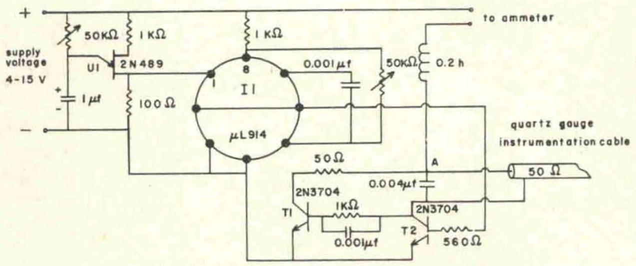

FIG. 19. Diagram of quartz calibration circuit.

relation between the 'scope deflection and the current output from the quartz gauge. A calibration circuit has therefore been developed to feed a pulse of known current amplitude through the instrumentation cable and to the oscilloscopes that are to monitor the output from the gauge.

The quartz gauge calibration circuit consists mainly of a unijunction pulse generator, a monostable multivibrator, and two switching transistors. Referring to the circuit diagram of Fig. 19, a unijunction transistor U1 pulses a monostable multivibrator I1 with a repetition rate of approximately 1 kHz. With each pulse from U1, I1 turns on and remains on for about 5 μsec. Initially, when I1 is off, current flows from point A in the circuit through transistor T1 to the negative supply voltage. As I1 turns on the current is switched to flow through transistor T2. This sends a current pulse down the instrumentation cable that is to be used in monitoring the quartz gauge output. The current before switching is measured accurately by the use of a precision digital ammeter. Therefore, the magnitude of the voltage step produced on the oscilloscope is related to an accurately known current value, since the inductor time constant is large compared to the 5 μsec time interval of the switched current pulse. The magnitude of the current step may be varied from 80 to 300 mA by varying the supply voltage from 4 to 15 V.

C. Manganin Gauge Pressure Transducer

The manganin gauge pressure transducer is a useful device at pressures in excess of those observable by quartz gauges or if the validity of the calculation necessary to eliminate the error due to impedance mismatch at the specimen–quartz interface is in doubt.[11] Auxiliary equipment needed for the manganin gauge technique consists of a constant current supply, an adequate gauge and mounting facility, and proper recording oscilloscopes and cables. The constant current supply has been described elsewhere.[12]

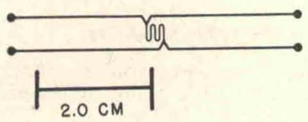

FIG. 20. Manganin grid for use as in-material gauge.

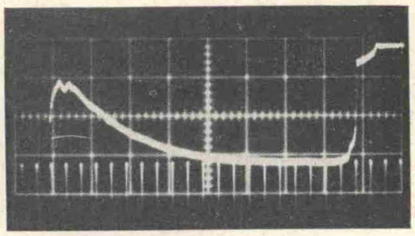

FIG. 21. Manganin gauge in aluminum with peak stress of 30 kilobars.

1. Gauge Construction

Gauges used are of the four terminal type, shown in Fig. 20. They are produced by a photoetch technique and are initially attached to a plastic film[13] from which they are easily removed by immersion in boiling acetone. The sensitive element lies within a 0.371 cm square while the gauge depth is approximately 0.002 cm. The aspect ratio (width/depth) is about 5 for the wire in the sensitive element. The resistance of the sensitive element is 2 Ω while that of the terminal leads is about 1 Ω.

In target construction, the gauge is mounted directly between two slabs of the material under observation if that material is an insulator and does not produce a significant polarization signal. For conductors, the gauge is insulated from the material by a 0.00089 cm Mylar film. The bonding is effected by air evacuated epoxy. The dimension of the sandwich in the latter case is approximately 0.005 cm. Since the shock wave transit time of this sandwich is on the order of 10 nsec and since in general there is a sample–epoxy impedance mismatch, fidelity of the wave profile will deteriorate to an extent depending on the magnitude of the mismatch. Stress profiles at the 35 kilobars level in CdS have been observed by both the quartz gauge and manganin gauge technique. Allowing for the impedance mismatch with quartz they were found to be closely comparable. In constructions involving both conducting and nonconducting samples, the gauge terminal leads were brought out the sides of the sample. This allowed recording times of from 2 to 5 μsec before the gauge leads were either severed or shorted, disrupting the current flow. This recording time is sufficient for most applications. Figure 21 shows a representative record.

2. Recording Facility

The voltage time profile is recorded on a 585 Tektronix oscilloscope with the aid of a type 1A5 offset preamplifier plug-in unit. This unit allows observation of the profile which is superimposed on top of the voltage step developed across the gauge when the constant current supply is initially turned on. This voltage step, knowledge of which is necessary for data reduction, is measured during the preliminary setup. This measurement is performed using the comparison voltage available on the 1A5 plug-in unit and a precision voltmeter. The comparison voltage is used to

