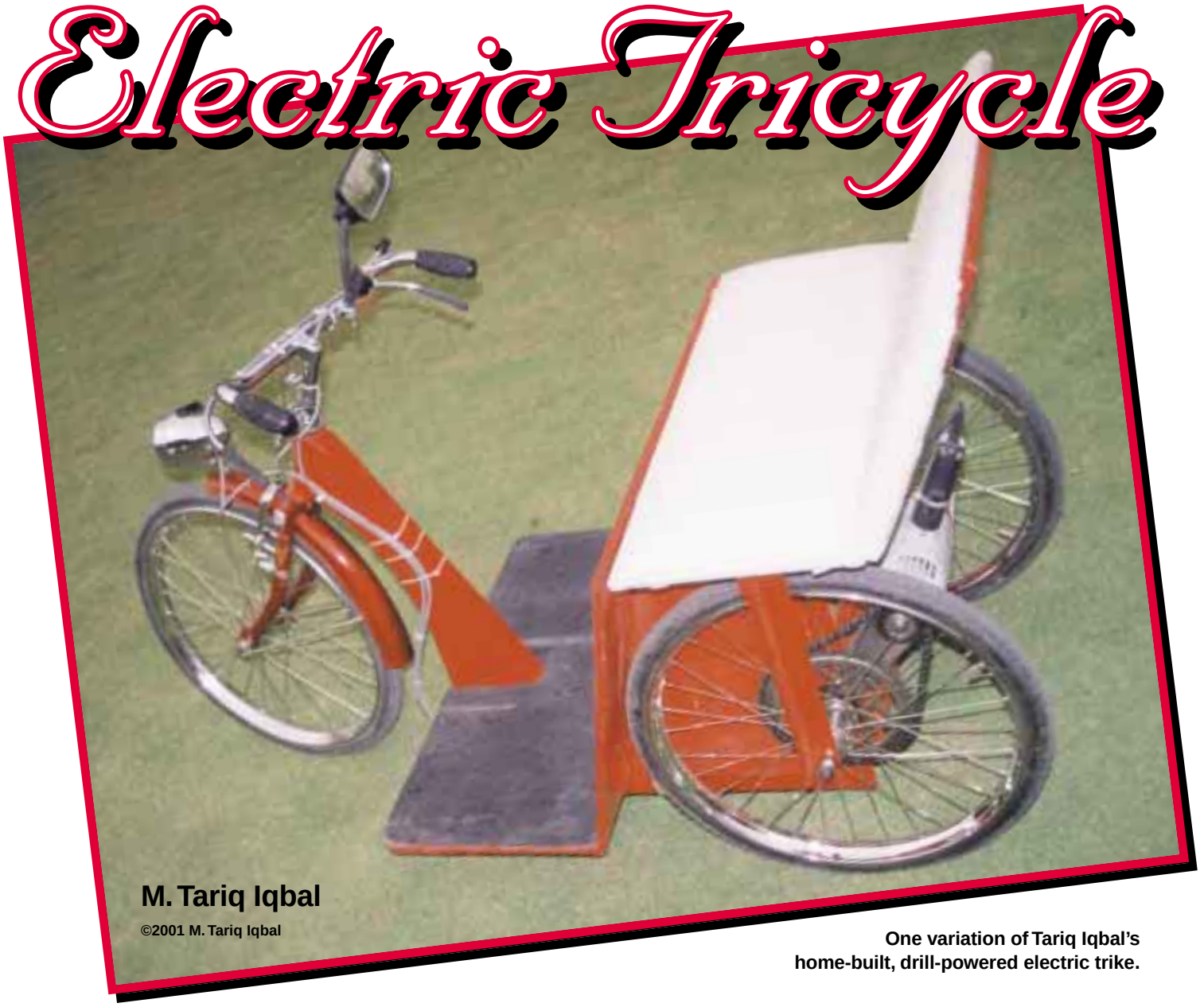
Electric Tricycle



M. Tariq Iqbal

One variation of Tariq Iqbal's home-built, drill-powered electric trike.

Before I moved to Canada late last year, I lived in Pakistan. When my father developed knee arthritis, I started thinking about building an electric tricycle for him. I had some experience building electric vehicles for fun, but none of my earlier prototypes was suitable for use by an old man on the road.

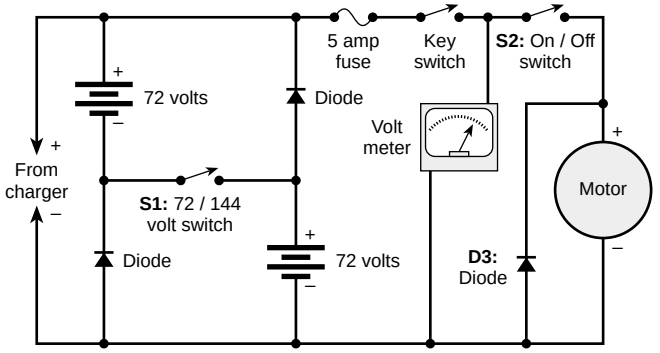
In a survey of the local Pakistani market, I found no locally developed products. A few imported electric wheelchairs were available, but these were very costly and there were many maintenance problems. I decided to make a cheap tricycle for outdoor use, using locally available materials. This tricycle can go up to 20 kilometers per hour (12 mph) for about 20 km (12 miles) per charge.

