TECH Talk

Electromagnetic Locks

INTRODUCTION

Relative to other electric locks, the electromagnetic lock is a "newcomer", originating around 1970. It was developed to fill the need for a true fail-safe electric locking device, primarily for securing egress openings.

Having no moving parts, electromagnets offer the convenience of electric locking without the problem of binding or jamming during attempts to egress.

Simplicity of construction provides a low maintenance device with a long life span, even under high frequency use conditions.

Through design evolution this type of lock now offers a great variety of models and options, allowing a high degree of security without compromising life safety. A wide range of mounting styles permits use of this model of lock on most types of doors and frames.

Commonly called electromagnets or mag-locks, these devices are also often identified by trade names assigned by the manufacturers.

Description

Electromagnetic locks consist of two basic parts: the electromagnet and the armature, or strike plate. The electromagnet portion is normally a long "E" shaped bar made of special steel. A coil of insulated copper wire is placed inside the bar and held in place by an epoxy compound. The epoxy is usually forced in place under high heat and pressure. It cures into a hard strong sealant, resistant to chemicals, heat and vandalism.

The entire assembly is then machined; the top surface ground flat to produce good mating contact with the armature, and holes tapped for later attachment of the electromagnet to a mounting plate and housing. The exposed portion of the steel bar is plated with a thin coating of material to resist corrosion.

Lead wires attached to each end of the coil are brought out of the magnet assembly. When DC voltage is applied through these leads to the coil, an intense magnetic field is created, causing the "E" frame to become magnetized.

The armature is simply a bar of steel, its size calculated to provide a certain mass to interact with the magnetic field produced by the electromagnetic. It is also machined; its face ground to provide a good mating surface and holes drilled to accept mounting hardware. The entire armature is plated to resist corrosion.

Operation

The electromagnet is mounted rigidly to a door frame and the armature to the door, directly opposite the face of the magnet. The armature mounting hardware allows the armature to flex, or pivot, on the door. This allows the armature to make a good bond to the magnet, not being influenced by slight misalignment or any war page of the door. When the door is closed, and the magnet is energized, the magnetic field attracts and "grabs" the armature.

Once a good bond is created it would take a direct pull force of 500 to 1500 lbs., depending on the size of the magnet, to part the armature from the magnet. When the input voltage is shut off, the magnetic field collapses, and the armature is released.

Electrical Characteristics

Input Power

Electromagnets are normally operated by 12 or 24 VDC. Voltage selection is usually a matter of convenience as the locks work equally well when designed for either voltage. Field selectability of voltage is offered on some locks. Most locks are available with a rectifier bridge option allowing AC operation. The current draw varies on different models and commonly runs between 1/4 to 1 amp.

The lock will operate most efficiently when input power is regulated around plus or minus 5% of rated voltage.

Electromotive Force (EMF)

Commonly called voltage spike or back EMF, this is a brief high voltage "kick-back" that occurs whenever an electromagnet is turned off. The spike heads for the nearest contacts that have opened to de-energize the lock. It can seriously damage light duty contacts and solid state switching components. Most locks have built-in spike suppression to dampen nearly all of the spike.

Field Collapse

When an electromagnet is turned off there is a slight hesitation before it completely releases. This is usually so short in time (a fraction of a second) that it is not noticeable during normal operation. It may be more prominent (up to two seconds) when power is interrupted on an AC power line to the lock. Faster release is possible by placing switching devices in the DC power line. Field collapse is sometimes mistaken for residual magnetism.

Residual Magnetism

Common steel, when used to make an electromagnet, will retain some magnetism after power is interrupted. The special steel normally used to make the "E" frame of the magnet does not retain any appreciable amount of magnetism, allowing complete and free release of the armature.

Magnetic Field

The question often arises as to whether the magnetic field surrounding the lock can adversely affect computer tapes, door status switches, or even pacemakers. The actual magnetic field (measured above normal earth magnetic field) does not extend much more than one to two inches from the lock. With the door normally closed and the lock energized, it is highly unlikely this field would adversely affect anything.

Electronic Features

Most manufacturers of magnetic locks offer a wide variety of electronic features. The diversity of these features continues to grow due to advances in electronics and the evolution of the product. Some features are built-in as standard, some offered as options at additional cost. Consult the manufacturer when in doubt.

Spike Suppression

Usually a built-in electronic component (e.g., diode or metal oxide variators) to prevent high voltage spike from leaving the magnetic lock and entering the system.

