For the chosen components, this fluctuation is about 0.01% for the required recording time.

The inductor L is an integral part of the experimental design. It is, of course, a major component in determining the rise time of the current pulse. More important, the inertia of the inductor maintains the current and, therefore, the applied magnetic field constant for the duration of the experiment. There are several effects which attempt to change the current. First, passage of a shock wave across the solenoid accelerates the forward face creating an effective solenoid collapse. Electromotive forces are generated in an attempt to produce currents which would conserve the flux in the closing solenoid area and thus increase the magnetic field. Second, when the stress wave transverses the magnetic sample, a gross flux reduction occurs. The response of the electric circuit is to attempt to compensate for this flux change. In both cases, it is the responsibility of the inductor L to maintain the current constant, denying the natural response of the system. About 0.25 to 0.5 millihenry inductors have been found sufficient for this purpose. It should be mentioned that this inductor is physically located within a few inches of the solenoid since its inertial characteristics must be realized within nanoseconds. To locate this inductor in the current supply would create coaxial cable reflections and nullify its stabilizing property.

There is a 1,000Ω resistor paralleling the solenoid to ground. This resistor carries several percent of the total current and, with the solenoid, has an L/R time sufficient to damp out ringing due to the finite stray capacitance of the solenoid windings.[49]

The current through the solenoid is monitored by recording the voltage across a precision 1Ω resistor in series with the solenoid as shown in Figure 4.2. The magnetic field is given by the solenoid formula

$$H_e = 0.4\pi NI \qquad (4.1)$$

where I in amperes and N in turns per centimeter gives the magnetic field in oersteds.

The solenoid is constructed of 1 by 15 mil (1 mil = .001 inches) OFHC copper ribbon obtained from The Wilkenson Co.[50] Usually between 12 and 20 turns per centimeter were used. The solenoid constituted about 6 to 9Ω of D.C. resistance, a factor which must be considered in the total circuit design. A standard lathe, set in the thread cutting mode, was found to provide an efficient and versatile means for winding a very smooth and regular solenoid. Magnetic fields required for this work required currents up to 60 amperes. The joule heating during pulsing was still substantially less than the softening temperature of epoxy; approximately 80°C.

A problem of concern is the ripple in the magnetic field due to the finite spacing of the solenoid windings. The magnitude is estimated by the following method. In the neighborhood of the grid, the magnetic vector potential is periodic and can be written as a superposition of terms,

$$\vec{A}_n = \vec{A}_n(y) \cos \frac{2n\pi x}{a},$$

where y is the normal direction from the grid, x is along the grid, and a is the period of the grid. The vector potential must satisfy Laplace's equation. Hence,

$$\frac{d^2\vec{A}_n(y)}{dx^2} - \frac{4n^2\pi^2}{a^2}\vec{A}_n(y) = 0,$$

which has the solution

$$\vec{A}_n(y) = \vec{A}_n e^{-2n\pi y/a}.$$