Building a Body

The first task was to build a frame. I decided to design the frame based on commonly available L-iron. After a few days of careful thinking, I developed a sketch based on 3/4 and 1-1/2 inch (19 and 38 mm) L-iron. My plan was to use 20 inch (51 cm) bicycle wheels, handles, and brakes. Cheap 20 inch diameter bicycle wheels are available everywhere.

A mechanic in a nearby workshop agreed to build the frame for me. He delivered it after two days, in finished painted form, for Rs.1,500 (Rs. 54.5 = US$1 in June, 2000). Plywood was the most available material for bodywork. It is cheap and resistant to battery acid. I got a 4 by 8 foot (1.2 x 2.4 m) by 1/2 inch (13 mm) sheet. The 20 inch bicycle parts were purchased from a local bicycle shop.

Trike Wiring



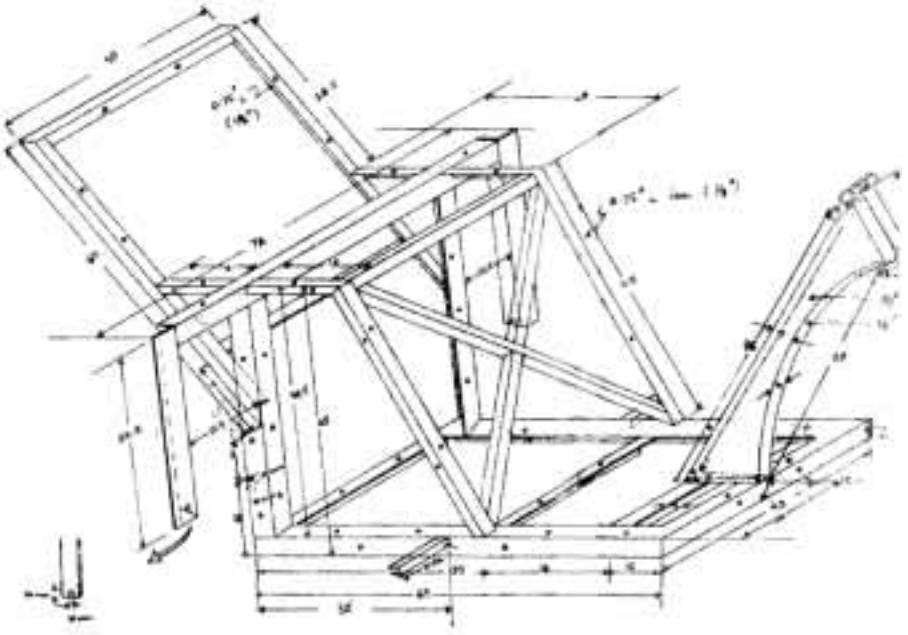
In my home workshop, I fitted the bicycle parts to the metal frame and screwed plywood pieces into shape. I also bought foam and curtain cloth for the seat and backrest. I enjoyed constructing and painting the trike in my spare weekend time. The tricycle is 140 cm long, 72 cm wide, and about 1 m high (55 x 28 x 39 inches).

Power Unit

Locally made DC motors are not available in this part of the world. But cheap Chinese electric drills are very common. I decided to use a drill to drive my tricycle. My father's neighborhood is flat, and acceleration was not a major consideration. I decided to use a 420 watt, 1/2 inch (13 mm), fixed-speed, aluminum body Chinese drill. It is a geared hand drill, but can be used in continuous duty. It is based on a universal motor that can run on AC or DC.

The drill is fitted to the left rear wheel of the tricycle. I attached a 48 tooth bicycle gear to the tricycle wheel and an 18 tooth bicycle gear to the drill shaft. A 5 mm (3/16 inch) thick metal strip acts as a support. This metal strip has two holes. Through one of the holes, I press-fitted the drill. The axle of the wheel goes through the second hole. Common bicycle chain is used to couple these two sprockets.

Frame Plans



The completed frame.

The local workshop did some machining and welding for me. The 48 tooth gear is attached through a standard bicycle freewheel (one way clutch). This allows free forward movement of the tricycle. In other words, if the tricycle is going down a hill, there is no need to run the motor.

