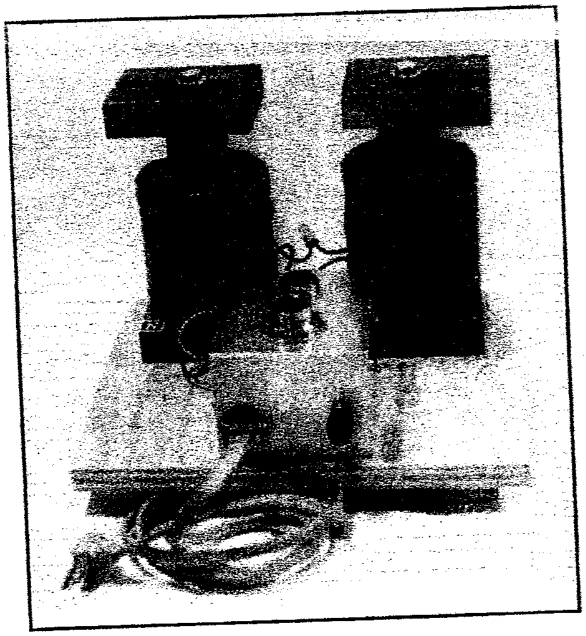

How to Build a

Magneto Magnetizer

David J. Gingery

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INTRODUCTION

There are few mechanisms more fascinating than old internal combustion engines. And equally fascinating are the ignition systems that enabled them to run. While countless thousands of the old engines have been broken up and melted down to be resurrected as more modern machinery, it would seem that they might easily have run forever had it not been for some mysterious failure in the ignition or fuel system. In fact today many of the relics are being rescued from the scrap heap, and determined people are restoring them to running condition.

Fuel systems are generally easy to troubleshoot and restore by simple cleaning and perhaps making a small part or two. Battery ignition systems, too, are straight forward, and any able mechanic can determine by simple tests whether the coil and condenser are good and if the points make and break properly. But if the engine is equipped with a magneto the challenge becomes greater and it will be necessary to delve a little deeper.

It is the purpose of this book to reveal a few clues to aid in solving the mystery of those very cunning mechanisms. And since there is much more to a magneto than its magnets we will spend a little bit of time discussing some of its other elements.

Like all mechanisms, a magneto is designed to do a specific job, and the best key to restoring a non-functioning mechanism to normal operation is to fully understand what is normal.

It would require a large book indeed to describe and fully illustrate the various types of magnetos. But I will have to leave that book for others to publish. The main intent here is to detail construction of the equipment for restoring the vitality of the magnets. But a few broad and general tips will be offered to guide those who are completely in the dark about magneto ignition devices.

In keeping with a very wise adage: "IF IT AIN'T BROKE DON'T FIX IT", I urge you to develop a careful series of diagnostic steps before diving into the inner workings of the magneto.

In all of this discussion it is assumed that you are working with old engine magnetos that will seem rather complex. And especially if they are equipped with "IMPULSE MECHANISMS" that are designed to accelerate the speed of the magneto rotor to gain voltage. But they do not differ in principle with modern magnetos as found on the usual engines of lawn mowers, garden tillers, etc.. However while you can buy just about any required part for the modern machine it is a very different matter with old equipment. And so also is it difficult to find specifications and service data for old machines. So then it becomes necessary to be very cautious and observant so that any part removed will not be damaged and that it will be reinstalled properly without the aid of a repair manual.

Even though the magnetizer is the main offering in this book it must be stressed that merely recharging the magnets will seldom restore a magneto to efficient operation. However magnets do lose their magnetism for various reasons and in that event it will be absolutely necessary to re-magnetize them.

There is nothing at all new or original in the design of the magnetizing device detailed later in the book. In fact a very similar device was most likely used when your magneto was originally manufactured. The only significant difference would be the modern solid-state power supply.

Since the pole pieces of the magnetizer are adjustable the device can be adapted to nearly any ordinary magneto or magnet. Further, specially shaped poles can be installed and adjusted to adapt to many other designs including flywheel magnets and bar magnets. And of course it can be adapted for experimental use or for production of many permanent magnets for a wide variety of purposes.

MAGNETO DEVICES

A magneto is not nearly as mysterious as some of the "BLACK BOXES" found on modern machinery and appliances. The fiends who design this stuff will put coils, capacitors, transistors, diodes, IC's, thermistors, varistors and other such truck onto a multi-layered circuit board and fuse the whole thing into a glob of plastic with wires sticking out at various points. Then they conceal its true identity with code numbers and letters that would stump agent 007, and then proceed to design a replacement that will obsolete the newest thing developed even before it hits the market. The things are designed to self-destruct if you apply a test meter to try and figure out if they are any good. If you break them open there will probably be nothing recognizable inside. And if you brought one to the feet of the Oracle at Delphi in the hope of learning something about it he would probably shrug his shoulders and advise you to devote your time to something more worthwhile. But you can understand and repair engine magnetos.

Magneto ignition systems are actually not greatly different from battery systems so basic troubleshooting is much the same. It would always be nice to have some sort of instrument that you could hook up that would tell you instantly where the trouble is and what to repair or replace. Such are modern computerized systems. Or at least that is the claim of those who build them and foist them upon us. A computer would prove of little value in diagnosing magneto troubles. But everything you need to know can be quickly learned by simple tests. And when these simple tests indicate that all should function if only the magnets are good you will have the necessary equipment to recharge the magnets if you build the simple recharger described later. But bear in mind that magnet failure is not the most common or likely cause of magneto failure. And, more important, magnets should not be casually removed or ever carelessly handled. In fact you can lose a significant amount of magnetic strength by simply removing the magnets improperly. And reinstalling them backwards can get you into some very serious trouble. Dropping a magnet or striking it with a hammer can also effect its strength. And excessive heating, as with a torch, can completely demagnetize the magnets. The discussion on basic trouble-shooting and repairs will be general and brief but you will get full details on building and using the magnetizer a bit later. The best rule to follow is to always leave the magnets undisturbed until you have thoroughly considered every other possible cause for failure.

A magneto is essentially a generator used in conjunction with inductance and capacitance to deliver an electrical spark at the required instant to cause ignition in the engine cylinder. As the name implies, its source of energy is its magnet or magnets so that is the proper place to begin the discussion.

MAGNETISM

Magnetism is among the most mysterious of the physical phenomenon. While its actions can be compared with those of electrical currents there are distinct differences that have challenged great minds for centuries.

The first natural magnets are said to have been discovered in Magnesia, a small country in Asia Minor, around 600 B.C., Thus they came to be called "Magnets". Knowing the origin and date of discovery helps not in the least except that we can impress people who did not know that already. And knowing the origin of the name frees the mind to look for more valuable information since we don't have to wonder why it's called magnetism. A great deal has been learned about magnetism in the past centuries but much remains to be discovered.

It is theorized that molecules are aligned within the body of magnetized materials so that the attracting and repulsing forces of the electrons are concentrated and polarized. Nothing can be gained from a discussion of theory except that we might finally agree that one expression of theory seems more plausible than others. But while little is known or understood about what magnetism is and how it works, a great deal is known about its effects. That knowledge is useful in a study of magnetos.

Natural magnets are a crystalline form of iron oxide that has come to be called "Magnetite". Very rich ore that yields high quality iron.

Early sailors discovered that an elongated piece of it hung from a cord or floating on a block of wood in a pan of water would always orient itself with one end pointing north and the other south and thus the first magnetic compass was invented. They called it a "Lodestone", which means "Leading Stone".

Modern manufactured magnets are many times stronger than natural magnets and they are made in an infinite variety of shapes and sizes. Many other uses have since been found for magnets and a large proportion are used in electrical and electronic devices.

Of particular interest to us is the fact that when a magnetic field is cut by a conductor an electrical current is induced. You can prove that yourself by winding a small coil of about 10 turns of insulated wire and connecting its ends to a very sensitive milliamp meter. Then pass a strong permanent magnet back and forth over the coil or through its center and watch the meter needle deflect. That is the phenomenon of INDUCTION, and what you have done is to fashion a simple generator.

And we are also interested in the "POLARITY" of the magnet. I.E., one pole of a magnet will align with the magnetic north pole of the earth and the other aligns with the south pole of the earth. The magnetic polarity of the magnet has a direct relationship to the electrical polarity of the current it induces. (Positive or negative) A physical law of magnetism is that unlike poles attract and like poles repel. And the same law applies in electricity and electronics. Understanding these laws is vital to an understanding of induction.

INDUCTION

Just as an electrical current is induced when a conductor cuts a magnetic field, so is a magnetic field induced each time an electrical current passes through a conductor. Generators and transformers function on these very basic principles. And a magneto is really a generator to supply a transformer, or it incorporates a transformer in its design. Actually the magneto is more precisely an alternator that produces an alternating current at low voltage to be built up to a voltage high enough to discharge a spark. It is the rapidly changing magnetic field that induces the current. And the greater the number of turns in the coil the higher the voltage. So also, the faster the magneto spins, the higher the voltage.

A typical magneto has a set of field magnets that charge the pole sections. The rotor is wound with a coil of wire that represents the primary of a transformer. As it rotates between the magnetized pole pieces an alternating current is induced. At precisely the right moment the contact points in the primary circuit open, which causes the magnetic field of the armature to collapse rapidly, inducing the necessary high voltage in the secondary winding to deliver the spark.

Given fully charged magnets, sound coils and condenser and properly functioning contact points, a magneto will deliver a hot, snappy blue spark of sufficient length to jump the spark plug gap and fire the engine.

MAGNETO TESTING

As with any electrical ignition system the logical first test is to determine whether a spark of sufficient strength is being delivered. It is a simple matter to remove the spark plug, rest it on the cylinder head and crank the engine. If you see a bright, blue spark and hear it snap it can be assumed that the magneto is functioning well. It remains only to assure that timing is correct and you can look to other causes for failure to start. If, on the other hand, the spark is dim orange and barely audible, if at all, you will be justified in looking more deeply into the ignition system. Naturally a weak or non-existent spark indicates a failure in the magneto.

By far the most common problem with magnetos is a faulty condenser or dirty contact points. Sometimes it is a simple matter to install a replacement condenser that is known to be good and the magneto is restored to perfect operation. But some older magnetos have the condenser built into the rotor and it can be a major job to disassemble it for replacement or to modify the design so that an external condenser can be installed.

The logical first step is to clean the points and make sure that they are opening and closing properly and that there are no electrical shorts or opens. A simple ohm meter is a practical tool for these tests. Then crank the engine or spin the magneto manually to see if it will deliver a spark.

You can test a condenser with the ohm meter if you isolate it from the rest of the circuit. The meter needle should jump perceptibly and return to zero when the test prods are touched to the condenser terminals. Then reverse the prods on the terminals and the needle should again jump and return to zero. If the ohm meter needle does not jump when connected in either polarity an open condenser is indicated and it must be replaced. If the needle does not return to zero in both directions it is an indication of a shorted or leaking condenser, which must be replaced.

It has been a common practice to test a magneto by applying battery voltage to the contact points to test the coil and the condenser. What the test might prove is that the points, coils and condenser are functioning and that the failure is in the generating or delivery system. In fact failing magneto systems are sometimes converted to battery systems in this way. But while it may enable the timing mechanism to deliver a spark and get the engine running it can also demagnetize the magnets. The particular design of the magneto will determine whether such a test or emergency measure can be safely used. So bear in mind that if you send an electrical current through a coil that is part of a magnetic circuit you may cause a counter magnetic field that can damage the magnets.

Some magnetos use brushes to collect the current and these can fail. It is also possible for carbon from the wearing brushes to collect and provide a short circuit to ground, causing the magneto to fail.

Bearings can fail, causing the rotor to drag on the pole pieces and that will cause magneto failure. Magnetos are usually cunningly made and disassembling can be tricky, so proceed slowly and cautiously. It may become necessary to completely disassemble a magneto to clean dirt, carbon and oil, or to replace bearings or other parts. That will require careful study, plenty of light and a clean bench top. In no case should you remove the magnets without first putting a "Keeper" across their poles. A keeper is a bar of iron or steel used to bridge the gap between the poles of the magnet so that the magnetic circuit will remain intact. A very substantial amount of magnetism can be lost in only a moment so always be prepared to recharge your magnets if you handle them improperly. And you should avoid removing the magnets if at all possible. If the magnets must be removed to complete disassembly they must be carefully marked to be returned to their original polarity. The magnets are also effected by shock so you must not pound on them or drop them.

