Model Analysis of Clutch Bite Point Detection By Using NPN Inductive Proximity Sensor

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Abstract- *A torsional oscillation or strong vibration occurs in the bite point of clutch as a judder effect in the clutch peddle and steering wheels which is sensible by drivers in the driveline. The purpose of this study is to analyse the engagement point of clutch through sensor detection. By analysing the diaphragm spring movements in the clutch assembly is helpful to measure the results of clutch judder or tactile sense of clutch by placing the inductive proximity sensor opposite to springfingers at suitable sensing field range for respective time which is programmed by microcontroller and using normal close configuration in sensor where the output is determined as "OFF" position even target is present inside the sensing field. The clutch bite point detection by inductive sensor plays the great role for people who begin to drive the cars. Where the beginners feel safe and comfort to learn any automotive manual transmission. This study is not discussed in any thesis and also in similar studies where this paper innovatively detailed about function of proximity sensor with diaphragm spring which gives best results for freshers and women who learn to drive the automotive vehicle of manual transmission in the drive line at the beginning*

Keywords- Torsional Oscillation, Clutch bite point, Diaphragm Spring, Inductive Proximity Sensor, Manual Transmission

I. INTRODUCTION

Various automotive vehicles of manual transmission have different clutch bite or engagement point depending on their clutch assemblies or clutch plates either single plate or multi plate clutches. At the engagement of clutch disc with flywheel, the car judder at around 10Hz to 13Hz [1].A strong vibration or torsional oscillation occurs during the bite point of clutch. A tactile sense which is sensible in clutch peddle and steering wheel which indicates the driver to stop depress their clutch peddle and to take their respective legs from the clutch is an essential one and a basic of manual transmission. This process is circulated continuously until the driver drives the car in the drive line by pressing and depressing the clutch by changing the stick shift. But many of the beginners failed to analyse this sense of vibration and taking their legs from clutch in quick session is pretty hard. The person who drives the car should be cool, calm and feel comfort without any stress. The major problem for freshers and women at the beginning is this clutch bite point analysing, which is rectified in the paper by placing the solution for this problem. Where inductive proximity sensor is a solution that is used to detect the various clutch bite point in automotive vehicle. They placed left corner of the diaphragm spring opposite to the fingers, where the finger is mild steel thicker than 1mm is predictable by proximity sensor. The sensing range for detecting the spring finger is >3mm (0.118) inch. Where inductive proximity sensors speed ranges from 10Hz to 20Hz in AC or 500Hz to 5KHz in DC and are relatively narrow sensing range from a fraction of millimetres to 60mm on average but the respective range taken for indication is >3mm, a small clearance is made between spring fingers and sensing field face, which is must to ensure the life of sensor. They are fitted to clampers and the clamp is welded inside the clutch transmission housing and placed opposite to diaphragm spring which clamped strong enough to hold the vibration during transmission inside the bell housing. The inductive proximity sensor detection is purely Based on forward and backward movement of diaphragm spring in any manual transmission vehicle when the spring comes backward along with release bearing, they induced by electromagnetic induction with high frequency oscillation where the noncontact output signal is detected and the information is updated to ECM (Electronic Control Module), when fingers move forward they far away from the sensing distance <3mm range and detection doesn't takes place. Where this inductive proximity sensor input is connected to CAN (Controlled Area Network) bus system of ECM and their output is successfully updated to actuators and are indicated to learners, freshers and women to avoid mistakes while driving a car in driveline at beginning

II. TRANSMIOSSION BELLHOUSING

It is the removable transmission case in the automotive vehicle, where the length of housing is168.3mm (6.625) Inch and diameter of housing is 12.319+/-0.101[0.485+/-0.004]. They are made of cast iron and aluminium. The face of engine flywheel housing and the face of transmission clutch housing should be parallel during installation. The bellhousing covers flywheel, clutch assemblies and torque converts powered by internal combustion engines. They perform housing for engine block.

They made strong to protect themselves from strong vibration and prevent crack formation. Bellhousing is the nonrotational case in the automotive vehicles "Fig 1". In transmission clutch housing a small piece of iron clamp is welded inside the house facing the clutch assembly which hold strong enough to vibration occurs in bellhousing. The inductive proximity sensor is placed inside the bellhousing and clamped in holder which is used to detect the diaphragm spring fingers. Using (Bridge type vertical mill) drilling the clamp with drill hole of 5/16"-24, where drill hole is used for sensor cablewiresto pass away without any complication and these cables are passed out through a gap which is available in clutch transmission housing on right side corner to transmit signal to the ECM of cars as output

Figure 1 clutch transmission housing [2]