Hook-up Terminals

Some locks offer screw type terminals, rather than lead wires, for ease of installation.

Voltage Selection

Normally a built-in switch or jumper pin that allows field selection of operating voltage (12 or 24V).

Rectifier Bridge

A built-in or add-on electronic device that changes AC to DC. It allows the magnet to operate from a 12 or 24 VAC power source.

Adjustable Time Delay

An electronic component that allows setting a delay in relock after an authorized release. Typical adjustment time is 0-30 seconds.

Door Status Switch

Generally, a magnetically operated reed switch concealed within the lock housing. It is triggered by a small permanent magnet concealed in the armature. Used to signal the open/closed status of the door at a monitor panel or to create multi-door interlock systems.

The switch output contacts are normally rated to carry only low current loads, typically ¼ to ½ amp. Also called a door position switch.

Lock Status Switch

Normally a factory calibrated electronic device built into the magnet assembly. It is used to detect a critical loss of holding force due to low operating voltage or foreign material, damage or misalignment between the lock and armature mating surfaces. It provides open and closed dry contacts to monitor the secure/not secure condition of the lock. The contacts are usually rated for low current loads, typically 200 - 300 milli-amperes. This feature is commonly identified by manufacturers trade names such as: Bond Alert Sensor, Dynastat Monitor, Holding Force Sensor, Magnetic Bond Sensor and Senstat.

Anti-Tamper Switch

A miniature pushbutton or lever switch within the lock housing. It is activated when an attempt is made to remove a housing mounting screw or the housing itself. Output contacts are normally offered either open or closed, with current ratings anywhere from ½ to 6 amps at low voltage.

CIRCUITRY

Many manufacturers offer sophisticated circuitry built into their electromagnetic locks to provide "specialized" electronic features:

Delayed Egress

Control circuitry to provide a delay in unlocking. The electronics usually also provide code related features such as: visual/audible status indicators, fire panel tie-in and reset devices.

Egress Detection

Some locks offer built-in passive infrared or other sensing technologies to detect an attempt to egress and cause the immediate release of the lock.

Status Indication

A digital display or tone/voice audible, or combination of both, indicating the status of the lock. Often associated with delayed egress systems.

Transaction Memory

Circuitry that is able to interface with programmable access control devices. In some cases the lock itself may be programmable and offer audit trail read-back.

Mechanical Features

Manufacturers offer a multitude of mechanical features to enhance the visual appeal of the unit or to facilitate installation of the lock.

Custom Length Housing

Housing lengths to fill the full width or height of the opening. Presents a "cleaner" unbroken line of sight.

Mounting Brackets

A variety of mounting brackets to accommodate in swinging or sliding doors and glass doors without top rail.

Filler and Angle Bars

Structural pieces to provide a full mounting surface for the lock at the frame.

Architectural Finishes

A wide range of finishes applied to the housing components to match or blend with door and frame finishes. Most locks are offered in satin aluminum clear anodized as standard.

TROUBLE-SHOOTING

There is very little that can go wrong with an electromagnet. Most problems are the result of improper mounting or improper voltage input When checking for magnetism, a steel object, e.g.. screwdriver blade, may be held against the face of the electromagnet. This will indicate if magnetism exists but is not relative to holding force. Placing the armature to the face of the magnet will better indicate the strength of the magnetic field. The following chart will assist in solving the most common problems that an electromagnet may exhibit

SYMPTOM	POSSIBLE CAUSE	ACTION TO TAKE
No Magnetism	Open circuit in system	Check wiring connections. Check hook-up diagram.
	AC input voltage	Rectify AC or supply DC voltage.
	No power	Check input power at magnet. Check output power at supply.
Weak Holding Force	Armature doesn't pivot	Remount using correct hardware.
	Foreign material between mating faces	Clean magnet and armature faces.
	Low input voltage	Check output voltage at supply. Check input voltage at magnet. Check wire size form power source.
	Misalignment	Check alignment of magnet face with armature face.
Works Intermittently	Loose connections	Check all wire connections.
	Defective control	Check operation of access control devices.

Applications

The electromagnet is normally classified for ordinary indoor use and has been used on almost any type door and frame. It has also been used for outdoor applications, usually protected to a limited degree from the worst weather and requiring a little more scheduled maintenance. Several models on the market offer weather protection and conduit installation features. The magnet can also be used in unique applications other than as a door locking device.

