Oersted Technology produces an innovative line of magnetics equipment and instruments for use in manufacturing, research, and development applications. Specifically, we provide products for use in the production and testing of magnets, motors, and electromagnetic systems. These products include magnetizers, magnetizing fixtures, gaussmeters, fluxmeters, and Helmholtz coils, as well as other magnetics equipment.

Through careful design and testing, we are able to provide you with equipment that is both accurate and reliable. Our magnetizing equipment is extremely versatile and uses patented ECS technology, which allows the user to switch capacitance electronically. All of our magnetizing fixtures are designed specifically for the user's application and part. In addition to our product line, Oersted Technology offers customized magnetics equipment and a variety of engineering services valuable to the magnetics industry, such as prototype magnetizing and part measurement. We hope that this catalog gives you a clear understanding of the products and services that we offer, and will aid you in finding the best magnetics equipment to fit your application.

OERSTED TECHNOLOGY
24023 NE SHEA LANE, UNIT 208
TROUTDALE, OR 97060
PHONE: (503) 612-9860
FAX: (503) 692-3518
EMAIL: OERSTED@OERSTED.COM

CONTENTS

MAGNETIZERS
300 Series

FEATURES

Suitable for magnetizing a broad range of magnetic materials, including samarium-cobalt, neodymium-iron, ferrite (ceramic), and Alnico

Utilizes patented ECS (Electronic Capacitance Switching) technology; capacitance is adjustable over a wide range: 1.25mF (min.) to 100mF (max. for Model 330B)

Solid-state SCR switching provides more reliable performance than with older ignitron-based units

Capable of producing 100 to 32,000 Joules (max. for Model 330B)

Variable voltage range from 0 to 800V

Peak current meter displays the peak output current of the magnetizing pulse after it occurs

DESCRIPTION

The Model 300-series magnetizers are designed to handle a variety of magnetizing applications and materials, from small Alnico parts to large blocks of neodymium-iron. Each of these magnetizers feature patented ECS (Electronic Capacitance Switching) technology, which allows the user to change the capacitance of the unit through the front panel. By setting the charging voltage and capacitance of the magnetizer properly, the user can scale the output energy of the unit to match the magnetizing fixture being used. The 300-series magnetizers also includes a peak current meter, which automatically captures the peak current of the magnetizing pulse once it occurs. A safety circuit internally discharges the capacitor banks if mains power is removed from the magnetizer or if the cabinet is opened during operation. When connected to a suitable magnetizing fixture, the magnetizer is able to disable its front panel controls if the fixture overheats. Other features include a lockout keyswitch and a current sense output jack (this connects to an oscilliscope for viewing of the magnetizing pulse). The Model 350B can be upgraded to either a Model 345B or Model 340B. The Model 345B can be upgraded to a Model 340B. All 300-series magnetizers can be modified for computer control, photocell trigger, or autocharge operation.

SPECIFICATIONS (BY MODEL)

Model	Max. Energy	Max. Current	Voltage Range	Capacitance Range	Input Line Power
350B	6,400 Joules	36,000 A	0 - 800V	1.25mF to 20mF	208VAC* or 120VAC 50/60Hz
345B	12,800 Joules	36,000 A	0 - 800V	1.25mF to 40mF	208VAC* or 120VAC 50/60Hz
340B	25,600 Joules	36,000 A	0 - 800V	1.25mF to 80mF	208VAC* or 120VAC 50/60Hz
330B	32,000 Joules	36,000 A	0 - 800V	2.5mF to 100mF	208VAC* or 120VAC 50/60Hz

* standard; also available for 240VAC service

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What is ECS?

Each time a part (or batch of parts) is to be magnetized, a fixture must be chosen as well as a magnetizer which is capable of delivering the proper amount of energy into the fixture. If the energy level is too low, the field created in the fixture will not fully magnetize (saturate) the magnet. If the energy level of the magnetizer is too high, the fixture may overheat or fail due to mechanical stress. In the past, manufacturers have dealt with this by either keeping a variety of magnetizers on hand (with varying energy levels) or by adding and removing capacitors from their magnetizer. ECS (Electronic Capacitance Switching) is our solution to this problem. With an ECS magnetizer, the user can electronically select the voltage and the capacitance necessary for the fixture being used, and can quickly change these settings once a different fixture is to be connected. If the user is uncertain of the settings required for an application, the capacitance and voltage can be adjusted until the right combination is found. This valuable feature effectively allows one machine to mimic a small magnetizer, a large magnetizer, or anything in between.

