THE ART OF MAKING AN ELECTRIC VEST

January of 2004 by R. Dow

WHY BOTHER ? It is more than the money! Even though an electric vest costs around $140 & you can make one for $2 & up, making your own is related to the self-sufficient & adventure makeup of motorcycle riders.

HISTORY If you do any research into making a heated vest, you will run across the 1994 'Sue's receipt of electric motorcycle clothing' article. This seems to be the seed of the idea & shows that the practice has been around for almost 10 years. From this beginning, I was lead to so many articles I had to quit reading them.

My article is more of a discussion on the subject than a detailed "how to …". Within & at the end of this article, I give you a lot of links of articles to read with specifics about how to make a vest, grips, chaps, even helmet visor - yes you can have an electric helmet visor too.

ART of RESEARCHING I watched my dad prepare for elk hunting for 2 months & only hunt for 10 days. I also find ways to extend the desired activity by adding preparation time. I find researching fun because it leads off in other directions that I usually didn't know existed. Looking up nichrome wire is an example. You will venture into the world of amateur rocket makers. Nichrome is their "electric match"; because it will burst into flame when hit with high voltage. *(Yeah, I though of that when I considered making my vest of something others use to LIGHT off their rocket.)*

FEED BACK Even though I will have made 2 vests & help with the making of 3 more, I would enjoy reading anything you know or learn about making a vest.

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PREPARATION This article has 3 components: (1) how to make a vest, (2) the wire options, & (3) vest features. If you are the impatient type, go to the end of this article & to the http://ibmwr.org site & read a few articles. It you want to read only one article, I recommend the hardest one to get to because it contains Sue's very detailed article. See VEST DESIGN for instruction to get to http://webpages.charter.net .

If you are the impatient type, I think you would do better to go buy a vest, because patience is required, & making one is more that just the finished product. You will probably need to go back & make at least one adjustment to your creation.

STARTING POINT Will your motorcycle electrical system handle a vest or grips? You should look into the capacity of your charging system, but it is not as critical as it first seems. The headlight is probably 60 watts, & by installing a witch to turn off the headlight, you can run a vest (44 watts). You should add an amp meter to your motorcycle. Go to Radio Shack or a parts store & get a small 1" x 5" LED device for $6 that will tell you the status of your charging system.

DECISIONS 1 -- 2 -- 3

Decision 1 Once you decide you want a heated vest, your 1st. decision is the wattage. I found an "Electric Riding Gear Product Summary Chart" article that gave wattage for products from a variety of companies. I chose 44 watts because it seemed to be common to several companies. This is also the value used in several of the articles I read.

If worried about the correct wattage, think in terms of an incandescent light bulb. A 50-watt bulb wastes about 90% of the energy in the form of heat. So, could you stay warm if you had a 50-watt light bulb (45 watts of heat) stuck in your jacket?

Decision 2 What kind of wire to use - copper or nichrome? I am going to assume you will go to some of the site referenced in this article, so I will not elaborate on the wire except to help get you started. The kind of wire used in all but one article I found was copper. The proper name is 'wire wrap wire'. Use "wire+wrap+wire", "resistance+wire", or "nichrome+wire" when researching wire. Wire wrap wire is easy to find because it is used to hook up telephones. The disadvantage is that it is fragile & takes a lot of wire. My vest design required 37 feet.

Nichrome wire is stronger & requires much less wire. The second vest I make will require only 24 feet of nichrome wire. The wire is very strong & flexible. The best place I found to buy nichrome is http://www.McMaster-Carr.com I bought 157 feet of 26 gauge for $9.70. Shipping was $4. (This is a great site to look at. They say it is a source for 400,000 products.) Nichrome wire is just the opposite of copper. You have to be creative to have enough wire. You don't want to use only 10 feet of wire, because that does not spread the heat over enough surface area.

Jason Sharman describes how he used 26 gauge nichrome. He ran a feeder line (common lamp cord) along at the base of his vest & connected 4 six-foot strands in parallel. DON'T GET CONFUSED & SWITCH THE TWO NUMBERS! Someone told me that would result in a 100 watt+ vest. *(This article is very hard to get to but worth it because of all the information there, & not just about heated vests. First go tohttp://ibmwr.org . There on the right in blue you will see a sub heading of TECH, below that "Other Tech Articles". There & on line 21 in the second section is Jason's article.)* If you are REALLY cold natured, read the next article about how to make a heated visor.

