ANALYSIS OF FIXTURE DESIGN TO AVOID SPACER FALL DOWN INSIDE THE CLUTCH HOUSING

P.Senthil Kumar[*1], S. Kaushik Rathan[2], A. Suheal[3], K. Yesuraj[4]
[1,2,3,4]Department of Mechanical Engineering, Panimalar Engineering College, Chennai, Tmailnadu, India
senthilmechsujpal@gmail.com*[1], kaushy.panimalar@gmail.com[2], suhealbe@gmail.com[3], yesu087@gmail.com[4]

Abstract

In automobiles, Power from the Engine is transmitted to the wheels through the transmission system. The objective of this project is to provide a FIXTURE DESIGN TO AVOID SPACER FALL DOWN INSIDE THE CLUTCH HOUSING and to enhance the driving comfort. Initially the process flow diagram (PFD) is constructed from the study of assembly process. The major root cause for the transmission Gear noise is analyzed using root cause analysis. Also various solutions were been derived by Brainstorming the possible ways to solve the problem, we have selected best among the possible solutions to eliminate the problem. Finally, by designing, magnetic fixture (POKA YOKE) which can act as a fool proof provision to eliminate Transmission Gear noise.

IndexTerms: ***Fixture design, Process flow diagram, Clutch housing, POKA YOKE***

I. Introduction

A transmission is a machine in a power transmission system, which provides controlled application of the power. Often the term transmission refers simply to the gearbox that uses gears and gear trains to provide speed and torque conversions from a rotating power source to another device. In British English, the term transmission refers to the whole drive train, including clutch, gearbox, prop shaft (for rear-wheel drive), differential, and final drive shafts. In American English, however, the term refers more specifically to the gearbox alone, and detailed usage differs.

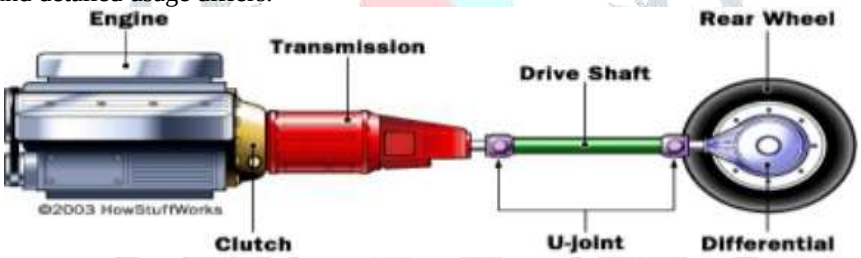

Fig.1 Transmission system layout

1.2 Functions of Transmission system

- To disconnect the engine from the driving wheels.
- To connect the driving wheels smoothly and without shock to the engine.
- To vary the leverage between the engine and the driving wheels.
- To reduce the speed of the engine at the driving wheels of about 1:4.
- To turn the drive through 90˚.
- To drive the driven wheels at different speeds, while the vehicle is turning a circle.
- To provide for the relative movement between the engine and the driving wheels due to flexing of suspension springs.

1.2 Different types of Transmission system

We can broadly classify transmissions into 4 types:

- Manual Transmission
- Automatic Transmission
- CVT (Continuously Variable Transmission)
- DCT (Dual Clutch Transmission)

a.MANUAL TRANSMISSION:

A manual transmission, also known as a manual gearbox, a standard transmission or colloquially in some countries as a stick shift, is a type of transmission used in motor vehicle applications. It uses a driver-operated clutch, usually engaged and disengaged by a foot pedal or hand lever, for regulating torque transfer from the engine to the transmission; and a gear selector that can be operated by hand.