The following examples demonstrate how capacitance is selected on an Oersted Technology ECS magnetizer:

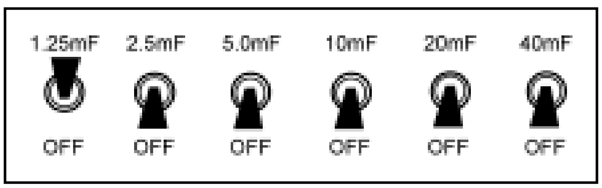

FIGURE 1. Total capacitance selected is 2.5mF

EXAMPLE 1:
The capacitance of the magnetizer is selected by setting a series of ECS select switches on the front panel of the unit. When an ECS switch is on (toggle switch flipped up), the magnetizers's charging voltage will be sent to the capacitor bank associated with that switch. The panel switch itself carries only a low signal-level voltage. In Figure 1, the 1.25mF select switch is on and the other five switches are off, so only the 1.25mF bank is selected. In addition to any selected banks, the magnetizer contains a fixed 1.25mF capacitor bank that is permanently selected. The total capacitance selected for charging is therefore 2.5mF.

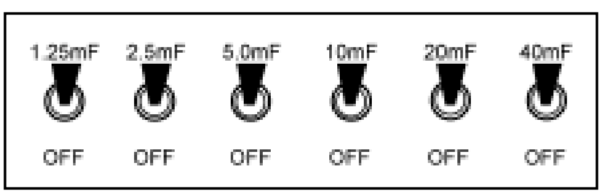

FIGURE 2. Total capacitance selected is 80mF

EXAMPLE 2:
In Figure 2, all of the ECS select switches are on. All of the magnetizer's capacitor banks will therefore be charged by the selected charging voltage, in addition to the fixed capacitor bank. The total capacitance selected (plus the 1.25mF fixed bank) is 80mF. This is the maximum capacitance available on the Model 340B magnetizer.

Output Cables	Dimensions	Weight
Flexible #4 AWG, 8 ft. long	22" wide x 31" deep x 62" high (56 cm x 79 cm x 160 cm)	280 lbs. (127 kg)
Flexible #4 AWG, 8 ft. long	22" wide x 31" deep x 62" high (56 cm x 79 cm x 160 cm)	300 lbs. (136 kg)
Flexible #4 AWG, 8 ft. long	22" wide x 31" deep x 62" high (56 cm x 79 cm x 160 cm)	350 lbs. (159 kg)
Flexible #4 AWG, 8 ft. long	22" wide x 31" deep x 80" high (56 cm x 79 cm x 203 cm)	375 lbs. (170 kg)

MAGNETIZERS
Model 412B

FEATURES

Small, desktop design is ideal for magnetizing Alnico, ferrite (ceramic), and smaller Neodymium magnet parts

Utilizes patented ECS (Electronic Capacitance Switching) technology; capacitance is adjustable from 1.25mF to 10mF (in steps of 1.25mF)

Capable of producing 100 to 3,200 joules

Variable voltage range from 0 to 800V

Peak current meter displays the peak output current of the magnetizing pulse after it occurs

Solid-state SCR switching

DESCRIPTION

The Model 412B magnetizer provides many of the features of the Oersted Technology 300-series magnetizers in a small benchtop cabinet. This unit is designed for magnetizing parts which require lower total energy levels due to their size or the magnetic material used. Like the 300-series magnetizers, the 412B is an ECS magnetizer, which allows the user to electronically vary the capacitance of the unit (see previous page for an explanation of ECS technology). The capacitor banks are internally discharged through a safety circuit in case of power failure or accidental power-down. When the 412B is connected to a properly equipped fixture, the front-panels can be inhibited through an overtemperature interlock circuit, preventing the magnetizer from being operated once the fixture begins to overheat. An external output is also provided for monitoring the magnetizing current pulse with an oscilliscope.