Decision 3 What do you want in a vest? One of the basic criteria is that the front of the vest should have more heat than the back, about 50% more. From here you start making decisions on heated collar, sheeves, connections, hi/low setting, & how it is to be made.

The Concours Owner's group has a section where riders discuss the features they like or dislike. You will find a similar discussion at http://www.advrider.com.

VEST DESIGN

What you choose to do is based on your skills, tools available, & personality. Below are examples of vest designs I ran across. I am assuming that you will read the advice of others that I have pointed to, so I will not repeat their advice.

Simplicity As hard as the site is to access, I recommend it. It contains the original "Sue's Receipt for Electric Motorcycle Clothing", which goes into details about how to make a vest. I am looking at the site as I write, & the address just doesn't work. (http://webpages.charter.net/hondapotamus/heat.htm) The only way I have found to get there is to sneak up on it by using the AltVista search engine at http://www.altavista.com & search "homemade+electric+gear". There is only one hit. Go there & read how Keith made his vest from a Tee shirt, hot glue gun, & phone wire. His story starts on page 4. He hot glued the wire to a tee shirt & the tee shirt to the jacket. No sewing, no zippers, & not high fashion.

DON'T USE 12 VOLTS IN YOUR CALCULATIONS! USE 13.5 VOLTS BECAUSE THAT IS THE RUNNING VOLTAGE OF A MOTORCYLCE. THERE IS A DIFFERENCE !

Determine the heat (watts) you want and work backward to the feet of resistance you need to create it. 44 watts = (13.5 X 13.5)v. / Resistance

One Step Up Tom used the liner of his old Army field jacket & fed copper wire inside the quilted liner. When he needed to reverse direction, the wire was poked through the shell & hot glued. Almost as simple as Keith's & a little more attractive. Unfortunately, he didn't calculate properly & used 32 feet of wire – or ran out of vest. His vest produces enough heat to soften the hot glue. He solved this by adding a variable resister & now can dial in the level of heat he wants.

Near Commercial My choice was to make an insert for an old windbreaker jacket that had a liner. I inserted the wired up material between the 2 surfaces. This is a good way to spend 2 days making a vest. Tom's way took 2 hours.

Commercial Quality Take the liner from your motorcycle jacket, open it up & rewire it. This is best done with nichrome wire. Tom & I have nichrome wire now, & this is our next project.

THE FORMULAS:

Volts = Amperes X Ohms
Amperes = Volts/Ohms
Ohms = Volts/Amperes
Watts = Volts X Amperes
Watts = (Volts X Volts) / Ohms
Watts = Amperes X Amperes X Ohms
Ohms = Watts / (Amperes X Amperes)

REFERENCES

http://www.wiretron.com This is the ultimate reference site. It has all of the charts, formulas, measurements, & conversion tables! At lower right of the home page, you will see "Nichrome & Other Resistance Wire – Tech Data Page". Go there. In the upper left corner of the page is "Heating Element Design Tips". Go there.

If wiretron is not enough try: http://www.resistancewire.com or http://www.pelicanwire.com. You will find references to both A (80/20) & C (60/16) nichrome. There is not much difference in the resistance, & C is the one I found most common. Try http://www.aeroconsystems.com/electronics/nichrome.htm .

MY VEST MAKING EXPERIENCE

The Vest After reading all the references in this article & MORE, this is the approach I took. I bought a piece of relatively heavy rigid material ($1.50 upholstery fabric) because I wanted something to prevent stress on the very very thin copper wire. I used copper wire because it was handy (about 30 gauge, but I am not sure because I stripped the wire from existing computer hookup cable I already had. You can also buy 12 feet of 4-strand phone wire, strip it & tie the strands together.) Not all wire is the same, so it is IMPORTANT to test the resistance or amps of the actual wire you choose to use. After testing my wire, I needed 37 feet laid out in 1 1/8" rows.

I then tested the wire 2 ways. I hooked up 37 feet to the car battery & read the amperage (3.8 amps) then I let the wire heat for an hour to see how hot it would get. Neither test was completely accurate, because the voltage was 12 volts not 13.5 volts, but I was satisfied with the test. Don't let the wire touch!

To prevent the wire from moving around as I sewed it to the fabric, I hot glued each row at top, middle & bottom. I then zigzag stitched the wire to the fabric (jump over the glue). This took time but makes the vest more durable. The fabric was inserted inside the windbreaker. Next, I spot sewed the 3 pieces of material together, like a baby quilt. The thin wire was attached, in series, to lamp chord, which was anchored by sewing & hot gluing to the upholstery material.

