Design of Internal Combustion Power Wrench

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Abstract

The overall structure of the internal combustion engine power wrench is used to study the design of the wrench transmission mechanism. The internal combustion engine power wrench uses the gasoline engine output power to pass the clutch, and the gearbox performs the first deceleration. Then, the gear shaft transmits the torque and the rotational speed to the power head portion, and finally outputs the torque. Based on the engineering machinery design and theoretical trial operation data, this design study uses the relevant design concept of industrial design, so that the power head part of the wrench has a secondary deceleration function, which is realized by bevel gear transmission; Function, in order to make the power head part have the function of limiting torque, so a torque limiter is added on the drive shaft to achieve the tightening process, and the loosening process is realized by the impact force to complete the tightening of the bolt.

Keywords

Internal combustion engine,power wrench, bolt tightening.

1. Introduction

Wrench is a tool for tightening and disassembling threaded fasteners such as bolts and nuts. The wrench is widely used in various industries. Especially in the maintenance of railways, the traditional elastic bolts are mainly manual, but the manual operation method can not accurately control the tightening torque, so that the buckle pressure is very different, the quality is poor, the rework phenomenon is more, the maintenance cycle is shortened, and it is difficult to ensure the line. The integrity and stability of the frame structure[1]. Therefore, an internal combustion bolt wrench with two kinds of rotational speed and torque control can be realized with a clutch separation device. This design is designed to reduce the labor level of workers and the fully automated power wrench for the problem of low degree of mechanization of railway maintenance work in China and the high labor intensity of workers.

2. Overall Structural Design

The internal combustion power wrench consists of a support, a power head, a handle, a connecting cylinder, a gearbox, a clutch, a coupling, a gasoline engine, and a frame. An internal combustion engine is mounted on the frame of the power wrench, and the output end of the internal combustion engine is equipped with a clutch, a reduction gear, a bevel gear shaft, a bevel gear and an impact mechanism, and a traveling wheel combined with the rail is mounted under the frame of the power wrench. .

The role of each part is as follows:

(1) Support: A support member for supporting the weight of a container or equipment and fixing it to a certain position. Also withstand the vibration and seismic loads during operation.

(2) Power head: A power component that can realize main motion and feed motion, and has automatic workpiece circulation. A relatively simple shifting transmission mechanism is available in various forms. The basic principle is a gear shifting mechanism driven by a motor.

(3) Handle: The metal handle of the mechanical device can be held, manipulated or moved.

(4) Connecting cylinder: used to connect the gearbox and the power head.

(5) Gearbox: It is mainly composed of gears and shafts, and the variable speed torque is generated by different gear combinations.

(6) Clutch: It is installed between the engine and the transmission. It is the component that cuts off and transmits power between the engine and the transmission system. It is also a common component in mechanical transmission.

(7) Coupling: A mechanical part used to couple two shafts (active shaft and driven shaft) in different mechanisms to rotate together to transmit torque.

(8) Gasoline engine: An engine that uses gasoline as a fuel to convert internal energy into kinetic energy.

(9) Rack: used to support and fix the engine, transmission parts and other components, is the skeleton of the whole machine.

2.1 Determination of Main Technical Parameters

After extensive research[2], according to the actual situation of the line, the main technical parameters of the internal combustion bolt wrench are determined as follows:

Gasoline engine: 6.5PS/3600r/min

Speed: 100r/min~150r/min

Tightening torque (continuously adjustable): 180Nm

Torque control accuracy: 10%

Unscrewing torque: 600Nm (impact mode)

2.2 Working Principle

The power output is connected to the transmission through the clutch and the transmission, and the power is transmitted to the gearbox. The clutch can transmit and cut off the power. The gearbox is geared to realize the change of the rotational speed, and the horizontal rotary motion is converted into the vertical rotation by the bevel gear. Movement, the direction of rotation of the output shaft is changed by the reversing mechanism, and the reversing mechanism is provided with three positions of positive, negative and middle. The bevel gear reversing speed reduction mechanism performs the second deceleration to realize the commutation and deceleration of the rotating torque, and the torque after the reversing and decelerating is transmitted from the connecting shaft to the impact urging mechanism which acts as a device for accumulating the force. Then, the nut on the bolt is loosened and tightened by the sleeve, which is simple and convenient. Its working principle is shown in the figure below.