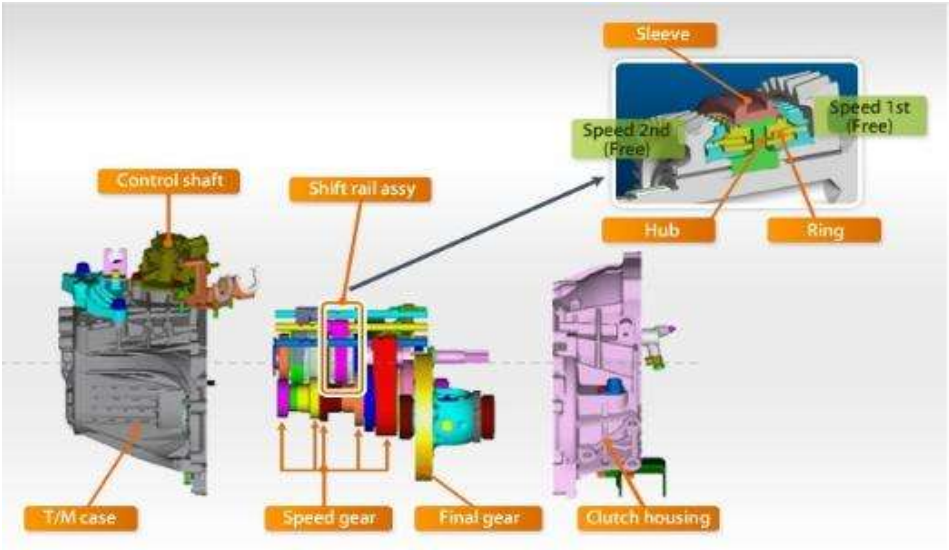

Fig.2 Manual Transmission system

A conventional 4- or 5-speed manual transmission is often the standard equipment in a modern base model vehicle, with 4-speed being more common in non-passenger vehicles such as pickup trucks and light commercial vehicles. Higher end vehicles, such as sports cars and luxury cars are often usually equipped with a 6-speed transmission for the base model

The types of manual transmission are:

- Sliding Mesh Gearbox
- Constant Mesh Gearbox
- Synchromesh Gearbox

1. Shafts– There are usually 3 shafts used in manual transmission that are-

(i) Main-Shaft- It is the shaft that is also called the output shaft and is placed in front of the clutch shaft and in parallel to the lay-shaft. gears, gear lever along with the meshing devices such as dog clutches and synchromesh devices are mounted over this shaft.

(ii) Lay-shaft or Counter Shaft- It is the shaft used as an intermediate shaft between the clutch shaft and the main shaft, it is usually mounted below and parallel to the main shaft, and act as an engine output carrier from the clutch shaft to the main shaft.

(iii) Clutch-Shaft- It is the shaft that carries the rotational output from the engine's flywheel to the transmission with the help of clutch that engages and disengages the output from the engine.

2. Gears –There are mainly 4 types of gears used in manual gearbox that are-

(i) Spur Gear: Used in old sliding mesh gearbox these types of gears have straight cut teethes.

(ii) Helical Gear: They are the modified version of the latter as they have angular cut teethes.

(iii) Bevel: They are best of all above gears having a conical cross-sectional area with angular cut teethes.

(iv) Idler-gear: It is the small gear used as a reverse gear usually mounted over the lay shaft.

3. Meshing Devices: There are usually 2 types of meshing devices used in manual transmission-

(i) Dog Clutches: They are the devices used for meshing of gears in constant mesh gearbox.

(ii) Synchromesh Devices: They are the devices which are used in synchromesh gearbox for the meshing, these devices provide smooth shifting of gears.

4. Gear lever- It is the lever used by the driver to shift a gear.

b. SLIDING MESH GEARBOX:

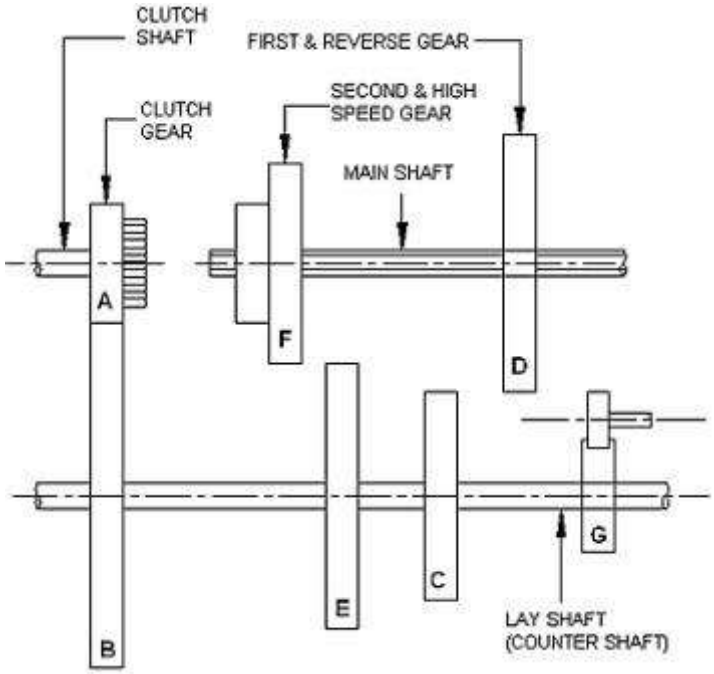

Fig.3 Sliding Mesh Gearbox

It is a transmission system that consists of various sets of gears and shafts that are arranged together in an organized fashion and the shifting or meshing of different gear ratios is done by the sliding of gears towards right and left over the splined shaft with the help of a gear lever operated by the driver.