The following listing shows the most common applications for this device. The ANSI/BHMA A156.23 type number (E08XXX) is included where applicable.

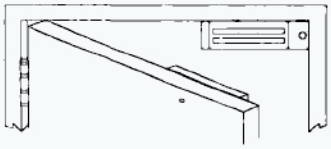

Fig. 1 Single Lock (E08501)

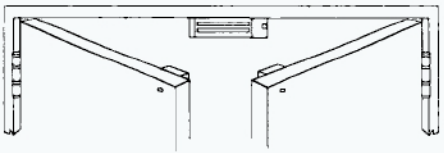

Fig. 2 Single lock w/ split armature for pair of doors

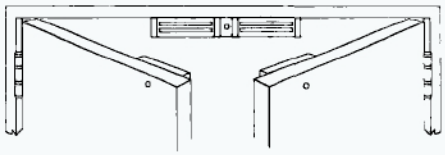

Fig. 3 Double lock for pair of doors (E08511)

Outswing doors with lock surface mounted on underside of header. Armature mounted on push side of door

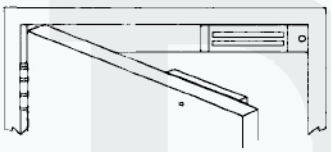

Fig. 4 Single lock (E08521)

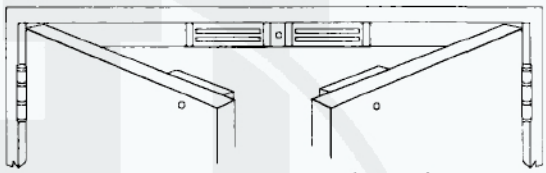

Fig. 5 Double lock (E08521)

Locks with housing cover extending across full width of opening. Note: Occasionally the housings are cut "shout" to allow clearance for heel of door on center pivot hung doors.:

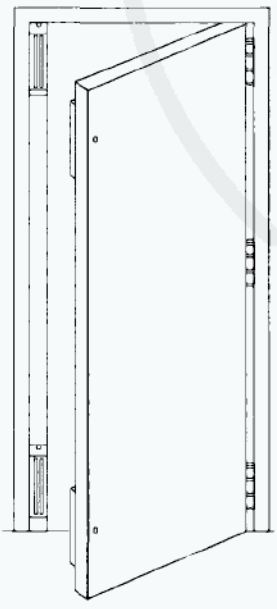

Fig. 6 Single door. Double lock mounted vertically with full length housing. Note: Check baskset dimension when using latching hardware. (E08551)

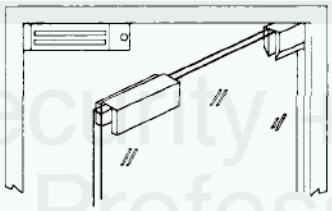

Fig. 7 Glass door — no top rail. Armature is mounted on "saddle" bracket straddling top of door

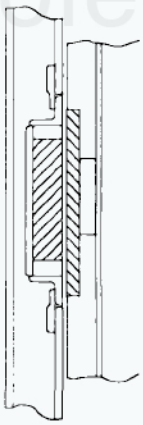

Fig. 8 Sliding door. Lock is mortised into frame. Armature is mortised into leading edge of door.

Maintenance

The electromagnet and armature are plated to resist corrosion during "ordinary indoor use" applications. Having no moving parts, the unit requires very little maintenance. The following service is recommended every six or twelve months, depending on the environment and frequency of use:

1. Inspect mating surfaces for cleanliness. The magnet and armature faces should be free of dirt, grease, paint or any foreign matter. They may be cleaned with a non-abrasive cleaning pad. To help protect against corrosion the surfaces may be wiped with an oil-dampened cloth. Do not leave an oil build-up on the surfaces.