III. DIAPHRAGM SPRING

Diaphragm spring is placed between the clutch cover and pressure plate. The spring shaped like a disc with tapered fingers pointed inwards like a wavy disc. Theand disengaging of the clutch "Fig 2". When the clutch is pressed, the pressure is applied on the spring and the pressure plate, where spring moves forward and thus makes disengage with flywheel, otherwise the pressure is removed and the metal spring comes back to its original shape and makes engagement. The metal spring are made of elastic steel which is processes the bending moment on the fingers and high stress will occur at the joining position of spring is slit into numerous fingers that act as release levers. The inductive proximity sensor is placed opposite to the tapered fingers, which is >3mm and the process happens without contacting the diaphragm springs. When the tapered springs are move forward, there is no detection takes place which is fare away from the distance < 3mm. when they are engaged, they came outward throughout the release bearing from the clutch cover. Where the sensor detects the rotating diaphragm accurately in various speed it depends on shifting the gears by pressing the clutch. Where the rotational fluctuation is measured by sensor which occurs in diaphragm spring and the intimation is done by actuators.

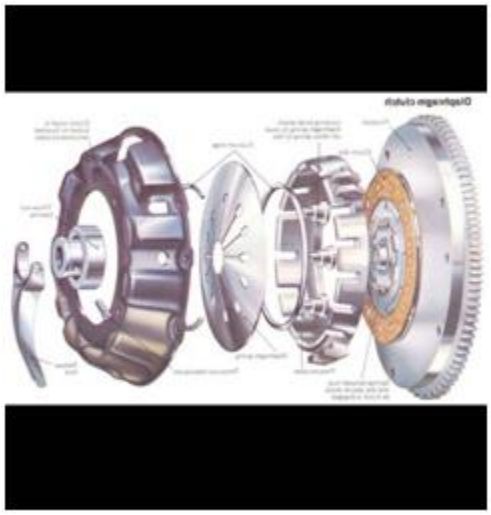

Figure 2 Diaphragm spring in the clutch assembly [3]

IV. INDUCTIVE PROXIMITY SENSOR

A) PRINCIPLE

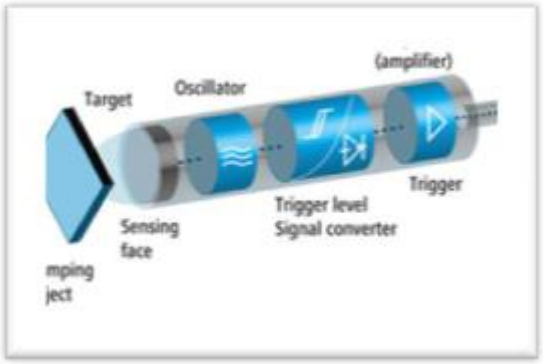

Figure 3 Operating process of inductive proximity sensor [4]

It detects the approach of an object without any contact. In proximity sensor a high frequency oscillation type using electromagnetic induction. The detection coil located at the front end of the sensor produce high frequency magneticField "Fig 3". When a objects (metallic) approaches the magnetic field, the current flow induced in the metal cause thermal loss and resulting in the reduction or stopping of oscillation where the eddy currents are generated, the thermal energy loss takes place due to resistance of the metal which reduces the amplitude of the oscillation. It cannot detect non-metal in which current cannot flow and also metals like ferrite doesn't allow current flow which cannot be detected.

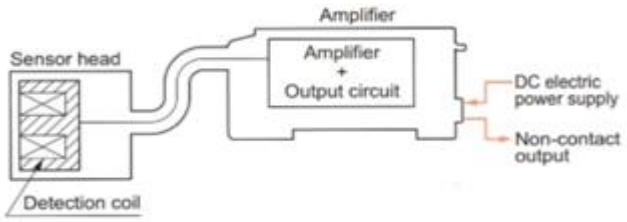

Figure 4 Amplified Separated sensor [4]

B) AMPLIEFIED SEPARATED SENSOR

For detecting the diaphragm spring fingers the proximity sensors with amplifiers separated structure is selected according to their mounting place to withstand strong vibration, power supply and noise immunity. Where the sensing position can be made small since the detection coil is separated as the sensor head"Fig 4". The sensor head place near the spring fingers, where the sensing portion is small, a stable is obtained. The detection coil induces the amplifier where the Schmitt trigger detects the rotating fingers and stimulated non-contact output which will received by ECM of automotive vehicle.