SPECIFICATIONS

Maximum Energy	3,200 Joules
Peak Current	5,000 A
Voltage Range	0-800V
Capacitance Range	1.25 mF to 10mF (in 1.25 mF increments)
Input Line Power	120VAC (standard, also available with 208VAC) 50/60 Hz
Output Cables	#10 AWG, flexible, 5 ft. long
Dimensions	21" W x 24" D x 17" H (43 cm x 53 cm x 61 cm)
Weight	78 lbs. (36 kg)

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Fixture Design Experience

Oersted Technology has designed many hundreds of fixtures over the past several years for a variety of applications, including those related to the aerospace, audio speaker, hard drive, and automotive industries. We have designed C-frame fixtures for magnetizing large speaker drivers, as well as fixtures for magnetizing large blocks of ferrite and neodymium-iron. We have also designed fixtures to magnetize motor rotor ring magnets, swing-arm actuator arc segments, linear actuator sleeve magnets, ring magnets with very high pole counts, and very small magnets of high precision. In order to meet the needs of our customers' quickly changing needs, we provide fast turn-around time on fixture design and construction. Each fixture is custom-designed for the application. This allows us to efficiently use the energy delivered by the magnetizer, while also keeping fixture heating to a minimum.

Supercoil Technology

We have recently developed and patented a new fixture design that significantly reduces heating, while maximizing the field produced within the fixture and making it highly uniform. Fixtures of this type are referred to as Supercoils. This design has been vital to applications involving fast cycle rates and high-volume production, and has allowed to us to maximize the magnetizing potential of our fixtures.

Fixture Options

There are many different options that can be added to our fixtures, which are used to both prolong the lifetime of the fixture and also increase the level of safety for the operator. These include:

Internal cooling coils for use in conjunction with a chiller system (liquid-based)

Embedded sensing coils for use with a fluxmeter. Allows peak fields in the fixture to be measured, when connected to a fluxmeter.

Display of internal temperatures via embedded thermocouples and a temperature display unit.

Inhibit of magnetizer operation if fixture begins to overheat (requires an Oersted Technology magnetizer with proper interlock circuitry)

Protective fixture covering to prevent parts from being thrown out of the fixture during magnetizing

Magnetic shielding of fixture in order to prevent stray fields from affecting nearby machinery

Automated part insertion and removal with

Forced air-cooled designs (especially useful for cleanroom operations, or where fluid leaks cannot be tolerated)

A conditioner is a device that is used to selectively adjust the magnetic strength of a part to a specified value. In the past, conditioners have been used to simply "knock-down" the magnetic field of low-coercivity magnet parts (such as Alnico and ferrite) until a certain field level was achieved. The resulting part was slightly weaker, but had a field strength that was repeatable.

For modern magnets, a conditioner can also be used to adjust the overall performance of a complete device based on any measurable parameter (not just the magnetic field strength), in order to make the device more accurate. The magnet in this device is knocked-down until the measurable parameter reaches the desired level or is within an acceptable tolerance.

A typical example of the conditioning process involves Form B reed relays. These devices contain a pair of magnetically permeable switch contacts surrounded by a coil of wire with a small biasing magnet next to it. When no voltage is applied to the coil, the magnet pulls the two contacts together. As voltage is applied to the coil, the field of the biasing magnet is opposed. Once the voltage reaches the proper level, the effect of the magnet is cancelled out and the contacts are able to pull apart. In spite of errors caused by the magnet strength, magnet position, number of turns in the coil, and the resistance of the wire, the device can be conditioned so that the contacts open at the same specified voltage for each part. Adjustments like this can be made to considerable accuracy, but require repeated pulses from the conditioner to achieve the desired value. It should also be noted that conditioners are slower and more expensive than magnetizing equipment of equivalent strength, due to the automation and process monitoring involved.

Oersted Technology conditioners and demagnetizers operate under computer control and are designed to process a particular number of parts within a time period selected by the customer. These machines are designed specifically for the customer's application and can be equipped with automatic part loading, go/no-go indicators, and lightscreens, as well as other options.

An automated system for conditioning reed relays

OTHER EQUIPMENT

Automated Systems

An automated system for magnetizing and testing 4-pole rotors

Automated systems have become important in the magnetics industry, particularly in the production of motors, actuators, and audio speakers. Because all Oersted Technology products allow for some means of remote interfacing, it is possible for us to build customized systems for your particular application. Magnetizing and demagnetizing can be integrated into this system, as well as magnetic measurement through a gaussmeter or fluxmeter. For high-volume applications, automated part loading can also be added. We are willing to either build around an existing system or create a completely unique, self-contained one.

Control of the system is performed by a computer or a microcontroller, depending on the requirements of the applications. This allows for efficient operation and makes it possible to reprogram and modify the system if needed. Magnetizing is typically performed by one of our standard magnetizer models (except when special requirements exist), allowing the magnetizer to be used as a stand-alone production unit when the system is not in use.