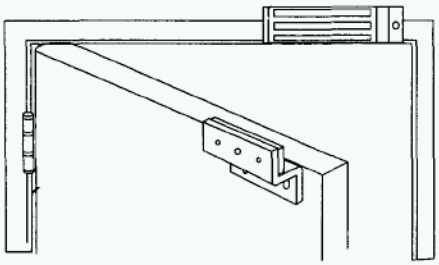

Fig. 9 Single Lock (E08531)

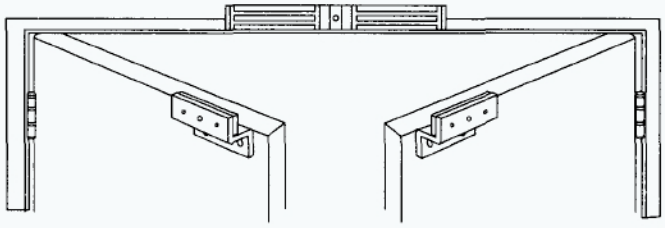

Fig. 10 Double for pair of doors (E08531)

Magnetic "Shear" locks are normally mortise mounted for concealment. Their holding force is measured in a sliding (shear) condition rather than direct pull force as with the surface magnets.

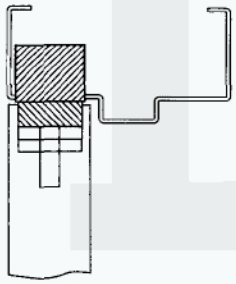

Fig. 11 Outswinging door. Lock mortised in header. Armature mortised in top of door. (E08571)

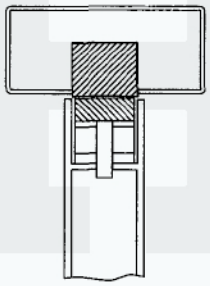

Fig. 12 Center hung single or double acting door. Lock mortised in header. Armature morties in top of door. (E08581)

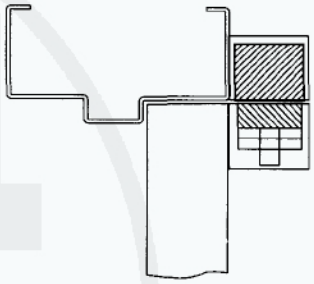

Fig. 13 Inswinging door. Lock and armature surface mounted. (E08561)

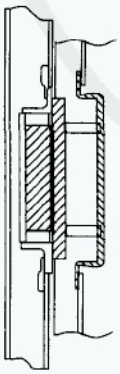

Fig. 14 Swinging door. Lock mortised in jamb. Armature mortised in door edge. (E08591)

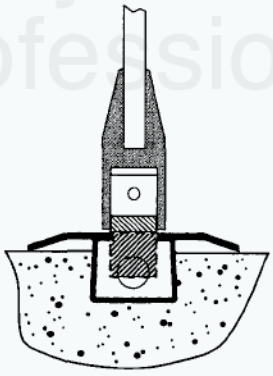

Fig. 15 Swinging door. Lock mortised in floor of threshold. Armature mortised in bottom of door. (E08601)

Maintenance (continued)

2. Check all mounting hardware. The electromagnet should be rigid on the frame. The armature mounting screw should be tight, with the correct support hardware to allow it to freely pivot on the door.

3. Check that a sagging door or distorted frame header has not caused misalignment of the mating surfaces of the lock.

When and Where to Use Magnetic Locks

The electromagnetic lock has been used on almost every type door and frame in almost every type facility that could be named here. The most important governing factor is that you must comply with the same codes, approvals and rules used for traditional hardware. One point to keep in mind is that the magnetic lock is often considered an auxiliary lock, used in conjunction with standard latching hardware. In some cases latching hardware is required by codes. In other cases latching hardware can help prevent the bending or racking of the door during an attempt to defeat the magnetic lock. A common "complaint" is not that the magnetic lock fails to hold, but that the door is damaged by the attempt to part the magnet from the armature! Some guidelines for the use of magnetic locks are provided below.

Low to Medium Security

Smaller magnets with holding forces ranging from 500 - 800 pounds are ideal for interior wood doors or even aluminum/glass storefront type doors. Although it may be possible for a person to generate enough force to part these locks it is more probable the door or frame structure would give first.

High Security

Magnets are commonly available with high holding forces ranging from 1000 to 3000 pounds. Good quality standard gauge hollow metal doors and frames are recommended for these locks. Heavy gauge doors absorb less shock than standard gauge doors and can transmit more force to the area where the lock is holding. These conditions are sometimes better served by double vertical mount magnets or magnet with built-in shock absorbing features.

Whatever the security factors are, a more important issue that must be addressed is life safety.

Life Safety Egress Openings

Local and national codes used in your area will address life safety features required of mechanical hardware. These same codes apply to the use of electromagnets.

