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When is 110 Volts not Over Voltage?

21 November 2007

Answer: When you WANT an alternator to deliver 110 Volts DC for the purpose of operating 110 VAC appliances and tools from your car's alternator.

In the early 1970's, alternators were becoming well established in the automotive world as the next greatest thing for replacing the venerable generator. Some thoughtful and inquisitive individuals were exploring capabilities of this relatively new technology with an interest in unusual but useful applications.

Someone noted that if a 14V alternator b-lead terminal was disconnected from the automobile's electrical system and the alternator provided with a fixed field voltage directly from the battery, one could adjust engine RPM with a manual throttle such that voltages well in excess of its rated output could be achieved. It was further discovered that many motor driven tools normally expected to operate from 110 VAC mains would perform quite well on 110 VDC. This was typical of the brushed, series wound, so-called "universal motor" tools. Further, devices such as light bulbs, soldering irons, etc did not care whether powered from AC or DC power.

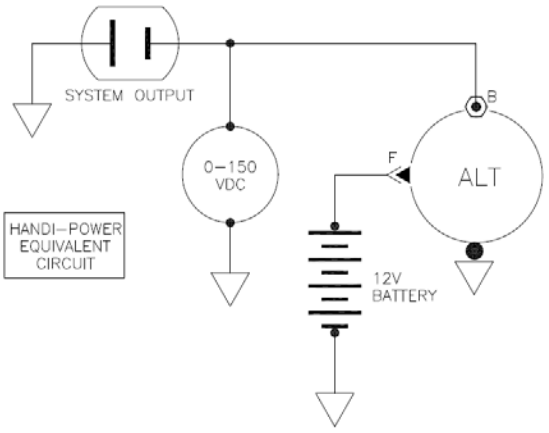
Articles appeared in several publications like **Popular Mechanics** describing how one might install a meter, switch and throttle to many alternator equipped vehicles for the purpose of exploiting this out-of-the-box characteristic of the automotive alternator.

When yours truly went to work for Electro-Mech about 1975, the company was actively working to recall a product they called the "Handi-Power". Seems that Electro-Mech made an earlier decision to merchandise this alternator system conversion in the form of a kit along with instructions for adding this obviously useful feature to a vehicle. It was thought that individuals in the service, construction and agricultural trades would find this product useful.

Unintended consequences of this modification arose with failures of diodes in some brands of alternator fitted with the modification. Originally intended for use in 14VDC systems, diodes rated at 50 Volts were over stressed when pressed into service at higher voltages. Some brands of alternators had diodes capable of performance at this task while others did not.

While cleaning and organizing my father's shop in Medicine Lodge, Kansas I stumbled across a box with the Electro-Mech logo on it. Upon opening the box, I found a

brand new, uninstalled Handi-Power kit my father had purchased but never used (He was a contractor, farmer, and locksmith - having such a device on his truck was no doubt an attractive idea). I was delighted to make this find. It provided me with a real-life example of an idea that demonstrated certain capabilities (and limitations) of the automotive alternator. You're welcome to cruise the attached installation instructions for the Handi-Power but I'll paraphrase pertinent operational details as follows:



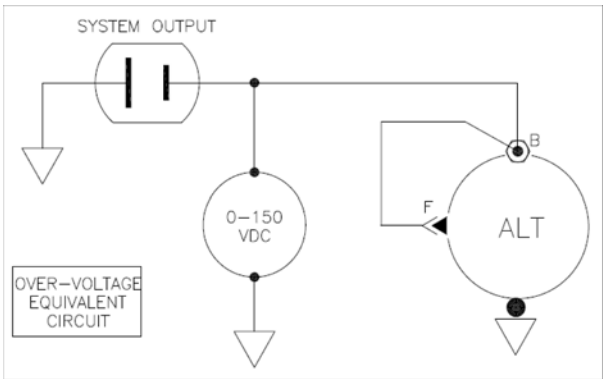
In the figure above, I've illustrated the equivalent circuit for the Handi-Power when in the 110 VDC power mode. Throwing the Handi-Power switch to ON disconnects the alternator field from the vehicle's normal regulator and routes it directly to the battery thus "full fielding" the alternator at 12 volts. The alternator's B-lead is disconnected from the vehicle's electrical system and routed to the standard AC power outlet jack on Handi-Power's front panel. Now the operator pulls out on a throttle control until the Handi-Power voltmeter reads approximately 110 VDC.

