very similar over a range of open-circuit voltages from 3 to 45 V.

The measurement of shock arrival was not affected by the spacing between the electrodes, 0.30 to 1.30 mm, nor by the protrusion of the electrodes from a position flush with the wall to a height of 0.94 cm (see Fig. 7). In each instance, the counter reading was compared with that of a normal probe (Fig. 1) mounted in the port diametrically opposite the probe in question. All of the counter readings were within 0.2 μsec of each other. Initially the probes were used with the electrodes extending slightly into the stream, which meant that they had to be removed after each run to permit cleaning of the shock tube. Currently the probes are installed with the electrodes mounted flush with the wall of the shock tube and are left in place for several runs.

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Small 10 kG Pulsed Magnet[*]

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A small magnet pulsed at 2000 cps is described. The method of construction by interlacing spirals of Teflon and copper is discussed. The field produced is through a volume of approximately 1 cc. The total volume of the coil and water jacket is 30 cc.

A MAGNETIC field of 10 kG over a volume of 1 $\text{cm}^2 \times 0.1$ cm is required to measure positron helicity in an experiment to determine the positron *g* factor, using the methods described by Rich and Crane.[1] It is desirable to use a pulsed field rather than a dc field to minimize magnetic perturbations for two reasons: First, the field is absent except during measurement, and second, the high frequency characteristic of the magnetic pulse allows this pulse to be confined to the measurement region by nonferromagnetic conductors.

It was found that ordinary magnet wire became sufficiently hot that the insulation failed at 1 or 2 kG and a few hundred cycles per second. Bitter[2] suggested constructing a coil using alternate washers of copper and mica, assembled in such a way that the copper washer passes through a slit in the mica to touch the copper washer below and form a continuous spiral. However, for a very small magnet, this construction method proved to be very tedious, and the result fragile, though current carrying capacities were greatly increased over magnet wire.

It was then found that by machining a complete spiral from copper and another from Teflon, a rugged, easily assembled coil could be formed which could also carry heavier currents.

The copper spiral is produced by first turning a cylinder on a lathe to the proper inside and outside diameter for

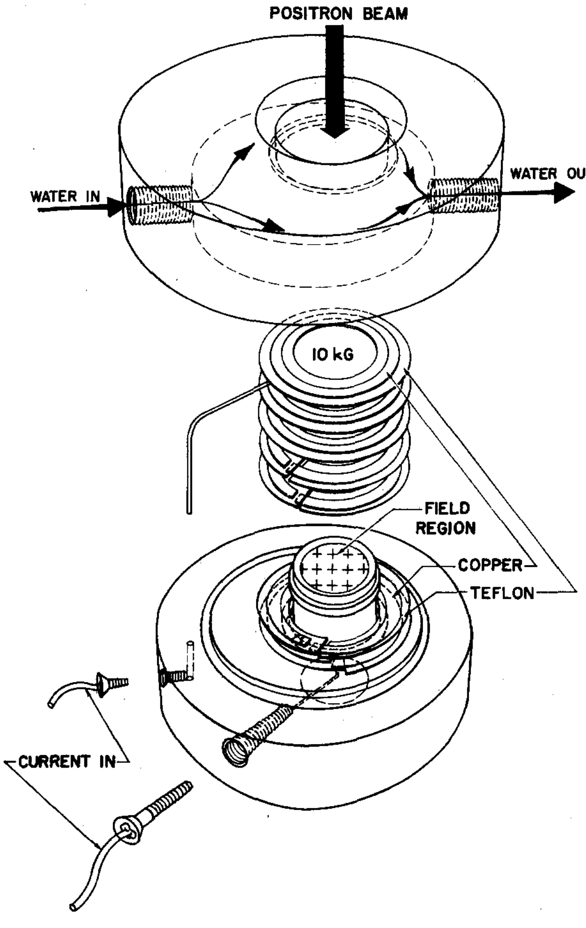

FIG. 1. Sketch showing construction of 10 kG pulsed magnet.

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[1] A. Rich and H. R. Crane, Phys. Rev. Letters **17**, 271 (1966).

[2] F. Bitter, Rev. Sci. Instr. **33**, 344 (1962).

the desired coil. This then is soldered to a brass rod. A square thread is cut on the lathe completely through the copper cylinder so that the brass rod is visible at the bottom of the thread. Then the solder is melted by heating the brass rod. The spiral of copper then easily slides from the rod. In our application, the spiral consists of 30 turns with a 1.3 cm i.d., a 1.7 cm o.d., and a thickness of 0.03 cm.