The complexity of an automated system varies greatly, depending on the application. An example of a very simple automated system is one in which parts are passed through a magnetizing fixture by a conveyor belt and magnetized once a photocell is interrupted. An example of a more complex system is a workcell that loads a large multipole magnet part into a fixture, magnetizes each magnet pole (with the desired orientation), and then checks each pole with a gaussmeter to determine whether the part has been properly magnetized. Such a system might also involve a barcode scanner for reading part numbers, audio and visual cues for the operator, and lightscreens to monitor access points to the workcell.

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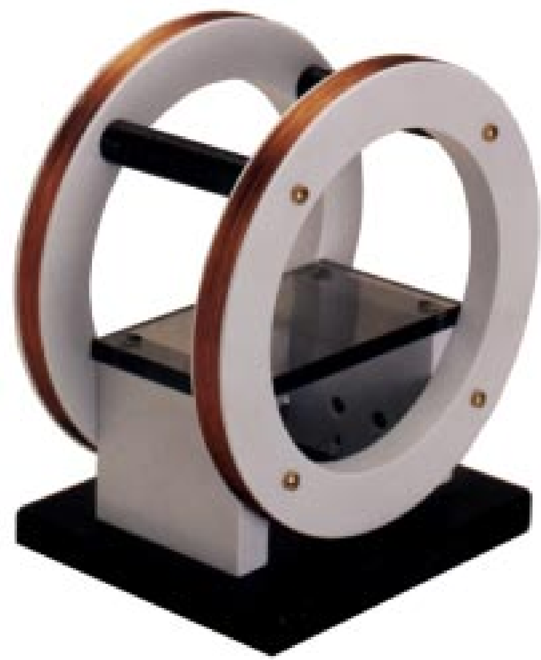


FEATURES

- Performs quick, accurate and reliable measurements when connected to a fluxmeter
- Measures the magnetic moment of a magnet part
- Immune to stray steady magnetic fields
- Ideal for performing measurements in an assembly environment
- Available with various coil diameters

DESCRIPTION

A Helmholtz coil is actually a pair of specially constructed coils mounted a fixed distance apart from each other on a common base. Current passed through the coils produces an extremely uniform magnetic field in the space between them. For the measurement of magnets, the coils are used in a different manner - they are connected to an integrating fluxmeter, which gives an accurate indication of the overall strength of the magnet once the magnet is withdrawn or rotated a half-turn. If a gaussmeter is used for this same measurement, many measurements may have to be made because of local variations of magnet strength. A Helmholtz coil, on the other hand, measures the entire magnet at once, in a fast and reliable manner. These devices operate on changes of magnetic flux only, and so are unaffected by fixed stray fields, such as the Earth's magnetic field. Helmholtz coils are useful for measuring bar and slab-type magnets (two poles only), but can also measure arc segments by using a correction factor. Because Helmholtz coils do not closely fit the part like a search coil does, it is easy to integrate them into an assembly application or automated system, where parts are moved through the coil by a conveyor system (after magnetization).

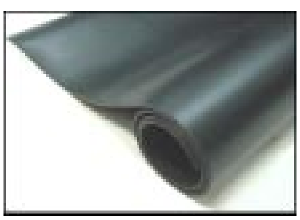
Chiller

A chiller is often used to reduce heating in magnetizing fixtures, especially in applications with fast cycle times or high-volume production. If a fixture is overheated, the overall magnetizing performance is reduced and it is possible that the fixture may be damaged. The chiller that we offer is fluid-recirculating and is recommended for use with all magnetizing fixtures that include cooling coils.

Heat Rejection	1100 Watts
Flow Rate	4 gal/min
Flow Pressure	50 psi (max.)
Input Line Power	115VAC 60Hz 8A max.
Fluid Line Connection	1/4 in. female quick-connects
Dimensions	14.38" W x 26.5" D x 24.25" H (62 cm x 37 cm x 67 cm)
Weight	165 lbs.

Thermocouple Readout

When magnetizing a batch of parts, it is sometimes useful to monitor the temperature inside the magnetizing fixture. This allows the user to determine whether the fixture is overheating or if the chiller connected to the fixture is operating correctly. Our handheld thermocouple readout is designed to connect to a type J thermocouple embedded in the fixture. Temperature can be displayed in either degrees Centigrade or Fahrenheit. Accuracy is 0.1 degree. Requires 9V battery.



