Building a Heavy Duty MAGNETO CHARGER

by John D. Rex
P.O. Box P
Bedford, Massachusetts 01730

"Could you send plans and drawings for the magneto charger in your article?" This was the most frequent inquiry I had after my November '86 GEM article on magneto recharging. This article has drawings and instructions for making and using that charger. Size and expense make the charger most practical for club or group use. The expense can then be divided among the group.

Construction of magneto chargers is not a new subject for GEM. Chargers have been described in the following issues: Jan-Feb '78, pp. 26, 27; Mar-Apr '78, pg. 7; May-June '77 shows pole pieces for charging flywheels, rotors, etc. Those units were not sufficiently heavy to charge many magnets while installed on the magneto. Remember that charging the magnets while installed on the magneto is essential. Chargers with sufficient energy have been pictured in GEM, but no construction details were given.

DESCRIPTION

The charger described here is designed to operate from a 12 volt automotive battery, has a core area of seven square inches and provides 20,000 ampere turns of energy. It is sufficient to saturate and charge most fully assembled magnetos used on antique engines. It's important to state that increasing charger size beyond the point where magnet saturation occurs does not improve magneto performance (there's no harm either).

Plan on spending at least $200 to $300 if all the materials have to be purchased. If you have a source of scrap iron, machine shop facilities and can come up with some surplus magnet wire, the costs can be drastically reduced. The charger weighs about 150 pounds and is mounted on an inexpensive 2 wheel hand truck. This second generation design features ease of construction, improved operation, bottom mounted coil terminals and diode protection to prevent excessive switch sparking and coil failure.

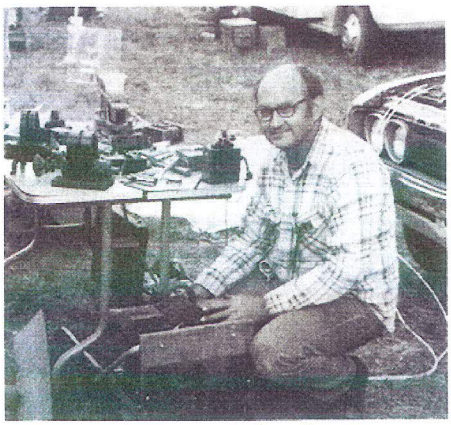

Fig. 1: John using the charger at a local New England engine show.

THE DESIGN

The main criteria for any charger design is core area, number of wire turns, and amount of current flowing through the coils. Core area must be large enough to saturate the magneto core without becoming saturated itself. Magnetomotive force (product of amps times turns of wire) must be large enough to bring magneto magnets to saturation.

This charger uses 3-inch diameter soft iron core pieces 6 inches long, each wound with approximately 500 turns of 10 gauge copper magnet wire. 20,000 ampere turns of magnetomotive force is provided with a 12 volt battery supplying about 40

