POWER ASSIST HAND TRICYCLE WITH BATTERY FOR DISABLED PERSONS

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ABSTRACT

A hand tricycle is originally designed to be used by a disabled person with lower extremity weakness but with power in his or her hands and arms. This tricycle is modified by the addition of an electric motor and battery to help power the vehicle. The functions of the original design are not altered. The battery, motor, speed reducer and clutch are properly arranged. An additional sprocket is attached to the drive wheel. The motor controller can adjust the speed in five different settings and the tricycle can be driven forward or backward. The vehicle is fully tested as shown in the video recording

Keywords: Electric Tricycle, Powered Tricycle.

I INTRODUCTION

The project is simple and straight forward. However our search of the literature revealed many recently-issued patents or patent applications. For examples, we found the following: 'Electric Front Wheel Drive System for Motorcycle' by Nicoson [1], 'Battery System for Electric Motorcycle' by Belton [2], 'Electric Motorcycle' by Kanno et al [3] and 'Electric Motorcycle and Controller Unit' by Hakamata et al [4]. These recent patents support the idea that the current project is at the frontier of the technology. In fact, while working on the project we received several inquiries regarding to the availability of battery-powered tricycles,

Many scientific articles related to our project are also published. The closest article is titled 'Velocity Control with Disturbance Observer for Pedal-assisted Electric Bikes' by Chang et al [5]. They describe the implementation and testing of an electric bike that is assisted by human power. Another group of articles deals with hybrid electric motorcycles. Motorcycles originally powered by internal combustion engines are modified with the addition of electric power to improve the performance and decrease the pollutants, reference [6-9]. A book titled 'Build Your Own Electric Vehicle' by Leitman ct al [10] gives comprehensive information on building your own electric vehicle is also listed in the references. We hope that this list of references gives readers sufficient information to build an electric vehicle without difficulty.

We salvaged a lightweight tricycle weighing about thirty pounds from a storage area. It was not in working condition. The wheels are arranged with one fixed direction drive wheel in front and two pivoting wheels for steering in the rear. Two handles beside the seat are used for hand control of the steering. A large sprocket 25.4 cm in diameter located in front of the driver is connected with two crank handles for the driver's hands to

power the vehicle. The crank sprocket is connected to the sprocket on the front wheel via a chain and ten speeds clutches. For a person with healthy arms and hands on a level ground a comfortable crank rate is 20 rpm. With the clutch set at 1 to 1 ratio, our vehicle may move 38 m/min or 2.3 km/hr. However, when a person is fatigued or moving on an incline, additional help to move the vehicle maybe required. This paper aims to solve this problem.

II MODIFICATION

Before modification it is necessary to restore the tricycle to perfect condition. As mentioned earlier that the original vehicle was not in a working condition, the rim in the front wheel was so severely warped. In order to straighten the wheel, the spikes were to be recut and threaded longer with a die. After the wheel is reassembled, each spike must be carefully adjusted to reach equal tension on the spike. This process is extremely tedious. All the tires must be inflated fully without leaking. When tires were checked, one of them found leaking so it was replaced. Brakes are checked and adjusted. All the bearings are properly greased. The pivot for steering is also lubricated.

Because of the existing configuration of the vehicle, the front wheel is chosen for the power assist drive wheel. Criteria for part selection are the following: light in weight, small in size and low in cost. 24 v battery is chosen for the power storage, de motor with 1/2 hp is selected for driving (CE Mite Motor Model MY1016 rated speed 2750 rpm), Speed reducer by SM-CY CLO, Model H3075/07, with 121 to 1 ratio is used to reduce the speed of motor to about 20 rpm to interface with the crank sprocket. Spur gears are used from the motor to the speed reducer and from speed reducer to the clutch. Because the battery power is not to be used continuously, an electric clutch was chosen, so it can be turned on easily with a switch when needed. However the only clutch that met our design constraints and had enough torque capacity is John Deere Electric PTO clutch. This was also modified. The output was originally a V-bclt pulley. The pulley is cut and a sprocket is installed. So that the input is a spur gear and the output is a sprocket. The original clutch and driving mechanism are on the right side of the front wheel an additional sprocket is installed on the left side of the front wheel. A chain connects the clutch sprocket to the new sprocket on the front wheel. The layout of the mechanism is given in Figure 1.