Insulating Floor Mat

Our electrically insulating floor mats protect the user during operation of the magnetizer. All floor mats are “switchboard-grade” and are rated at 3,000 Volts (tested to 30,000 Volts). Available with a smooth-black finish in two sizes:

3 ft x 4 ft x 1/8” thick

3 ft x 6 ft x 1/8” thick

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Magnetic Viewing Film

This green plastic sheet changes color, becoming black, when penetrated by a magnetic field perpendicular to its surface. It is useful for viewing magnetic poles, fields, and transitions. Color change occurs at a low field strengh (10 to 50 gauss), and remains after the field is removed, but can be “erased” by stroking with a magnet, or reset by exposure to another magnetic field. Unlike some other magnetically sensitive films of coarser grain, this film has very high resolution, and easily shows details less than ten thousandths of an inch wide (less than half the width of a typical pencil line).

Magnet Pole Indicator

This small, handheld device gives a light indication when a north or south magnetic pole is held near its active location, red for north and blue for south. It is battery operated (one 9V), and includes pushbutton activation. Sensitivity is approximately 20 gauss.

Prototype and Small Batch Magnetizing

Oersted Technology is committed to providing for all of our customers' magnetics needs. In some cases, a small batch of parts must be magnetized before a cusomer's magnetizer or magnetizing fixture is completed and shipped. In situations like this, we are able to magnetize prototype parts so that our customers can begin testing of their products immediately.

Assistance to the Speaker Industry

Oersted Technology has a great deal of experience with companies involved in the design and production of audio speakers. We understand the unique magnetics problems associated with magnetizing speakers and are willing to assist you in optimizing the speaker's magnetic structure for the magnetizing process (by reducing eddy currents in the basket structure, for example). We have designed and built C-frame magnetizing fixtures for magnetizing large ferrite car audio speakers and are now using a new method of fixture design that greatly reduces heating (thereby allowing for a faster cycle rate). If you are currently magnetizing your parts manually, Oersted Technology can create an automated magnetizing system that will allow you to increase your production rate and save on labor costs.

Magnetizer Characterization

Oersted Technology provides magnetizer characterization and safety evaluation services to companies who need technical information for an existing magnetizer or group of magnetizers. These services are performed on-site in order to minimize magnetizer down-time and to avoid interruptions in production. To properly design a magnetizing fixture for a given magnetizer, several things must first be known about the magnetizer's operation and electrical properties. This information may have been supplied by the magnetizer's manufacturer, but may not be accurate or may change if the magnetizer is modified. Our tests will give you valuable information about the actual performance and characteristics of your magnetizer, which can then be used to design a magnetizing fixture that is optimized for it.

On-site Training and Seminars

If your company is interested in learning more about magnetics and magnetizer operation, we offer training at our facility free of charge. We also offer on-site training at your facility for a small fee. If you or your company would like to learn more about magnetics topics, we offer on-site seminars customized for your area of interest. Our training and seminars tell you how to get the most out of your magnetic test instruments and magnetizing equipment, while also providing an informative look into the field of magnetics.

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Trends in Magnetizing

When magnets are first produced by the magnet manufacturer, they are usually not magnetic at all, or possibly very weakly magnetic. For the magnet to exhibit a permanent magnetic field, it must first be magnetized. Magnetizing can be performed at the factory which first made the material, but it is usually preferable to ship the parts in an unmagnetized state. The magnets are then either built into devices such as speakers, electric motors, generators, and instruments, then magnetized in place; otherwise, they are magnetized just prior to assembly. Because magnetized material may affect electronic instruments, destroy nearby delicate equipment, or erase magnetic media, there are legal restrictions on the shipping of active magnets. Larger masses of magnets can be dangerous to personnel, causing objects to fly at high speed, and pinching or crushing body parts. In addition, magnetized magnets attract some kinds of dirt particles, and are extremely difficult to clean once they have become contaminated. The new types of magnets can be made and used in extremely thin sections, and these materials are often brittle. Once they are magnetized, additional forces are caused, which could greatly increase breakage in shipment. For these reasons, it is usually preferable to magnetize magnets in place in the final product, or just before assembly.

A History of Magnetic Materials

The earliest magnets were lodestone, or Ferric Ferrite (Fe_3O_4), a type of natural magnet related to modern ceramic magnets. This material was a useful ore for iron, and was mined for that purpose in ancient times. The lodestone (which means "travel-stone") was apparently magnetized from the Earth's magnetic field, as it was deposited. By 1200 AD, compass needles were being made of steel, which were magnetized by being rubbed or "touched" with lodestones. In 1600 Gilbert recorded three ways to magnetize a steel needle: by touch with a lodestone, by cold drawing in a North-South direction, and by prolonged exposure to the Earth's field while in a North-South orientation. He also mentions that a magnet when brought to red heat is no longer magnetic, but that it would become magnetic if allowed to cool while pointing North-South.