Some magnetos have both the primary and secondary windings on the rotor, while others have only the primary winding on the rotor with the secondary on a separate laminated core. Still others will have both primary and secondary on a separate core and the rotor will provide the magnetic field.

Coils fail through open or short circuited windings and they can be tested with the ohm meter.

More difficult and uncertain to determine is whether or not the secondary coil insulation is leaking. Lacking specialized equipment a leaking coil is diagnosed only by elimination. That means when you have made certain that everything else is OK the problem can only be a leaking coil.

It is rarely possible to restore a leaking coil by baking it for a couple hours at 225 degrees F. to drive out the moisture. But if you are certain the coil is leaking nothing is lost by trying. You are going to need permission from the lady of the house to do that, and you are probably going to get into big trouble anyway if you make some smoke or smell. If baking out the moisture restores the coil you should soak it in thin varnish to seal it.

When testing coils with the ohm meter make certain that they are isolated so that you don't get a false reading from a faulty condenser or shorting or dirty points. Also check for "carbon tracking", which is a tiny high resistance path to ground due to a dirt or carbon filled crack in insulation.

Some magnetos have a "Safety Gap", which is designed to discharge the spark to ground safely if the high tension wiring or spark plug fails. The idea is that voltage could become high enough to pierce insulation in the secondary winding if it does not find a safe path to ground through the spark plug. The safety gap will be somewhat wider than the normal spark plug gap so that it won't interfere with normal ignition. But it will be close enough so that if the spark plug gap widens too much or the spark plug wire is removed the spark will jump the safety gap and preserve the insulation of the secondary coil. It is possible for the safety gap to become shorted so that spark will not be delivered even though the magneto actually is functioning. And if you remove the spark plug wire and crank the engine to test for spark you may not see a spark at the wire because it is discharging at the safety gap out of view. By now it must be apparent that magneto troubleshooting is very little different than trouble-shooting battery systems. The only other element of doubt is the condition of the magnets and how to test them.

The only practical magneto magnet test I've ever known of is that "A good magnet will lift 20 pounds of iron.". It is a simple matter to attach a plate of mild steel to a spring scale and observe the scale reading then the magnet pulls free of the plate. Of course there are modern devices that will measure field strength and evaluate magnets in technical terms. But by far the most common practice in commercial magnet testing continues to be comparing the "pull" or field strength in some sort of mechanical testing fixture. Without very expensive and sophisticated equipment magnet testing for most of us will remain a matter of acquired judgement. It will generally be impractical to remove the magnets to determine if they will lift 20 pounds. But after handling a number of normally functioning magnetos you will learn to judge the amount of magnetic "drag" you feel while rotating by hand. Of course the impulse mechanism can interfere with manual turning so partial disassembly will be required for some testing.

OTHER MAGNETO DESIGNS

The types of magnetos we have discussed up to this point are all "High Tension" magnetos that deliver a high voltage spark through a rotating mechanism. There are also reciprocating magnetos or oscillating magnetos that accomplish the same thing by different mechanisms. And there are "Low Tension" magnetos that deliver a spark by breaking the primary circuit inside the cylinder. The common element in all of them is the magnet, and if it is determined that the magnets have failed the next step is to build a magnetizer.

BASIC REQUIREMENTS

As intricate as magnetos may seem, a magnetizer is about as simple a device as can be imagined. A hefty steel core with appropriate pole pieces, a pair of coils and a simple direct current power supply with a convenient switching arrangement is all that is required. Cost is not at all prohibitive and everything needed is generally available. But while only ordinary basic mechanical ability is required, at least a portion of the work should be machined for best results. Namely, the heavy cylindrical cores should be faced off to true flatness and uniform length in a lathe. And the slots in the pole pieces should be milled or cut with a metal cutting band saw. Additionally, if specially shaped pole pieces will be required they will surely have to be made with a lathe or milling machine.

While most of what you need will be available locally you may not be able to buy magnet wire. Some local motor rewinding shops may sell you magnet wire if they are persuaded that you are not going to compete with them in the motor winding business. If you have an amount of magnet wire available from a large transformer or other salvage item study all of the design considerations text before proceeding. But if you don't find what you need locally for less than $3.00 per pound you can order it. What you need is two 6 pound spools of 18 gauge enameled copper magnet wire. It is available from:

CONDUCTORS UNLIMITED
PO BOX 282
LYONS, IL 60534-0282.

Write or phone 708 447-2666.

The cost varies from day to day due to fluctuations in the copper market so it is not possible to quote an accurate cost here. But Conductors Unlimited will quote you the current price plus shipping and handling and tell you how to enter your order. A reasonable source for magnet wire is vital to a project like this and I would not have dared to publish this manual unless I was able to name such a source.

DESIGN CONSIDERATIONS

This device is nothing more or less than an electro-magnet with specially designed pole pieces to make it adaptable to various sizes and shapes of magneto magnets. The basic consideration was to make it powerful enough to saturate its own steel core with magnetism, which ensures that it will saturate any other magnetic material of cross sectional area in the same size range.

Once its size was determined the next consideration was to keep construction methods as simple as possible. And also to specify materials that are commonly available even though better materials might be in existence but difficult for individuals to obtain. Thus common cold-rolled steel is specified for the core and poles even though better alloys exist. And the chassis is made of wood instead of steel for no other reason than ease and simplicity.

There are empirical formulas that make it possible to design such a device very precisely in regard to many factors. And there is a very broad and comprehensive scientific language to express the many factors in measurable and comparable terms. But since this device is more than twice as powerful as it needs to be for its intended purpose, all formulas except for ohms law were disregarded.

Once the main core size was determined the next step was to design the coils. Since the strength of an electro-magnet is determined by the number of turns in the coils and the amount of current flowing through the coils, there are a nearly infinite range of possible choices. For example a coil of 100 turns at 60 amps induces the same magnetic force as a coil of 600 turns at 10 amps. Neither the current or the number of turns alone determines the strength, but rather the product of current and turns. That is expressed simply as AMPERE TURNS. Both coils described above have the same effect even though they are physically much different. Both deliver a magnetic force of 6000 ampere turns and would be equally as effective in identical applications. But both require vastly different electrical power supplies, and the size of wire required is very different.

While many magnet rechargers have been built using heavy coils drawing high current from batteries, that design concept has more than one drawback. Most serious is the danger of explosion of the battery by igniting the very dangerous hydrogen gas that is liberated from the rapidly discharging battery. For that reason the battery must be a substantial distance from the point of use. And even that does not fully guarantee that ignition won't occur from causes other than arcing at the switch. The very high current also generates considerable heat in coils, wiring and switches, which poses a burn hazard. And just as important, heavy cables and switching must be used and that tends to be quite costly.

A maximum current of 10 amps was selected for this design because that permits the use of easily available and low cost electrical components. It also enables the use of standard household line current and the use of a solid state D.C. power supply that is much cheaper and more reliable than battery power, and safer as well.

18 gauge magnet wire was selected for the coils because it will safely carry the 10 ampere current without any dangerous heating. And it is flexible enough to make coil winding easy while strong enough so that there is no undue danger of breaking.

Given a coil form diameter of 2 1/8", more or less, and a form length of 4", six pounds of 18 gauge magnet wire will give 16 to 18 layers of turns at about 95 turns per layer. That will mean a total of from 1600 to 1800 turns on each coil. The total number of turns can vary significantly, depending upon how neatly the turns are laid on. There is no need to count turns or to take any steps to ensure that the coils are exactly equal in turns. But wind them as neatly and compactly as you can for firmness and easy finishing.

The D.C. resistance of 18 ga. magnet wire is 1.2721 ohms per pound so the resistance of each six pound coil is 7.63 ohms. The coils are connected in series so the nominal circuit resistance is 15.26 ohms. Ohms law declares that the current in a D.C circuit is equal to the voltage divided by the resistance so 115 volts divided by 15.26 ohms gives a current of 7.54 amps. In fact an amp meter in series with the coils on the initial test read just slightly under 7.5 amps so we can be satisfied that it works well within the design limits.

A total of 1600 turns at 7.5 amps gives a magnemotive force (mmf) of 12,000 ampere turns. (1600 x 7.5 = 12,000) The technical term for units of mmf is the "Gilbert". Simply multiply 12000 ampere turns by 1.26 and you have 15,120 Gilberts. In this application I'm unable to tell you of what use that information is, except that, again, you might impress people who don't happen to know that. And it will satisfy any scientific types that you have more than twice the required magnetic power to saturate any ordinary magneto magnet you might apply to the poles of this magnetizer.

Since no voltage dropping transformer is in the circuit we are applying the full 115 volts of A.C. to the full wave bridge rectifier. The output of the rectifier is a nominal 115 volts pulsating D.C. to be filtered by the 100 mfd capacitor for a reasonably smooth direct current supply to the coils.

A momentary switch, either push button or spring return lever, rated at 10 amps or more closes the circuit to energize the magnets. If you connect an amp meter in series with the coils you will see the current climb to a peak of around 7.5 amps in less than 5 seconds. When the current peaks the magnetic core is fully saturated and nothing is gained by additional time. In any case an on time of 5 seconds will be adequate so there is no serious need for an amp meter in the circuit. However there is no reason for leaving it out if you happen to have one on hand.

Of course the unit will work as well without the pilot light. But the practical purpose for the pilot light is to let you know if the switch ever fails in the closed position.

WARNING!

The three wire grounded supply cord and plug is specified for your safety. The steel core and chassis box must be connected together and to ground in the event that the coils or any other electrical component fails. Such failures do happen without warning or any indication, and this equipment is capable of delivering a DEADLY ELECTRICAL SHOCK. And bear in mind that no protection is gained by using the three wired grounded cord and plug, if it is not plugged into a properly grounded outlet. Seek professional help if you have any doubts about your own competence. Bear in mind also that you may be subject to local codes or fire insurance underwriters rules so make sure you are in compliance

BUILDING THE MAGNETIZER

Before you buy your wire or other materials make sure that you have the capability to prepare the heavy metal cores and pole pieces. Other aspects of the project are quite simple and direct but the ends of the core pieces must be truly flat and they must be of uniform length. That can pose a great challenge if you don't have machining capability. While it is conceivable that you could do the work with hacksaw and file it would require several hours of tedious work and you would have to be a very determined individual. The better plan is to get a friend or local machine shop to face off the core pieces to truly flat and equal length and to mill the slots in the pole pieces. Another idea is to enroll in a local vocational school class to gain access to their equipment. But of course if you do that you should complete the entire period of enrollment in order to take full advantage of the course, which is certain to benefit you in many ways.

