magnetic field strength. A further application of the experimental method is suggested.

I. OPERATION OF CURRENT SUPPLY

The following operational description will refer primarily to the schematic of the current supply and target circuitry in Fig. 2. Initially the large electrolytic capacitor C is charged to a predetermined voltage $\mathcal{E}_0$. Prior to impact the projectile triggers the current supply as illustrated in Fig. 1. The subsequent discharge of capacitor C develops a current in the solenoid. The form of this current pulse is given by the equation[5]

$$I=(\mathcal{E}_0/\omega L)\exp(-\beta t)\sinh\omega t, \quad (1)$$

where

$$\beta=R/2L$$

and

$$\omega=(R^2/4L^2)-1/LC.$$

The voltage $\mathcal{E}_0$ and the resistance R are preadjusted to obtain a maximum current I_m at a time t_m. R is the dc resistance of the components in the discharge circuit. The time t_m is adjusted to correspond with the arrival of the projectile at the impact surface. The values of $\mathcal{E}_0$ and R are selected from calibration curves obtained from the relation

$$t_m=(1/\omega)\tanh^{-1}(\omega/\beta). \quad (2)$$

At t_m, the current, and, hence, the magnetic field, are quasistationary and remain so for the duration of the experimental measurement (approximately 200 nsec).

The inductor L is an integral part of the experimental design. It is a major component in determining the risetime of the current pulse. More important, the ballast property of the inductor maintains the current and, therefore, the applied magnetic field constant for the duration of the experimental measurement. There are several effects which attempt to change the current. First, passage of a shock wave through the solenoid accelerates the forward face, creating an effective solenoid collapse. Magnetic forces are generated which attempt to conserve the flux in the closing solenoid area and thus increase the magnetic field. Second, when the stress wave traverses the magnetic sample, a large flux reduction occurs during shock demagnetization. The response of the circuit is to attempt to compensate for this flux change. In both cases, it is the function of the inductor L to maintain the current constant. About 0.25–0.5 mH inductors have been found sufficient for this purpose. It should be mentioned that this inductor is located within a few centimeters of the solenoid since its ballast property 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 1000 Ω 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. The current through the solenoid is monitored by recording the voltage across a precision noninductive 1 Ω resistor in series with the solenoid.

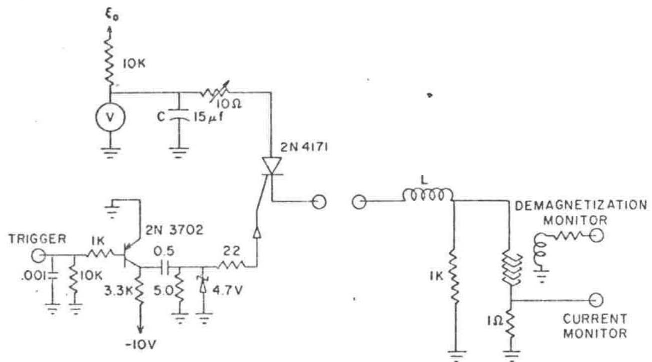

FIG. 2. Current supply and target circuit.

II. EXPERIMENTAL DESIGN

The magnetic samples used in the present work were rectangular slabs of polycrystalline yttrium iron garnet.[6] The dimensions were 0.1×1.0×5.0 cm. The width to depth ratio was chosen to minimize lateral relief wave effects while the length to width ratio was chosen to minimize demagnetizing fields. The sample is positioned with its long dimension along the magnetic field, and the slab face is oriented parallel to the impact surface. A cross section of the solenoid assembly is shown in Fig. 3. Either Lucite or aluminum oxide was used for material on the impact surface. Lucite was used for the solenoid interior. The solenoid windings were constructed of 0.025×0.38 mm OFHC copper ribbon.[7] Usually between 12 and 20 turns per centimeter were used. The solenoid constitutes about 6–9 Ω of dc 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.

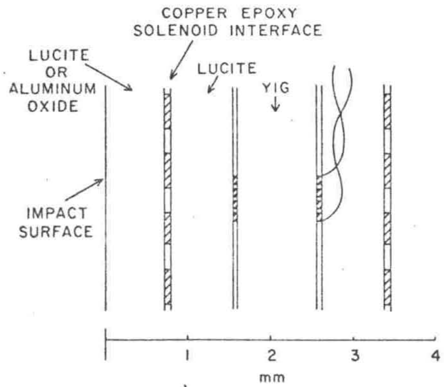

FIG. 3. Cutaway cross section of solenoid. Exhibits approximate dimensions and construction of solenoid.