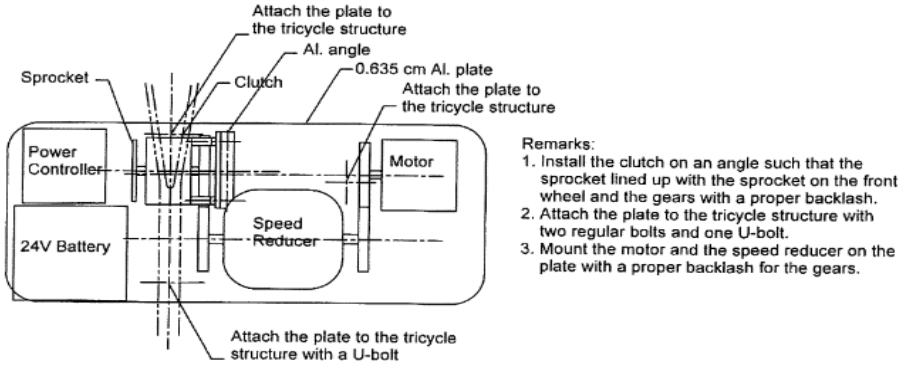

Fig. 1 Layout of Mechanisms

The sprocket on the clutch is attached to the shell of the original pulley; the sprocket on the front wheel is attached to the hub of the wheel. The size of the sprocket is only 5.7 cm. The distance between the two sprockets is more than 50 cm, to avoid the touching of the upper portion of the chain to the lower portion, a guide idler is installed. The guide idler is made of a small ball bearing pressed on with a pulley shaped ring. A sketch of the setup is shown in Figure 2.

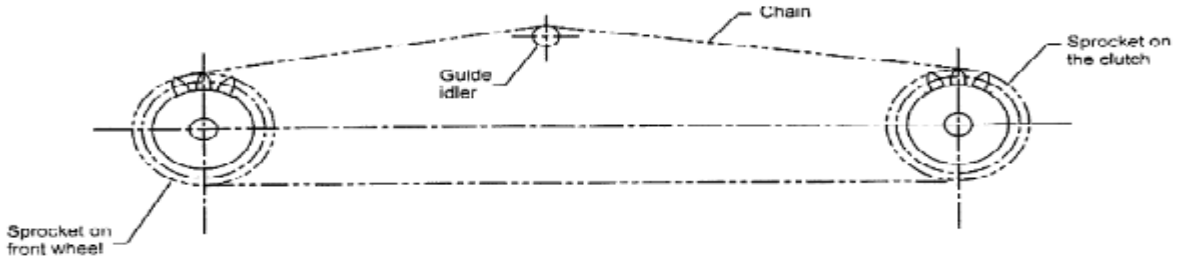

Fig. 2 Sketch of Driving Sprockets

The speed control was originally designed by using NPN transistor to control the current supply to the motor, but because of large current the life of the transistor was very short, Finally the speed controller is made by 5 wire winded resistors and different speed is achieved by a rotary selection switch. The voltage to the motor can be adjusted from 24 v to 8 v. The speed of the motor varies from full speed of 2750 rpm to nearly zero. The resistors and the switches are arranged in one control box. The circuit of the power supply is shown in Fig. 3.

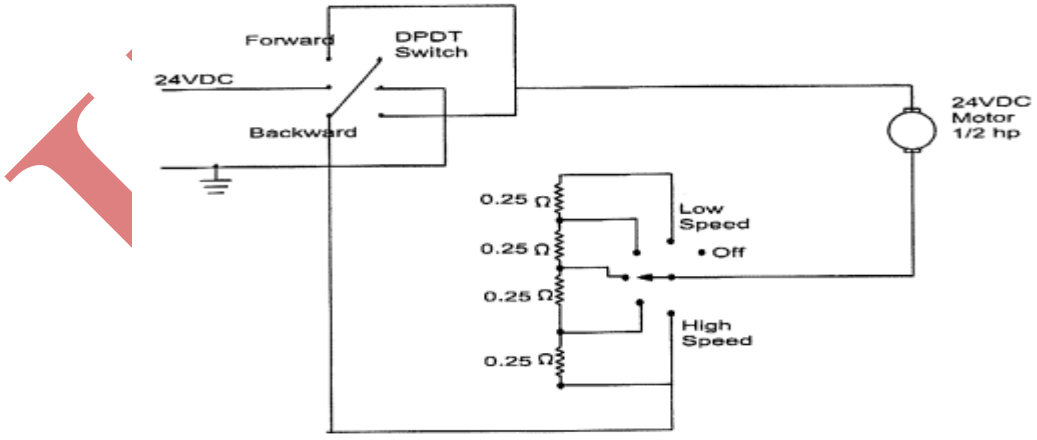

Fig. 3 Circuit of Power Controller

All the parts are mounted on a 0.635 cm aluminum plate attached to the structure under the seat of the vehicle. Here a couple of points ought to be mentioned. The cost is very minimum only a few hundred US dollars. The total additional weight is about 14 kg. A picture is taken to show the actual situation as given in Figure 4.

Fig. 4 Real Situation of the Tricycle

III TESTAND RESULTS

Each part when it was purchased it was always tested just to make it certain that it is in a good condition according to its specification. Then after the mechanisms were assembled the operation of all the parts and the controller are tested in the lab. Certainly we want that everything is working properly before it was taken out to test in the parking lot. Because the battery chosen is small in size, it is also very small in capacity, so it needs to the charged very often. Consequently, the battery charger becomes very important. So a good battery charger is built and it serves well.

The vehicle is tested. Certainly it is working as expected. The maximum speed of the driving wheel is 23 rpm just as expected or 44 m/rnin, 2.6 km/hr. The range of the vehicle is very short because of the battery, but it can be improved by install additional battery. Just for a record a short video is made for forward and backward operations of the vehicle.

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