MATERIAL LIST

BASE

1 . 3/4" plywood, 10" X 12"
2 . 3/4" X 1 1/2 wood, 9"
4 . #8 X 1 1/2" screws

CORE

1 . 1" X 4" X 10" C.R. Steel
2 1" X 4" X 3" C. R. Steel
2 . 2" dia. X 6" C. R. Steel
4 . 3/8" X 1 1/2" Cap Screws
1 . 1/4" X 2" Carriage Bolt

COIL WINDER

1 2" X 6" X 18"
2 . 3/4" Plywood, 6" X 18"
2 . 5" dia. Plywood Discs
1 . 5/16" dia. Rod, 9 1/2"
5 . 5/16" Hex Nuts
6 . 5/16" S.A.E. Washers
2 . 2" X 3/8" O.D. Copper Tube
1 . 1/8" X 3/4" X 4" Strap
1 . 1/8" X 3/4" X 3" Strap
8 . #8 X 1 1/2" screws
2 . 3/4" Plywood, 2" X 2"

3.45lb = 600FT 174FT/lb 1044FT

COILS

2 . 6 LB. spools, 18 ga. wire
1 . roll plastic elec. tape.
2 . sheets of poster card
1 . small white glue

ELECTRICAL

1 . 5" X 4" X 3" Chassis Box
1 . 25 Amp, 200 V. Rectifier
1 . 100 mfd, 200 V. Capacitor
1 . 10 Amp Fuse holder & Fuse
1 . 3 lug terminal strip
1 . 115 V. pilot lamp
1 . 15 amp switch
1 . 3 wire cord and plug

ASSEMBLE THE BASE

The base is simply a 3/4" plywood rectangle with common 1 X 2 cleats screwed to the underside to provide finger clearance when you want to move the unit about. Two 3/4" holes are drilled through the board to accept the heads of the core bolts. And a single 1/4" hole is drilled to accept the 1/4" X 2" carriage bolt that will fasten the core to the base. One or two coats of varnish or paint will preserve the base and enhance its appearance. See figure 1

ASSEMBLE THE CORE

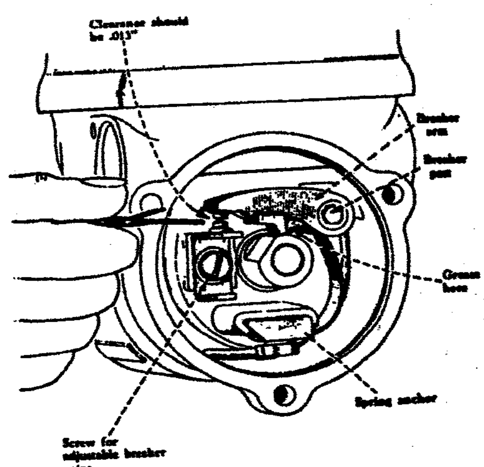
The material for the core and poles is common cold-rolled steel. 2" round and 1" X 4" stock is very heavy so you should buy it locally if at all possible * to avoid shipping costs. Shop around and buy "Drops" if available because some suppliers charge very exorbitant fees for cutting. It is possible to pay more for the cutting than for the steel itself so be forewarned. Mail order suppliers who charge only reasonable cutting fees are, in alphabetical order:

Blue Ridge Machinery & Tool
2806 Putnam Ave.
Hurricane WV 25526
1-800-872-6500

Campbell Tools Co.
2100 Selma Rd.
Springfield, Ohio 45505
1-513-322-8562

Cardinal Engineering
RR 1, Box 163
Cameron, IL 61423
1-309-342-7474

Power Model Supply
13260 Summit Dr.
DeSoto, MO 63020
314-586-6466



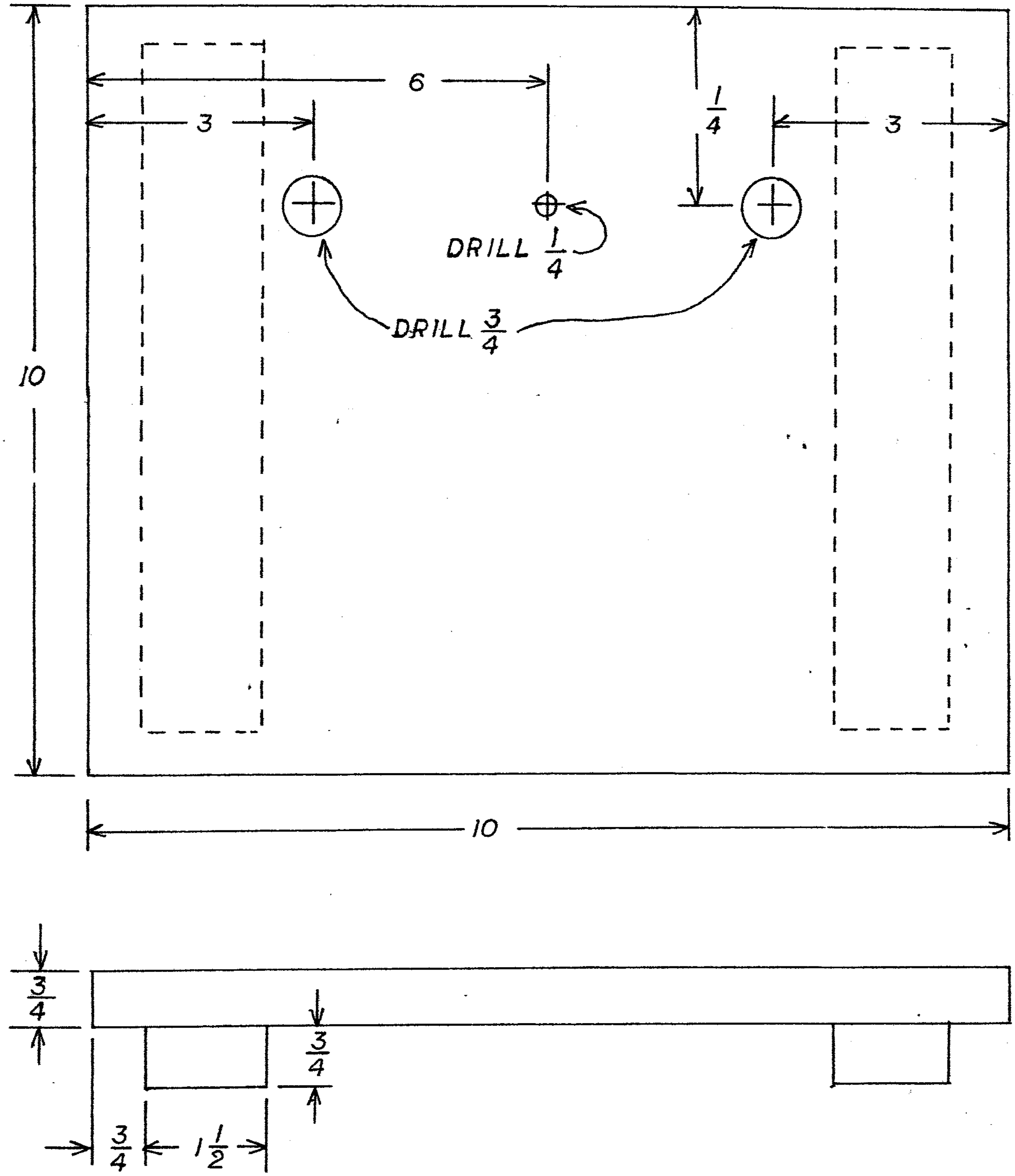


Figure 1
THE BASE

The dimensions suggested for the core pieces are not critical so you may be able to work with materials of near dimension on hand. For example The cylindrical pieces could be 1 1/2" or 1 3/4". And the flat stock could be 3/4" thick instead of 1". Hot rolled steel could be used for the cylindrical pieces since the ends must be faced off or milled anyway. But if hot rolled steel is used for the flat pieces the scale should milled, filed or scraped off to provide good contact with the ends of the cylindrical pieces. Any scale, rust or dirt between the core pieces introduces "reluctance" in the magnetic circuit and that reduces the magnetic flux at the poles.

The first, and surely the most challenging, task is to face off the cylindrical cores truly flat and to identical length.

The flatness is very important because even a small air gap where the parts of the magnetic core meet will introduce reluctance with the same effect as dirt or scale. And both cores must be the same length so that the surface of both poles will be on the same plane to ensure full contact with the magnets to be charged.

In addition to facing off or milling the ends, drill a 21/64" hole about 1" deep in both ends of both pieces and tap them 3/8"-16. The usual tap drill size for 3/8"-16 is 5/16". But tapping a hole 1" deep puts a very considerable strain on the tap, while the oversized hole eases the task and much reduces the risk of breaking the tap. There will be no great strain on the threads so the shallower threads will be strong enough.

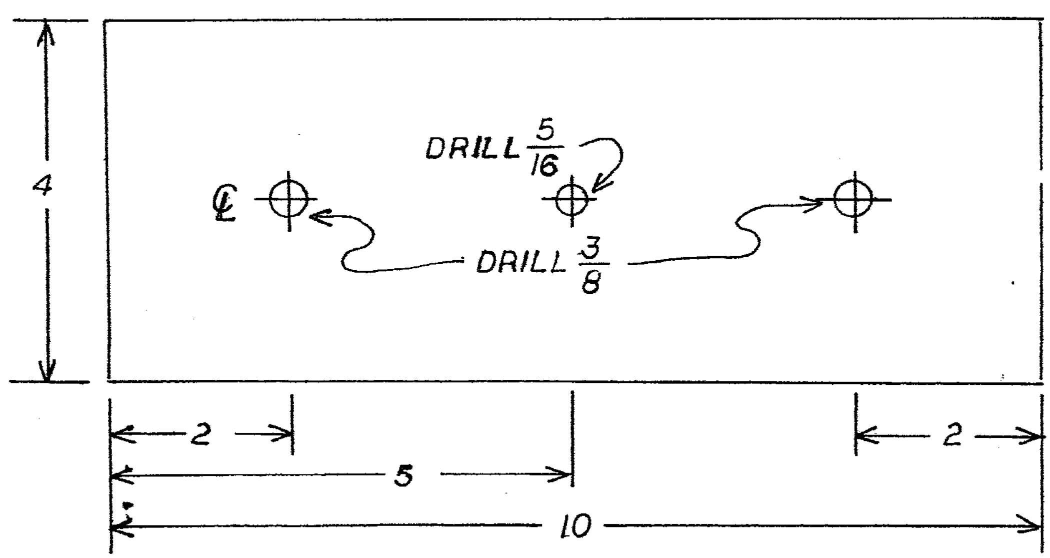


Figure 2

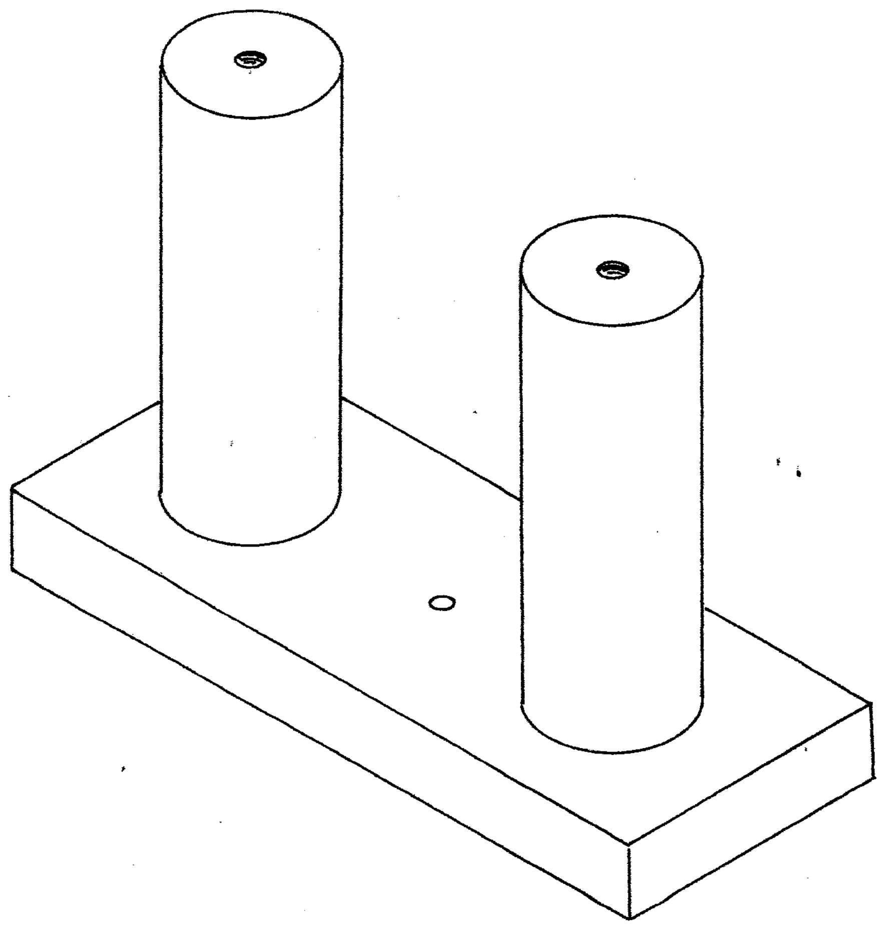


Figure 3

The next operation is to drill two 3/8" holes and one 5/16" hole through the 10" long bar. This work should be done with a drill press to ensure that the holes will be truly perpendicular. And the best procedure is to drill three 3/16" holes on the locations on the center line as indicated in figure 2, enlarge all three to 5/16" and finally enlarge the outer two holes to 3/8". This "step-drilling" procedure ensures that the holes remain closer to the layout dimensions and it reduces the amount of power needed to do the work.