Connecting Up I recommend that you think through how you dismount & work out a design that minimizes damage when you forget & walk away - still plugged in. My solution was:

(1) The vest cord is attached to the motorcycle below the seat, in front of my left leg.

(2) I chose to use a high quality RCA plug (the kind used to attach stereo speakers) because it would separate easily. I also picked it because I wanted a lightweight plug end. The plug I used has a metal cover that screws down & a

plastic sleeve that extends through the collar which can be zip tied for good measure. I found a single screw mounted female RCA end that is easy to mount on a metal plate below the seat. Tom found that this connection vibrated loose & is looking for another way of attachment. Mine doesn't, maybe because my leg falls over it. If you connect to a loose cord, you could double back the cord & wrap a rubber band around it.

(3) Think about walking around with a cord hanging from your jacket. I chose to hot glue a strip of Velcro to the end of the vest plug & a strip (chest high) to the inside of the windbreaker. This allows me to secure the lamp cord up out of the way. On my riding jacket, it also allows me to attach the vest cord to the Velcro flap over the zipper. Before attaching the RCA end, mount & dismount your motorcycle & determine the optimum length for the lamp cord.

(4) You need an on/off switch. Mine is located adjacent to the RCA plug because the battery is only 6" away. Other designs utilize a relay switch at the handlebars. You don't want to run a wire from the battery to the bar & back to below the seat. That adds more amperage drain to the system. When working with the system, remember the amperage. My system draws 3.8 amps so all components (switchers on/off lights, etc.) need to be able to handle about 6 amps. DON'T forget to fuse the system with a 5 or 6 amp fuse.

If you are real energetic, you can add a rheostat to the design & 'dial in' the temperature. This will mean making a vest of higher wattage (less wire), with the excess bled off throw the resister. Keep in mind that the variable resister must have the proper values. Other designs switch in a ceramic resister to allow a dual heat range.

LESSONS LEARNED

- THINK ABUSE! Even under the best of circumstances, the vest & wiring needs to be sturdy. On Nace's first motorcycle ride (7 hours away from home & at 28 degrees) the motorcycle wiring shorted out. Tom just grinned & said he was really enjoying the morning ride.
- Test for continuity in each step, don't sew & be sorry.
- Consider vibration & the possibility an RCA plug will not always stay connected.
- Test the actual wire you plan to use! Wrap the wire around a box. Don't let any wires touch. The heat will amplify, insulation melt, & then short out. It is okay to hook up the wire to the car battery & see how hot it gets. The vest will not be quite as warm as it will be in use, because there is no vest insulation, & the voltage is 12 volts because the car is not running.
- Add an amp meter in your electrical system. This way you won't worry that you are over taxing the system. It is of value even without a vest, especially if your motorcycle does not have a kick start.
- I ride a KLR 650 & at 4,000 rpm the electrical system is fine with both vest & headlight on.


I hate disclaimers but take into consideration I haven't been trained to make electric vests & you take on this adventure at your own risk.

REFERENCES

http://www.ibmwr.org This site contains several good articles. Look at "Repair Your Electric Vest". It is seven pages & includes a photo of the inside of a Gerbin vest. Next look at "Electric Vest Connection". The go find Jason's article.

http://www.wsaa.net/e_vest.htm You may find several references to an open cockpit site. That site is no longer valid. This is the current site & may be the best site to read about how to make a vest. It is 3 pages & includes a wire layout sketch.

http://www.suzukicavalcade.com This site has a sketch for a vest with sleeves, & talks about using 85 ft. of wire.

http://www.Horizon.it.luc.edu/~shuff/electrics.htm #@*&$@#** Read under VEST DESIGN how you have to get here. IT IS WORTH IT. The original "Sue's receipt for Electric Motorcycle Clothing" can be found here. There is also information from Raymond who made a vest following Sue's article.

WIRE SOURCES & ELECTRICAL REFERENCES

http://www.resistancewire.com

http://www.omega.com (nichrome is NI60)

http://www.pelicanwire.com

http://www.action-electronics.com

http://www.mpaksys.homestead.com

http://www.aeroconsystems.com

http://www.mcmaster.com Best price for wire & shipping was $4. The site says they sell 400,000 products.

http://homepage.sunrise.ch/mysunrise/joerg.hau/mot/hotgrip.htm Here is a 10-page article on making heated grips. A good site to help you understand how to make heated equipment. You might also be interested in reading how to repair a CDI (ignition black box).