In 1820, Oersted in Denmark discovered that electric current in a wire produced a magnetic field encircling the wire, and soon thereafter Ampere in France was able to deduce the general relationship between electric current in a short element of wire and the magnetic field it produced at any distance and angle. Sturgeon made the first solenoid in 1823, and after a few improvements (such as the invention of electrical insulation, by the American, Joseph Henry) it was possible to magnetize permanent magnets using electric current.

Permanent magnets made from steel require very little energy to magnetize, by comparison to today's magnet materials. On the other hand, these materials are also very easily demagnetized - by shock, other magnets nearby, or even the effect of the Earth's field, accidentally concentrated by steel objects. In 1932, Alnico was discovered, which is much more stable and also harder to magnetize. The magnetizing requirement was still not difficult to meet, however, and parts could be magnetized by simply using electric current off the lines and a solenoid, or a transformer to boost the current and a few turn of wire. Large "C" frame magnetizers using thousands of turns for each of two coils could magnetize assemblies on a conveyor belt. The same could be said of Cunife, a material which is now rare, but still occasionally used today, and various other types which are completely obsolete, such as Cunico and Lodex. Starting in 1952, with the development of Barium and Samarium ferrites (by Philips, in Holland), however, better magnetizing means were needed.

The shift from use of Alnico magnets to ferrite was greatly accelerated in the 1970's. During this time period, a war took place in Zaire, which was a major supplier of cobalt (Alnico contains about 30% cobalt). This caused an increase in the cost of cobalt, bringing its price to roughly five times its original cost. The huge price increase created great hardship for the magnet users, even driving some of them out of business. The survivors began an urgent search for replacement materials, which lead to the use of ceramic (also called ferrite) magnet materials. Ceramic magnets have very different characteristics than Alnico, however, and existing products (with Alnico magnets) often had to be completely redesigned in order to utilize them.

Despite this fact, most manufacturers who could changed to ferrite magnets, leading to a major and permanent loss of market share for Alnico.

The machines used to magnetize the ferrite materials required much more electronics than the earlier and simpler magnetizing machines, but were also far more powerful and efficient. The ignitron, a mercury-filled tube switch, invented about 1928, made these magnetizers possible. After the invention of the transistor in 1948 at Bell Labs (now called Lucent Technologies), solid-state devices became possible. The silicon control rectifier (SCR), invented in the early 1960's at GE, came to replace the ignitron, as it was (and continues to be) much more reliable, repeatable, and efficient.

Rare-earth magnets, first pioneered in 1962 by Dr. Karl Strnat and others, required much higher magnetizing fields than the older materials. Nonetheless, relatively little development in magnetizing technology took place until 1990 or so. Since that time, however, new development has accelerated.

Magnetizing Techniques

In order to magnetize a part, a very short (perhaps a thousandth of a second) pulse of electric energy is sent, at very high voltage and current, through a fixture which converts the electric pulse into a magnetic pulse. Whenever electric current flows through a wire, a magnetic field is set up in a circular field (no poles) around the wire, the direction of the field being at right angles to the direction of current. By properly shaping wire conductors, often with steel (or other magnetically permeable pole material) used both to support the wires, and also to help concentrate and direct the magnetic flux, a fixture can be made which holds the part and causes it to assume the required magnetic pole pattern. The currents in the fixture are usually so high that it would overheat, burn out its insulation, and even melt or vaporize the wire, if the power were allowed to be on for too long. The magnetization of the part is accomplished in an extremely short time, once the required coercive field is attained (in much less than a millionth of a second), and so the field does not need to be present for very long. This is fortunate, since otherwise the extremely high currents needed to produce the required field could not be achieved in the space available.

In addition to complete magnetization, there are some other magnetizing operations which are often needed. Measurements have to be made to insure that the magnets, as magnetized, meet the requirements of intended use. Sometimes errors are made in magnetization, handling, or assembly, or for other reasons parts must be demagnetized. Magnets are somewhat variable in strength, from one part to another, and often from one batch of magnetic material to another. If this variation is too large for the intended application, then the magnets may be partially demagnetized by a small amount, to bring them to closer magnetic tolerances, in a process called "conditioning". In certain magnetic assemblies, conditioning of magnet strength may be done based on the performance of the entire device, rather than that of the magnet alone, thus removing an entire range of variables. This is done, for example, with some magnetic relays.