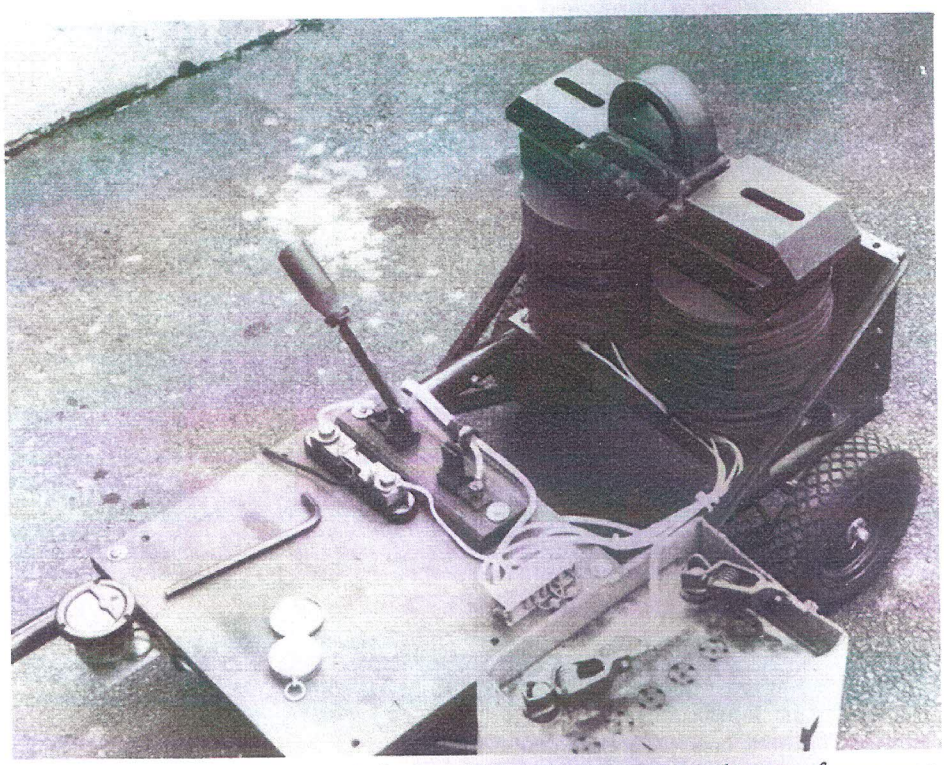

Fig. 2: A view of the finished charger. Note the automobile battery for power and a compass for checking magneto polarity before charging.

amps. The coils are connected in parallel and protected with diode arc suppressors. A knife switch is used to turn the charger on and off.

MATERIALS

- 2 each 3-inch diameter x 6-inch-long bars C-1018 steel for the magnetic coil cores
- 1 each 3¼-inch square x 11-inch long bar C-1018 steel for the base and magnetic return path
- 4 pieces 1½ x 3½ x 5 inch rectanglular bar C-1018 steel (2 for the pole pieces, 2 for auxiliary pole pieces)
- 2 each 14-inch long by 1¼ inch angle iron cut from old bed rails for mounting to hand truck
- 4 each fiberglass insulating washers 5/16 or ⅜-inch thick, by 6½ inch outside diameter by 3 inch inside diameter for coil end washers (2 have brass bolts for terminals installed)
- 40 lbs. (two twenty pound rolls if possible) #10 gauge heavy formvar magnet wire for the coils
- 4 each 22 ampere 50 volt (or greater) diodes, type SK3639 or 5812 for arc suppression (automotive alternator diodes may be used).
- 10 feet 10 gauge or larger hookup wire for wiring
- 1 set 12 foot automotive jumper cables at least 8 gauge wire size for lead wires to connect to the automotive battery
- 2 each ⅜ x 3½ inch bolts to mount coils to magnetic base
- 2 each ⅜ x 1½ inch socket head cap screws to mount adjustable pole pieces
- 4 each 5/16 x 1 inch brass flat head bolts for coil terminals
- 8 each 5/16 inch brass nuts for coil terminals
- 8 each 5/16 inch lock washers for coil terminals
- 1 each knife switch (at least 40 amp rated)
- 1 each terminal block with at least 4 terminals
- 1 each two wheel hand truck or other cart (optional)
- 1 each ammeter, 0-50 amp
- Miscellaneous equipment, heavy duty solder lugs, 10 gauge hook up wire, solder, other items as required

