"Degaussing" and other Demonstrations with CRT Monitors
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Abstract

The display on a CRT color monitor is remarkably sensitive to the ambient magnetic field. The tube itself may acquire a residual magnetization, either through exposure to external DC magnetic fields or during normal operation. The removal of such retained fields from the CRT by "degaussing" with an AC magnetic field is a standard remedy for restoring picture quality. This technique and others have been employed as lecture-demonstrations to illustrate the characteristics of magnetic fields from permanent magnets, coils, and various electrical appliances. Semi-quantitative comparisons of field strengths from different sources are possible. The relative effectiveness of different materials and enclosures as shields can also be demonstrated visually to large audiences.

I. INTRODUCTION

A. Practical Issues: Monitors get magnetized in physics labs.
B. Demonstration Opportunities

II. CATHODE RAY TUBE DISPLAY BASICS

A. Anatomy and Physiology of Shadow-Mask CRT

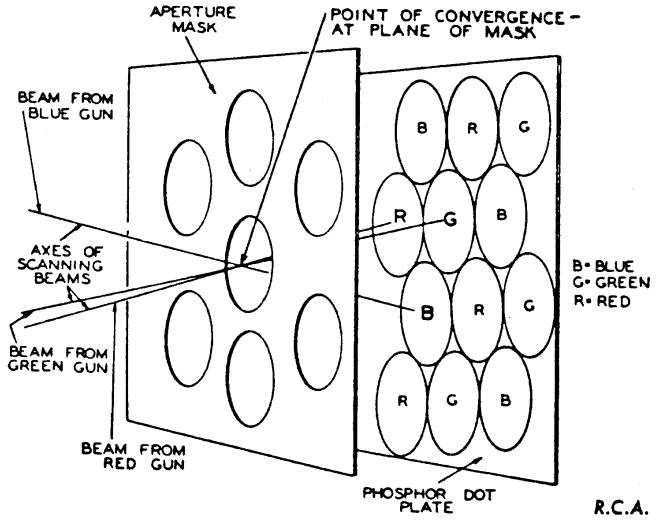

Figure 6.3: **APERTURE MASK IN DELTA SYSTEM.**
***Color TV Servicing,* 3rd Ed., Walter H. Buchsbaum. Prentice-Hall, Inc. Copyright 1975.**

1. The electron beam is deflected by AC magnetic fields generated in the yoke.

2. The shadow mask covers the rear of the phosphor screen with a pattern of apertures that masks the phosphor dots with a precise shadow. The mechanical and thermal stresses that the shadow mask is subject to require that it be made from ferromagnetic alloys. These materials have some unavoidable remanence.

3. The beam currents flowing through the shadow mask will magnetize it slightly, leading to a blurred, non-uniform, and color-shifted display. External DC fields from nearby permanent magnets (such as those in loudspeakers) and the Earth can contribute to deflection problems and to the remanent magnetism in the mask.

B. Automatic Degaussing

1. Most color televisions and computer monitors degauss themselves by means of a coil wrapped around the outside perimeter of the bell nearest the screen. When the set is turned on, the coils receive a rapidly decaying AC current (usually at the line frequency or a self-resonant frequency) which imposes a collapsing H-field through the shadow mask.

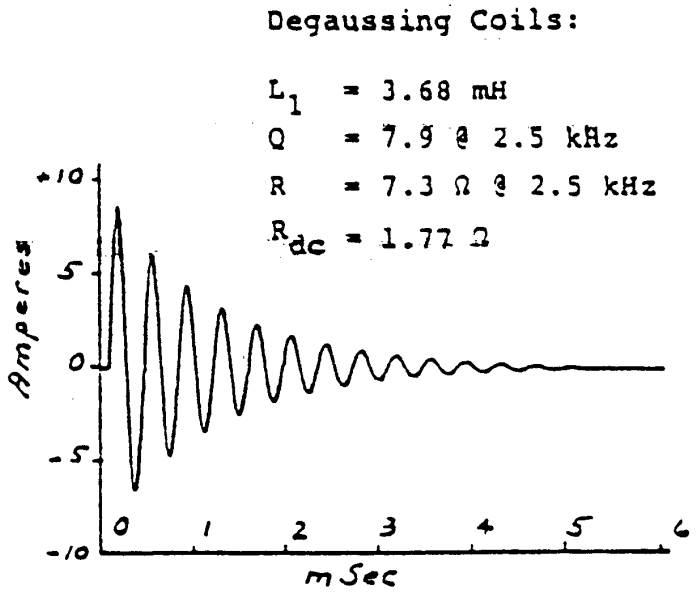

Figure 10: Current in the Degaussing Coils, Side Mounted on a 19V Tube.

2. A variety of circuits have been developed and patented to control the degaussing coil current. Often a combination of positive temperature coefficient resistors and thermisters are connected in series and in parallel with the coil.