With both cylindrical cores prepared and the base bar drilled you can begin the assembly. Bolt the cylindrical pieces to the bar with 3/8"-16 X 1 1/2" cap screws as shown in figure 3. The heads of the 3/8" bolts will fit in the 3/4" holes drilled in the base board so that you can bolt the entire assembly to the base with a 1/4" X 2" carriage bolt as shown in figure 4.

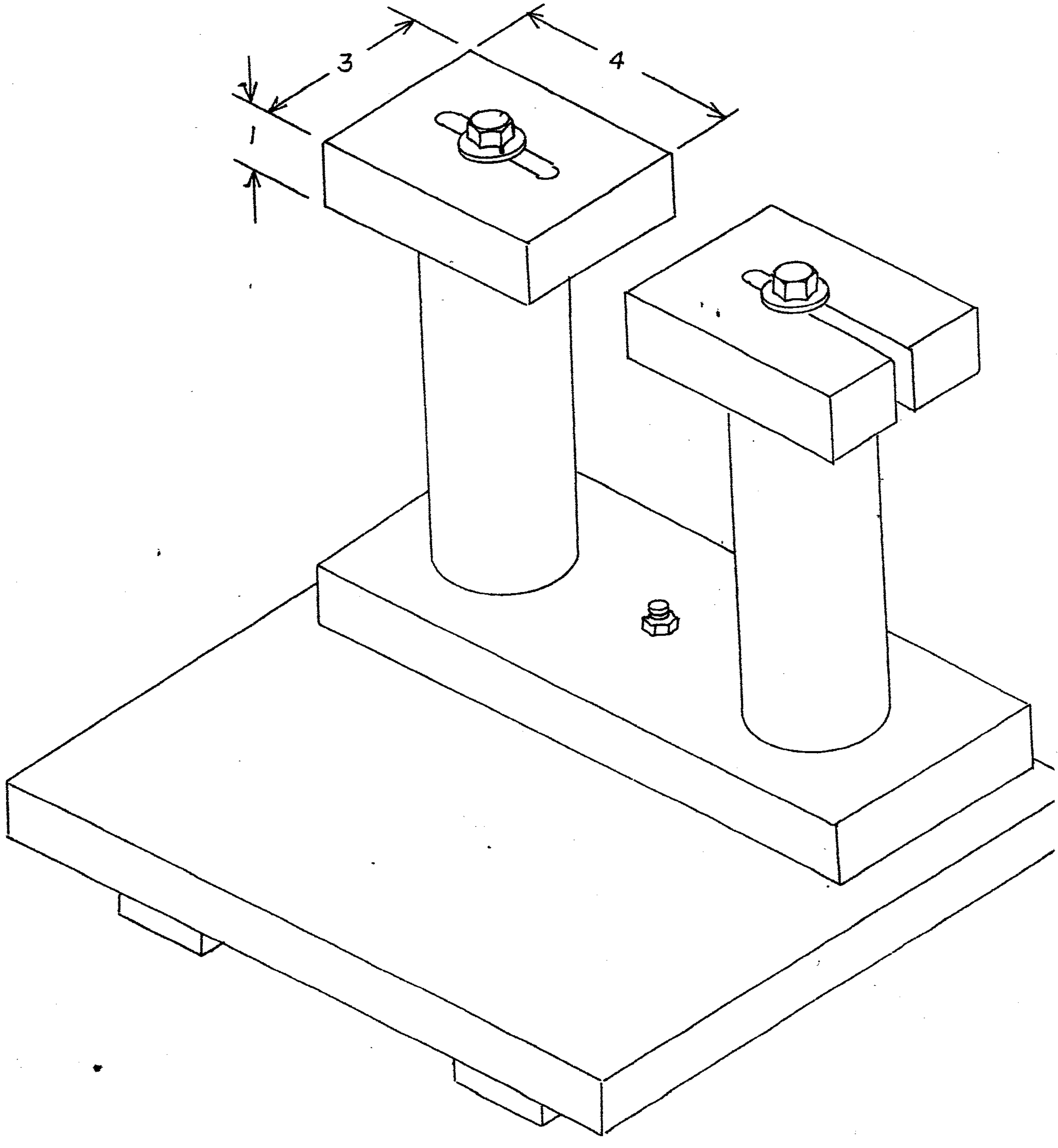


Figure 4

The pole pieces that will actually contact the magnets to be charged may be made in a variety of shapes. But the simple ones shown in figure 4 will serve in the majority of applications.

Two alternate methods for making the pole pieces are shown in figure 4. Notice that the one on the left has a 3/8" slot milled on the center line. And the one on the right has a slot sawed from the edge, which is one answer if you don't have access to a milling machine. A metal cutting band saw will cut the slot with relative ease compared to a hand hacksaw. Yet another way would be to drill a row of holes on the center line to provide a means of adjusting the space between the poles. And yet another idea would be to make a variety of pole pieces or to custom prepare them for each job. A large flat washer is used with a 3/8"-16 X 1 1/2" cap screw to secure the pole pieces to the cylindrical cores.

The illustrated pole pieces are 1" X 3" X 4" cold rolled steel. If you work with magnets of irregular shape you can make auxiliary pieces that will adapt the poles to the magnets. They do not necessarily have to be bolted in place. But you must provide a maximum contact surface so that the cross sectional area of the magnetic circuit is not significantly reduced. The safe rule of thumb is that nowhere in the magnetic circuit should the cross sectional area be less than the cross sectional area of the magnet you are working with. However satisfactory results can be had with arrangements less than perfect.

COIL DESIGN

The coils required for this unit are simple solenoid coils. That means that they are simply wound on a spool without any particular need for counting the turns or laying them in with great precision. It does make sense, though, to prepare spools for them so that you can easily slip them in place. And in the event that they ever get damaged in use it will be a simple matter to remove them for repair or replacement. The simple coil winder that is to be described later will make the job much easier and it will save more time and labor than is consumed in its making.

Earlier, in the section on design considerations, we discussed wire size and the characteristics of the coils. In the event that you decide to use a different size wire keep the basic characteristics of the suggested coils in mind. When you change the wire size the amount of resistance also changes and so also the total current. Remember that it is the product of the current and turns that determines the power of the magnetic flux. A coil of heavier wire will pass a higher current and, Conversely, a coil of lighter wire will pass less current.

Your main consideration must be to use enough wire so that the resistance will limit the current to a safe level for that size wire at the available voltage. Even though power is applied to the coils very briefly they should be designed to carry the current for longer periods of time. A safety ground is an absolute must. And keep in mind that the fuse is sized to protect the wire in the event of a short circuit. In no event should the fuse be larger than the capacity of the wire to carry a continuous current. If you elect to use heavier wire at lower voltage and higher current remember that considerable heat may be generated. And if you decide to use a battery power supply be sure to use a switch heavy enough to carry the high current. And be sure to use cables long enough to isolate the sparking of the switch from the battery to avoid explosion, and heavy enough to avoid excessive heating.

THE COIL FORMS

Initially it might seem that you could simply wrap the cores with an insulating material and wind the coils directly on them. In reality that would be difficult if not altogether impractical. It is a simple matter to make a pair of sturdy forms to simplify the job.

While some may be fortunate enough to find a paper mailing tube of the right size to slip easily over the cores, most will have to make the tube. Ordinary poster card as found in local variety stores is a cheap and handy material for making the forms. It comes in a 24" X 36" size and two sheets will be enough.

The tube must be an easy fit over the core and it must be sturdy enough to retain its circular shape during the winding operation. Three thicknesses of poster card is adequate unless you elect to use heavy wire for the coils. Then it may require four or more thicknesses of card.

A cylindrical form is required to make the tubes. I used a length of automobile exhaust tubing of the same outside diameter as my cores. The local muffler shop cheerfully let me pick some out of their dumpster at no charge since the pieces were too short for use in their work. I wrapped the exhaust tube with three layers of plastic from a plastic shopping bag so that the glue would not bond the poster card to the form and so that it would be slightly larger than the core for an easy slip fit.

Then cut the poster card into 2" wide strips and wrap the first strip, spirally around the form as shown in figure 5. Fasten both ends with masking tape.

It will be a good idea to prepare a dozen or so short pieces of masking tape and stick them in a handy place to be ready for the following operations.

When the first strip is secured to the exhaust tubing wrap the second strip over the first,

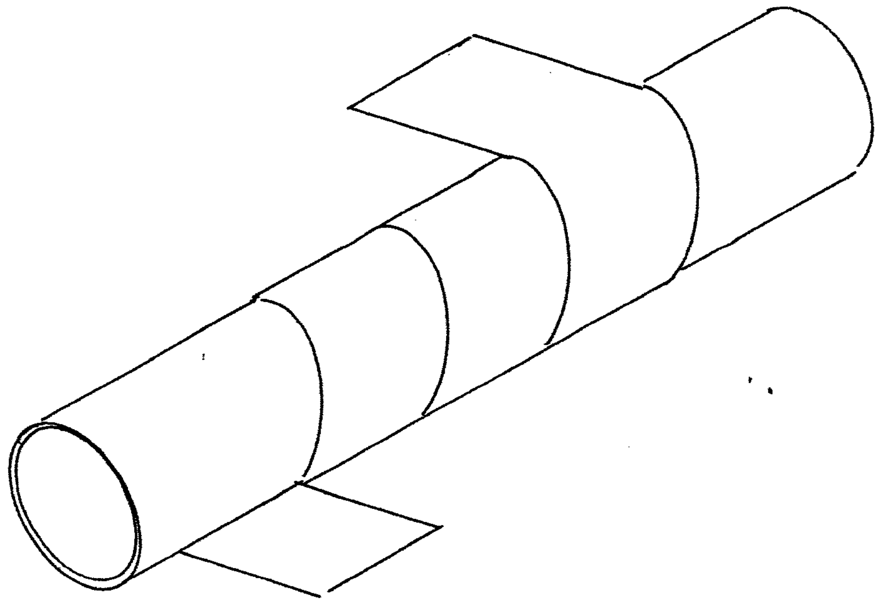


Figure 5

spirally in the opposite direction, and secure it at the ends with masking tape.

Now make a small squeegee of a piece of stiff cardboard. Release one end of the second strip and let it unwind for about half the distance of the form. Apply white carpenters glue to the first strip and spread it evenly around with the cardboard squeegee. Then immediately rewind the second strip over the glue and secure it at the end with masking tape. Then release the other end of the second strip and let it unwind to the area where it has been glued. Apply the glue, spread it with the squeegee and rewind and tape it. This operation is done in two steps because the glue tends to set rather quickly so it would not remain open long enough to wrap the entire second strip over the first.

Apply the third and any subsequent strips in the same manner, with each being wrapped in an opposite spiral. The result is a neat cylindrical form several inches longer than required. The first one can be slipped off the exhaust tube soon after it is finished and the second one made on the same tube. When both have had about a half hour to dry they can be squared and cut to 5" length.

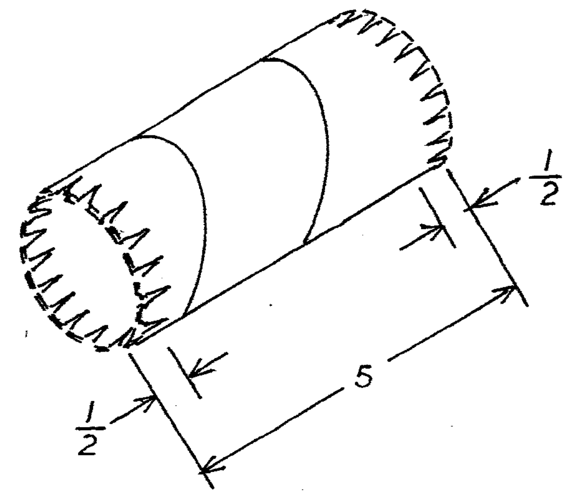


Figure 6

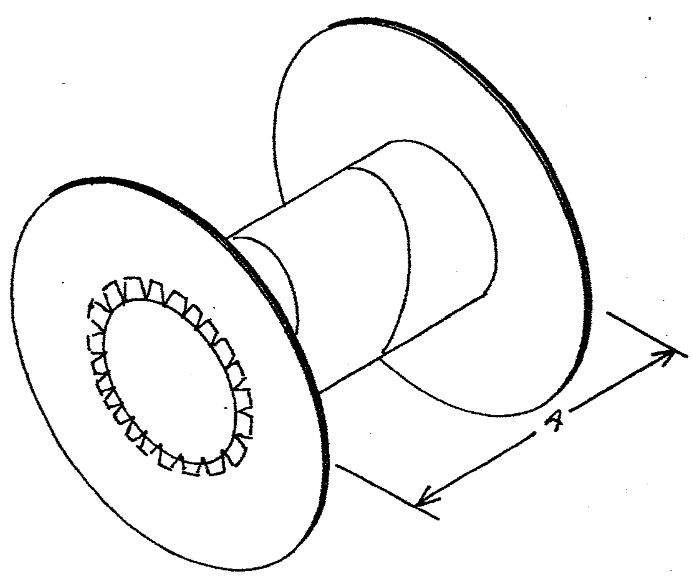


Figure 7

Next cut notches 1/2" deep and spaced about 3/8" on each end of both tubes as shown in figure 6. Set them aside while you prepare the ends of the forms. Now cut twelve 5" diameter discs with holes in the center to slip easily over the cardboard cylinders. Glue the discs together in sets of three each to make four ends for the forms. Complete the forms by bending over the tabs and gluing them to the discs as shown in figure 7.