In this mode of operation, the vehicle's 14V alternator could be used to operate any 110 VAC appliance that could be expected to operate on DC power as well. Cool idea . . . as long as the alternator's diodes were capable of withstanding the extra-ordinary stress of higher operating voltage.

I've not seen this system in operation so I have no first-hand knowledge of how fast one had to run the vehicle's engine to achieve the desired output voltage. I'm assuming that it wasn't outrageous or folks would have been wanting their money back due to "unreasonable expectations" for practical use of the system.

When I get the drive stand running this winter, I'll be able to duplicate this scenario with a modern alternator and acquire some real numbers.

In the mean time, let us consider the scenario on board an aircraft (or any other vehicle) where the normal field voltage control system has failed and full bus voltage is applied to the field.



The equivalent circuit is illustrated in the figure above:

In the previous case, we limited field excitation to a steady 12V. In this new case, field voltage rises along with the bus . . . a positive feedback that exacerbates rise in bus voltage for any given RPM and load.

In the case of many regulator failures, a BATTERY was, willing and able to accept a lion's share of the runaway alternator's output. In some cases, the battery's self sacrifice was sufficient to prevent bus/field voltage from rising to damaging heights unrestrained . . . but at no small expense to the battery!

Consider the modern alternator turning over 10,000 rpm on the front of a Lycoming. Combine this with an

unrestrained or poorly restrained rate-of-rise on bus voltage. There exists a potential for spectacular voltages on the ship's bus accompanied by equally spectacular damage to ship's electrically powered accessories.

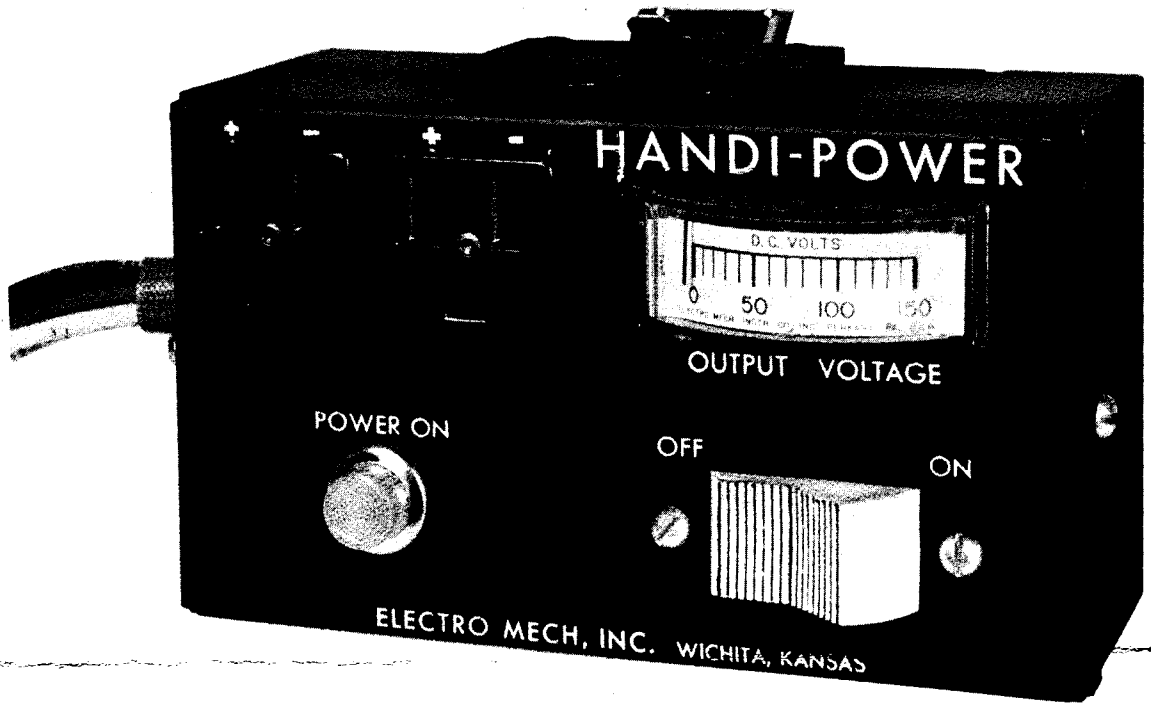
Remember, alternators do not and cannot put out great amounts of current over and above their nameplate rating . . . this is why the self-sacrificing nature of batteries is often sufficient to hold voltages at or below 20V for the much less than 1 second that it takes for OV protection to react. But without the combination of battery and OV protection, hazard to ship's systems goes up markedly. Voltage from a runaway alternator loaded to a fraction of its nameplate rating will easily rise to the levels DEMONSTRATED by Handi-Power's performance of some 30 years ago. At over 10,000 RPM in cruise, the voltage rise could be worse yet. If it's so easy to get 110 VDC out of an alternator when you really want it, consider how easy it can be to get much more voltage even if you didn't want to!