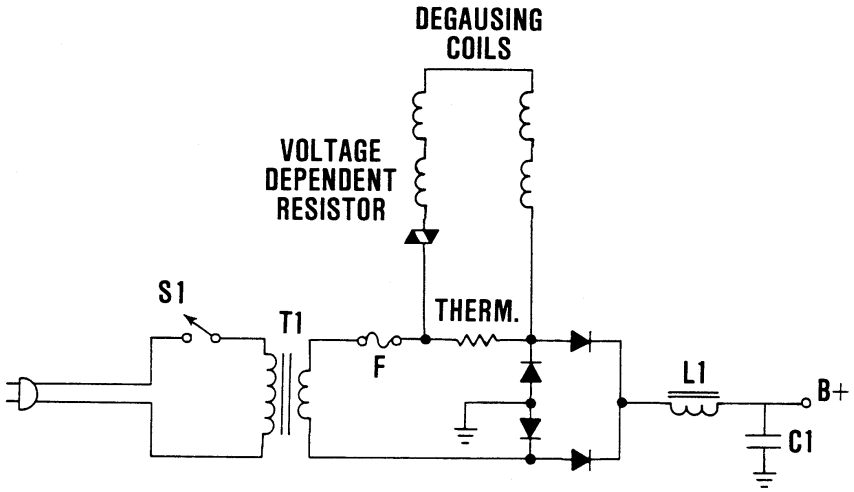

Figure 6.17: AUTOMATIC DEGAUSSING CIRCUIT

C. External Degaussing

1. In the early years of color television the combination of thicker and more remanent shadow masks and higher beam currents, combined with primitive or non-existent automatic degaussing circuits, meant that most color television tubes were partially magnetized most of the time. Since these receivers were also full of vacuum tubes, and were anything but stable for all sorts of reasons, external degaussing by the TV repairman was routine. The training manuals and magazines contained "how to wind and use your own degaussing coil" articles.

2 Such a coil usually consisted of a few tens of turns of magnet wire on a circular form, connected directly to a line cord. There needed to be enough resistance and inductance so that the coil drew only a few amperes. In use, the coil was plugged in, moved around the screen, and then slowly withdrawn and unplugged.

III. DEMONSTRATIONS

A. Effects of Permanent Magnets

1. Bar magnet

a. Color distinguishes poles
b. Non-uniform fields can be seen along bar
b. Some remanence affects the display

2. Strong C-shaped magnet

a. Much more disruption of the display

b. Geometry of shadow mask can be displayed, like a magnifying glass
c. Lots more remanence. HELP!

B. Degaussing

1. With a Weller of Soldering Gun (or other brand)

2. With a planar field coil driven by a step-down transformer

3. With a bulk tape demagnetizer for hard-to-cure cases

C. DC Field Shielding Demonstrations

1. Bar magnet inside capped copper pipe. Essentially no shielding, just slightly increases minimum distance between magnet and screen.

2. Bar magnet inside capped steel pipe. Dramatic shielding. External field is less an 2% of previous value.

3. Presence of the steel pipe actually "cleans up" the display a bit by providing a high permeability (low reluctance) path for remanent field lines beyond the point where the electron beam can be deflected.

D. Measurements and Demonstrations of Ambient Magnetic Field from Appliances [Table]

APPROXIMATE MAXIMUM MAGNETIC FIELDS NEAR VARIOUS DEVICES

	B[1] (GAUSS RMS)
WESTCLOX ELECTRIC CLOCK (2.5 W)	19
SALON SERIES HAIR DRYER (1.5 KW)	0.4
KLINGER STEP-DOWN TRANSFORMER	9.6
THIN COIL (D=0.13 M; NI=220 AMP-TURNS)	35
THICK COIL (D=0.13 M; NI=1100 AMP-TURNS)	130
BLACK AND DECKER DRILL (MODEL #7190)	8
WELLER SOLDERING GUN (200 W POSITION)	45
WELLER SOLDERING GUN (260 W POSITION)	51
TOASTMASTER HOT PLATE (750 W)	2-3
BROIL KING HOT PLATE (POWER NOT LISTED)	2-3
WALKER BULK DEMAGNETIZER (AXM 7167-109)	620
WALKER BULK DEMAGNETIZER (.10 M AWAY)	110

[1]MEASURED WITH BELL MODEL 620 HALL-TYPE GAUSSMETER AND TRANSVERSE PROBE

Bibliography

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Walther H. Buchsbaum. *Complete TV Servicing Handbook* Prentice-Hall, New Jersey, 1982)

Harald Löbl and Rudolf Roßgotterer, "Degaussing Circuits with PTC Resistors," Siemens Electronics Components Bulletin **6**, No. 3, 74-76 (1971)

Walter Truskalo, "Resonant Degaussing for TV and High Definition Color Monitors," IEEE Transactions on Consumer Electronics **CE-32** No. 4, 713-722 (Sept. 2, 1986)

David Ramsey, "When is it time to degauss?" MacWEEK **6**, No. 39, 86 (Nov. 2, 1992)

Post-presentation additions 8/27/2006:

"Experiments and Demonstrations with Soldering Guns", D.C. Henry and S.A. Danielson, The Physics Teacher, Vol. 31 No. 1, pp. 42-46 (January, 1993)

The "Little Shop of Physics" directed by Brian Jones at Colorado State University (www.littleshop.physics.colostate.edu) has included at least one CRT/magnetic field demonstration. I have in my file a nice paper by Brian Jones and Matt Fackelman entitled "Magnetosh", picked up by a colleague some years ago, with several demonstrations along these lines.