While the white carpenter's glue sets up rather quickly it takes a day for it to reach full strength. So set the forms aside while you assemble the coil winder. Of course you will make certain that the forms slip easily over the cylindrical magnet cores before you proceed.

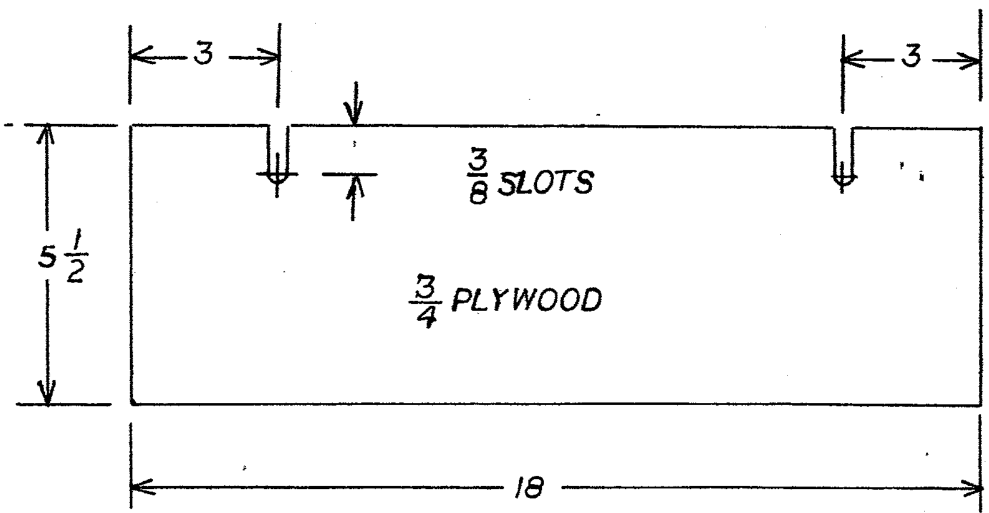


Figure 8

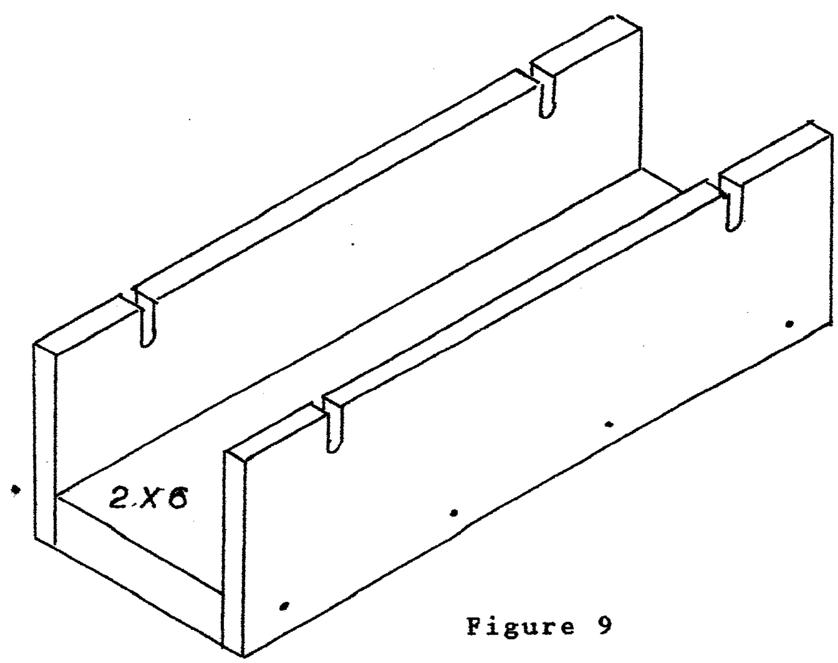


Figure 9

THE COIL WINDER

Certainly the coils can be wound on the metal lathe if you have one, but for those who don't have such a luxury a means must be had for firmly supporting the coils while winding them, and also for supporting the supply spools. There is a substantial amount of wire involved here and you can easily get into a very bad tangle if you don't anticipate what can happen in advance. It won't take long to assemble the winder. And you may even find it worthwhile even if you have a lathe.

The frame of the winder is a simple wooden trough as seen in figure 9. The sides of the frame are 3/4" plywood, 5 1/2" X 18", with two slots formed by drilling 3/8" holes 1" below the edge and cutting the slots from the edge to the holes as seen in figure 8. Fasten the sides to an 18" length of common 2 X 6 lumber with screws or nails to complete the frame.

One pair of slots will be used to accommodate a shaft to support the supply spool and the other will accommodate the spindle that will be used to wind the coil. So the next order of business is to make the spindle and crank.

Two bearings are made by soldering flat washers to the ends of 2" lengths of 3/8" copper tubing. Ream the ends of the tubing after cutting so that it will slip easily over the 5/16" spindle. A 4" length of 1/16" X 3/4" strap is drilled 5/16" at each end to form the crank. Cut the head from a 5/16" X 2 1/2" bolt and fasten it to one end of the crank with 2 nuts. Fasten the other end of the crank to the

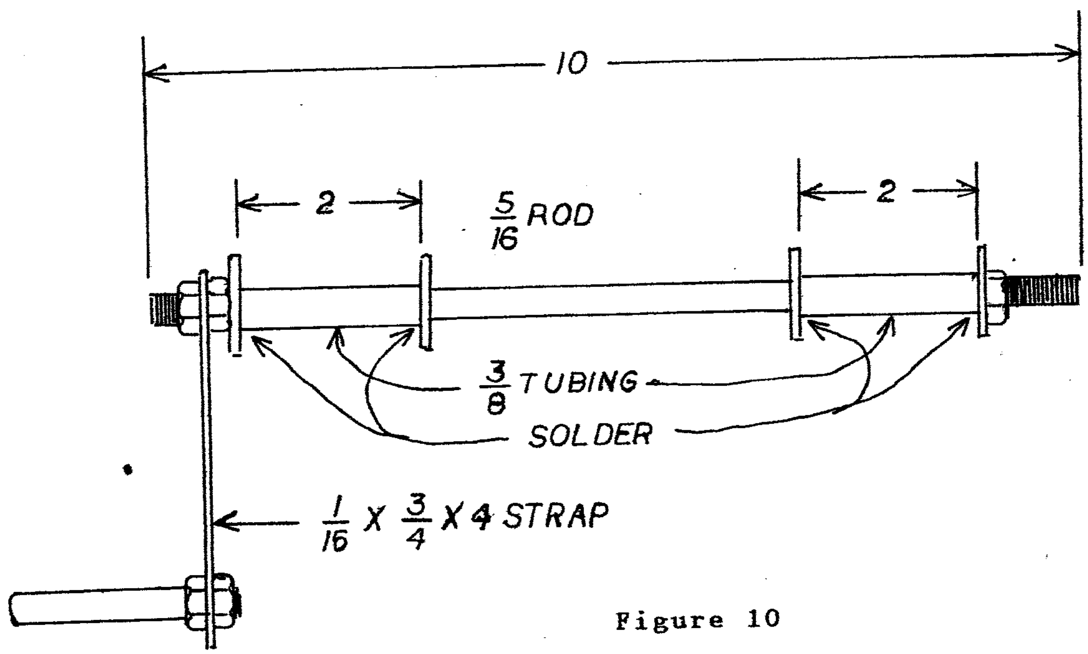


Figure 10

10" length of 5/16" threaded rod used for the spindle with 2 nuts and assemble the whole unit as shown in figure 10.

Cut a pair of 5" diameter discs from 1/4" plywood. Drill 5/16" holes in the center of the discs and fasten hubs to the discs to fit the inside diameter of the coil forms. If you have a lathe you can turn hubs from 3/4" plywood to an easy fit inside the forms. If you don't have a lathe it is easier to make square hubs with a diagonal measurement to give a snug fit in the forms. For a 2" diameter the square hubs will measure about 1 7/16" square. Or you could make them 1 1/2" square and trim off the corners until they fit inside the forms without distorting them. The discs and hubs support the form during the winding. See Figure 11.

Drill a 3/16" hole near each end of a 1/16" X 3/4" strap and center it over the slot where the crank end of the spindle will be. Drill pilot holes into the edge of the wood to screw the strap in place. Cut a block of wood to fit the slot and long enough to bear against the spindle bearing when the strap is tightened against it. This strap and block will hold the spindle in place while you turn the crank and it will also enable you to quickly and very easily lift the spindle when winding is finished. It also provides an adjustable friction brake that you will appreciate when the winding work begins.

Note that the winder is universal in that it can be operated either right or left handed. In use the supply spool is mounted on a 3/8" rod that rests in one pair of

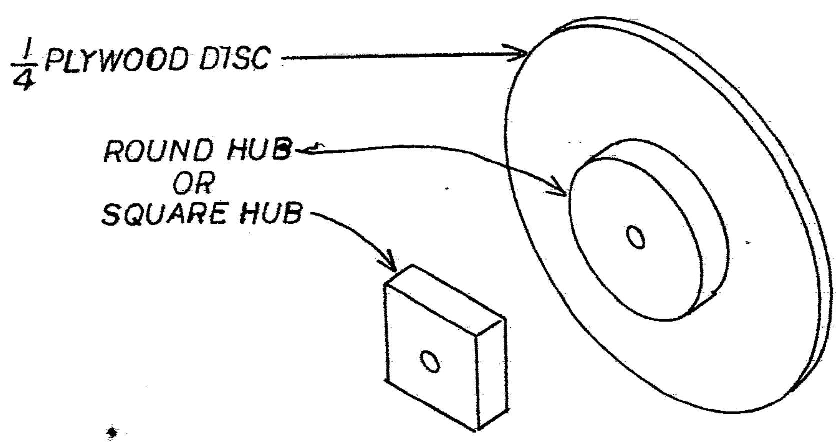


Figure 11

slots. The coil form is mounted on the crank spindle with about 6" of the wire pushed through a small hole in the end of the form at the starting position. Then you simply apply moderate tension with one hand as you turn the crank with the other to lay in the turns. Refer to figure 12.

WINDING THE COILS

Have a few short lengths of masking tape stuck in a handy place near by in case you need to stop winding for any reason. According to Murphy's law you will surely get a phone call or a visit. or the prunes you had for breakfast will work today or something.....

With patience it is possible to lay the turns in snugly, layer by layer. But do not become upset if things go awry after a time. In fact you could simply "scramble wind" the coils and they would work as well. The important thing is the number of turns all in the same direction. But keep them as neat as you can so that it will be easy to finish them off nicely. And take special care to avoid kinks and curls. Modern magnet wire has a very durable insulating film that will tolerate some mild abrasion. But take care not to damage the insulation, for example by allowing it to scrape on a finger ring or other cutting or scraping edge. Assuming that you begin with two 6 pound spools of # 18 wire, simply continue winding until all 6 pounds are on the form. There is no need to count turns because when properly connected the magnetic fields of both coils will add to the same total even if they are significantly different in number of turns. And if they are both wound with the same weight volume of wire they will not be significantly different in number of turns. Wind all but the final 6" of wire onto the form. Manipulate the winding so that the final turn is on the same end of the form as the starting turn. Tape the final turn securely. Make both coils with the start and finish on the same end.