Older magnet materials could often be magnetized by such means as exposing them to a fixed magnetic field caused by other magnets, focused through a steel pole structure, or by using a short time duration current (perhaps a second) of rectified AC current directly from the power lines into a fixture of many turns (and high inductance), among other techniques. The newer high-coercivity magnets are much more resistive to demagnetizing effects, and are correspondingly much harder to magnetize.

At present, the most common method of magnetizing modern materials is with a capacitive-discharge magnetizer. A capacitive-discharge magnetizer is a device which accepts electrical power from the line, usually boosting it in voltage in the process, and stores it in large capacitor banks. When enough energy is stored, and a part is in place in the fixture, a switch (typically an ignitron or SCR) is closed, and the energy is allowed to flow in a fast pulse through the fixture. The fixture is designed to transform as much of the electrical energy as possible into a momentary magnetic pulse, usually of only a few milliseconds or less in duration, which coerces the magnet into the desired magnetic state.

The magnetizer (magnetizing pulse generator) consists of a power supply operating off line AC current which produces DC current at a very high voltage, at moderate current levels. The current is then stored in a bank (or banks) of capacitors. In order to insure proper operation, both the value of the capacitance and charge voltage must be matched to the fixture which is in use. A switch capable of carrying very high currents is then closed to allow the magnetizing pulse to flow. In Oersted Technology magnetizers, these switches are solid-state SCR devices, which are fast-acting and have very little voltage drop or lost power. The load fixture stores energy in its magnetic field, and behaves electrically like a nonlinear inductance. If the inductance is high enough, the current would surge forward, then slow up, stop, and reverse direction, which is called “ringing”. Reversed current in the fixture would be disastrous, since it would destroy the capacitors and also partially demagnetize the part. Reversed current into the capacitors is blocked by separate diodes (which only conduct electrical current in one direction), one for each bank. If the current were to be abruptly cut off in the fixture, however, the voltage across the fixture would rise to a very high value, until it forced a path to dissipate the stored energy. This would destroy the electrical insulation of the fixture, burn out the blocking diodes, and possibly cause a fire or endanger the operator. Instead, a large diode (the freewheeling, or “flyback” diode) is provided to allow the energy to continue out one side of the fixture winding and back into the other, until it is dissipated safely in the electrical resistance of the fixture.

Many magnetizer designs use line-frequency transformers to obtain the high charging voltage. Oersted Technology uses a high-frequency design instead, which saves weight and space. It also results in even charging, so that the capacitor banks are charged faster for the same maximum line current, with less stress on the capacitors.

Magnetizer Safety

Safety is certainly a consideration in using magnetizers and fixtures, as the voltage and current levels are high enough to be lethal. A major safety concern is bare contacts between the magnetizer cables and fixtures. A magnetizer should never be used if the cables are damaged, as the high voltage could short out to the surroundings. It may be helpful to use an electrically insulating mat on the floor in front of the magnetizing station. Some rubber mats are not electrically insulating, because of filler material used in the rubber. A Switchboard Grade mat, however, is made specifically for this purpose, and can withstand very high voltages and considerable wear.

If the fixture is used on a metal table, it may be attracted or repelled from the table with considerable force. If a fixture must be used on such a table, it should therefore be mounted above it using nonmagnetic and non-electrically conductive spacers (a short distance, such as 6 inches, is usually sufficient) and then securely fastened down to it. Metal objects, such as sheet metal plates, should not be laid across the top of the fixture in operation.

Parts inside a magnetizing fixture may be thrown out during the magnetizing pulse. Magnetically permeable parts located below the center of the fixture may be accelerated upward, towards the center, but arriving there after the pulse has stopped. The part will then continue upward, and out of the fixture. Parts which are above center and are electrically conductive, may experience large eddy currents due to the rapid change of magnetic field. These eddy currents are in the direction to produce a magnetic field which opposes the field that caused them, and so the parts are repelled from the fixture.

