Design of Transmission Device for A Two-speed Automatic Transmission of Pure Electric Vehicle

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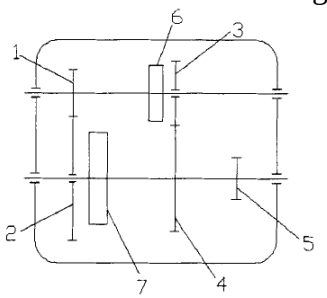
Abstract. Requests based on the small pure electric automobile lightweight to the pure electric automobile two grades of automatic transmission transmission devices carries on the design. Including transmission gearbox transmission system the computation and main gear box design of scheme of arrangement and gear parameter. While considering disassembling and service convenient caused the overall size and quality of this transmission gearbox greatly reduce. This design is suitable for the small pure electric automobile.

Introduction

Role that in the pure electric automobile the transmission gearbox plays in traditional automobile basic consistent, is changed the electric motor to transmit the rotational speed and torque on driving gear from pilot's request and ambient condition, enables the automobile to have the corresponding moving velocity and overcomes various travel operating modes the ability, what is different, the pure electric automobile's reverse gear realizes through the electric motor reverse. While reducing the load of battery and electrical machinery also raised the electric motor working efficiency. Regarding the small pure electric automobile, the complete bikes lightweight and reduces the cost to be especially important, when designs the pure electric automobile transmission gearbox should reduce the overall size and quality as far as possible, reduces the cost, and causes disassembling and service convenience and so on.

Transmission gearbox transmission system scheme of arrangement

Transmission type. This vehicle is the pretage forerunner, uses two shaft-type transmission gearbox forms to be possible greatly to reduce the transmission gearbox overall size.



1.Keeps off the drive gear 2.Keeps off the driven gear 3.Two keeps off the drive gear 4.Two keeps off the driven gear 5.Main gear box drive gear 6.Keeps off the coupling high 7.Keeps off the coupling lowly

Fig1 Transmission gearbox structure schematic drawing

Reverse gear form. Different can only revolve along the unidirection from internal combustion engine's crank, electric motor's gyrotropic may transform, therefore the reverse gear in the electric automobile may through hanging keeps off the electric motor reverse to realize**.**

The gear form. Presently automobile transmission gearbox gear uses the straight spur gear and helical gear two kinds generally. When helical gear merit numerous like revolution is steady, noise to be small, life long and so on, but manufactures the complex cost to be high when revolution will produce the axial force damage bearing. Presently in the transmission gearbox the reverse gear and low speed keep off the use straight spur gear, other use the helical gear generally.

The computation and examination of transmission gearbox gear parameter.

Vehicle transmission gearbox center distance generally in 60~80mm.Theoretically automobile transmission gearbox center distance changes along with the complete bikes mass variation, the quality is smaller, transmission gearbox center distance A is smaller.This vehicle for small pure electric automobile, preliminarily determines A=59mm.The influence transmission gearbox external dimensions' factor has many, takes the shifting gears organization's the logarithmic of form and gear as the most obvious two spots. Moreover when the shifting gears organization's arrangement way and as well as the size of gear is also the design unnegligible factor, because this automatic transmission is suitable for the small pure electric automobile, when design under satisfying the function premise makes various sizes small as far as possible[1].

This vehicle owner reduction gear velocity ratio i_0=4.22, keeps off velocity ratio i_{g1}=2.08, two keep off velocity ratio i_{g2}=1.446.

The gear parameters. This vehicle keeps off helical gear normal module m=2.0mm respectively.Takes the standard angle of pressure α=20°.In the vehicle transmission gearbox, two shaft-type transmission gearbox helical gear angles of spiral's scopes are 20°~25°，this article takes β=21.2°.This design takes gear addendum coefficient h_a^*=1.0.The input axis keeps off gear b_1=23mm, output shaft keeps off gear b_2=20mm.The input axis two keep off gear b_3=23mm, output shaft two keeps off gear b_4=20mm.Tooth width coefficient position k_c=10.

The calculation of the gear parameters.

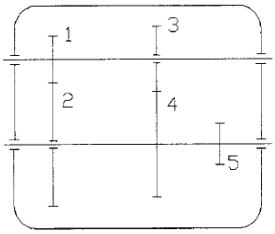


Fig2 Transmission gearbox gear structure

Figure 2 is transmission gearbox's gear structure, may according to keep off velocity ratio and designation that center distance A and other parameters of determined respectively calculated to keep off the number of teeth of gear respectively.

