

In-Wheel Motor Transmission System in Electric Vehicle

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Abstract— Electric vehicle is the alternative, efficient and eco friendly in the future automobile industry. In today's world due to depreciation of the fossil fuels rapidly, engineers have found the other mode of vehicle movement. ie- moving the car or a vehicle by the mode of electric motor. The end of the engines powered by fossil fuels and entering to the new era of electric automobile by 2075 almost 95% of the fossil fuel content and production from the earth will get over. There are electric vehicles like Tesla automobile and some other companies like Mahindra etc have started production of electric vehicles and the vehicle is powered by AC Induction motor, BLDC motor etc by using shafts and cv axle for transmission of power generated. Here this research paper is about the implementation of in-wheel electric motor, construction, mechanism and working of alternative design of 3 phase ac induction 4 pole motor with figures and tables.

Keywords— electric motor, efficiency, transmission system, transmission.

I. INTRODUCTION

In 1887, AC Induction motor was invented by Nikola Tesla and Galileo Ferraris, known by Tesla motor. AC induction motor is electrical device which works on the principle of electric magnetic induction, in which it consists mainly two parts stator and a rotor, and stator remains fixed and rotor rotates inside the stator, where both have the windings named stator winding and rotor winding. When AC current is supplied to the motor, magnetic field is produced which helps rotor to rotate in result rotates the shaft and wheel rotates. There are various types of AC induction motors like 2 phase induction motor, 3 phase induction motor. Tesla electric automobile which is the most efficient and fastest car in the world uses 3-phase 4 pole AC induction motor, whose wires are connected in star connection as shown in below fig.1.

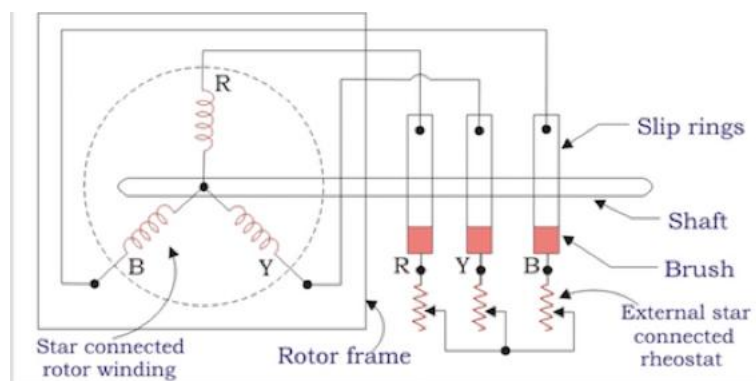


FIGURE 1: Star Connection in AC Motor

As we need more torque so for that we know the condition that less is the number of poles more is the torque produced, as per research it's found that 3 phase 4 pole induction motor is the most efficient electric motor but as it uses CV axle for the transmission of torque to the wheels there is loss and efficiency is decreased. We are in a rapid developing technological world new technology and inventions we come across frequently. Not only for the minimizing the losses and increasing the torque but also for the new technological method for which future electric vehicle can be taken to the next level of automobile industry.

II. THEORY

The concept behind this new technology "direct wheel-motor transmission system in electric vehicle", we have various and enough ways to propel a car or a vehicle but the methods of propelling used before was using SI Engine (spark ignition or petrol engine) or CI Engine (compression ignition or diesel engine) where the car consists of transmission system which consists of Engine, Gear box or transmission, Clutch, connecting shaft (from engine to differentials), Differentials, CV axle. This is the whole method of transmitting power from the engine to the wheels in form of torque. If a vehicle consists of so much of components then the empty space in the vehicle decreases and most important there are many losses due to this kind of transmission, and engineers cannot fit the engine directly in contact or inside the wheel as the space inside the rims of the

wheel is too less and engine isn't that compact to fit in. Now the new era is coming i.e. Electric vehicle generation, where electric motors like Ac motor or BLDC motors, till date since the electric cars are made electric motors are placed between the two wheels from where power is transmitted to the wheels via connecting shaft or cv axle. Let's take an example of world's first and most advanced electric car i.e. Tesla automotive. If we take example of Tesla roadster it's the world's fastest car it uses THREE-AC 3 phase 4 pole induction motors it's an all wheel drive as power is transmitted to all of the wheels. Motors are such things which can be made more powerful and more compact. In below fig. 2, we can see the how Tesla incorporates its motors in its car.



FIGURE 2: Motors incorporated in Tesla Roadster

III. EFFECTS & PROBLEM OF USING THE ELECTRIC MOTORS IN BETWEEN THE TWO WHEELS

There are many effects which occur to a vehicle. This kind of transmission system in the vehicle occupies most of the area of the car base and less empty space is left. By using cv axle to transmit the power it restricts the turning radius of the wheel. Power transmission in this method there are many losses like mechanical losses, frictional losses, less efficiency.

IV. MY PROPOSAL FOR THE NEW TECHNOLOGY AND SOLVING THE PROBLEMS

My proposal for the new technology is "IN-WHEEL MOTOR TRANSMISSION SYSTEM" to be used in electric vehicle. On going to the explanation part of this technology:

4.1 In-Wheel Motor Technology

This technology has not been used by any automobile manufacturer company till date. Basically in wheel motor means motors are placed inside the rims of the wheels. There will be no cv axle or connecting shaft be used for transmitting the power to the wheels. This hypothesis is given by a small company know as protean but their research is not completed yet, it's under process and they have used dc motor. Myself I have a motor of higher torque, I have made use of 3 phase ac induction motor as its much more efficient than that of dc motor whose power, torque, weight etc is given in below table.4.1.1 and that's of 3 phase Ac induction 4 pole motor which is placed inside the wheels. The values stated below for the AC induction motor is for single motor, for more power of the car we can use 3-4 motors, 1 motor in each wheel, simultaneously if we use 2 motors at the back it will act as rear wheel drive, if 2 is used in the front it will act as front wheel drive and if we use 4 motors in a car then it acts as all wheel drive (which makes the car very powerful).