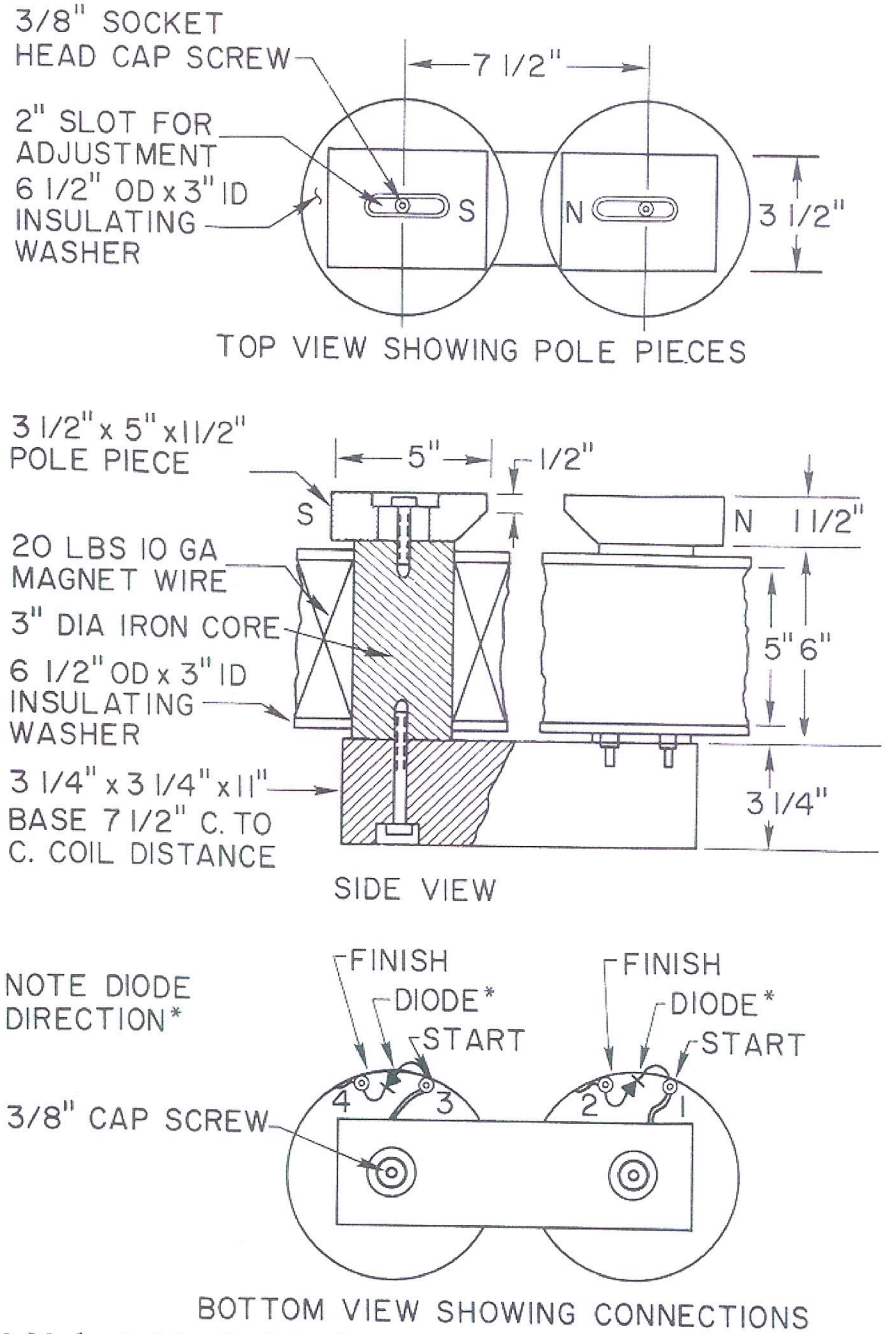

Fig. 3: Mechanical details of the charger.

THE MAGNETIC PATH AND POLE PIECES

The optimum material for the magnetic path is hydrogen annealed Vanadium Permendur. This material is too high priced so I used low carbon steel. American ingot iron, Swedish charcoal iron, Armco iron, relay iron, and certain low carbon steels are suitable. Do not use tool steels, cast iron or other high carbon steels, they have too much magnetic loss.

I used C-1018 steel for all components in the magnetic path. This is adequate from a magnetic standpoint and is readily available from steel supply yards. The pole pieces are shaped to concentrate the magnetic flux at their tips. An auxiliary set of pole pieces in conjunction with the first set is used in most charging applications and is essential for magnetos such as the Bosch AB-33 and AB-34.

To minimize machine work, all material should be sawed to length. The single most important point in machining parts for this charger is to provide close fitting joints at all points in the magnetic path. The core

ends and top surface of the bottom bar should be faced or ground flat to minimize the air gap losses. Air is a poor conductor of magnetic flux and we want to put magnetic energy at the pole pieces rather than waste it in cracks and gaps due to poor fits. If a lathe or mill is not available, file and hand scrape the parts for a perfect fit at the joints.