CLOSING

If you have questions, contact me & I will try to help. Don't forget to write & tell me how your experience turns out. The experience of making a vest is open ended. It may lead you to the need to add a "dash", switches, amp meter, & more. Tom came back from his Christmas ride saying he was going to add a heating element in the insoles of his boots.

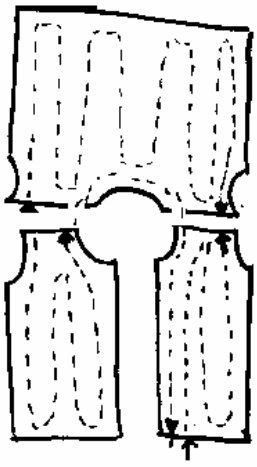
One of the side benefits of researching nichrome wire will be your excursion into the world of amateur rocket builders. Don't be surprised if you wander to sites that may/should be monitored by the government.

EPILOG

All you need to know has already been covered. These are just some things that I considered when I designed my electric vests.

Vest or Liner In considering the design, you need to decide if you are making something to supplement your jacket liner or replace it? In cold weather you probably need covering on your arms so a sleeveless vest alone would not be adequate.

Most of the articles refer to an electric vest. Some of the sketches show sleeves. I think of a vest as not having sleeves. I have called my creation a vest because the heating element is without sleeves, but I put it inside a windbreaker that has sleeves, so I should have called it a liner because I wear it in place of my jacket liner. The second "liner" I will make will use the jacket liner itself.



Back

Front

Sleeves Because of the potential for damaging wire when flexing your elbow, I ruled out making a long sleeve "liner". I thought the top of the shoulder would be an area needing heat, so I added short extensions to cover the top of the shoulder & ran wiring over the top of the shoulders. If your jacket has extra padding on the shoulder, this may not be necessary. It does make construction of the heating element more complicated.

Wiring Layout The more time you spend "Planning" how you run the wire & attaching it to the motorcycle, the happier you will be with the finished results. The nichrome parallel design is the simplest. Running almost 40 ft. of copper wire in series is the most complicated. It requires planning because you must wind up back where you started. This is made more difficult because you have to move from vest to back panel to vest & then back to the first vest.

Do you put the wire next to your skin or the liner material next to your skin? If you use a lot of wire, the temperature of the wire will be very mild & can go next to your shirt. My vest wire is so mild that when testing it with the car battery, I had to put it up to my face to feel the heat. When riding (with 13.5 volts) it is considerably warmer, but it is still so mild that it feels good next to the skin. If your car battery test gives you hot wire, then I would put insulation between you & the wire.

Fit Several articles mention the importance of a snug fit. You feel the warmth against your skin. If the heating element is not touching the skin, then it is heating the air, not you.

Is It Worth It I think a heated vest ranks right up there with the TV remote control.

This article was written in January of 2004. With thought of New Years Resolutions in my head, I offer this word of wisdom on **"How to be Happy"**

Lower Your Expectations

This sketch shows one way of wiring up the heater insert. This layout has 2 weaknesses - the single feed wire over the top of each shoulder and it has the same amount of wire in the front as in the back. I chose to lay the vest out: front panel left, back panel center, front panel right, and to connect the wiring along the bottom of the 3 panes.

This plan makes the battery connection in the front center of the vest. I made my connection below my left arm, between the left front and back pane. Don't be misled by the sketch. It only shows about 30 feet of wiring (assuming 18" runs). If you use copper wire wrap wire, you will need closer to 38 feet.

