The analysis in Section 4.3 assumed that a steady state shock existed in the material. Thus, if a square shock enters the medium one would ideally expect the recorded emf to be a square pulse and the analysis would be trivial. This behavior is not the case. Consequently, the factors which complicate this behavior must be addressed.

The first problem is due to the finite rise of the stress profile brought about by its transit through the solenoid face. The expected emf can by shown to be of the form in Figure 5.2(a). This can be seen most easily by considering an incremental application of Equation (4.13). There will be a finite rise to the demagnetization approaching a constant value when the wave is completely in the medium.

The second effect is due to relief waves generated at the lateral limits of the magnetic material. The slabs of YIG used in this work had an aspect ratio of 10 to 1. A first approximation calculation can be made by assuming the relief behavior shown in Figure 5.3. If the longitudinal strain in the unaffected material is e, then the equivalent strain in an element of the relieved material is

$$e' = \frac{2(\mu + \lambda)}{2\mu + \lambda} e, \tag{5.6}$$

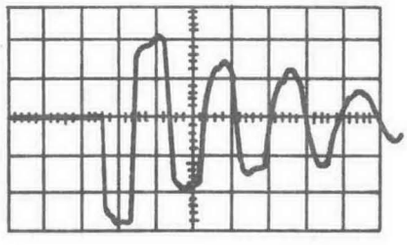

Fig. 5.1.--Oscilloscope record of shot no. 70-039. 0.2 μs per division.

obtained from consideration of static displacement in the two dimensional elastic problem. λ and μ are the Lamé constants. The emf produced by the demagnetization corresponding to a given state of strain is

$$\mathcal{E} = 4\pi 10^{-8} bND\delta M(e),$$

ignoring the relief problem. By considering this approximation to the relief problem, the induced emf becomes

$$\mathcal{E} = 4\pi 10^{-8} ND((b - 2Dt)\delta M(e) + 2Dt\delta M(e'))$$

or, after reorganizing, the expression becomes

$$\mathcal{E} = 4\pi 10^{-8} bND\delta M(e)\left[1 + \left(\frac{\delta M(e')}{\delta M(e)} - 1\right)\frac{2D}{b}\, t\right]. \qquad (5.7)$$

This equation predicts that the lateral stretching due to relief waves produces a linear increase in emf over that predicted for the infinite slab. The expected behavior is shown in Figure 5.2(b).

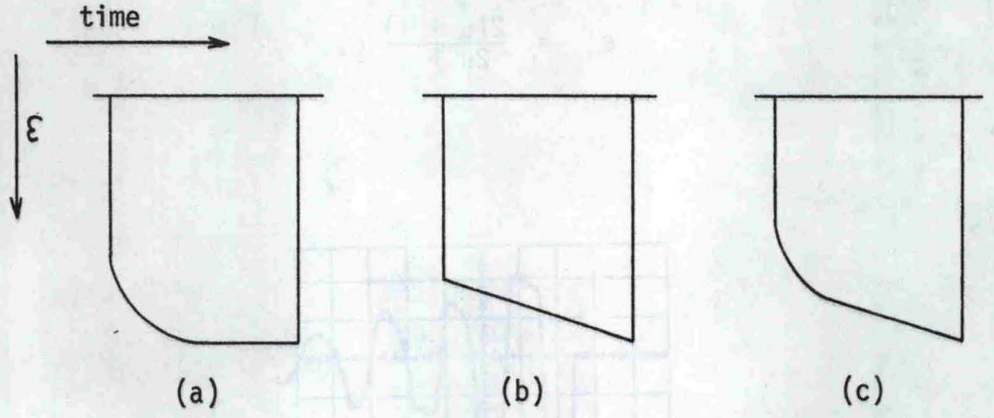

Fig. 5.2.--Effect on the demagnetization profile due to (a) finite rise time of strain wave, (b) lateral relief waves, and (c) combined effect.