Additional shaped pole pieces are useful for charging flywheels, rotors, etc. The shapes and uses of additioanl pole pieces have been particularly well described in GEM May-June '77, pg. 16, and March '87, pp. 26 and 27.

WINDING THE COILS

Insulating washers for the coil ends are cut from 5/16 inch thick fiberglass or other insulator and are epoxied to the core ends before winding. One washer for each coil should be prepared with brass terminal screws as shown. Allow ¼ inch of core to protrude from each washer. To prevent shorts, the core must be insulated. Cut manila folder into a strip, wind and cement it to the core between insulating washers. A half inch overlap prevents any possibility of shorts between the core and wire.

The use of magnet wire is important because wire with thick insulation can't be densely packed. Magnet wire is available from motor rewinding shops, transformer shops and suppliers specializing in magnet wire. The yellow pages of larger cities usually list these. 40 pounds of 10 gauge heavy formvar insulated magnet wire is required—20 pounds for each coil. Try to purchase two 20 pound rolls rather than one 40 pound roll. The exact number of turns is not important so don't bother counting turns, just wind until 20 pounds of wire is on each coil.

Wind the coils on a lathe using back gears and clutching. Mount the core with terminal end facing the lathe tailstock and run the lathe in reverse to make winding easy to view. This will insure winding direction and poles match those in the photos. Two people are required, one to operate the lathe clutch, while the second layers wire onto the core with gloved hands. If a lathe is not available, coils can be wound by attaching a crank with bolts threaded into each end of the core. The bolts may be run through wood supports which act as bearings and support the coil during the winding. 10 gauge wire is very heavy and a lot of force is required in order to make the windings neat and tight.

The actual winding is started by scraping off a half inch of insulation and poking the wire through the start hole in the insulating end washer and soldering it to a lug on the terminal marked "1". The wire is then wound in layers progressively on top of each other. Try to keep the layers uniform with adjacent turns touching tightly. As winding progresses, it will be more and more difficult to prevent the winding from becoming scrambled. Eventually some scrambling will occur, but try to keep it to a minimum. After most of the 20 pounds is wound, the winding should be planned so the wire will end near the terminal end of the coil. Guide the wire through the notch on the insulating washer, scrape the insulation off and solder it to a lug at the terminal marked "2". Tighten a nut and lock washer over each lug. Repeat the procedure for the second coil except mark the terminals "3" and "4" instead of "1" and "2".

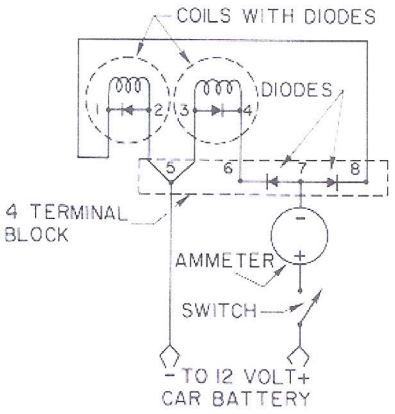

Fig. 5: Wiring diagram.

To protect the coils from damage, I wound several strips of fiberglass cloth and string over the entire coil and painted them with polyester resin. After hardening, the fiberglass and resin were sanded smooth and painted. At this stage, the coils are finished. Assembly and testing are all that remain.

ARC SUPPRESSOR DIODES

The purpose of arc suppressor diodes is to reduce the high voltage arc produced by the coils when the switch is opened. This arc is exactly what is wanted across ignitor points with battery and coil ignition, but in a magneto charger, the arc could lead to switch failure, insulation breakdown or electric shock. Diodes absorb the energy when the switch is opened. A second pair of diodes is necessary to prevent damage to the first set in the event the battery is connected backwards. Alternator diodes will work fine if the ones listed aren't available.