LESSONS BEING LEARNED

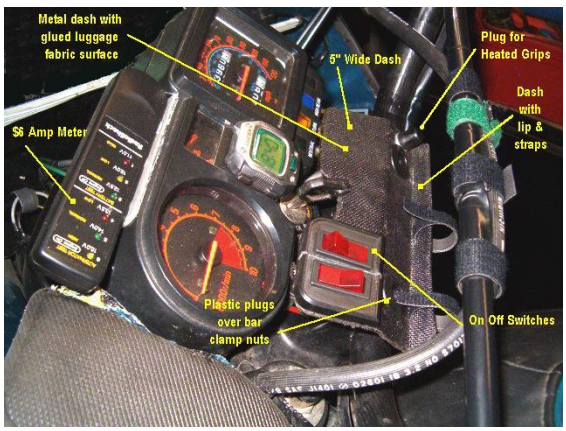
The article was written after 2 of us made our vests, but before we had much experience using them. It was also before we had worked with nichrome wire. For you tenacious readers here's your reward. This site will do all of your electrical math http://www.csgnetwork.com/electronicsconverters.html. About 30 lines down, pick 'Ohms Law Calculations with Power' or 'Parallel Resistance Calculator'. Type in 2 of your knowns & it will tell you 3rd. You want a 55 watt vest with the running voltage (13.5) & you want to know the amount of resistance you need in the wiring. The site will give you the total resistance. You divide that by the resistance per foot of the wire you are using, & you know the length of wire to put in the vest. Then use the battery voltage (12 volts) & your resistance to find the amps you should read when working on the vest.

Parallel circuit calculations are more complicated, but this site allows us non-electrical engineers to make guesses. Four parallel wires generate about ¼ of the total watts you select for the vest so enter about ¼ of the wanted wattage & adjust until you get resistance per parallel wire you want.

Working with Nichrome Wire After making 2 copper wire vests, a third one was made out of nichrome - with less success. Lessons Learned: (1) Nichrome wire is strong & should hold up well, but 26-gauge nichrome is like working with a fine needle. You will bleed! (2) It is easy to solder nichrome with acid core solder. (3) Testy our wire's resistance. Nichrome wire has a high resistance per foot so a small difference in length makes a big difference in heat.

(4) Cut & lay out your wires, twist them together, & test for the right amperage before assembling & soldering. (Don't let any of the wires touch)

(5) It is okay to test the circuit using a battery but know what amps you should read with 12 volts. If you achieve the design amps when testing with a battery, the vest will be too hot with the engine running (13.5 volts).



Overall Design It wasn't until mid February that it was cold enough in Ft. Worth for me to try my vest out. We still haven't had enough winter to have much experience with them. Lessons Learned (1) On Tom's 1st. trip, his plug wouldn't stay in, so he change to a diffirent plug. I like my RCA plug, but I keep a rubber band handy in case it doesn't make good contact on rough roads. (2) On Nace's 1st. trip, he learned to do a better job of wiring the motorcycle. He blew fuses & didn't get to use the vest. Think abuse, vibrations, rain, etc. You only want to wire thing up once, so make things secure & without stress points. It is best not to wire to the handlebar or farring because they move. (3) Make the fuses accessible. When you are cold is not the time to run down the fuse to change it.

(4) Think a lot about the location of the plug & the wire route from the vest to the plug. My vest plugs in just under my left thigh. I made a set of 4" heat wraps for my grips & located a plug near my speedometer. I find both locations acceptable. In fact, I found having 2 places to plug in my vest to be a good idea. In my first ride, I lost power at the plug. I simply unplugged my grip heating pads & plugged in the vest. (The cause of my power loss was a loose connection to the battery.)

(5) Think through the idea of a heated vest but nothing protecting your arms. If you wear a coat without a liner & a heated vest, your arms will get cold. All 3 of our vests have sleeves, so our arms have "some": protection. I considered wiring the sleeves but didn't because I thought flexing could break the wire. I figured there was a reason most vests you buy don't have sleeves. (6) Think about wearing a vest with a long cord handing down. Some designs have a disconnect at the vest & the motorcycle. I wrapped a piece of velcro around my cord at the mid point. Then, I sewed a velcro patch on the inside where a vest pocket would be. With just the vest on, I secure the cord there. With the riding jacket on, the cord sticks to the flap over the zipper. It is best if this cord is made of soft flexible rubber insulation.

(7) Install a switch for the vest, you will need to turn it on & off. The switch for my vest is under the seat close to the battery. My switch for the grip pads is near the speedometer. Both locations are easily accessible. Wal-Mart & AutoZone sell small lighted rocker switches that work well. I added a switch to turn off the headlight if my voltmeter showed charging problems. The headlight draws 60 watts or more & that more than your vest draws. I also like being able to turn off the headlight if I have problems starting the motorcycle.

EVERYONE NEEDS A DASH I hate to bring up the subject because that could be another article. The photo makes thing look more complicated than the are. My dash is only about 2.5" by 5.5" and three times as large as I needed. It could hold 4 switches and the watch.