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DESIGN OF DIFFERENT PARTS OF POWER WINDOW IN AUTOMOBILE

A. I. PANDEY[1], K. R. PATELIY

[1]R.C.TECHNICAL INSTITUTE, pandeybright@gmail.com

Abstract: *Power windows or electric windows are automobilewindows which can be raised and lowered by depressing a button or switch, as opposed to using a hand-turned handle Power windows provide more safety compare to simple window to avoid accidents particularly for children. Therefore most of automobile industries are shifted towards power window. In design of power window, we have to focus on weight to lift, motor selection and gear design etc.*

Keywords: *Power Window, Automobile, Weight, Motor Selection, Gear Design*

I. INTRODUCTION TO POWER WINDOW

The concept of power windows was introduced by Ford Motors for the first time in the year 1941 in their car model Lincoln Custom and Packard Custom Super 180. Power windows are electric windows which can be raised and lowered at the touch of a button rather than the traditional handle which has to be turned manually for raising and lowering car windows. Power windows can either be in built or they can be externally installed by paying an extra amount. All the cars today come with a power window variant which is slightly higher in price as compared to the car with normal windows.[1]

II. WORKING OF POWER WINDOWS

Power windows mostly work on the principle of electricity or battery that is controlled by switches and a number of wires. Power windows work only when the car is on start mode. This is so because they run on electricity or battery unlike the traditional windows. The basic power window system comprises control of all four windows by the driver. This is so because the door of the driver receives power from an optimized circuit breaker. This power is then sent to the window switch control panel from where it is further transferred to a centre point where the wirings of all the four windows meet. The power contact then gets connected to the vehicle ground on one end and the battery or electric motor at the other end.

When the driver presses the switch mounted near his seat then one of the two side contacts gets disconnected from the ground and connects to the centre power. This provides the power to get distributed to the rest of the windows.

However the latest luxury car brands have a more technologically advanced power window system. This is so because the car is fitted with many powered components like power windows, power door, and power mirrors. In such a case it becomes very difficult for the car manufacturers to assemble all the wires together in one so they merge all the wires into one module to monitor all the controls. Hence when the driver presses the button power gets transmitted directly to the central wire module and then to all the four windows.[1]

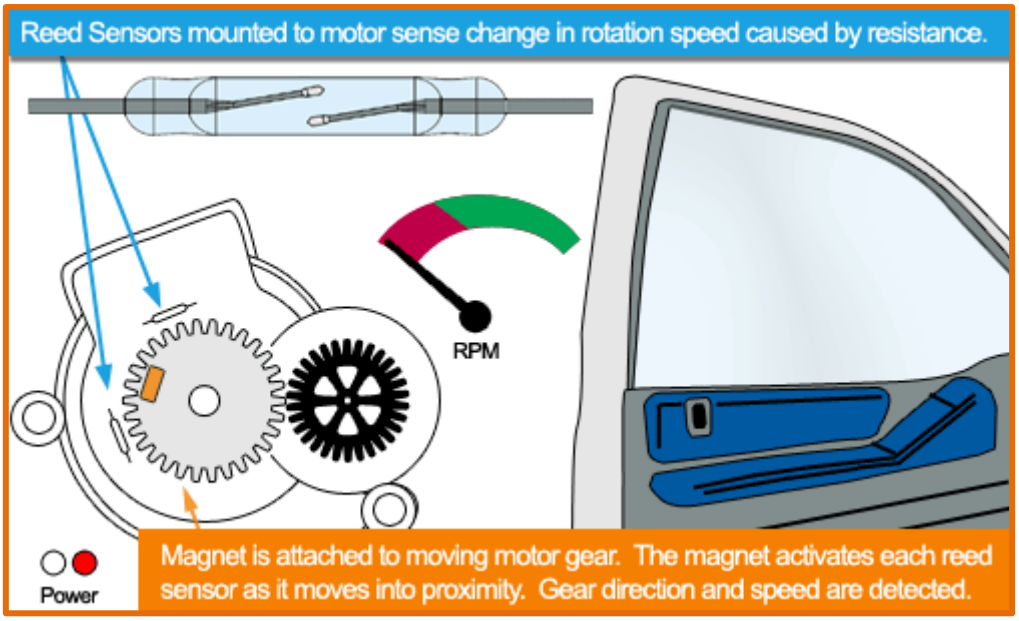

Fig 1 Power Window operation [3]

III. DESIGN OF POWER WINDOW

Objective of design of power window:

To move glass with load of 12kg, 650mm within 15sec with dc power supply

1. Travelling of glass =650mm
2. Travelling time = 15sec
3. Direction = up & down

IV. CALCULATION FOR WEIGHT OF GLASS

Weight of product
Total load that motor has to carry
Density of glass = 2.5gm/cm^3
=0.0000025kg/mm^3
Volume from the model=1.57 X $10^6 mm^3$
Weight of product =Volume X Density
=1.57 X 10^6 X0.0000025
=3.92 kg
≈4kg
The weight of glass with considering friction.
Types of friction:Sliding friction
Co efficient of friction for glass =0.05
Additional weight due to friction = weightof product X co efficient of friction
= 0.05 X 4
= 0.2 kg
Additional weight due to human being approximately =3.5kg
So total weight that motor has to lift during uplifting of glass is
= weight of glass + friction load + weight due to human being
= 4+0.2+3.5
=7.7 kg
≈8.0kg
With factor of safety, we will consider total weight
Factor of safety=1.5
So load with factor of safety=1.5X8
= 12 kg

V. MOTOR SELECTION PROCEDURE

Torque = force X diameter of pulley/2
Diameter of pulley= 60mm
Torque = (12X10X60)/2
= 3.6 Nm
So required Torque = 3.6Nm
We have to select reversible motor with following specifications
Company name: orient motor
Type: DC Reversible motor 15w Gearhead
Motor specifications

rpm	20	18	15	12	10
Gearhead Ratio	90	100	120	150	180

Required rpm
We need 3 revolutions per 15 sec to move glass
So if in 15 sec ⟹ 3 revolution
60 sec ⟹ ?
So required rpm is =(60X3)/15
=12 rpm
So we have to select motor with gear head ratio 150 which will give 12rpm.

VI. GEAR SELECTION

The 3 rev of Pinion =120^0 rotation of Gear means1/3 rev of Gear
It means 9 revolution of Pinion make 1 revolution of Gear so the ratio required is 1:9.

Type of gear is SPUR GEAR
Module= Pitch circle Diameter/T
m=D/T
And P= πD/T
Where P= Circular Pitch
D= Pitch circle Diameter
Pressure angle Φ =20^0
Addendum =1m
Dedendum = 1.25m
Ng/Np = 1/9
Working depth= 20m
Clearance C= 0.188m + 0.05 mm
Face width F = 10m
Now we have selected preferred module (m) = 3
And gear ratio is 1/9
Pitch circle diameter of pinion Dp =60 mm
As we know that m_p = Dp/Tp
So teeth on pinion Tp= 60/3
Tp = 20
And teeth on Gear Tg= 20X9 = 180
As we know that Ng/ Np = Dp/Dg
Therefore 1/9 = 60/Dg
Pitch circle diameter of gear Dg= 9X60 = 540mm
Center distance between two gear is = (Dg+ Dp)/2
= (540+60)/2
= 300mm
Material of gear AISI 1020 Steel
Allowable ultimate tensile strength = 380MPA
Yield strength = 210MPA
Design factor = 3
So allowable bending stress =210/3
= 70MPA
As we know that the rpm revolution per minute of pinion is 12.
How many revolution takes place in per second for pinion= (1 X 12)/ 60
= 0.2 rev/sec
Now velocity of pinion V= (πDpNp)/1000
= (3.14 X 60 X 0.2)/ 1000
= 0.038 m/s
Velocity factor Kv = (6 + V)/6
= 1.01
Form factor Y= 0.3
Now W= $FmY\sigma_{all}/Kv$
= (26 X 3 X 0.3 X 70)/1.01
= 1621 N
So power = H= (W X V)/1000
= (1621 X 0.038)/1000
= 0.06 kw
=60 w

VII. CONCLUSION

By designing the power window, we find that 12kg weight is lifted by electrical DC reversible motor with gear head ratio 150. The dimensions are
Pitch circle diameter of pinion or gear2 Dp= 60mm, Pitch circle diameter of Gear or gear1 Dg= 540mm, module m=3, Pressure angle =20^0, Number of teeth on gear1 = 12, Number of teeth on gear2(pinion) = 108

VIII. FUTURE SCOPE

- Mechanical parts should be replaced by electronic system
- Water resistance system
- Material of gear and pinion should be replaced by nylon materials.

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NOMENCLUTURE

Dg = Pitch circle diameter of gear
Dp = Pitch circle diameter of pinion
Ng = Speed of gear
Np = Speed of Pinion
Tg = Teeth on gear
Tp = Teeth on pinion
F = Face width
Kv = Velocity Factor
Y = Form Factor
m= Module
σ_{all} = Allowable bending Stress
W = Load
V = Velocity
Φ = Pressure angle
kw= Kilowatt
w= Watt
P = Circular Pitch