The coil will finish up at something near 4" in diameter. With the final turn securely taped in place, remove the coil from the spindle. Punch a small hole through the end disc of the form and draw the finishing lead through the hole. Now cut a strip of poster card to fit between the discs of the form and wrap it around the finished coil and secure it with masking tape. Then cut notches around the edge of the end discs so that the excess can be folded over. With the resulting tabs folded over, wrap the entire outside of the coil with plastic electrical tape. Figure 13.

While you could connect the coils together and into the circuit using the magnet wire leads it will be much better to use stranded insulated wire. You may lose track of which lead is which when the coils are finished so they should be identified either with a tag or by using a different color lead

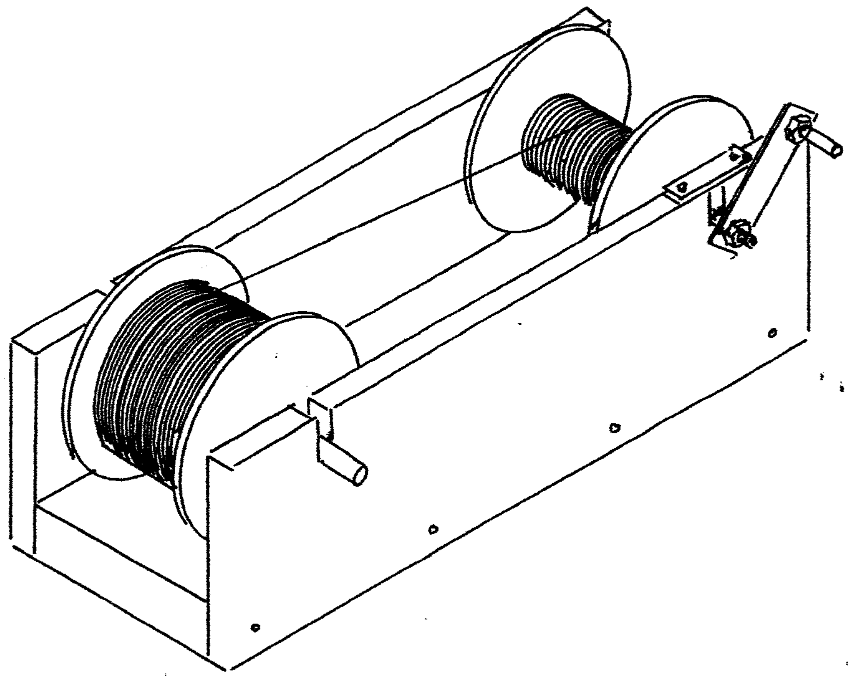


Figure 12

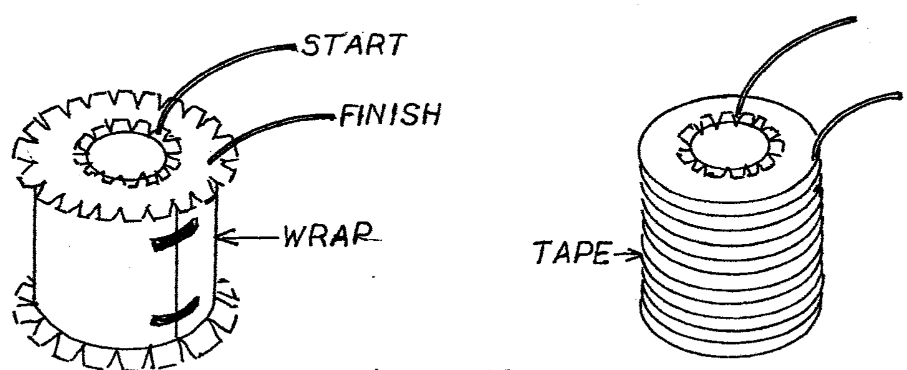


Figure 13

for start and finish. Avoid the error of tagging one lead "S" for START and the other "S" for STOP. (I jest!)

Cut two 4" diameter discs of poster card with holes in the center for an easy fit over the cores These will cover the splices where you attach the stranded leads. Shorten the magnet wire leads to a convenient length and scrape about 1/2" of each lead clean of its insulating coating. Splice 18 ga. stranded

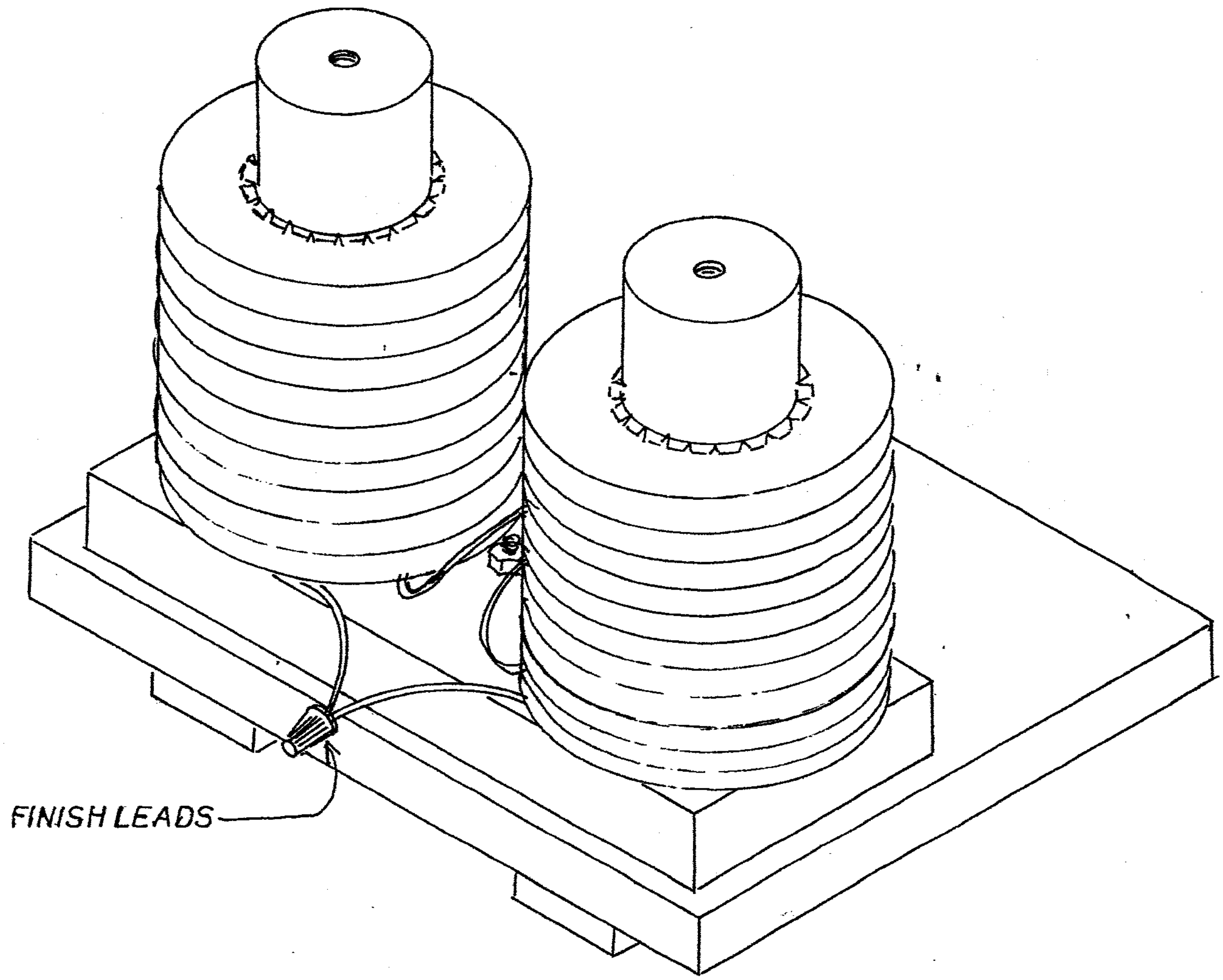


Figure 14

insulated leads about 10" long and apply solder to the splice. Then cover the splice with electrical tape or apply heat-shrink tubing. Finally, lay the splices well separated against the end of the coil forms and glue the poster card discs over the splices.

INSTALL THE COILS

Slip the finished coils onto the cores with the leads at the bottom and facing towards the rear as in figure 14.

Shorten the 2 finish leads to a convenient length, strip the

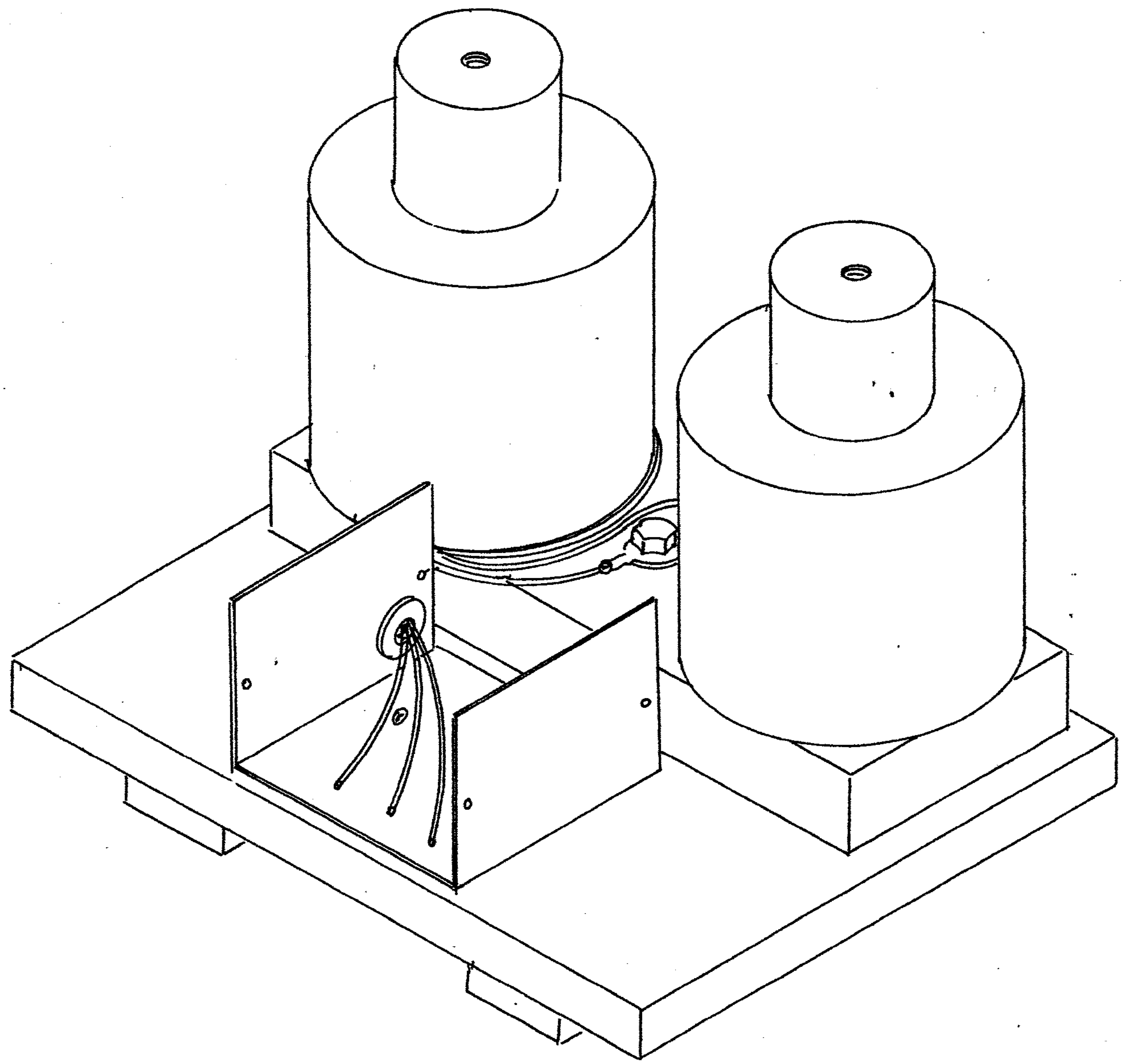


Figure 15

ends and join them with a "Wire nut" as shown in figure 14.

Pass the 2 start leads between the coils towards the front so that they will be available to connect to the power supply.

