition starter motor power cut again pushes back in its inventive condition. In flywheel assembly, woodruff key is provided there which is devoted in crankshaft slot and while successively so many sequences on the vehicle; the wood ruff key got damaged and owed to vibration on key break up from the crankshaft and flywheel slot. Causing the quivering occurs in ring gear and during running process, it also damaged engine other parts.

- 1) More hardness of both pinion gear and ring gear should be done.
- 2) In most failure key breaks out rubbing with flywheel ring gear slot & tear apart from crank shaft results system failure.
- 3) Ring gear displaced at assembly line.
- 4) Proper fitment problem
- 5) Industrial defect at covering plant.
- 6) Due to vibration in addition axial play in flywheel and key, while starting Bendix gear to ring gear.

4. DIMENSION

Below given table demonstrations the dimensions of pinion gear and ring gear.

Table 4.1 Dimensions of pinion gear and ring gear

Name	Starting Motor Bendix Pinion Gear	Flywheel Ring Gear
Pitch Diameter	32 mm	160 mm
Base Diameter (Db)	30.98 mm	154.9 mm
Circular Pitch	5.91 mm	6.283 mm
Center Distance	96 mm	96 mm
Diametral Pitch	0.53 mm	0.5 mm
Gear Ratio	4.70	4.7058
Number of Teeth	17	80
Addendum	1.88 mm	2 mm
Dedendum (Preferred)	2.35 mm	2.5 mm
Outside Diameter	35.77 mm	164 mm

Root Diameter	27.29 mm	155 mm
Whole Depth	4.23 mm	4.5 mm
Working Depth	3.76 mm	4 mm
Whole Depth (Preferred)	4.23 mm	4.5 mm
Clearance (Preferred)	0.47 mm	0.5 mm
Fillet Radius (Rack)	0.56 mm	0.6 mm
Root Diameter (Preferred)	27.29 mm	155 mm

By tactics to improve detailed and measured inspection while vis-à-vis with the base strategy materials with development media along external morphologies, little gauge uneven part pieces and underneath organization settings development of main drivers to settle disappointment, almost devices were deliberated, and measured counter measures are anticipated [4].

5. ACTION TAKEN

All problems rise owing to vibration of flywheel and indecorous bendix gear meshing with ring gear. After some modifications due to gear dimensions vibration decreased between system along with alignment transmission power to differential gear. Gear Dimension modified. The following actions are taken on vehicle:

- 1) Ring gear teeth Circular pitch are changed from 160 mm to 162 mm.
- 2) Ring gear teeth fillet value changed from 1mm to 1.2 mm.
- 3) Ring gear teeth Chamfer value changed from 1mm to 0.8 mm.
- 4) Pinion gear teeth Circular pitch are changed from 32 mm to 30 mm.
- 5) Pinion gear teeth Chamfer and fillet provided.
- 6) Cut off no.: **BGD38AAI9P1336843, Engine No.: H 3028 K 93.**

6. MODIFIED PARTS

- 1) **RING GEAR MODIFIED:** Ring gear teeth Circular pitch are changed from 160 mm to 162 mm. Ring gear teeth fillet value changed from 1mm to 1.2 mm. Ring gear teeth Chamfer value changed from 1mm to 0.8 mm. By simulation and design analysis the effect of force is decreased and more life cycle span is received in modified following part.



Fig 1.3 Before modifying Flywheel ring gear

Fig 1.4 After modifying Flywheel ring gear

- 2) **STARTER MOTOR PINION GEAR MODIFIED:** Pinion gear teeth Circular pitch are changed from 32 mm to 30 mm. Pinion gear teeth Chamfer and fillet provided. Chamfer provided in flywheel ring gear at edge while meshing on bendix pinion gear shaft. As a result, functional maneuver of gear meshing take place under contented prosperity. In existing model, no privileged circumstances corresponding chamfering is on condition that as in improved on. While operative on ring gear, smooth transmission of influence with less noise & friction.



Fig 1.4 Pinion Gear without chamfer

Fig. 1.5 Pinion Gear with chamfer

7. EFFECT OF MODIFICATION

Modification carried out on both bendix and rotor gear in order to avoid starting issue.

- 1) Modified bendix gear with two dots given for identification of modified part, during starting, abnormal noise stopped and life cycle of bendix and rotor while meshing on start increased. The play/vibration happening is decreased and also increase in lifecycle of both fragment with less quivering occurrence. Also, effectiveness with performance of influence transmission augmented.
- 2) The chamfering at teeth of ring gear part of flywheel assembly provided which increases in ease purposeful operation as well with even power transmission.
- 3) There is significant reduction trendy bending stress value designed for circular root fillet strategy in assessment to that of bending stress rate in trochoidal root fillet proposal.
- 4) Ring gear pitch circle thickness changed and immobilize pinion gear pitch circle diameter transformed to proper mesh on pinion gear.

8. CONCLUSION

The current effort establishes theoretically feasibility in adapted part. Amendment which agreed out arranged starter motor bendix gear flywheel ring gear in order to thwart engine starting issue. This frequent development & enhancement is done to progress engine influence transmission parts robustness. New amendments are given of improved parts. Fragment interchangeability process is at present in process for innovative improved vehicles. Process development laterally with improvement circulars are proceeding development and modified starting parts are familiarized in new portion of finest automobiles.

For future inquiries of bendix and rotor gear, static analysis, it is indorsed to simulate all further functioning fragments with different borderline conditions in order to achieve more structures available in software. For revolutionary instance, other analysis corresponding applied turning on different spinning parts, fatigue analysis can be agreed out for improved results. At assessment, analysis consequences and reports associated to parts project design to their accuracy, replication may unpretentious structures is recommendable. Safeguarding ease and clear publicized, arranged measured calculation with reminiscent conclusions, supplementary used absolute standards will be linking the simulation results.

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