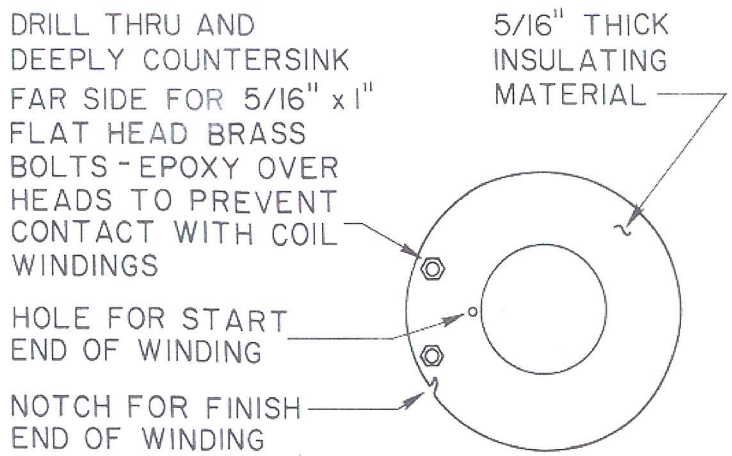

Fig. 4: Detail of the insulating end washers for the coils. These are epoxied to each pole piece. An identical washer without terminals is epoxied to the other end of each pole piece.

Make sure all diodes are connected exactly as indicated in the wiring diagram (note direction of arrow on diode). Failure to observe this precaution will result in smoked diodes when the charger is powered up!

KNIFE SWITCH

The choice of a knife switch has one big advantage. You can actually see if it's open or closed. This is important, because there have been cases where an enclosed switch has had the contacts stick closed even though it indicated open. The result was a set of cooked coils. If an ordinary switch is used, always check the ammeter to make sure the current has stopped flowing when the switch is opened.

AMMETER

The use of an ammeter, although optional, is useful to monitor the current through the charger. Once the current has built to a maximum, the switch may be opened because a full charge has been delivered to the magneto magnets. An ordinary automotive ammeter reading 50 amperes is sufficient. The ammeter is connected in series with the switch and mounted to the wood base attached to the hand truck. Fancier ammeters are available from electronic supply houses or surplus electronics stores. The ammeter shown, unlike automotive ammeters, requires the use of an external shunt for operation. No current will be indicated on the meter if the jumper leads have been improperly connected to the battery.

FINAL ASSEMBLY

Now things start to get heavy, so it's good to build the charger onto a two wheel hand truck or other cart. Inexpensive ones costing under $15 are available but require reworking so they will stand up to the weight. The one pictured has had the joints welded and additional braces welded on to improve strength. The wheels were replaced with old lawn mower wheels which are stronger. The main base is attached to the hand truck using the two pieces of steel angle cut from bed rails. These may be welded or bolted to the hand truck frame. The coils are now bolted to the base. Arc suppression diodes and connecting wires are attached to the coil terminals using 5/16 inch brass nuts and lock washers.

Other components, such as the knife switch and terminal board, are mounted to a wood base on the hand truck. If an ammeter is used, it should be placed away from the coils so the magnetic field won't affect meter accuracy. A set of automotive jumper cables attached to the terminal block connects the charger to any 12 volt automotive battery or power source.

TESTING THE CHARGER

Once the unit is wired according to the wiring diagram, it's time to test it. Connect the leads to a 12-volt automotive battery (observing polarity) and close the switch. Don't leave the charger on for more than a few seconds at a time, because the coils and diodes will overheat. The current should build up to a maximum (about 40 amps) in about 3 seconds. If not, check the wiring, paying special attention to proper battery polarity and diode polarity.

If the wiring and winding have been done as indicated the north and south poles should be as shown in the figures. Mark the poles with the letters N and S to indicate their polarity. The easiest way to see if the poles are as marked is to test with an ordinary compass.

As everyone knows, opposite magnetic poles attract while like poles repel. A compass needle points north, because the end of the needle is charged south. The needle is really a "north seeking needle" and seeks the north pole of the earth or magnet. The north pole of the magneto charger can be verified by bringing the compass to about a foot from the charger pole while the current is switched on. The north seeking compass needle should point to the north charger pole as the compass is circled around it. Mark the north pole "N". The other pole should attract the south seeking needle and should be marked "S".

Warning! Don't bring the compass too close to the charger (or to magnets) because the needle may be demagnetized or remagnetized in the opposite direction. It's always a good idea to periodically check the compass to make sure the north seeking needle still points north (my compass gets messed up a couple of times a year and has to be remagnetized so it points properly).