Now you can fasten the chassis box to the base as shown in figure 15. A 1/2" hole is drilled in the chassis box to accept the leads from the coil

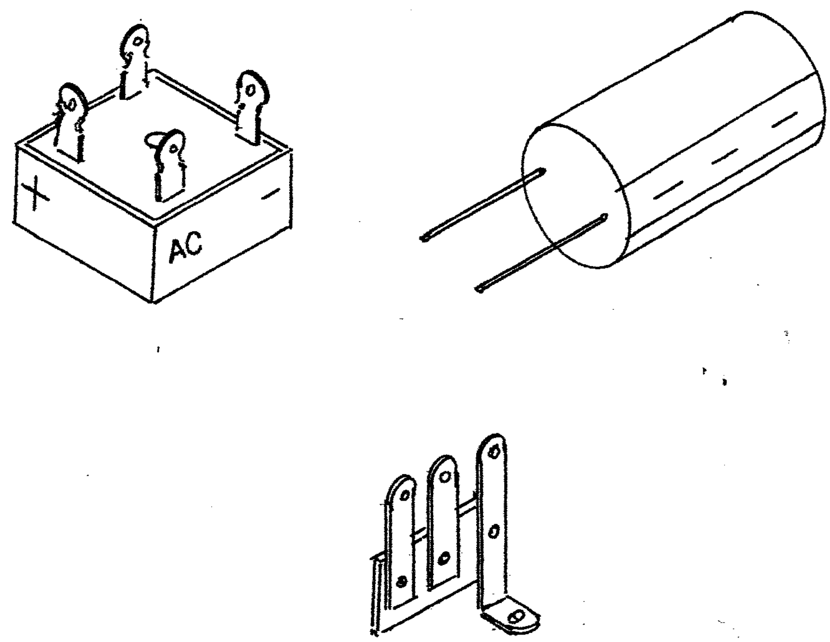


fIGURE 16

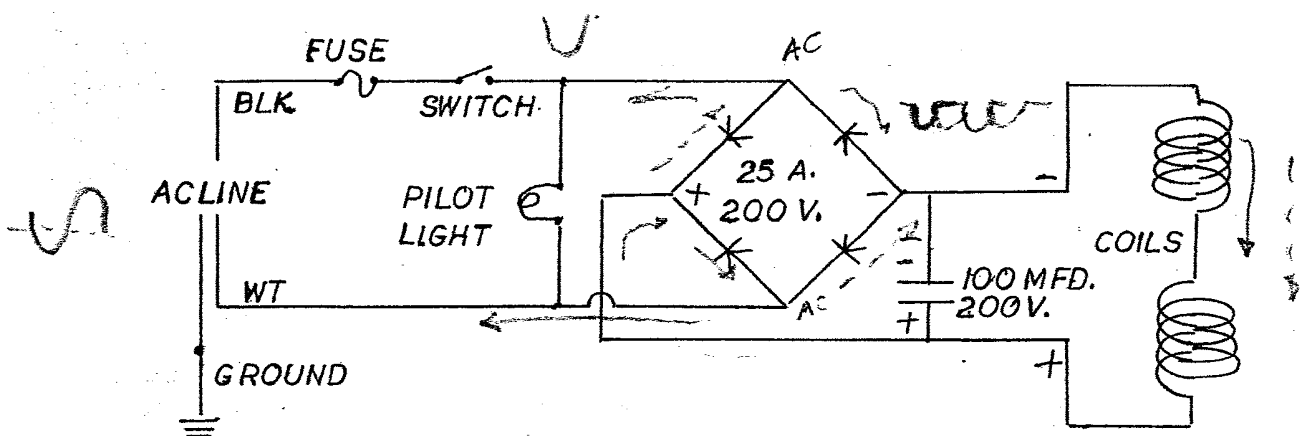


fIGURE 17

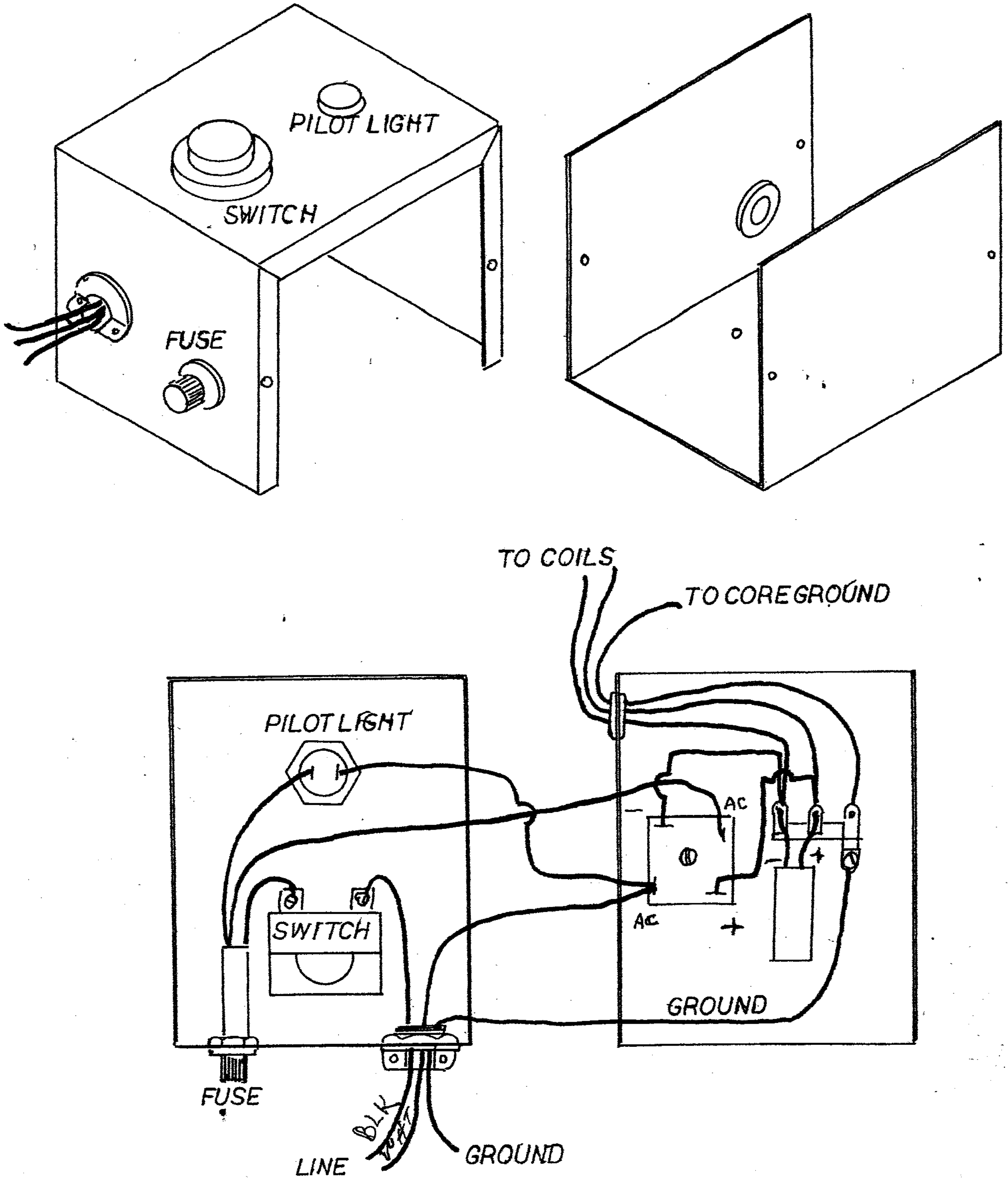

PILOT LIGHT
SWITCH
FUSE
TO COILS
TO CORE GROUND
PILOT LIGHT
AC
AC
+
SWITCH
GROUND
FUSE
BLK
LINE
GROUND

fIGURE 18

and the ground wire, and a rubber grommet is used in the hole to protect the insulation of the wires. Pass the coil leads and the ground wire through the grommet.

THE POWER SUPPLY

WARNING: DEADLY ELECTRICAL SHOCK HAZARD!

A schematic wiring diagram is shown in figure 17. And a pictorial diagram is shown in figure 18. The power supply is extremely simple and no difficulty will be had in finding the components and assembling them if you are experienced in working with electricity and electronics. If you are not experienced it may be best to ask help from someone who is. There are simple rules, both for safety and technical reasons, when working with electricity.

The first and most important rule is that if you allow any part of your person to become a part of an electrical circuit you can get a very painful electrical shock, and the shock can be FATAL. Common elements of your home or shop that you may not suspect can be a part of the electrical supply circuit. These elements include the plumbing or heating pipes and any metal article or appliance that is connected to the electrical supply or that is in good contact with the earth. In fact the earth itself is a part of the electrical power supply, and it conducts electricity very well when wet or even damp. That means that a wet or damp floor can complete an electrical circuit so remember that ELECTRICITY AND WATER DON'T MIX.

It is customary to use different colored insulation on wiring, and those colors have specific meaning. In AC devices the white wire (WT.) is called the "neutral" wire and there should be no voltage between it and ground. The black wire (BLK.) is called the "hot" wire and there will be line voltage between it and ground. The green wire (GRN) is the safety ground. There is no voltage between it and ground and it is connected to metallic parts, cabinets, etc. so that any accidental short circuit will deliver its current safely to ground instead of through the body of any person in contact at the moment of the short circuit. Other colored wires may be used in more complex circuits for identification to make circuit tracing and troubleshooting easier. In DC circuits wire colors may indicate polarity. Red wires are of positive polarity and black wires are negative polarity. Other color codings are used but there is no need to consider them in this project.

Figure 16 illustrates three components that you may not be familiar with. If they are not properly used serious problems can arise.

The rectifier is called a "full wave bridge". It is comprised of four diodes arranged internally to convert the alternating current of the standard outlet to direct current for the coils. The whole is imbedded in a case that measures 1 1/8" square and about 1/2" tall. It has a hole in the center that is used to mount it to the base with a screw that also mounts the chassis box. A 25 amp 200 volt bridge is specified because it is commonly available at local electronic supply houses. Actually any bridge rated above 8 amps and 115 volts can be used as well. The terminals will be clearly identified as either AC or + or -. AC meaning alternating current, + meaning positive DC and - meaning negative DC. The AC terminals will be diagonally opposite, as are the DC terminals. Connections to the bridge rectifier are to be made with "spade" terminals crimped to the leads.

The electrolytic capacitor is also "polarized" and the body will be marked to indicate which wire is positive and which is negative. As with the rectifier, the polarity is important and these components must be connected properly.

The terminal strip is comprised of three solder lugs mounted on an insulating bar to keep them separate. Note that one lug is also the mounting lug and it makes electrical contact with the chassis box. The ground wire in the line cord is green and it is fitted with a terminal to be screwed to the base with the same screw that mounts the terminal strip. And the ground wire from the magnet core is soldered to that same grounded lug on the terminal strip. The other two lugs on the strip are insulated from ground and from each other so they provide connecting points for the polarized leads in the circuit, including the leads of the filter capacitor.

Connections in the circuit that are not made with spade terminals or screw terminals are to be soldered with rosin core solder. DO NOT USE ACID CORE SOLDER FOR ANY ELECTRICAL WORK, EVER!

Note in the schematic diagram in figure 17 that the fuse and switch are connected in series with the black AC wire. The white wire in an AC circuit is never broken with a switch or fuse. Remember that the white wire is neutral and has no voltage potential to ground. So if the white wire is broken with a switch or fuse the black wire remains live and any open in the white wire will also be live.

Leads from components in the chassis box cover to those in the base should be long enough so that the cover can be removed easily and laid upside down beside the base. None of the leads should be less than 18 ga..

CAUTION!

The electrolytic capacitor becomes charged when voltage is applied to it and it can retain that charge for long periods of time unless it is discharged when the current is shut off. If charged and left with open circuit it can deliver a very painful and dangerous shock. In this power supply circuit the capacitor will normally be discharged when the power is off because the coils are always in the circuit to provide a discharge path. When working on the power supply circuit it is sound practice to short the capacitor terminals together after the power is shut off before touching any wiring.

TESTING THE POWER SUPPLY

To those who are familiar with electrical or electronics projects the term "Smoke Test" is well understood. Of course that means that when you plug it in there should be no flash of fire or puff of smoke. And there usually will not be any fire or smoke. But components can be faulty and you can make errors in assembly so every reasonable test should be made to ensure that all is sound and safe.