2.3 Transmission Scheme and Structural Design

A power wrench is a tool used on railways to tighten or loosen bolts or nuts. The specific transmission scheme is as follows: the output power of the gasoline engine passes through the clutch, and the first deceleration is performed by the reduction gear box. Then, the gear shaft transmits the torque and the rotational speed to the power head portion, and finally outputs the torque.

Transmission scheme of internal combustion power wrench

Transmission scheme of the transmission

After the speed is output by the gasoline engine, it is decelerated by the reduction gear box. Specifically determine the following options:

(1) First determine three transmission schemes:

a Two-stage cylindrical gear reducer, suitable for long-term work under heavy and harsh conditions. Easy to use and maintain, large size structure.

b The worm reducer is compact, but the transmission efficiency is low, the use efficiency is low, and it is not economical when used continuously for a long time.

c The use of the first-stage cylindrical gear reducer and open gear transmission has low cost and short service life.

(2) Analysis of three options:

Option 1 uses a secondary cylindrical gear reducer. The characteristics of this transmission mechanism are: the lateral dimension of the reducer is small and the oil immersion depth of the two large gears can be approximately the same [3]. The structure is complex and suitable for long-term work under heavy and harsh conditions. Easy to use and maintain, large size structure.

Option 2 uses a worm reducer. The worm gear reducer is a power transmission speed reduction mechanism. Currently, the mechanism for transmitting power and motion has a wide range of applications. The transmission ratio is large and the structure is compact, which causes serious wear in the case of long-term use. Moreover, it has low transmission efficiency and can be economically wasted if used for long-term continuous use. Therefore, this solution should not be used.

Option 3 uses Open gear drive and primary spur gear reducer. The primary spur gear reducer is rotated by a pair of meshing gears mounted in the casing, and the power is transmitted from one shaft to the other to achieve deceleration. The power is transmitted by the electric motor to the gear shaft through the pulley, and then transmitted to the shaft through the two meshing gears, thereby achieving the purpose of deceleration. The open gear is easy to wear during the working process and has a short life, so this solution is not suitable.

The transmission diagram of the transmission is as follows:

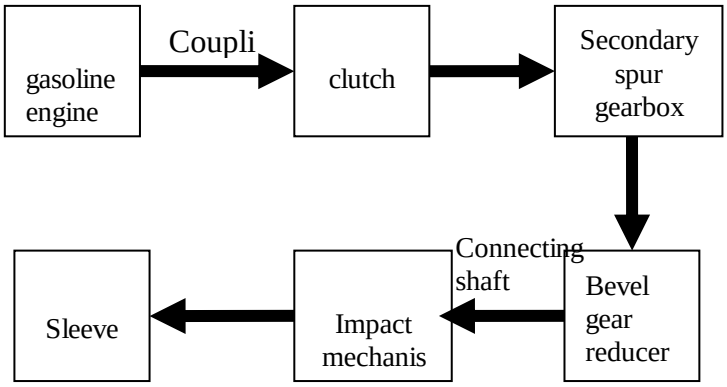

Fig 1. Operational principle of power wrench

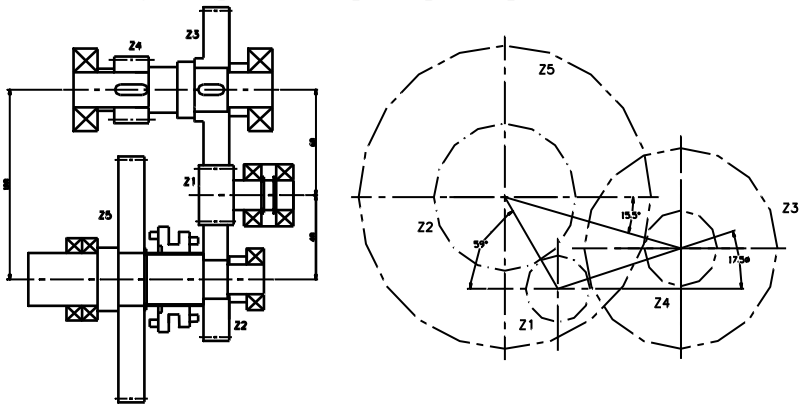

Fig 2. Reducer transmission diagram

(3) According to the working conditions of the internal combustion engine power wrench and the actual output speed, the first transmission scheme is now adopted. And the transmission can achieve positive and negative. The low speed realizes the forward rotation, and the secondary reduction transmission is the process of tightening; the high speed reverse rotation and the first stage deceleration are the loosening process.

(4) The forward and reverse rotation of the reducer is realized by adding an idler between the transmission shafts. The high and low speed shifting is realized by the shifting of the sliding sleeve by the shifting fork, so that different gears mesh with each other.

2.4 Power Part Design

As a line maintenance equipment, due to the long working distance, the equipment is inconvenient to transport, and the selection of power is strict. One is to ensure sufficient power, and the other is to ensure a low weight[3]. Based on the above two points, it is determined that the internal combustion engine is used as the power. Due to the weight and noise of the diesel engine, although it has the advantages of low price, good economical use and convenient maintenance, it is still not suitable. The gasoline engine has the outstanding characteristics of light weight and low noise. With the localization of the gasoline engine, its purchase price has been reduced, and it has been widely used and decided to adopt a gasoline engine.

According to the actual working conditions of the gasoline engine and the working conditions, the basic parameters of the gasoline engine are as follows:

n=3600r/min P=3.36kw

$$\text{Output torque: } T = 9550\frac{p}{n} = 9550\frac{3.36}{3600} = 8.913Nm$$

3. Power Transmission Part Design

3.1 Working Principle of Power Head

The rotational torque of the gasoline engine passes through the clutch, and the gearbox is first decelerated by changing the gear ratio between the drive shaft and the driven shaft. The reducer can achieve positive and negative rotation. The power coming out of the gearbox is decelerated by the bevel gear reversing mechanism for the second deceleration, which realizes the commutation and deceleration of the rotating torque. The torque after the commutation and deceleration is transmitted by the connecting shaft to the device with the accumulating force. Impact on the force mechanism. Then, the nut on the bolt is loosened and tightened by the sleeve, which is simple and convenient [4].

3.2 Overall Structure of the Power Head

The power head is mainly composed of a display head, a spring, a torque limiter, a bevel gear, a bearing, a sleeve, a shaft, a circlip, a steel ball, a nut sleeve and the like. The power head part has a secondary deceleration function, which is realized by bevel gear transmission. In addition, it must have a torque limiting function, so a torque limiter is added to the drive shaft to achieve the tightening process, which is achieved by the impact force. The power head part is the most important part of the design. The speed and torque of the power wrench will eventually be tightened or loosened. It must also have a torque limiting function due to the design of the subject.

The various parameters required for the design of the power head are shown in Table 1:

Table.1 Dynamic head parameter

Axis number		Rotating speed *n* (r/min)	Torque *T* (N.m)	Power *P* (kW)
Input shaft	high speed	1600	18.15	3.04
	Low speed	300	96.77	3.04
Output shaft	high speed	800	600(Use shock)	No calculation
	high speed	150	60~180(Continuously adjustable)	0.94~2.83

4. Conclusion

By searching for the relevant design parameters of the wrench, a new innovative concept is proposed to calculate the design structure and data, and the internal design of the engine is used to refer to the previous design results to optimize the design of the internal combustion engine power wrench, and the design results are analyzed with relevant analysis software for theoretical reliability analysis. Get the best design results. The internal combustion power wrench has simple and convenient operation, good reliability and high degree of automation, and can greatly reduce the labor intensity of the user. Can be widely used in the construction and maintenance of railway tracks.

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