CHARGING MAGNETOS

Magnets have the unique property of magnetizing opposite to the polarity of the charging source. In other

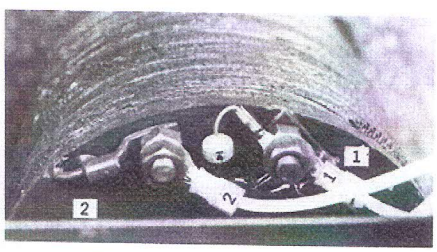

Fig. 6: Wiring connections for coil 1. Note diode orientation. Coil 2 is wired the same except the diode is reversed and terminals are marked 3 and 4 instead of 1 and 2.

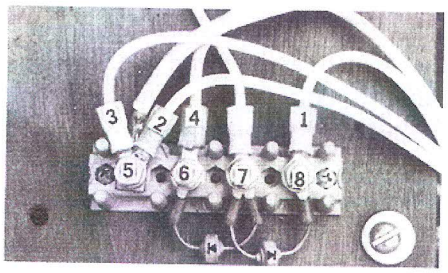

Fig. 7: Wiring connections at terminal block. Note diode orientation.

Fig. 8: Hand truck after modification—ready for mounting the charger.

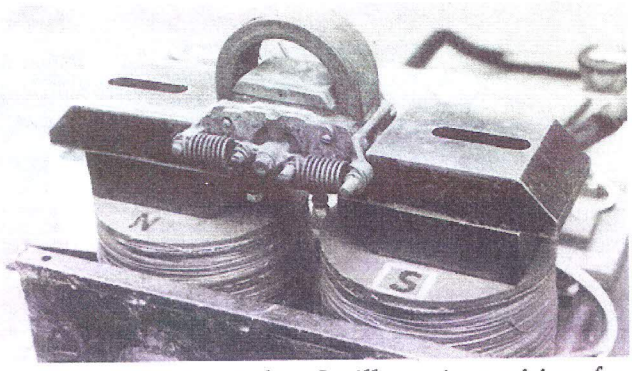

Fig. 10: Webster Tri Polar Oscillator in position for charging.

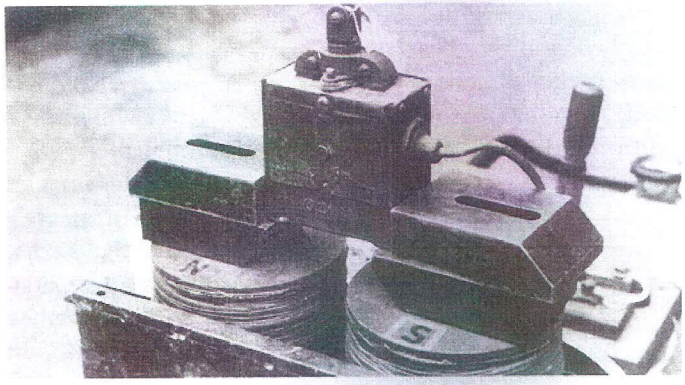

Fig. 9: Charging a Wico EK magneto. Note: It is not necessary to remove the covers or put shims under the armature of this magneto when charging.

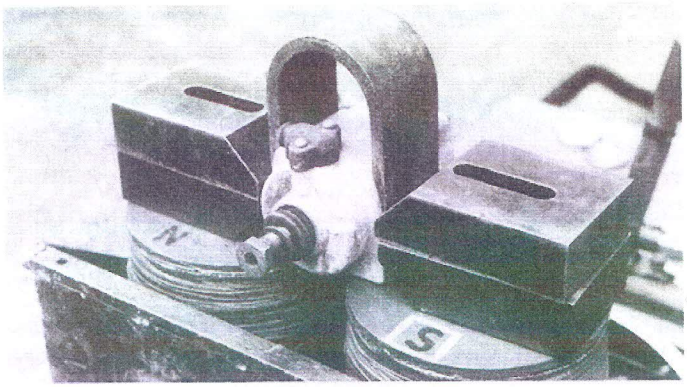

Fig. 12: Fairbanks-Morse model R.