Magnetizing – A Molecular View

In magnetic materials, the individual atoms, or small groups of atoms which together act as one magnetic unit, may be thought of as comprising an interior structure (the nucleus, plus perhaps some electrons), around which one outer electron orbits. This single electron “looks” like an elemental electrical current loop. Just like a loop of electrical current, it produces a magnetic field (this very simple model, called the Bohr Magneton, is an oversimplification, but will serve the purpose). The effect is to produce a magnetic effect at a distance which is called a magnetic moment. As these atoms or atomic groups line up during formation of the material, they align themselves in the same direction over a small volume called a “domain”. This alignment minimizes their total energy. Once the domain grows to a certain size (and shape), however, the system energy may be reduced further if the atoms nearby align into another domain, with magnetic axis in a different direction. Each domain is a tiny magnet by itself, then, but its field is cancelled out at a distance by that of other domains, so that the net effect at a distance is zero. In a magnetic material, when an exterior magnetic field is applied all the domains tend to align with it. Some domains align more easily than others, and so the resulting magnetic moment depends on how strong the applied field is, up until all the possible domains are aligned. We then say that the material is "saturated". Further increases in coercive force caused by an exterior field only increase the magnetic field at the magnet by the same amount as the applied field, and the magnet itself does not add to it further. In a "soft" magnetic material, the domains are held in alignment only very weakly by so-called "pinning" forces within the material itself. If the exterior field is removed, thermal agitation of the individual atoms even at room temperature is enough to cause the domains to realign randomly, and the field breaks down. Even in materials in which the pinning forces are large, there is some temperature at which the alignment will collapse, called the Curie temperature. At lower temperatures, however, the domains of a strongly pinned material remain in place after alignment, producing a permanent magnet. The alignment can be reversed, in some or all of the domains, by again applying a magnetic field, this time in the reversed direction. For some materials, however, the virgin magnetization curve (that is, the curve of magnetization from the original, unmagnetized state) is different from that on subsequent remagnetization cycles. This is particularly true of some neodymium-iron products, for example. It can be understood, therefore, that temperature has an effect on the magnetizing process. Increasing the temperature of a part may assist in magnetizing, if the rise is not too great, by helping to reduce the net pinning forces.

Many modern magnet materials are said to be "anisotropic", meaning that they have a preferred axis of magnetic field, built-in during manufacture. The part may be magnetized in either direction along this axis, north-south or south-north. The part is extremely resistant to magnetizing in any other direction, however. Many of these materials are easier to magnetize the first time, from the virgin state, than they are to remagnetize again in the opposite direction. For this reason, if a part made of material with these characteristics must be remagnetized, it would first be aligned in the fixture in the same way that it was originally magnetized (not north pole to south pole).

Mass	1 kg = 1000 g = 2.2046 lb. 1 lb = 16 oz = 453.6 g 1 oz = 28.35 g
Length	1 meter = 39.37008 inches 1 cm = 0.01 m = 0.3937008 in. 1 inch = 2.54 cm (exactly) 1 ft = 12 in. = 0.3048 m (approx.) 1 m = 3.28084 ft
Force	1 newton = 0.22481 lbf = 101.97 g = 0.10197 kg
Presure	1 pascal = 1 newton/meter^2 1 lb/in^2 = 6894.9 pascals 1 kilopascal = 0.145034 lb/in^2
Energy, work	1 joule = 1 newton-meter = 1 volt-amp-sec 1 joule = 1 watt-sec = 9.4781×10^{-4} BTU 1 BTU = 1055.06 joules 1 joule = 0.73757 ft-lb = 8.8508 in-lb
Power	1 watt = 1 joule/sec = 1 volt-amp 1 horsepower (British, US) = 550 ft-lb/sec = 745.7 watts
Temperature	$T_{Centigrade}$ (Celsius) = 5/9 ($T_{Fahrenheit}$ – 32° F) $T_{Fahrenheit}$ = 9/5 ($T_{Centigrade}$) + 32°F
Volume	1 gallon = 0.13368 ft^3 = 231.0 in^3
Magnetic Flux	1 weber = 1 volt-sec = 10^8 maxwells = 10^8 lines 1 maxwell = 1 gauss-cm^2
Magnetic Flux Density	1 tesla = 10,000 gauss 1 tesla = 1 weber/meter^2 = 6.4516×10^4 lines/in^2
Magnetic Field Intensity	1 ampere/meter = 1.2566×10^{-2} oersteds 1 oersted = 79.577 amps/meter 1 oersted = 2.0213 ampere-turns/inch 1 amp-turn/inch = 39.37008 amp/m = 0.49474 oersteds
Angle	1 radian = 57.29578 angular degrees π = 3.141592654…