4.3. Demagnetization Measurement

The reduction in magnetization is measured by recording the flux change in a pickup coil surrounding the sample of yttrium iron garnet. This pickup coil consists of 10 turns of 1 mil by 15 mil manganin ribbon wound intimately around the specimen as shown in Figure 4.3. The active recording region, defined by the face of the pickup coil, is about 1 cm^2. Manganin ribbon was originally chosen because of its distributed resistance. It was thought that this resistance might tend to dampen parasitic oscillations in the pickup circuitry. No attempt has been made to test the merit of this precaution. The pressure dependence of the resistance is negligible for this experimental configuration. A twisted pair of 3 mil, insulated copper wires are solder-connected to the pickup coil immediately behind the YIG sample and brought out the end of the solenoid. This twisted pair and their connections are not disturbed by the stress wave during the recording time.

A high impedance recording circuit is used to monitor the emf developed across the pickup coil during the demagnetization process. The equivalent circuit, shown in Figure 4.4, consists of an ideal source of emf and a resistance R consisting of the load resistance plus the internal resistance of

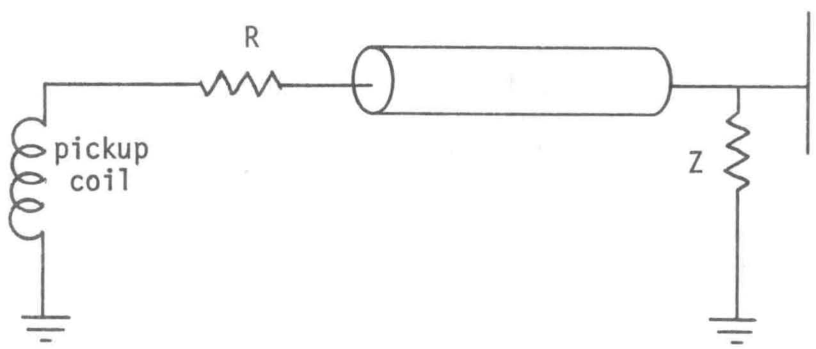

Fig. 4.4.--Pickup coil circuit.

the pickup coil. The signal is transmitted to the recording oscilloscope by 50Ω coaxial cable and terminated there in 50Ω. The emf is given by

$$\mathcal{E}(t) = \frac{(R + Z)}{Z} V(t) \qquad (4.9)$$

where V(t) is the voltage recorded at the monitoring oscilloscope and Z is the characteristic impedance of the coaxial cable. The resistance R is selected to maintain the current flow in the pickup circuit sufficiently small such that the magnetic field produced by this current is negligible compared to the magnetic field produced by the solenoid. In practice, several hundred ohms are found to be sufficient for this purpose. The dynamic impedance of the pickup coil inductance is small compared to this resistance.

To relate the demagnetization to the emf developed, it will be assumed that a steady state shock profile is progressing through the magnetic material as shown in Figure 4.5. In the spirit of mechanical jump condition calculations,[58] consider, prior to passage of the shock wave, an element of area $bD\delta t$ which is compressed to $b(D - u)\delta t$ after passage of the shock wave. b is the width of the pickup coil and D is the velocity of the shock profile. The change in magnetic flux across the shock wave is

$$\delta\Phi = b(B(D - u) - B_o D)\delta t$$

where B_o is the initial magnetic induction and B is the final magnetic induction. Considering the case where the external applied field is constant and using

$$B = H_e + 4\pi M$$

along with the jump condition,

$$(D - u)\rho = D\rho_o,$$