(1) Keeps off the determination of gear parameter.

$$i_{g1} = Z_2 / Z_1 \quad (1)$$

$$Z_1 + Z_2 = 2A\cos\beta / m_n \quad (2)$$

Equation (1), (2) can be calculated Z_1 = 18, Z_2 = 37, is the actual first gear transmission ratio i_{g1} = 2.056.

For gear may produce root cutting, the gear should match up center distance, in addition to increase the gear strength and stability, to Angle deflection gear.

Computation theory center distance, end surface angle of pressure and end surface pressure angle.

$$A_0 = m_n(Z_1 + Z_2) / 2\cos\beta \quad (3)$$

$$\tan a_t = \tan a_n / \cos\beta \quad (4)$$

$$\cos a_t' = A_0 \cos a_t / A \quad (5)$$

$$A_0 = 58.99\text{mm}, a_t = 21.325^\circ, a_t' = 21.40^\circ \text{ 。}$$

Dislodges the sum of coefficient

$$X_\Sigma = (Z_1 + Z_2)(inva_t' - inva_t) / 2\tan a_n \quad (6)$$

$$X_\Sigma = 0.0152 \text{ 。}$$

By the number of teeth compared to $U=Z_2/Z_1$=37/18=2.056 ,checks material to be possible to result in two gears' dislodgement coefficients respectively is X_1=0.30，X_2=-0.2848[2].

As a result of X_{1min}=（17-18)/17=-0.058823529＜0.30,therefore dislodges reasonably。

(2) Two keeps off the determination of gear parameter

$$i_{g2} = Z_4 / Z_3 \quad (7)$$

$$Z_3 + Z_4 = 2A\cos\beta / m_n \quad (8)$$

Equation (7), (8) Z_3 and Z_4 of values that can be obtained after the integer Z_3 = 22, Z_4 = 33, the actual second transmission ratio i_{g2} = 1.5.

Tab.1 The gear parameters

Keeps off the gear parameter		Two keeps off the gear parameter	
Drive gear number of teeth Z_1	18	Drive gear number of teeth Z_3	22
Driven gear number of teeth Z_2	37	Driven gear number of teeth Z_4	33
Velocity ratio	2.08	Velocity ratio	1.446
Actual velocity ratio Z_2/Z_1	2.056	Actual velocity ratio Z_4/Z_3	1.50

The design of main gear box.

In the transmission system, the main gear box is its vulnerable area. The gear not only needs in withstanding big load situation the long-firing operation, but also needs to adapt to the changeable ambient condition. In order to cause the gear can the long-time effective work, the request of counter gear material is high. First should have the high surface contact fatigue strength and bending gatigue intensity. The next gear can be under the impact on cause the tooth with breaking off, therefore the gear teeth core should have certain toughness. Finally the performance change of material in the processing process, as far as possible the guarantee the performance change of material around the processing is not big. When needs to use the alloy material is, elects as far as possible including manganese, vanadium, titanium, silicon and other element the alloy steel, little uses including the nickel and chrome tanning element material[3].

This vehicle owner step-down gear uses the helical gear, the gear material selects 20CrMnTi, the precision class is 7 levels, the angle of spiral β=20.582°.Center distance a=94mm and modulus m=2mm and gear addendum coefficient h_a^*=1 and top crack coefficient C^*=0.25.

Gear：Drive gear number of teeth Z_1=17,Pitch line diameter d_1=36.32mm，Gear width B_1=27mm

Drive gear number of teeth Z_2=71,Pitch line diameter d_2=151.68mm， Gear width B_2=25mm

Concluding remarks

The pure electric automobile takes the clean renewable electrical energy as the power, may realize zero emission, and noise small and other merits, will cause it gradually to become in the future automobile's development direction. The electric quantity that the accumulator cell on pure electric automobile carries is very limited, is unable to satisfy the long distance of pure electric automobile to continue the course, therefore the complete bikes lightweight is enhances long distance to continue the course important means. Under satisfying the premise of security of service reduces the cost to be helpful to the pure electric automobile popularizing fast. This article and reduced the cost under the premise to provide one kind of automatic transmission transmission device based on the consideration complete bikes lightweight, was suitable for the small pure electric automobile.

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