VANCOUVER ELECTRIC VEHICLE ASSOCIATION

VEVA NEWS

Feb 2004

February MEETING

7:30PM on **Wednesday,** Feb 18, 2004
BCIT SE1 Cafeteria
3700 Willingdon Ave, Burnaby, BC

See the web page www.veva.bc.ca for a map and additional information on parking.

EV of the Month

2003 Honda Civic Hybrid

February Calendar EV

This 2003 Honda Civic, owned by VEVA member Walter Wardrup, is the second hybrid put out by Honda. The first was the Insight, a two door, two seater, introduced in 2002. The Civic Hybrid with it's four doors and seating for 5 gives good competition to the Toyota's Prius. Walter was looking for an EV that could accommodate his family and still have the range needed for his work travel. With a range of 1000km on a 50L tank of fuel the Civic Hybrid while not an EV in the purest sense was for him a good choice. The car has a 144 volt nickel metal hydride battery pack and energy stored from regenerate braking and supplemented by the 1.3L gasoline motor is used to drive a 13Hp electric motor that provides the power for quick accelerations. It will be interesting to see how these hybrid vehicles perform, especially the Nickel Metal Hydride battery packs.

Elections!

We really need to get this done this month so please come out and vote for your favorite candidate.

Calendars Are (Still) Here!

The 2004 Electric Vehicle Calendars will still be available at the February meeting. If you will not be there to purchase up your calendar, I can mail it out to you. The cost for mail was $1.60 last year. Calendars are the same price as last year, at $18.50 each. 12 new EVs for display.
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Minutes

January 21st 2004

Not available at the time of printing.

COLIN, VEVA Secretary

Local Interest

We have two construction articles this month by VEVA members. The first is a concept car being designed and built by Jan Engstrom. The other is an EV bike which I understand David brought in to show off last month.

Veva members are building a three wheeled MC

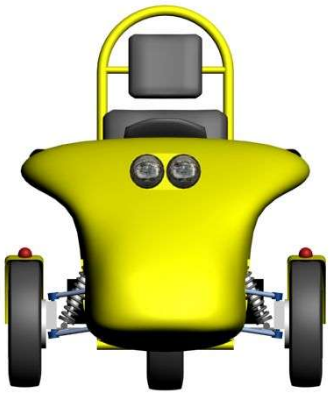
Ready to roll out at the June VEVA event is a three wheeled Motorcycle car conceived by Jan Engstrom.

He invites VEVA members to get involved.

Already on board is our young power electronics specialist David Kronstein who is designing the electronics and the controller.

Gathering material over some time now, the vehicle structure is now being built. The battery box doubles as a structure connecting the front clip (from a Quad MC) with the single rear wheel. A hatch opens to reveal storage and the electronics.

Jan is looking for sponsors/collaborators. Plastic parts fabricators, and manufacturers of the following components are needed: a reversing contactor, disconnect switch/circuit breaker, and battery charger, etc.



Some specs:

Length	6.5 ft
Width	4 ft
Height	4.5 ft (roll bar)
Weight	540 lbs incl 240 lbs Batteries
Top Speed	70-90 km/h
Acceleration	0-50km/h in 4 seconds!
Range	50-70 km
Charge time	3-4 hours
Drive	Rear wheel, single speed transmission with electric reverse.
Wheels	Lightweight trailer wheels on front, larger modified rear wheel to accommodate lighter motorcycle hub/spokes Motor: Advanced DC 8HP (continuous), 25HP peak
Controller	400A, 72V Regen
Batteries	6 x Exide 34XCD Extreme Deep cycle AGM

Construction of a High Power Electric Bicycle

By David Kronstein (tesla500@hotmail.com)

I started this project in early summer 2002, with the goal of creating a fun, powerful, and cheap PEV that would not need a license to operate. This meant that the vehicle had to look similar to a bicycle, so I went with the obvious choice and used my dad's old mountain bike as the base vehicle. This old bike is well built, with a frame made of thick wall round steel tube, and has lots of attachment points to mount things to without welding to or drilling holes in, and thus weakening, the frame.

Modern mountain bikes are usually built with thin oval section tubes that are a poor choice for a heavy EV, not only because they are weak, but because they take up a lot of space inside the triangular frame where batteries and motor controller have to be mounted.

The hardest decision of this project was what motor to use. To get the performance I wanted, I knew I would need a motor capable of at least 3HP peak. The motor also had to be relatively light, and this immediately ruled out most motors. After searching for awhile, I found three prospects; the Scott 4BB-02488, the Briggs and Stratton E-Tek, and the eCycle MG13.

The Scott 4BB-02488 is rated 1HP continuous, 3.5HP peak, and costs $400.

Other than the no-load speed of 3,300 RPM, this motor is perfect. To get a top speed of 45KPH, the 26" bike wheel needed to spin at 360 rpm, which would have required a two stage reduction. The high no-load speed dictated a toothed belt first stage to keep the noise down, and would be large, expensive, heavy, and difficult to construct without a metal lathe.