A practical safety test is to touch one lead of the AC voltmeter to a good ground, such as a water pipe, and the other lead is touched to the chassis box and the magnet core. A voltage reading in any amount indicates that there is a shorted or leaking component and it is not safe. There should be absolutely no voltage potential between the metallic parts and ground.

Having proved that it is safe to touch the unit when plugged in, try the same test while closing the switch with an insulating material. Again there should be no voltage reading between the metallic parts and ground. And if the pilot light glows when you close the switch you are assured that you are at least delivering AC voltage to the circuit. The remainder of electrical tests must now be made inside the chassis box.

Unplug the unit before removing the chassis box cover. Invert the cover beside the base to expose all of the components and wiring. An assistant may be required to close the switch as you apply the volt meter leads to the terminals.

With the meter switched to DC function, test to see if DC voltage is supplied to the terminal strip when the switch is closed. If you get a DC reading near line potential no further tests will be needed. Assuming that the coils are properly connected in the circuit the unit will function. It remains only to test the magnet.

TESTING THE MAGNET

The poles of the magnet are meant to be opposite. That is one will be north and the other south. An ordinary compass is all you need to determine which is which.

A fundamental rule of magnetism is that like poles repel and unlike poles attract. So a preliminary test will be to place a bar of iron or steel across the poles of the magnet and close the switch for a moment. It should become firmly attached and it will take considerable force to remove it.

When you remove the bar it will quickly lose most of its magnetism and so will the poles of the magnetizer. But an amount of residual magnetism will remain and that is enough for the compass test.

Simply bring the compass near either pole and note the compass reading. If it is indicating north you are close to the south pole of the magnet. And of course if it indicates south you are close to the north pole. Once you have identified the poles mark them by some permanent means. Now you are ready to use your magnetizer.

OPERATING THE MAGNETIZER

CAUTION!

Magneto impulse mechanisms can be made inoperable if their parts become magnetized. It is necessary to remove those mechanisms before re-charging the magnets on the magneto.

The actual application will differ from job to job. In most cases it will be best to magnetize the assembled magneto, and in some cases that will be the only practical way because it would be too difficult to devise a keeper so that magnets could be removed. You must determine the polarity of the magneto magnets and the compass will serve very well for that purpose. Remember that the poles of the magneto magnets are applied to OPPOSITE poles of the magnetizer. North to south and south to north. You must avoid reversing the polarity of your magnets. If the magnets or the magneto is suspended from a strong cord, free to turn, and allowed to approach the magnetizer slowly when the current is on it will orient itself properly.

In some cases the magnets will be covered with a brass shield and that must be removed before re-charging the magnets. Any non-magnetic material in the magnetic circuit increases reluctance, which reduces the magnetic flux.

The main requirement is that the pole surfaces of the magneto magnet must be in very good contact with the poles of the magnetizer. That is usually not a problem with magnetos that use horse shoe shaped magnets. However it is not always possible to achieve full contact so compromises must be made to pass the greatest magnetic flux possible through the magnetos magnetic circuit.

When magnets are removed for re-charging they must be returned to the same original position. Although reversing polarity entirely may not necessarily reduce performance, all of the magnets must be oriented in the same way or performance will be lost. So it is always safest to ensure re-installing in the original position.

It is absolutely necessary to use keepers when magnets are removed from the magneto for re-charging. Even if it takes only moments to transfer the magnets from the magnetizer to the magneto a very substantial amount of magnetism will be lost. The keeper can be a bar of iron or mild steel of any shape so long as it closes the magnetic circuit. Of course the keeper is removed during charging. But it must be in place before the magnet is removed from the charger.

If magnets are removed from the magneto even momentarily they will need to be re-charged.

Although the magnetic flux reaches a peak in the magnetizer in 5 seconds or less there may be some benefit in holding the current for as long as 30 seconds. There have been claims in old manuals that additional time was beneficial. So also was it claimed that rapping the magnet with a brass hammer was beneficial. And some claimed that rocking the magnet back and forth on the magnetizer poles would make it stronger.

Magnetos with two-pole rotating magnets may require removing the rotor and charging it between the magnetizer poles. And a special keeper made like a tuning fork is used to transfer the rotor back to the magneto and re-install it between the poles to retain maximum magnetism. It may also be practical to remove the coil with its core so that the rotor can be re-charged in place. If the coil and core are not removed the magnetic flux will travel through the coil core instead of the rotor and no recharging will occur. You may want to slip steel shims between the rotor and poles to reduce reluctance.

Type E.K. Wico magnetos have a set of bar magnets instead of horse shoe magnets. This is an oscillating magneto and the electricity is generated as the magnet makes and breaks contact with the laminated core of the transformers. They can be re-charged without removing the magnets.

1. Remove outer sheet brass housing.

2. Wedge the armature open with wooden shims 1/16" thick.

3. Place the magnet end of the magneto on the poles of the magnetizer in the proper orientation.

4. Close the magnetizer switch for 20 to 30 seconds and tap the magnets lightly with a brass hammer.

5. Remove the wooden wedges.

6. Remove the magneto from the charger and re-install the brass housing.

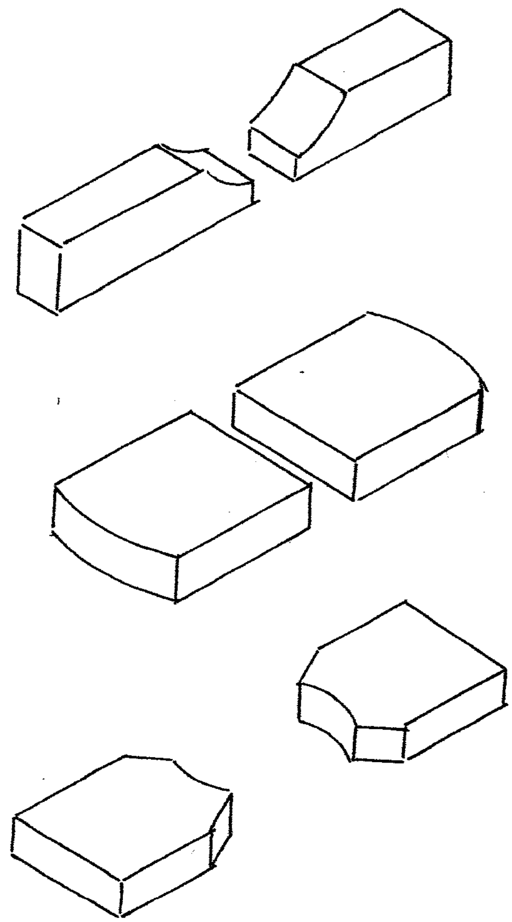


fIGURE 19

SPECIAL POLE SHAPES

While most magnetos that have horse shoe magnets or bar magnets can be recharged with the simple rectangular pole pieces, some unusual designs and those with the magnets imbedded in the flywheel will require auxiliary pole pieces. These include outboard motors and the many small engines with flywheel magnetos. Dimensions will have to be worked out as needs occur. But a view of several basic shapes in figure 19 will show how to design your special pole pieces.

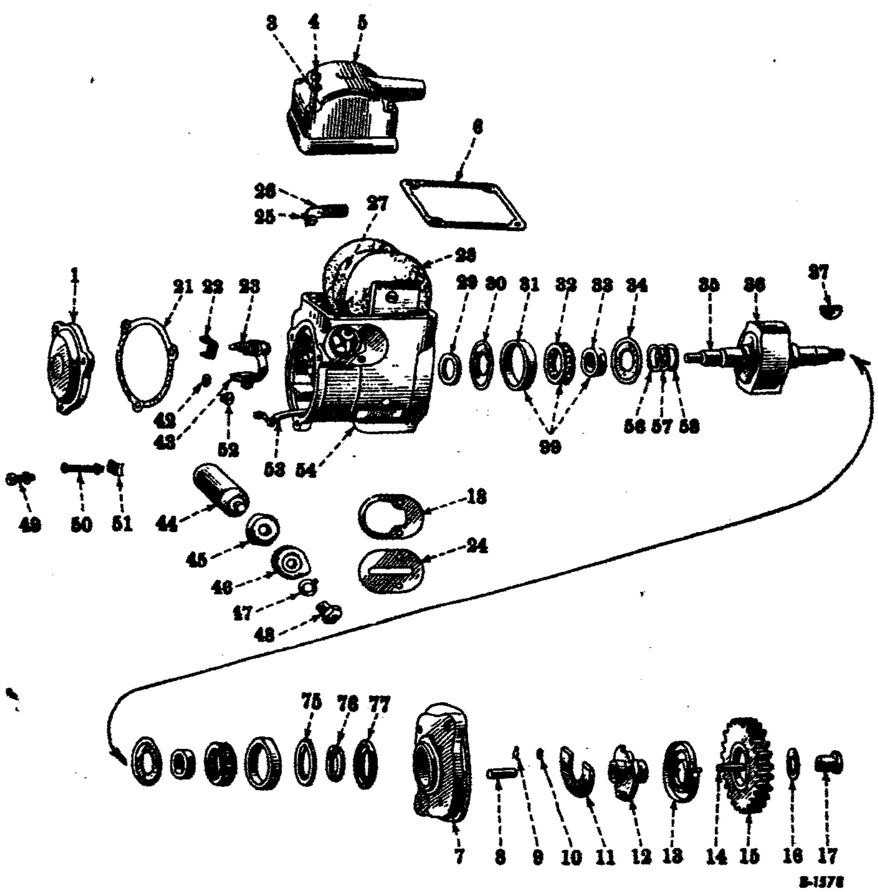
These sketches point out the basic principles so that the magnets mounted in inside or outside diameters can be dealt with as the need arises. The object is to make good contact with the poles of the magnet while maintaining isolation of the poles.

The idea is to use these auxiliary pole pieces along with the universal rectangular poles as adapters. And they may or may not have to be bolted or doweled to the universal poles.

Obviously machining capability is required to make them. And any grade of mild steel stock will be acceptable.

While the magnetizer detailed here is adequate for re-charging magnets made of hardened alloy steel, as commonly used in magnetos of older manufacture, It may not be adequate for modern magnets, such as those called "ALNICO". These modern, powerful magnets are originally charged with "IMPULSE MAGNETIZERS" using special power supplies equipped with capacitors and electronic triggering circuits that send a great surge of current through the coils. It is certainly practical for individuals to build such equipment and information has been published in engineering manuals. But these modern magnets are so stable and so resistive of ordinary demagnetizing forces that it does not seem at all worthwhile to research that process so I can't tell you how to build it.

MAGNETO (IHC TYPE H-1)



How to Build a Magneto Magnetizer

Scientific phenomena include fascinating mysteries in such fields as electricity, electronics, chemistry, and so on. These areas of scientific study have been extensively explored over the years and many of the mysteries have been solved. Although the phenomenon of magnetism has been explored in great depth, it still remains very much a mystery.

Magnetism is absolutely vital in modern technology. We know how it acts. We can create magnetism in materials that were not formerly magnetized. We can use magnetism in countless devices and mechanisms. But when pressed for a clear definition of exactly what magnetism is and why it acts the way it does, we can only offer theories and analogies that compare magnetism to electrical and electronic principles that are better understood. Like gravity, magnetism remains mostly a mystery. Although we can't diagram it or illustrate it in a definitive way, we can put it to work and use it.

If you have a particular interest in magnets, you can build this simple device to create new magnets and recharge weak ones. Although specifically designed to recharge magnets used in engine magnetos, this device can be used for producing or restoring magnets in a great variety of shapes and sizes so long as they are made of alloy steels.

A limitation of the magnetizer described here is that it will most likely not be adequate for charging the ALNICO magnets found in modern equipment. Such magnets require far greater magnetizing force than can be generated with the type of power supply described. Nevertheless, this magnetizer can be of great use to the restorer and of great interest to the experimenter.

This is a relatively simple device. Only ordinary mechanical skills are required to build it. The metal core is of very heavy steel, however, and some machining operations will surely be required. While it would at first appear that the machining might be accomplished with a hacksaw and a file, all but the most dedicated builder will surely resort to a lathe or milling machine.

Once built, you'll realize that this magnetizer is worth many times the cost of building it.

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