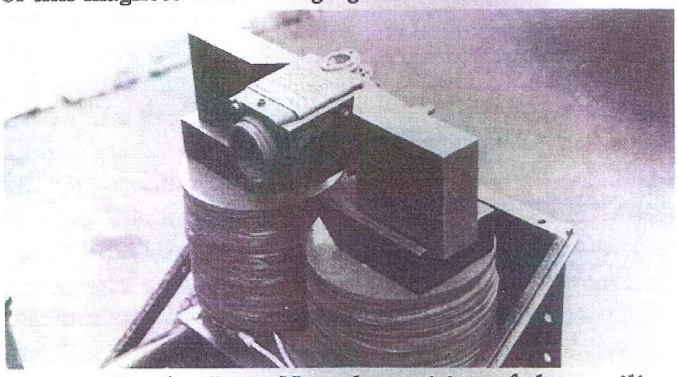

Fig. 11: Bosch AB-33. Note the position of the auxiliary pole pieces when charging this magneto.

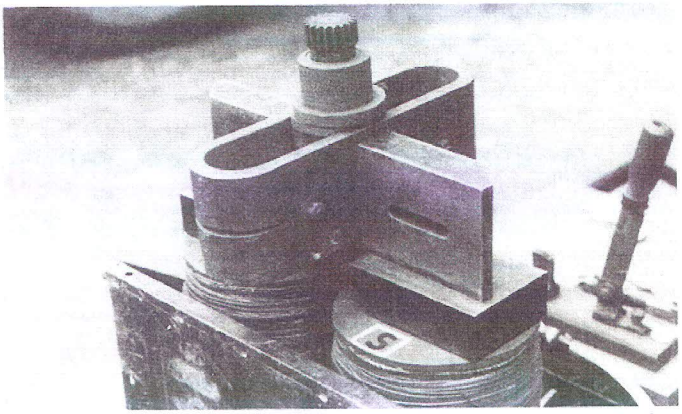

Fig. 14: Sumner magneto (from Watkins engine) ready for charging. Note location of auxiliary pole pieces.

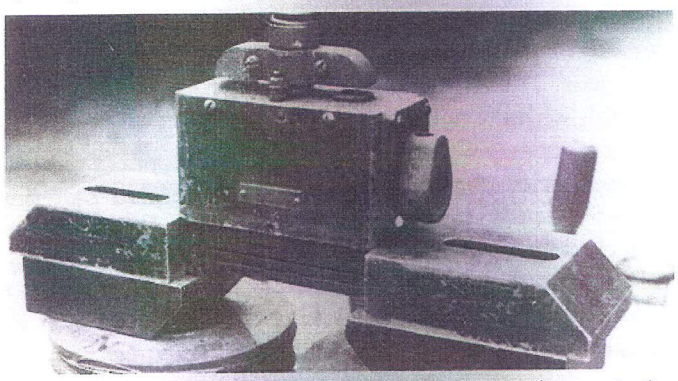

Fig. 13: Wico AX or PR with top cover removed—ready for charging.

words, the charged magnet comes off the charger with its south pole originating from the north pole of the charger. Because of this fact, when charging magnetos, remember the pole which you desire to be north should be placed at the south pole of the charger (first test the magnet with a compass to determine the north pole). The pole pieces of the charger should be adjusted to concentrate the magnetic field across the magnets while on the magneto. Use the auxiliary pole pieces if necessary. The figures show optimal pole piece placement for charging most popular magnetos.

The reader should refer to the March 1987 edition of GEM, pages 26 and 27, for further examples of magneto placement on the charger. Once the magneto is positioned, charging is accomplished by closing the switch and letting the current build to a maximum as indicated on the ammeter. This takes only a few seconds. Additional time does nothing but drain the battery. During charging, it is not necessary to tap the magnets, "wipe the poles", or perform the other mysterious procedures indicated in some old literature on magnets and magnetos. These procedures were used in the old days because many chargers were inadequate and magnetic theory was not well understood. After charging, the polarity can be verified by the use of a compass.

Remember, if the magneto is dismantled or the magnets are removed, recharging after assembly will probably be required to restore full performance. For more information on this, see the November '87 GEM on "How Often Do Magnetos Need Recharging?" ▣