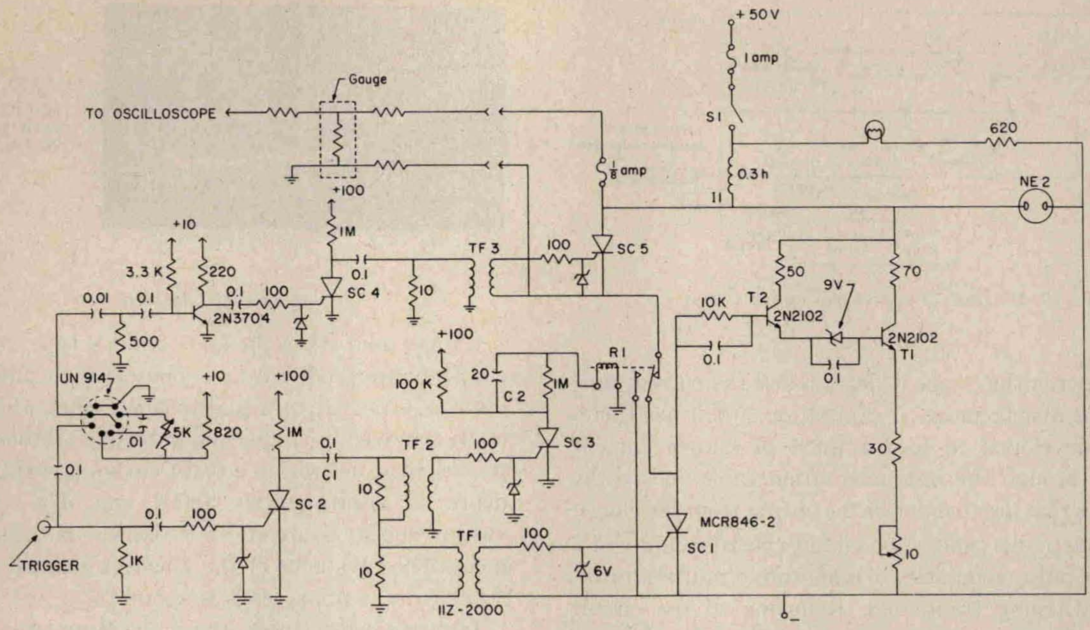

FIG. 22. Block diagram of constant current supply for use with manganin gauges.

nullify the voltage step while the comparison voltage is in turn monitored by the voltmeter. This measurement can be made to well within 0.5% accuracy.

Cable termination is carried out at the gauge rather than at the oscilloscope.[12] Figure 22 shows a schematic gauge with representative termination resistors. Termination at the gauge rather than at the oscilloscope eliminates the problem of a current shunting the gauge and therefore simplifies data reduction. In practice the gauge element will change resistance by about 1 Ω as the stress profile passes the gauge. The terminating resistance values should be selected so that proper termination is effected when the gauge resistance is in its final state.

GUN PERFORMANCE

A. Projectile Velocity

Predicted velocity curves for the gun as designed using nitrogen or helium are shown in Fig. 23. Also shown are representative data points derived from the approximately 100 shots fired to date at pressures up to 206 bars. The agreement is seen to be good for helium, but is less satisfactory for nitrogen. The reason for the discrepancy is not established; possibly throttling at the orifices connecting the breech to the barrel, which is more important for nitrogen than for helium, is the source of the difference. The reproducibility is very good, amounting to about ±1% at velocities above 0.2 mm/μsec.

B. Tilt

The major question with regard to this design is whether adequate control of the tilt of the projectile face with respect to the target face can be maintained. In order not to degrade seriously the time resolution of the recording instrumentation it is necessary that the closure time of the two surfaces (of 10.16 cm diameter) be less than about 50 nsec. The time required for the induced stress wave to sweep past a gauge whose lateral dimensions in a plane parallel to the impact surface is 10 mm or less will then be no more than 5 nsec. This time is comparable to the re-

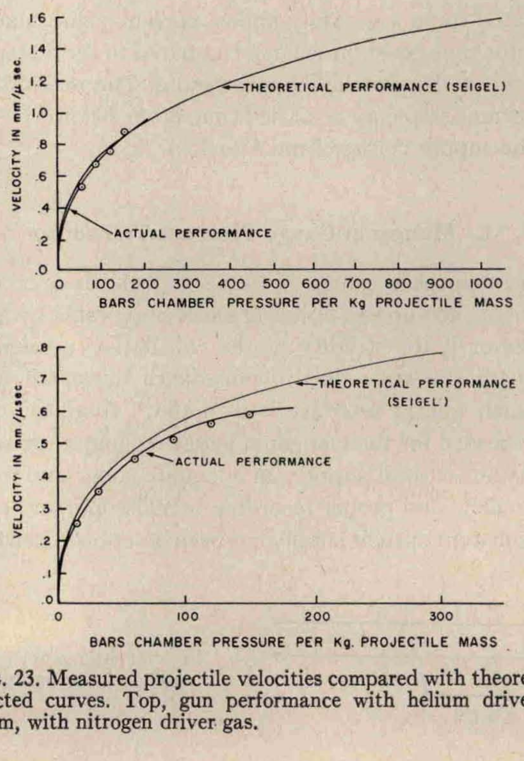

FIG. 23. Measured projectile velocities compared with theoretically predicted curves. Top, gun performance with helium driver gas; bottom, with nitrogen driver gas.