c. MESH GEARBOX:

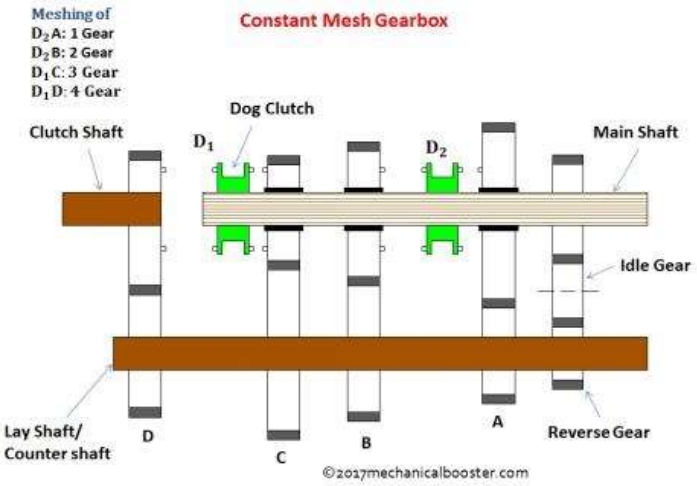

Fig.4 Mesh Gearbox

A constant mesh transmission is the type of manual transmission in which sliding gears from the sliding mesh transmission is replaced with the constantly meshed pairs of gears and the new shifting devices named dog clutches are introduced which helps in transmitting the required output to the main shaft by making contact with the appropriate pair of the meshed gears. A constant mesh gearbox usually comes with 4-speed 1-reverse manual transmission configuration.

II. Materials and Methods

INPUT AND OUTPUT SHAFT ASSEMBLY:

In this section the input and output shafts are been sent to the main assembly from the sub assembly, where both shafts are been assembled in the clutch housing.

FORK AND RAIL SHAFT:

In this section of the assembly the fork and rail shaft are been used to avoid the gears to be upset from the housing.

PLUNGER CHECKER:

In this section of the assembly the plunger is been checked before it goes to the housing.

REVERSE IDLER AND SHIFT SHAFT ASSEMBLY:

In this section of the assembly the idler gear and the shift shaft is been assembled.

SPRING PIN ASSEMBLY:

In this section of the assembly the spring pin is assembled inside the clutch housing.

5^{th} GEAR ASSEMBLY:

In this section of the assembly the 5^{th} gear is been assembled inside the transmission.

LOCK NUT TIGHTENING:

In this section the locknut is tightened to prevent the rotatable 5^{th} gear in the input shaft from moving up, a locknut is assembled in this stage to hold the gears tightly.

LOCKNUT CAULKING:

In this section of assembly, the locknut is placed on top of the T/A case, where the locknut is placed over one of the shaft on the T/A case.

AIR LEAK TESTER:

After assembling all the major parts, the transmission is subjected to air leak test. In this air is forced inside the transmission and air leakage is tested .Air leak up to 15ml/min can accepted, and the transmission is passed if the air leak is within the acceptable limits. If not, the TM is sent again for rework.

OIL FILLING:

Finally the oil is been filled inside the T/A case. The oil is filled automatically.