C) SHIELDEDNPN OPEN COLLECTOR TRANSISTOR

There isa metal enclosure which shields the sides of the detection coil. The sensor can be embedded in metal as it is less affected by the surrounding metal. The metal diaphragm requires a small clearance at the front sensor end. Some sensors like Gx-3s, Gx-4s, Gx-5s, Gx series sensors are used, where the NPN (Negative-Positive-Negative)transistor has supply voltage of 24 VDC. Normally the sensor in open configuration, the "ON" signal process otherwise they are close configuration "OFF" signal process even the target is present. The NPN proximity sensor is high speed response and are separatelypower supplied and used for the load. When it comes to wiring a proximity sensor, the NPN transistor is one that can switch negative side of the circuit called "sinking source" because they sink ground to the output. This NPN proximity sensor detects or sense the range within 3mm (0.118) inch from the tip of the sensor and the object to be

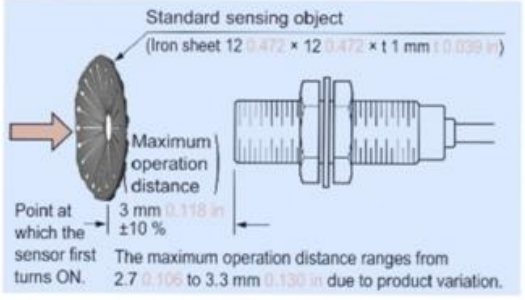

Figure 5 Sensing range of sensor with respect to spring [4]

V. CAN (CONTROL AREA NETWORK) SYSTEM

The CAN is developed to replace the complex wiring harness with a two wired bus "Fig 6". They are used to repair data errors and ability to diagnose with ease. The inverted logic of a CAN bus can be used for inductive proximity sensor. They allow the microcontroller and device to communicate with each other without a host computer. The 16th terminal is directly connected with battery. It designed for multicomplex wiring inautomotive industry. It specifies the "Dominant" bits and "Recessive" bits, where dominant is logically (0) and recessive is (1). Where both dominant and recessive bits are transmitted by nodes. The dominant bits remain during collision and high priority message is form without delay, where low priority message is retransmitted to six bits clocks after the dominant message is achieved. This will help to real time prioritized communication system. The received input from the inductive proximity sensor is send to transfer layer and it receives message from the physicallayer

and transmit those toobjective layer. The transfer layer is responsible for bit timing and synchronization. The message framing process takes place and check the error detection and fault confidence of input and finally updated to the actuators. Where the output is received to receivers by indicating light or buzzer depends upon connection of sensor circuit.

VI. PINOUT CONNECTION OF CAN BUS WITH NPN INDUCTIVE PROXIMITY SENSOR

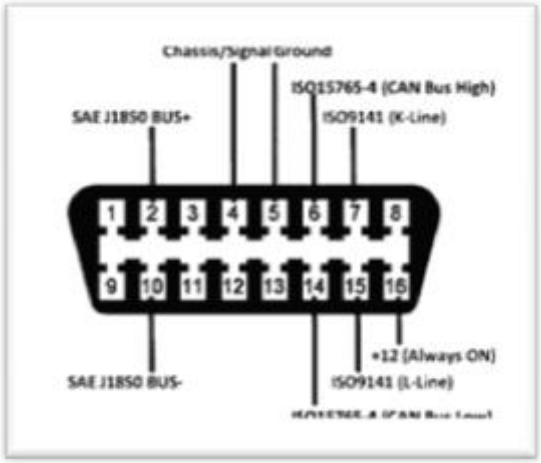

Figure 6 CAN bus system [5]

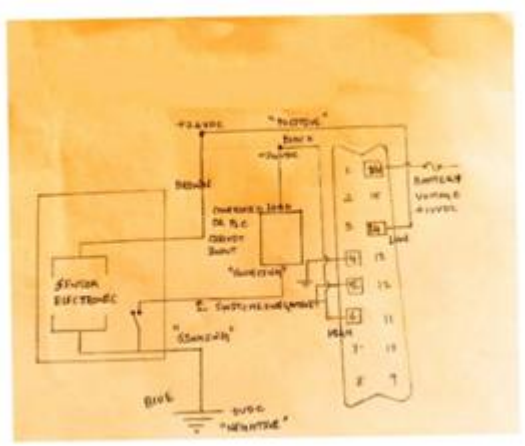

Figure 7 pinout connection of CAN bus with proximity sensor [6]

