ANNIS
PRECISION DEMAGNETIZING
AND TESTING EQUIPMENT

# NOTES ON DEMAGNETIZING (INDUSTRIAL)

Most modern equipment and technical gadgets consist of an assemblage of many different kinds of materials. Predominant among their important working parts is most apt to be that ubiquitous and versatile alloy of iron called steel.

Steel is chosen because it is inherently strong, it can be readily worked into many useful forms and it is relatively cheap. Sometimes it is chosen because of its superior magnetic permeability, the ability to "conduct" magnetism some thousands or times better than any other common material. This property is used to its advantage in all kinds of electro-magnetic equipment such as transformers, relays, electric motors, and tape recording heads.

Steel for such electro-magnetic components is not only designed for high orders of permeability, but it must also be magnetically "soft" as well with a very low value of "magnetic memory" or retentivity. In other words, when the influence of any magnetizing force is removed, such magnetically "soft" steel retains a very small amount of magnetism as a residual.

In contrast to the above "soft" magnetic steels, there exists a wide variety of magnetically "hard" steels. These are usually more highly alloyed, they may be heat treated or perhaps work-hardened for strength, wear resistance or hardness etc., wherever superior mechanical characteristics are necessary.

Such magnetically hard materials have a somewhat lesser ability to conduct magnetism but have a relatively good "magnetic memory". Should magnetically hard steel be exposed to magnetism, even if only for a fraction of a second, it will "remember" the exposure by retaining a fair portion of the original magnetism, becoming a secondary source of magnetism in its own right, acting somewhat like a permanent magnet. There are all shadings of magnetically soft to magnetically hard steels, with most mechanical components falling with the middle to hard range so as to obtain superior mechanical strength and wear characteristics.

There are many sources of magnetism that can directly or indirectly magnetize steel equipment or components. Every time an electric current flows, a magnetic field is generated. The intensity of this field is proportional to the amount of current flowing. Whenever switching is done in an inductive circuit, there is a random chance of creating a "switching surge" which causes a momentary high current peak. Capacitors, often employed in electronic circuits, can also create high peak charging circuits. Often the circuitry includes a multiple turn coil where the magnetic effect of the current is multiplied in proportion to the number of turns. Any steel within the area of such field will become magnetized, a portion of which will be retained as residual magnetism. Care should also be taken not to bring magnetized tools or other magnetic devices in contact with steel components. Even the effect of the earth's magnetic field should not be discounted. This source of magnetism is ever with us. Remember- the mariners' magnetic compass is actuated entirely by just the horizontal component of force created by the earth's field.

Typical for most of the U.S.A., the vertical component of the earth's magnetic field is considerably stronger than the horizontal component, due to the fact that the field dips down about 70 degrees toward the north. This steep angle of dip is due not only to the curvature of the earth's surface, but also to the fact that the effective magnetic pole area of the earth is displaced and located considerably below the surface.

Fairly long iron or steel members, which may be oriented somewhat parallel with the direction of the earth's magnetic field, will become magnetized due to the fact that their high magnetic "conductivity" tends to concentrate the earth's magnetic field in that area. Rather strong magnetic poles will appear at the ends of such iron or steel members. Steel components brought near such poles will, in turn, become magnetized, the same as when exposed to any other magnetic field source. Very little consideration is usually given to such possibility. In other words, don't place magnetically sensitive steel parts close to the ends of steel members of structure oriented vertically or in a generally north and south direction. It is well to be alert to the possibility of picking up magnetism from a myriad of electro-magnetic or permanent magnet devices that may have extensive stray fields. For instance, some meter type photometers and many transistor radios contain very strong unshielded permanent magnets.

An instrument known as a pocket magnetometer can be used to discover or determine the magnitude and polarity of such disturbing residual magnetic fields. The calibrated magnetometer is quick and handy to use, giving an instant indication of unacceptable levels of magnetism that may be present in components.