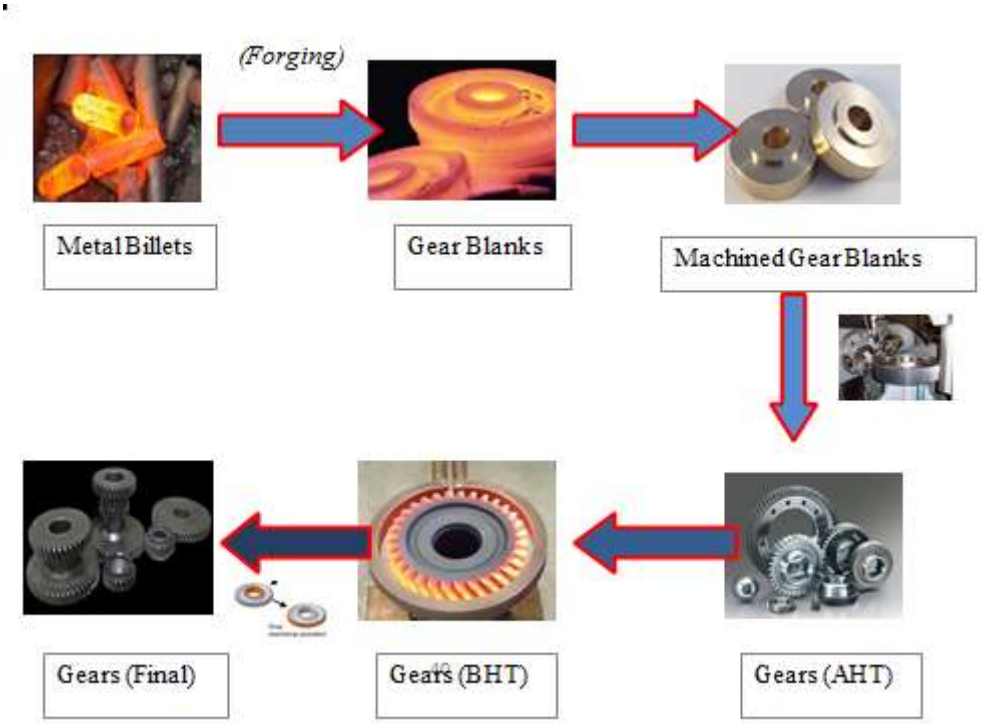

Fig.5 Tranmission Machining process layout

Fig.5 Transmission Machining process ka-yoke is a Japanese term that means "mistake-proofing" or "inadvertent error prevention". The key word in the second translation, often omitted, is "inadvertent". There is no poka-yoke solution that protects against an operator's sabotage, but sabotage is a rare behavior among people. A poka-yoke is any mechanism in any process that helps an equipment operator avoids mistakes. Its purpose is to eliminate product defects by preventing, correcting, or drawing attention to human errors as they occur. The concept was formalized, and the term adopted, by Shigeo Shingo as part of the Toyota Production System. It was originally described as baka-yoke, but as this means "fool-proofing" (or "idiot-proofing") the name was changed to the milder.

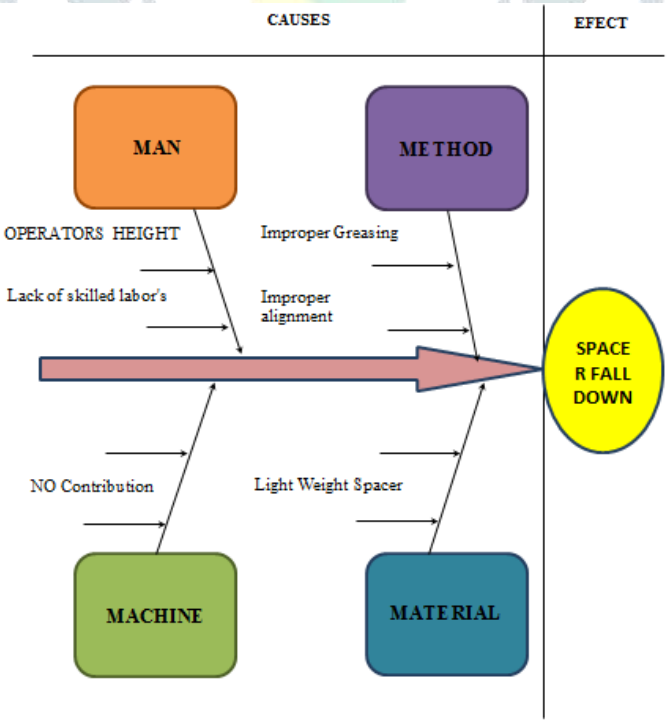

Fig.6 ROOT CAUSE ANALYSIS (FISH BONE DIAGRAM)

III. Results and Discussion

Fig.7 New Fixture design

The above shown above is the starting stage of the design of the fixture. We have taken the wooden box to act as a prototype for the T/A case. Inside the T/A case we have the spacers which are to be placed over the input shaft and for the output shaft. Later this design was proposed to the next stage, where we thought to design it in the form of a fixture. The fixture resemble similar to the design of a phone holder.

The two plugs which are shown in the prototype model are used to retain the exact position on the T/A case.

MAGNET CAPACITY:

The most common metals used for permanent magnets are iron, nickel, cobalt and some alloys of rare earth metals. There are two types of permanent magnets: those from “hard” magnetic materials and those from “soft” magnetic materials. “Hard” magnetic metals tend to stay magnetized over a long period. The magnet is designed according to the size of the T/A case.

SIZE OF MAGNET:

Size is just one of the ways one can change the strength of a magnet. By reducing the electrical resistance, much higher amounts of electrical current can be put through the magnets, thereby generating a much stronger magnetic force.

ADVANTAGES OF MAGNET:

- No power supply needed
- Cling to vertical surfaces
- No electrical contact problems
- Inexpensive
- No damage to test piece
- Light weight.