This is why every well considered power generation system aboard aircraft has included OV protection for more than 40 years. Even the new kids on the block (Plane Power) have seen fit to install crowbar OV protection on their popular internally regulated offerings to the OBAM aircraft community. The practice has nothing to do with the relative merits of any particular generator/regulator or alternator/regulator combination. There are no manufacturers of regulators ready to claim 1 x 10^{-9} failure rates for their products. Until such devices come onto the market, addition of OV protection is the order of the day.

I am pleased that my father purchased this product for me to find some 30 years after it was produced by the same company that gave me my first engineering job. I'm equally pleased that he did not install it on any of his vehicles with a risk of discovering that his alternator would not withstand the abuse. It was fortunate that I found it and could use it to illustrate the potential hazards for cases where 110 volts from your ship's alternator is indeed an over voltage condition.

HANDI-POWER

MODEL EM 216-1



With HANDI-POWER you can now use the power normally available from your vehicle alternator.

Obtain 110 volts, 0-30 amps D. C. current from any vehicle equipped with an alternator, without harming or reducing the life of your alternator or battery.

Easy to install under the hood or in the cab. With the use of extension cables, it can also be installed in campers.

EXCLUSIVE CONSTRUCTION FEATURES OF HANDI-POWER

1. Spring mounting clip provides mobility.
2. Light-weight corrosion resistant aluminum case.
3. Permanent finish that is abrasion resistant and also provides elec- insulation.
4. Power on light.
5. Meter to indicate voltage.
6. Ground wire, so HANDI-POWER can be used without being mount- ed to vehicle.
7. A finished product that will add to the interior of the finest auto- mobile, mobile home or camper.
8. Rugged enough for installation at any location.

SOME OF THE MANY USES OF HANDI-POWER.

HANDI-POWER provides safe D.C. power to operate all AC-DC tools, soldering irons, coffee pots, electric skillets, bottle warmers, ordinary light bulbs, electric heaters and many other items.

HANDI-POWER can also be used for starting cars with dead batteries, and charging batteries.

OPERATING INSTRUCTIONS

HANDI-POWER can not be used to operate television, A.C. radios, induction motors and etc.

CAUTION: The ON-OFF switch on HANDI-POWER should only be operated with the car not running, or at a slow idle. The higher voltage and power available could produce arcing of the switch contacts that would damage the switch.