The electromagnet, being truly fail-safe, is used extensively with panic exit hardware. The magnet is also easily controlled by fire panel systems, enabling quick release during fire emergencies. The National Fire Protection Association (NFPA) 101 Life Safety Code is a good guideline for the "rules" to follow when treating an egress opening.

Labeled Openings

Fire rated openings are also governed by codes. These codes normally do not specifically address electromagnets, as these devices are not required hardware for labeled openings. The electromagnet is usually submitted to a testing laboratory, such as UL, for an approval "listing" as an auxiliary lock for use on labeled openings. It should be noted that although a "listed" magnet can be used on a labeled opening it never replaces required latching hardware. A good reference for listed hardware is DHI publication "Hardware For Labeled Fire Doors."

Approvals

Underwriters Laboratories (UL) has several listing that apply to magnetic locks. If listed magnets are specified or required by code be sure you have the correct listing for your application.

Auxiliary Locks — Category GWXT

An important listing for magnets intended for use on listed fire doors and frames. It is noted that these locks are used in addition to the primary latching device required on these openings. It is also noted that the AHJ be consulted before installing auxiliary locks on fire doors/frames.

Special Locking Arrangements — Category FWAX

This listing generally covers delayed egress locking systems used on egress doors. It refers to NFPA 101 Life Safety Code for installation and use of this system. Although the use of delayed egress systems does not always require approval, the trend among manufacturers is to apply for this listing.

Releasing Device Equipment — Category SZNT

A somewhat vague listing, this category appears to

cover the release of magnetic locks under the control of fire protective signaling equipment. The use of this listing does not appear to be widespread.

Burglary Resistant Electrically Operated Door Locking Mechanisms — Category CVXJ

A few magnetic locks have this listing that generally covers prison or institutional cell doors or other high security openings.

Underwriters Laboratories of Canada (ULC) Egress Door Securing and Releasing Devices

Category 105E4: generally covers delayed egress locking systems used on egress doors.

Category 105E4.19: general listing for electro-magnets and components including use on fire doors.

Standards

ANSI/BHMA A156.23 American National Standard for Electromagnetic Locks Provides full requirements for electromagnetic locks including operational, strength and finish tests. The locks are ranked in three strength categories: 1500 LBF, 1000 LBF and 500 LBF. Of particular interest are the residual magnetism test: 4 LBF within one second and the inductive kick back test: 53 volts peak maximum.

It is the strength ranking and these two particular tests that most establish the quality of an electromagnet.

ANSI/BHMA AT 56.24 American National Standard for Delayed Egress Locks Provides general description of delay egress system operation with test parameters.

CONCLUSION

Electromagnetic locks offer a versatile, truly fail-safe electric security device. The absence of mechanical parts and linkages lend to a long life, low maintenance device. Its popularity has led to the establishment of standards, codes and approvals for guidance in its various applications. Increasing enhancements through the development of sophisticated electronics will broaden the future uses of these devices in electronic security systems.

Reference Documents

NFPA 101 Life Safety Code, National Fire Protection Association

Hardware for Labeled Fire Doors, Door and Hardware Institute

Building Materials Directory, Underwriters Laboratories

Fire Protection Equipment Directory, Underwriters Laboratories

Automotive, Burglary Protection, Mechanical Equipment Directory, Underwriters Laboratories

A156.23 *American National Standard for Electromagnetic Locks,* Builders Hardware Manufactures Association, Inc.

A156.24 *American National Standard for Delayed Egress Locks,* Builders Hardware Manufactures Association, Inc.

Electric Locking Devices, Butterworths

The following Tech Talks are also available from the Door and Hardware Institute:

• ASD-1	Aluminum Store Front Doors (1990)
• BH-1	Butts and Hinges (1990)
H DS-92	Door Spec. Writing (1992)
• EAH-91	Electrified Architectural Hardware (1991)
• ED-1	Exit Devices (1988)
• EH-1	Electronic Hardware (1989)
• FC-1	Concealed Floor Closers (1990
• HH-1	Hospital Hardware Problems (1990)
• HTL-92	Hotel/Motel Hardware and Keying
• MK-1 and 2	Masterkeying (1973)
• P-1	Pivots (1986)
• PH-1	Protective Hardware (1978)
• SP-1	Specifications (1990)
H SDC-1	Surface Door Closers (1992)
• WS-1/REV	Gasketing and Thresholds (1989)

Contact DHI for price and ordering information.

• Denotes revision