APPLICATIONS OF MAGNET:

- Magnets can also be used for sorting magnetic material from non-magnetic material.
- Magnets are used in the mining industry to separate metals from ore.
- Food manufacturers use magnets to prevent small iron particles from mixing with the food

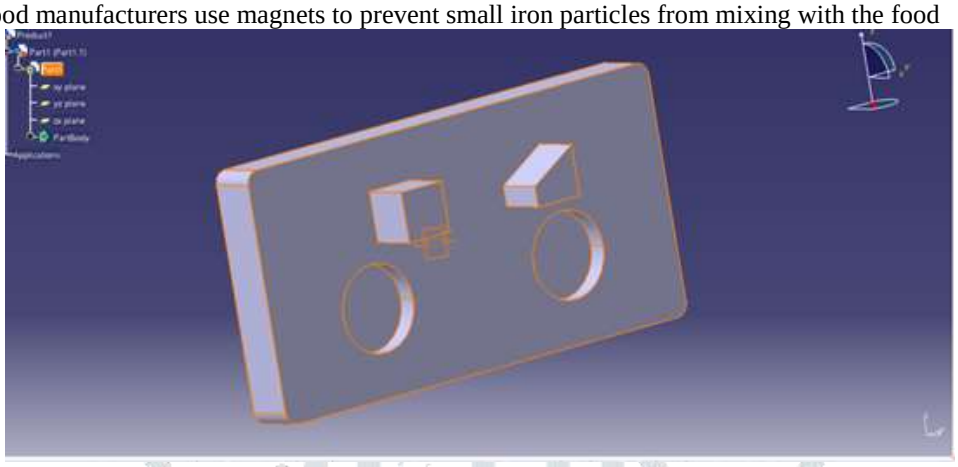

Fig.8 Isometric View

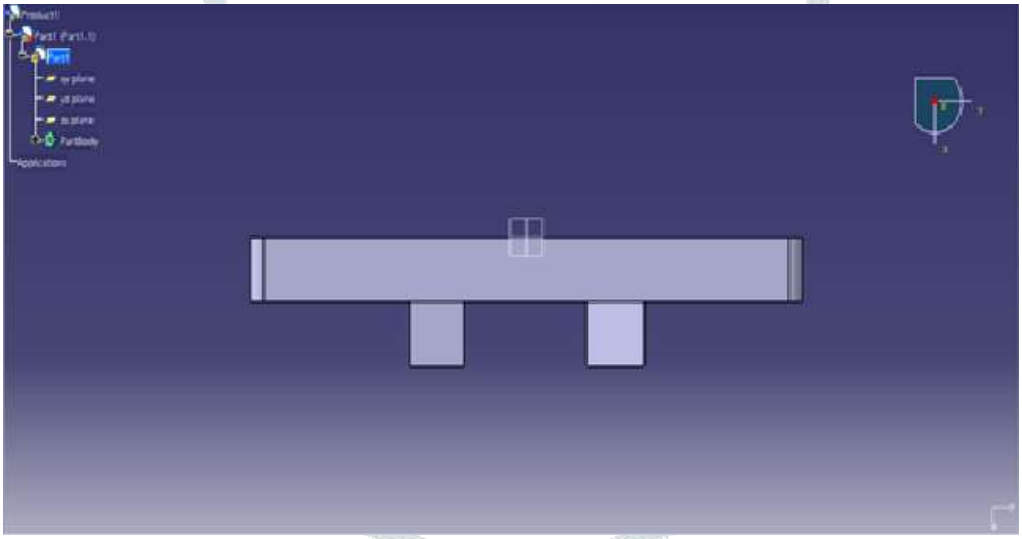

Fig.9 Side View

The fixture is nothing but a holding device, the fixture is meant to hold the magnet tight so that the Magnet can easily be magnetized to the spacers present inside the T/A case.

- The fixture is designed in such way so that the plugs are been fixed firmly to the T/A case.
- The fixture material is selected by considering the material of the magnet. The material of fixture is selected to be Nylon.
- The fixture is designed with the help of CATAIA V.5.2 (3D Modelling software).The dimensions for the fixtures are taken approximately.

IV. Conclusion

To eliminate the transmission gear noise in the Clutch housing, the Assembly line is first reviewed, and a process flow diagram is constructed to visualize the sequence of the process. The failure modes and the causes of the failure was analyzed though root cause analysis and using Brain storming we listed out various possible solutions and finally the best solution was selected after a successful trial. The solution was to designing a magnetic fixture (POKA YOKE) which can act as a fool proof provision to eliminate spacer fall down and hence gear grinding noise. Here there is still more possibility for the operator to miss the usage of magnetic fixture, so a proximity sensor was proposed to ensure the usage of magnetic fixture and hence making the system a complete fool proof method.

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