The Briggs and Stratton E-Tek run on 24V has a continuous power of approximately 2HP, a peak power of 3.75HP, and costs $600. This motor is relatively large, heavy and expensive, but has two advantages over the Scott motor. First, it has a no-load speed of 1700rpm, meaning a single stage reduction would be practical for my bike. Second, this motor can be used on other, larger vehicles because of its ability to run on a higher voltage and produce more power.

The eCycle MG13 is a brushless DC pancake motor designed for 24-48V. Except for one thing, this motor is perfect. It's relatively small, light and (was at the time) cheap. At 24V, The no-load speed is 1725 rpm, perfect for my bike. Power is certainly not lacking at 7HP peak. The pancake design of the motor is perfect to fit over the rear wheel and not get in the way of anything. But all these benefits were outweighed by the lack of a proper controller. The stock controllers are extremely expensive, about $1,200, and can only deliver 100A. I could have built a controller, but at the time I had little experience and didn't want to take such a risk.

All options carefully weighed, I chose the E-Tek. It's combination of low speed, high power, usability in future projects and ease of control were best for my bike.

With the motor chosen, it was time to think of the electronics. From the beginning, I knew I was not going to spend half the project's budget on a motor controller. I had built several small motor controllers before, but nothing this large.

I decided on 24V, 400A peak and 150A continuous as the ratings for the controller. After a look through the Digi-Key cataloge, I settled on 6 IRF1404 MOSFETS and a 240A Schottky diode for the power section.

The control section was a basic triangle wave generator and comparator circuit to generate the PWM signal for the mosfet driver. There was originally going to be a current limiter based on motor speed, but I abandoned that early on.

All the parts were mounted in a standard plastic project box, measuring approximately 18cm x 10cm x 6cm. The

MOSFETs and Diode were mounted on separate extruded aluminum heatsinks, which also functions as conductors.

The internal power connections were made with aluminum bar and #8 wire.

Reliability was paramount for this controller. MOSFETs usually fail short circuit, and this could cause the vehicle to flip over backwards from the acceleration. To prevent this, both the MOSFETS and the Diode are protected with zener clamps and RC snubbers to prevent damage due to high voltage spikes. This design has proven to be extremely reliable, with no component failures to this day.

Batteries were the next thing to be decided upon. To achieve a long range, a large battery capacity is necessary. Two single batteries of sufficient size were out of the question, as there was no room on the bike to mount them. To overcome this, multiple parallel batteries had to be used. I decided on 3 parallel sets of two Panasonic 12V 17AH SLA batteries in series. Hawker batteries would have been preferable, but were too expensive.

With the electronics and motor out of the way, it was time to decide how to get the power to the wheel. Running a chain from the motor to the rear cassette was impractical due to the required reduction required and the weakness of the chain. Gearing the motor down sufficiently to drive the crank was not practical either, because such a gearing system would be extremely difficult to build. The other options were a friction drive system, which was out of the question, and a second drive chain on the opposite side of the wheel as the cassette. I of course chose the latter.

I decided on a gearing of 14-60 to attain a top speed of 45 km/h. This was chosen based on the motor's performance curve, the wheel diameter and a rough estimate of how much power would be required to move the vehicle at top speed. My original plan was to use a #35 (3/8" pitch) chain, but I was unable to obtain a 60 tooth sprocket of that pitch. I had to use #40 (½" pitch) chain.

Mounting a sprocket on the opposite side of the wheel as the derailleur was not an easy task. Eric Peltzer accomplished this on his bike, but it required access to a metal lathe, and the result was not as robust as I would have preferred for the amount of torque I wanted to transmit. I eventually came up with the idea of using a hub designed for a disc brake, installing a sprocket in place of the disc. This simple solution quickly became more complex, because it was impossible to mount the sprocket directly to the hub due to lack of clearance between the sprocket and the bike frame. To get enough clearance, I had to make an adapter to move the sprocket toward the center of the wheel. This adapter consisted of an aluminum plate with two sets of holes, near the center and near the edge.

The center holes are for bolts to mount the plate to the hub, while the outer holes have bolts that go through a set of washers to space the sprocket back. The sprocket has a hole in the center cut to a shape that matches the cross section of the hub to help transfer torque more directly.

Now it was time to design the battery and motor mounts. The design had to be easy to build, requiring only basic metalworking tools, and cheap. Thus I chose angle and flat cross-section steel for the mounts. This material is easy to work with, yet strong.

The mount for the batteries that go on each side of the front wheel was made with three pieces of flat steel welded into an inverted "U" shape that goes over the wheel. Plates welded to this frame support the batteries, which are held in place on the plates with rectangular shaped steel rings. The top of the frame is supported with two pieces of flat aluminum, one going to the top of the fork and the other going to the handlebar to take some stress off of the fork while braking.