It is indeed fortunate that residuals can be removed from steel components in several different ways. In other words, they can be demagnetized.

One very effective method is to heat the steel red hot, then slowly cool it in a low magnetic field area. This, however, is obviously not a very practical method for most requirements. A second method is to expose the steel to a carefully controlled magnetic field of opposite polarity, but oriented in exactly the same direction as the original magnetizing field. The intensity of this oppositely polarized field must be an accurately determined fraction of the original magnetizing field. This fraction will vary depending on the type of steel, it heat treatment, or work hardening, etc. Determination of such a precise fraction is practically a laboratory procedure and therefore is not a very suitable process either.

A third, relatively demagnetizing method is to expose the steel to a magnetic field of cyclically reversing polarity, which must have an initial intensity higher than the fraction method in the above described laboratory procedure. This cyclically reversing field is then reduced in intensity so that each succeeding half-cycle, of opposite polarity, is slightly less than that proceeding half-cycle, but more than the critical minimum "fraction" as dictated by the type of steel involved.

The intensity of such a cyclical alternating demagnetizing field can be reduced to near zero by means of a rheostat or a variable transformer, or much more simply by progressively separating the steel and the source of alternating demagnetizing field to such a distance that the field induced in the steel is essentially zero. This is not difficult, nor is the separation distance involved too great because such induced magnetism very nearly follows the inverse square law, where doubling the distance apart will reduce induction to one quarter the initial amount and doubling again, to one sixteenth, etc.

One of the most important points to remember in cyclical demagnetizing is that actual demagnetizing is accomplished only during the incremental reduction of successive half-cycles of the demagnetizing field, or only during that time when the work and the demagnetizer are being separated. Leaving steel to "cook" in an alternating demagnetizing field is of little value unless one might consider the secondary effect of heat being generated in the work due to losses from induced eddy currents.

When demagnetizing objects having considerable width, such as rings, gears, or cabinets, it is generally more effective to rotate such work approximately 90 degrees while it is being demagnetized or, if this is not practical, demagnetize again while oriented at right angles to the original demagnetizing position.

Another important point concerning cyclical demagnetizing is that there must be no interruption of the power to the demagnetizer during separation or the incremental reduction period, even momentarily. If this occurs, the steel will be left in a highly magnetized condition as a result of being magnetized by the last half-cycle prior to interruption. When this occurs, the complete procedure must be repeated.

A third point to remember is that complete demagnetization of steel cannot be accomplished while it is still under the influence of the original magnetizing field or any other stray unidirectional field of any consequence. One can't completely demagnetize components while they are subjected to magnetic bias.

On very critical work, even the "bias" cause by induction from the earth's magnetic field can prevent complete demagnetization without the use of special procedures. This effect is particularly noticeably when the long dimension of such work is stressed either mechanically or magnetically while oriented more or less parallel with the earth's magnetic field (north and south or vertically). This condition is encountered more often when working with some stainless steels or other steels in the middle to low hardness range. An auxiliary demagnetizer control unit, the Annis Ambient Cancellator can be used to neutralize this bias and attain lower magnetic residuals on critical work.

While unwanted residual magnetism is often indicated by chips or "magnetic fuzz" clinging to the work, or possibly by how long a contact "daisy chain" of steel paper clips will hang suspended from one end etc., it is easier and much more meaningful to actually measure the level of magnetism present.

The Model 25 Annis Pocket Magnometer will give an instant indication of polarity and the relative magnetic field strength is gauss. When using, it is only necessary to touch the lower test edge of the instrument to the work and read the pointer position on the dial. These center zero instruments are available in eleven different ranges from 0.5 to 400 gauss full scale. The 10 gauss range is the one most often used for machine shop and tool room work.

It has been said that one really knows very little about a problem until it can be reduced to figures. One may or may not need to demagnetize, but until one actually measures residual levels of magnetism, one really doesn't know where he or she is. One has not reduced the problem to figures.

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