The proximity sensor has three pins brown, black and blue are connected anywhere from 6 to 36 VDC. Where everyECM have CAN bus system. There are 16 terminal pins in the breakout box of CAN. Various testing methods like voltage test and resistivity test is must to check the CAN system before the sensor is installed.Where the appropriate measurement should take relevant to proximity sensor where initially 4th and 5th terminal pins of chassis\signal is grounded. The 16th terminal pin is connected with battery voltage at around +12 VDC. Both high and low CAN bus terminal will add up to 5 VDC as the reference voltage line to check the sensor. The voltmeter reading of this particular sensor is 12.83 VDC and the resistance test is done by connecting parallel to divide the original resistance, where ohms metre shows 60 Ω +1Ω to have good communication network with sensor while placed in the car for detection. The brown wire (positive) is connected to 6th terminal (ISO15765-4 (CAN bus High)) pin. Blue wire is grounded negative (0 VDC). The black wire is switched "Negative" and connected with controller load or PLC input sourcing "Fig 7". The NPN proximity sensor connection should be parallel to prevent short circuit of thermite resistance of 120Ω present in ECM. The NPN sensor connection is from high to low or low to high. The high signal proceeds when metal is not detected and low signal proceeds when the metal is detected by the object. From this connection the indication light or buzzer is connected in panel of automotive vehicle by special connection which is fixed for driver convenience to guide them correctly throughout the driveline of manual transmission

VII. LIFEEXPECTANCE OF INDUCTIVEPROXIMITY SENSOR

The inductive proximity sensor housing is nickel plated brass, stainless steel and PBT plastic, so they protect themselves from mechanical expansion and contraction of materials. The sensor face is shielded so no damage occurs for internal winding system and the shielded type sensor are environmentally adaptable and have metal sensing versatile. The proper setup to resist strong vibration may guarantees long life of sensor. The inductive proximity sensor is specially designedIP-68G with optimum temperature withstand of 75 degree Celsius which prevent from dust penetration and immersion of water even more harsh environment which increase the life expectance of sensor "Fig 8". The inductive proximity sensor is more reliable then capacitive due to small sensing distance which makes the sensor life strong and doesn't produce false triggering. Where they positioned right or left of the detecting object by setting different distance, which determines the mounting position of the sensor with respect to diaphragm spring ensures the life of sensor"Fig 9"

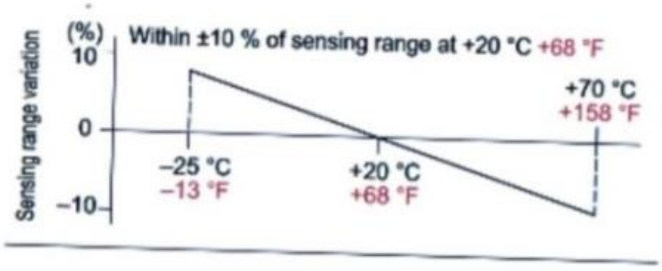

Figure 8 sensing range of sensor with respect to temperature change

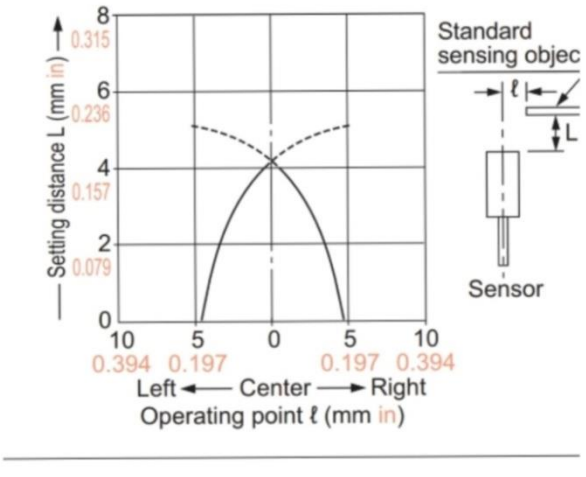

Figure 9 Mounting position of proximity sensor with respect to approaching target [7]

VIII. CONCLUSOIN

In this paper, the validated theoretical experiment is discussed by using inductive proximity sensor which detects the clutch bite point in various automotive vehicle through sensing the diaphragm spring fingers movement with suitable field range of >3mm to 4mm by sensor is achieved in the mild steel of less thickness. This sensor helps the beginners to take their foot at appropriate time when the sensor output signal is updated to driver in the driveline. They are effectively work in hilly region and slope regions. They even performed in parking areas where shifting the stick to front and rear by pressing and depressing the clutch is quite often in manual transmission and pick up the cars smoothly at the beginning of traffic signals and crowdy areas. By analysing this sensor indication, it remarks the greatest achievement in installing this in automotive vehicle. The inductive proximity sensor is adopted great enough not only finding the clutch bite point detection but also withstand various temperature change, vibration withstand, design and specification rating shows that it is completely fit for clutch point detection. Where this paper ultimately achieved the detection of engagement point of clutch of any model either high or low is discussed in this paper. Due to the welfare for every learners, freshers and women who learn to drive the automotive manual transmission vehicle with confidents and discouragement at the beginning

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