**TABLE 1
SPECIFICATION OF PROPOSED 3 PHASE INDUCTION MOTOR**

Parameter	Details
Added weight	34 kg
Peak Torque	1500 Nm
Continuous Torque	650 Nm
Top Speed [At nominal Voltage]	1480 rpm
Peak Power [At nominal Voltage]	110 kW
Continuous Power [At nominal Voltage]	77 kW (Liquid cooling)

The construction of the motor is in such a way that it will exactly fit into the rims. While the motor having the screws coming in outward direction so as to get fit into the wheels depending on the no. Of lugs used in the car if the vehicle is of less power

and small then 4 lugs are used in wheels and if the vehicle is having higher power like sedans and heavy vehicle it can go from 5 lugs to 6 lugs.

4.2 Author's technology construction and working

Generally ac motors are of cylindrical in shape but our shape of ac motor is circular in shape with some width exactly to that of rims of wheels. This motor consists of all the components same as that of other ac motors like stator, stator bracket, rotor, rotor bracket, inverter, bearing , motor outer case, front end bell and rear end bell, power electronics, brake disc, brake calliper. The fitting of motor in wheels can be seen in below figure 3.



FIGURE 3: Fitting of Motor wheels

Basically this motor mainly consists of a stator and a rotor where rotor is inside the stator and an inverter connected to the stator. With the motor from the outer casing of motor suspension is attached which is attached to the chassis of the vehicle. Moreover all the attachment system is fully different in this system. In simpler words we can say here the outer casing of the motor acts as a hub with screws to hold the wheel (the fig shown above wheel is of 5 lugs), for steering control, steering control rods are connected above the suspension system with the supporting system is given for the motor and wheel. This system removes the restrictions to the turning radius of a vehicle. Steering arms and steering system can be seen in the below fig.4 and fig.5.



FIGURE 4: (Rear view)

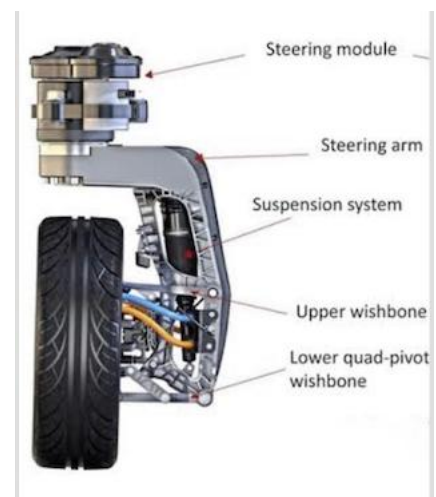


FIGURE 5: (side view)

As we can see in the above fig. From the steering module, steering connecting rods will get connected and then to the steering wheel and some important parts which gives support to the wheels and motor.

This new technology which will be very beneficial in the future and I will be trying it on my project sports car in progress.

Below figures we can see the organic chassis structure made in solid works platform and the real ongoing project sports car where it will be applied later.

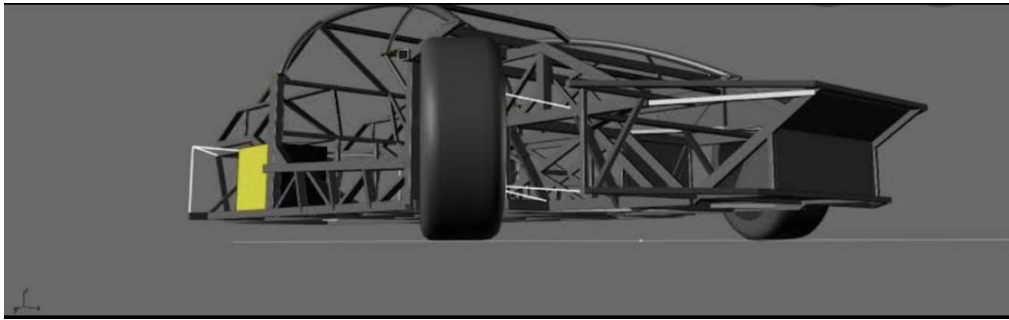


FIGURE 6: Organic Chassis of my Sports Car (Drawn in Solid Works)



FIGURE 7: Organic Chassis and Sports Car in Progress in Real.

4.3 Advantages of in-wheel motor transmission system

There are many advantages of behind this invention. The most important point is these systems are as stated below:

- 1) As there is no restrictions in the turning radius so the wheel can turn upto 180 degrees, in that case if all 4 wheels turn through 180 degrees then by standing in one position without any extra area a vehicle can turn directly through 180 degree or 360 degree, which will be very helpful where there will be less place to take turn and parking's, etc.
- 2) Direct transmission of power from the motor to the wheel in form of torque ($2\pi N/60$), decreases the losses as direct attachment is there in result increases the torque.
- 3) Free space in vehicle increases as there is no components in the chassis base rather than batteries. We get extra free spaces.

V. CONCLUSION

This innovation will be proved very useful in the near future if this system will be installed in the electric cars and other vehicles and lots of problems will be solved by this. I am personally going to apply this on my experimental car which I am making can be seen in the fig. 7.

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