The center battery mount is extremely simple, comprised of one piece of angle iron and two flat pieces of steel welded to another flat piece which attaches to the bike. The angle piece is on the low side of the mount and stops the batteries from sliding out. Gravity and the bike frame top tube stop the batteries from sliding out the other way, and a steel support stops the batteries from coming out of the top of the mount.

The rear battery mount is similar to its counterpart in the front. It's comprised of three pieces of angle iron welded in the same inverted "U" shape as the front mount. The battery supports are also similar to the ones in the front, but are more robust. The batteries are held in by angle iron running up the outside corners, with another piece of flat steel to support the tops of the angle iron and stop the batteries from coming out the top of the mount. The top of the frame is held in place by the motor mount.

On top of the rear battery frame is the motor mount, which is made up of angle iron welded into a rectangular shape. One piece is longer than the others to facilitate mounting. This protruding piece attaches to an angle iron adapter that attaches to the bike frame, and allows the motor mount to pivot up and down to adjust chain tension. A bolt extends from the center of the motor mount down through a hole in the top of the rear battery mount and allows chain tension to be adjusted.

The power switch is a four pole double throw unit rated at 25A 120V AC. I had done tests with old computer power supply switches and found that a 15A switch can easily handle 100A for a few seconds, so I was not worried about the switch failing. With the six battery set-up, one pole was used for each parallel string, thus isolating them when the power was off. This switch is mounted in a box on the handlebars, along with a charging connector and capacitor precharge switch and resistor.

With all the components now in place, it was time to wire everything up. I chose #8 wire to connect the parallel strings of batteries to the switch, and #4 for everything after the switch. I used ultra fine strand speaker wire, normally used in high performance car audio systems.

The last thing to be completed was the throttle. I used a twist grip designed for an ICE, with an adapter to convert the pull of the cable into a 270° rotation of a potentiometer.

The first test ride was quite an experience. I had the cover (which has the cooling fan on it) off the controller so I could check for overheating.

Therefore, I had to hold back on the throttle. Even so, the ride was still great fun. After a few trips up and down some hills, with time to let the controller cool off in between, I brought the bike back in and put the controller's cover on.

On the second test ride, it became clear that the fan wasn't providing enough cooling for the controller. The base of the controller under the MOSFET's heatsink was extremely hot, and the plastic under it was slightly discolored. The solution was simple, though, involving a Dremel tool and a larger fan. I cut out an opening beside the heatsink, and plugged up the original air outlet, forcing all the air to go through the heatsink. Voilà, problem solved. I would have done this in the first place, but the MOSFETs dissipated more power than I calculated they would.

The only other problem I have had with this bike is it getting stuck at part throttle due to the toothed belt on the throttle adapter slipping. I later replaced it with a Magura twist grip throttle.

This bike cost about $1600 to build, which is about twice what a commercial E-Bike would cost. The far greater range and power more than make up for the cost, though. The bike's range is about 25km at 25km/h, and it has a measured top speed of 43km/h.

All in all, this project was a great learning experience, and produced a very satisfactory vehicle. Its construction taught me a great deal about motor controller design, metalworking, and mechanical design. I encourage anyone who has an interest in Electric Vehicles to build one, be it a small scooter or a full size car or truck.

For Sale

1. 2 Electracs to be rebuild, plus accessories. Contact Dave Koehn 604-467-6028
2. 2 – 24 volt DC traction motors, 2-3 hp size. Contact Dave Koehn 604-467-6028

Events

1. Saturday June 5th, 2004 REV!2004. See the web site www.veva.bc.ca for more details as the date approaches.
2. **AAB** will be holding the 4th International **Advanced Automotive Battery Conference** in **San Francisco, June 1 to 4, 2004**. At this dynamic time for the march of advanced vehicles into mainstream production, this is a must-attend event to keep abreast of the fast-changing power source industry that will drive these vehicles. Please check out http://www.advancedautobat.com for information, including a preliminary session agenda.
3. Check out www.nedra.com for information on Electric Drag Races.

Member Area

Goto www.veva.bc.ca, username *veva*, password is *revshow.*

VANCOUVER ELECTRIC VEHICLE ASSOCIATION

VEVA is registered under the Societies Act of British Columbia as a Non Profit Organization. The AIMS of VEVA are:

- To educate and support members with the design, construction, or purchase decision of EVs.
- To educate the public on the economical and ecological benefits of EVs by participation in rallies, parades, exhibitions, and trade shows.
- To lobby government to implement legislation conducive to the use of electric vehicles.
- To collect nominal membership fees for the purpose of publishing a newsletter and to solicit donations to further these AIMS.

VEVA meets on the third Wednesday of each month at 7:30 PM (July and August excluded) in the BCIT SE1 Cafeteria, 3700 Willingdon Ave, Burnaby. VEVA is open to membership by any individual or organization.

For a one-year membership, please send a cheque for $25 ($10 for students attending school) to:

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