At first I designed and built a 700 W, 12 VDC to 220 VAC pulse width modulated inverter to drive the drill in variable-speed mode. I installed it and tested it on the road for few days. It was costly and there were many blown fuses. Once I burnt my expensive set of power MOS transistors on the road and learned a lesson.

Later I decided to switch to a simple DC system. The universal drill motors can run on DC or AC. Torque output with DC supply is higher than AC because of much reduced inductance. I reduced the input voltage to have a reasonable torque. After some testing, I settled on 144 V as my battery voltage.

In a local battery shop, the cheapest option was twelve AGS 12 V, 2.5 AH motorcycle batteries. I decided to test my tricycle with these before buying costly 12 V, 6 AH maintenance-free batteries. To keep my system as simple as possible, I

An early prototype in progress.

Aizaz Iqbal likes the smaller model.

decided to stick to a two-speed on/off control arrangement. The batteries are installed in a battery box under the seat.

Controls & Metering

A circuit consisting of diodes and switches is shown on page 85. One switch is a key switch, and the other two are on/off switches. These switches are normally used in automobiles and meant for DC operation. When switch S1 is on, the motor is supplied with 144 VDC and the tricycle goes faster (about 20 kph). When switch S1 is off, the two battery banks are connected in parallel to run the motor at 72 VDC, resulting in a slower speed. Diode D3 is a freewheeling diode. All diodes are rated at 600 V, 6 A.

A voltmeter is attached across the motor to indicate battery state-of-charge. I marked the existing scale with red and green areas to clearly indicate battery limits. I marked the lower limit as 11.5 V per battery when the motor is running.

Electric Tricycle Costs

Item	*Cost (Rs.)*
12 AGS batteries, 12 V, 2.5 AH	3,800
Bicycle parts, 20 inch	2,500
Metal frame	1,500
Chinese electric drill, 1/2 inch, 420 W	1,500
Foam and curtain cloth, 15 inches by 4 feet	500
Switches, voltmeter, & wires	500
Plywood, 1/2 inch, 4 by 8 feet	350
Battery charger, homemade	300
Paint and fillings	250
Machining costs	200
Diodes, bulbs, fuses, & neon indicator	100
Total	11,500*

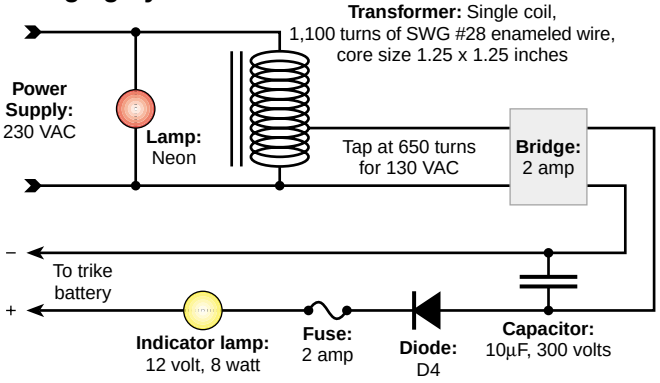
* US$200

Charger

I was not able to find a charger suitable for my use in the local market, so I decided to build one. I purchased iron core winding wire, wound the coil, fitted the core, and tested it. It worked fine. My design is based on a 65 W output. It can easily charge fully discharged 2.5 AH batteries in about six hours. The transformer output voltage is 130 VAC at 500 mA. To limit the charging current, a 12 V, 8 W automobile bulb is used in series.

Circuit diagram and transformer specifications are given in the schematic below. Note that it is a single-coil type transformer. Diode D4, connected in series, is meant to avoid discharge of the batteries through the capacitor. The wiring insulation has to be good.

Charging System



I have been using this design for more than a year without any problems. The charger is installed in the battery box, under the seat of the tricycle. To charge the batteries, switch S1 is switched on along with the charger. This is a manual battery charger, so I have to switch it off after reading a final voltage of 186 V (15.5 x 12 V) from the meter. This charger does not dry up my batteries, since peak AC input to the rectifier is 187 V.

Performance
I have tested this tricycle on various roads, and it has performed well. It is able to climb 10 degree slopes for a while. Motor temperature remains below 40°C (104°F) after continuous running for more than half an hour. It can go more than 10 km (6 miles) during that time. The motor draws about 1.1 A in slow-speed mode, and about 1.6 A in high-speed mode.

I keep depth of discharge to a minimum, and charge the battery bank as soon as possible. After about a year of use, the batteries are still going strong. I gave this trike to my father. He used it for few months before dying of a heart attack. Now I drive it for fun.

I made two copies of this electric tricycle for handicapped people. I also made a fourth copy using 16 inch (40 cm) diameter wheels. It is bit smaller, but the power pack is similar. My son is very fond of the smaller version shown in the photo on page 50. Total cost of this electric tricycle was about US$220 in 1999. This very cheap electric tricycle is good for fun, and is very useful for handicapped or older people.

Access
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