With the HANDI-POWER switch in the OFF position, start your vehicle and observe that all operation is normal. In the OFF position, your vehicle is the same as before HANDI-POWER was installed. With the motor OFF or at a slow idle, turn the HANDI-POWER switch to the ON position. The POWER ON light will come on and stay on until HANDI-POWER is turned off. In some cases the discharge light on the car instrument panel will also come on and stay on as long as HANDI-POWER is on.

NOTE: HANDI-POWER draws its power directly from the alternator and will not discharge the battery. However, the battery is not charging when HANDI-POWER is on. HANDI-POWER can be operated up to 15 hours without discharging the battery. As soon as HANDI-POWER is turned off the car is back to normal operation and the battery will be charged back to full power in a short time.

Slowly increase engine speed until voltmeter indicates 110-115 volts. Plug in and turn on any tool, light, heater, etc. for immediate use. Since the output voltage is proportional to engine RPM, it is necessary to maintain engine speed to maintain the voltage.

It is recommended that the optional LOCK-IN-PLACE throttle control be used to maintain output voltage. The throttle control can be mounted under the hood or in the cab. Any hand tool can be operated as a variable speed unit by simply varying the engine speed and, therefore, the output voltage.

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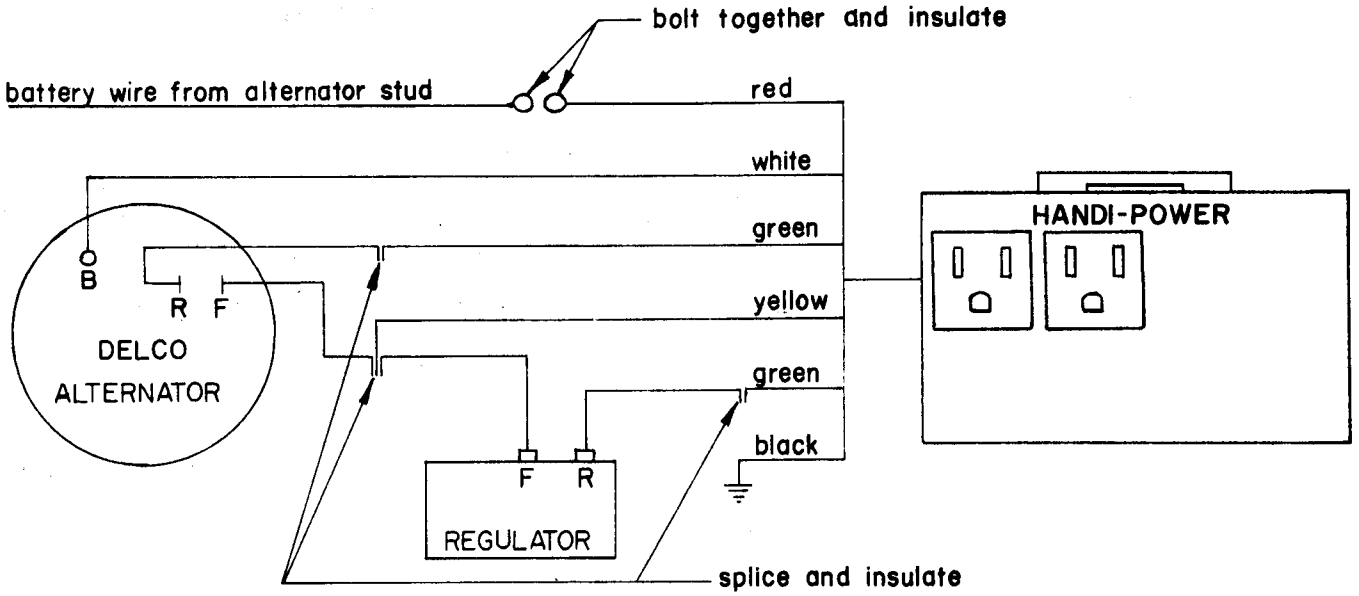
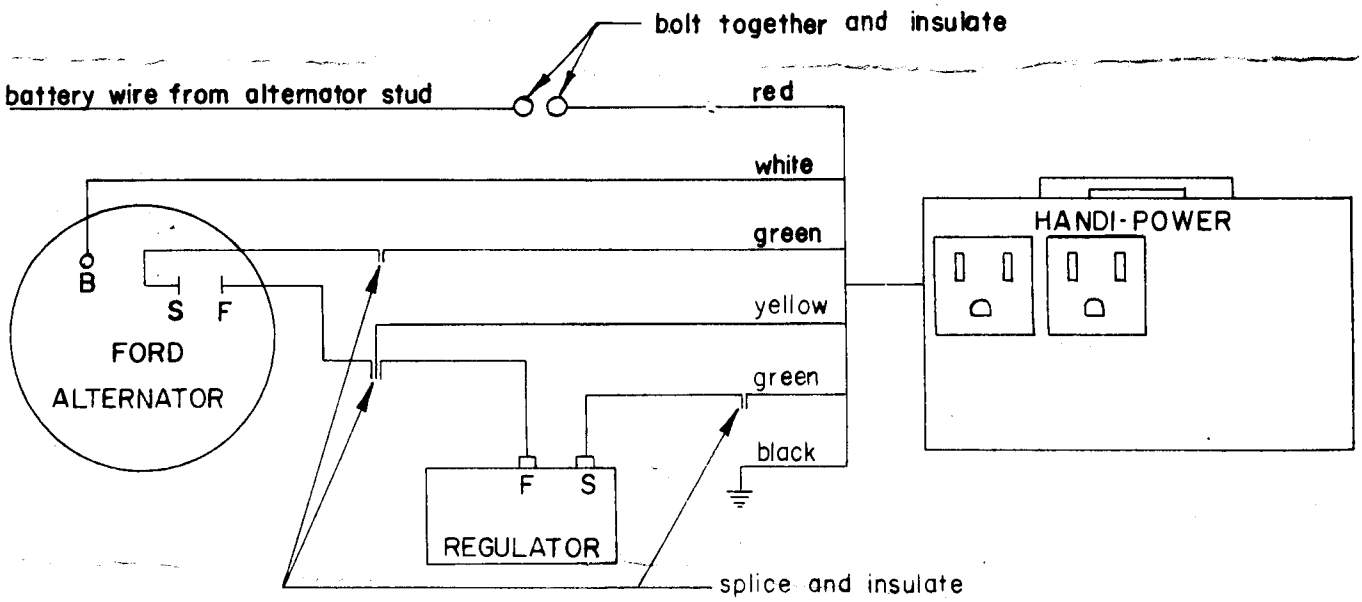
HANDI-POWER

