All of the above techniques suffer from a common drawback; namely, the observations are made at an interface at which there is usually an impedance mis-match. Consequently, in order to infer the character of the undisturbed wave requires an impedance-matching analysis similar in principle to that mentioned in Section I. This analysis cannot be performed rigorously without knowledge of the constitutive relation of the sample, although useful information can be extracted by making some reasonable approximations and with subsequent iteration. For some materials such as aluminum the quartz gage is a reasonably good impedance match and the analysis is less sensitive to uncertainties in the constitutive relation of the sample.

Detailed descriptions of the above techniques have appeared in several review articles in recent years and the reader is referred to those for a more thorough presentation.[2,22,23] The remainder of this section is devoted to more recent developments; these include piezoresistive gauges, electromagnetic velocity gauges, sapphire gauges, and laser interferometry.

1. Piezoresistive Gauges

Manganin wire was first used as a pressure transducer in hydrostatic apparatus by Bridgman in 1911.[24] It is desirable for this purpose because it exhibits a positive pressure coefficient of resistance and at the same time a very small temperature coefficient.

In 1964, Bernstein and Keough,[25] and Fuller and Price,[26] reported experiments in which a fine manganin wire was imbedded in an epoxy disc. The disc was used much as is a quartz gage; it was placed against the free surface of a sample and the change in resistance monitored as the pressure pulse, transmitted into the epoxy by an initial pulse in the sample, passed over the wire. (Figure 5.) These experiments established that the fractional change in resistance is linearly proportional to pressure up to about 300 kbar.

Numerous dynamic experiments have yielded pressure coefficients in the range[27]

$$(1/R)(\Delta R/\Delta P) = 2.0 \text{ to } 2.9 \times 10^{-3}/\text{kbar}$$

The statically determined value is 2.6×10^{-3}/kbar.

These discrepancies have not yet been fully resolved; the values seem to depend on the supplier of the manganin and/or the calibration technique. For this reason some investigators use manganin gauges at present primarily as interpolation gauges between pressures established independently.[28] For commercial manganin a value near 2.9×10^{-3} seems to be most widely observed; little or no temperature dependence has been observed so that the calibration should not depend on the material in which the manganin is imbedded. There is some indication that there is a hysteresis effect so that the coefficient may be different when measuring the compression part of a pulse than when measuring the rarefaction portion. It is uncertain whether this effect is real, however, or what physical mechanisms might be responsible.

In spite of these difficulties it seems reasonable to expect that, as development proceeds, a reproducible gauge with a well-determined coefficient can be fabricated.

Because of impedance mismatches between the sample and the insulating material in which the gauge is imbedded, the gauge used in this mode has the same limitations mentioned above when an undisturbed wave profile is desired.

More recently, experiments have been performed in which the manganin is imbedded directly into the sample material.[27] In this mode a relatively undisturbed record of the shape of the pressure pulse is obtained. A variety of thin elements have been developed for this purpose. They are typically 0.001" or less in thickness and frequently are in the shape of a grid in order to increase the resistance of the active part of