The production of the Teflon spiral is easier. Again one must cut a cylinder, this time of Teflon, to the proper inside and outside diameter. Then a tool sharpened to a knife edge is run with automatic longitudinal power feed against the end of the cylinder at the rate for the thickness desired. The Teflon spiral consists of 31 turns with a 1.1 cm i.d., a 2 cm o.d., and a thickness of 0.01 cm.

Then the two spirals are twisted together, leads are soldered on the copper spiral, and the unit is inserted in the water jacket as shown in Fig. 1.

The coil is pulsed at 2000 cps with a 300 A peak current. The pulses are delivered from a capacitor bank and resonant charging network using two Tung-Sol 4948A thyratrons. The pulse voltage across the coil is 15000 V, although only 500 V are necessary from a 3 A charging supply, due to voltage multiplication in the resonant charging line. By passing 3.8 liters (of tap water)/min in direct contact with the outer edge of the coil, 500 to 600 W of heat are removed from the coil. The coil reaches approximately 40°C. Tap water is completely acceptable if Tygon water lines over 3 m long are used to present a high resistance along this ground path.

This coil is normally operated at 10 kG; however, at reduced frequency, it can be operated without modification at 15 kG. The design is very satisfactory for producing medium strength pulsed magnetic fields over a small volume.

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Retracting Pedestal Apparatus that Presents a Single Solid Target to a Focused Q-Switched Laser Beam

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An electromechanically operated retracting pedestal system has been developed for injection of a single solid target as small as a few tens of microns in radius into a vacuum system. After the pedestal has withdrawn completely from the system, the falling target, which originally was positioned on top of the pedestal, is ionized by a focused, high power, Q-switched laser beam. Since the plasma is produced in a relatively large volume free of mechanical obstructions, it can be easily studied or used as a source of ions. The pedestal is withdrawn with a velocity in excess of 10 m-sec^{-1}, whereas the target falls with a velocity given solely by the acceleration due to gravity. The laser beam which ionizes the target is triggered by an optical tracking system, consisting principally of an He–Ne laser whose beam is collinear with that of the pulsed laser. The device can be loaded rapidly in vacuum from a reservior with a capacity of hundreds of targets, and fired every few minutes. Application to experiments on laser created plasmas is discussed.

INTRODUCTION

SINCE the development of high power, Q-switched lasers it has been of interest to study plasmas created when the laser beam is focused onto single isolated solid targets ranging from approximately 10 to 150 μ in radius.[1–3] With the Q-switched lasers presently available, one can produce easily plasmas whose temperatures are in excess of 100 eV.[1–7] In a previous paper[1] we discussed the properties of plasmas created from targets suspended on very fine glass fibers. Some laboratories have successfully levitated a single isolated particle by electrodynamic means.[2,7–10] Another technique[3] of obtaining an isolated target has been to inject a single particle and to track it by some suitable means.

A disadvantage of the fiber system is that impurities such as C, Si, and O_2 may be introduced, and the fibers

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[1] E. W. Sucov, J. L. Pack, A. V. Phelps, and A. G. Engelhardt, Phys. Fluids **10**, 2035 (1967).

[2] A. F. Haught and D. H. Polk, Phys. Fluids **9**, 2047 (1966).

[3] G. Francis, D. W. Atkinson, P. Avivi, J. E. Bradley, C. D. King, W. Millar, P. A. H. Saunders, and A. F. Taylor, Phys. Letters **25A**, 486 (1967).

[4] J. M. Dawson, Phys. Fluids **7**, 981 (1964).

[5] A. G. Engelhardt, Bull. Amer. Phys. Soc. **9**, 305 (1964).

[6] N. G. Basov and O. N. Krokhin, Soviet Phys. JETP (English Transl.) **19**, 123 (1964).

[7] M. Lubin, Bull. Amer. Phys. Soc. **13**, 320 (1968).

[8] R. F. Wuerker, H. Shelton, and R. V. Langmuir, J. Appl. Phys. **30**, 342 (1959).

[9] C. DeMichelis and S. A. Ramsden, Phys. Letters **25A**, 162 (1967).

[10] P. E. Faugeras, M. Mattioli, and R. Papoular, Plasma Phys. (to be published, 1968).