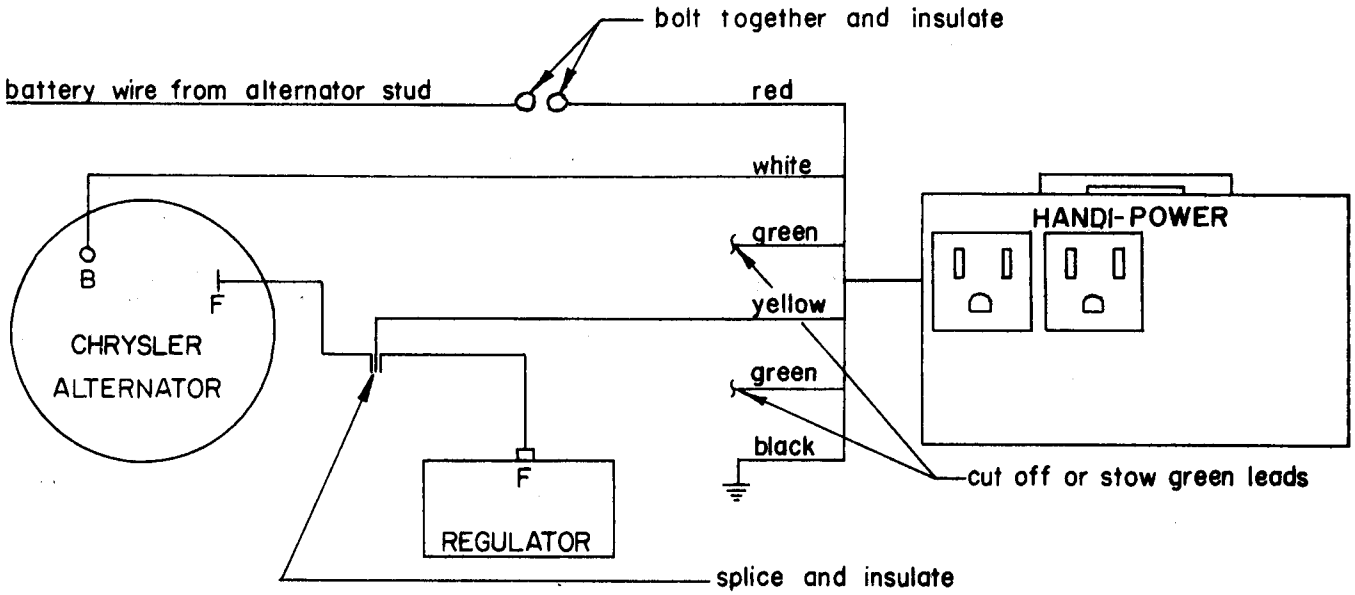
WIRING DIAGRAMS

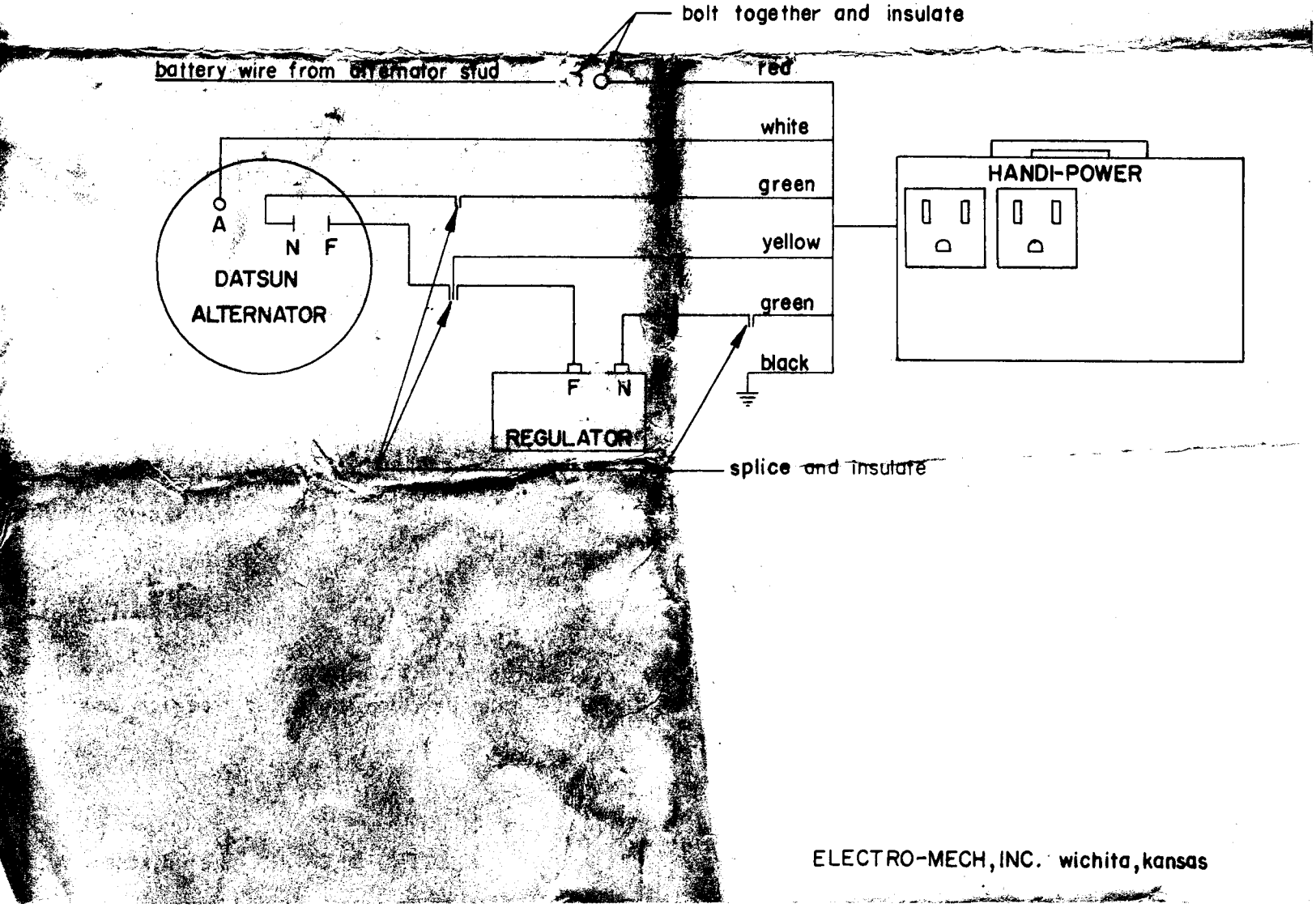




NOTES

1. connectors are provided for all splice joints.
2. all connections must be clean and tight.
3. remove one battery cable from battery post prior to installing HANDI-POWER.
4. the attach point of the black lead from HANDI-POWER must be clean, tight, and free from paint.





ELECTRO-MECH, INC. wichita, kansas

HANDI-POWER

INSTALLATION INSTRUCTIONS

1. Remove one of the battery cables to prevent accidental shorts from occurring during installation.
2. Mount the spring clip at any location on the vehicle, truck bed, camper, etc.
3. Remove the battery wire from the alternator battery terminal.
4. Bolt or splice the wire removed from the alternator battery terminal to the red lead from HANDI-POWER (a 10-32 nut, screw and lockwasher are provided for this purpose). Make sure the connection is clean and tight and insulate the joint with electrical tape.
5. Attach the yellow wire from HANDI-POWER to either the alternator or regulator field terminal. If the alternator and regulator field terminal connections are spade terminals, it will be necessary to cut the field wire and strip each end 1/2 inch and join these ends to the yellow wire from HANDI-POWER with the insulated connector provided.
6. Attach the black wire from HANDI-POWER to any convenient place on the vehicle frame using existing studs, bolts, or screws. The attach point of the black lead from HANDI-POWER must be clean, tight and free from paint.

   Note: For Chrysler vehicles or alternators the installation is now complete. The two green wires from HANDI-POWER may be cut off or stored in any convenient place. There is no power to either green lead in either position of the switch.

7. For Ford (Autolite) vehicles or alternators cut the wire that connects the stator terminal (S) of the regulator. Strip each end of the cut wire 1/2 inch and attach one end to either of the green wires from HANDI-POWER. Attach the other end of the stator wire to the remaining green lead from HANDI-POWER. Fasten both joints with the insulated connector provided. Either green lead from HANDI-POWER can be connected to either end of the cut stator terminal.
8. General Motors (Delco Remy) vehicles or alternators connect exactly the same as Ford except the terminals on the alternator and regulator are marked "R" for relay rather than "S" for stator.
9. Datsun automobiles connect the same as Ford except the battery terminal on the alternator and regulator is marked "A" rather than "B". The field terminal is marked "F". The stator or relay terminal is marked "N".
10. After completing the installation of HANDI-POWER replace the battery cable removed prior to beginning the installation procedure.

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