reproducibility of $^1/_2$ deg F, while the resistance measurement was accurately repeatable to 10 ppm change. Samples were placed in a well-stirred oil bath, and the temperature of the bath slowly raised through the temperature interval desired. When the temperature cycle was completed, a continuous record of resistance changes was obtained. From such records, the accompanying curves were plotted. Thus several spools of manganin were found which had exceptionally good temperature characteristics for the construction of pressure coils.

Gold Chromium. Samples were prepared by either winding the wire on ceramic bobbins or were formed into self-supporting coils, as in the case of the manganin samples. It was found that the gold-chrome wire was quite sensitive to mechanical handling or cold-working. These locked-in strains disappear with extensive baking at 300 F. Subjecting the wire to temperatures of −100 F was found to have little effect on its temperature properties, so the Bridgman cycle, as used in the preparation of manganin coils, was abandoned in favor of extensive baking at 300 F. Care must be taken not to expose the wire to temperatures greater than 350 F, as the material will be many times more sensitive to temperature change after such a treatment.

The gold-chrome wire amalgamates readily with solder, so care must be exercised when the soldering technique is used. Spot-welding is recommended.

Experimental Results. The temperature-resistance properties of a typical sample of gold chrome are shown in Fig. 1. This illustrates the effect upon the temperature properties by extensive baking at 300 F. A temperature coefficient of from −1 to +1 ppm per deg F can be obtained readily over a temperature range of 80 deg F. The sample shown contained 2.1 per cent chromium in gold and was in a dead-soft annealed condition. This appears to be the combination that has the least sensitivity to temperature.

A comparison of the temperature-resistance properties of gold-chrome, manganin, and Advance wire are shown in Fig. 2, all being plotted to the same scale. The advantages of the use of gold chrome over manganin are at once evident. Advance, which also has an excellent temperature property, unfortunately has a very small pressure coefficient.

The properties of alloys containing different percentages of chrome in gold are shown in Fig. 3, from which it is evident that almost any coefficient, positive, negative, or nearly zero, can be obtained by suitable choice of alloy composition and heat-treatment. Hard-drawn wires of all alloy proportions do not respond to baking procedures, but always have a large temperature coefficient. For this reason, half-hard or dead-soft wire is recommended for precision resistors and pressure coils. Half-hard wire will have a 2 to 4 per cent elongation, while soft wire will have 15 to 16 per cent elongation on a rupture test.

Pressure Measurements

Experimental Procedure. The material used in the construction of manganin coils was selected on the basis of uniformity of resistance, and minimum temperature-resistance properteis. The manganin wire was of No. 38 gage, double-silk and double-silk plus nylon-braid insulation. Coils were wound noninductively, using a small piece of spaghetti as a starting form, and were interleaved for several layers. Then the coil was lashed securely with strong thread, forming a firm, self-supporting unit, which could be handled readily for mounting in pressure cells. Although the finished coil appears bulky, its cross section is mostly porous insulating material, allowing pressure fluids readily to penetrate the structure. Where a smaller physical size was required, the nylon braid was omitted, and the coils were wound as before with thin paper between layers to minimize the possibility of shorts. Coils were usually of 60 or 120-ohm resistance.

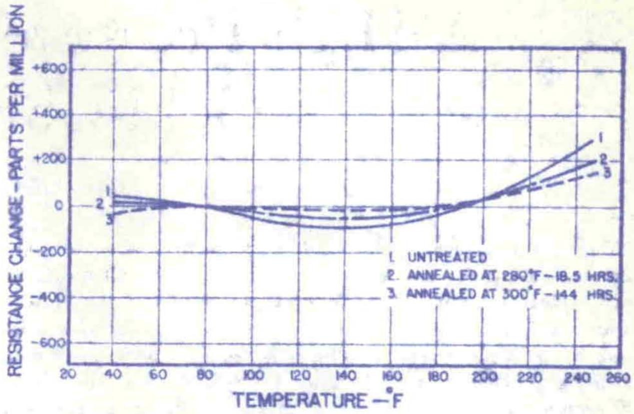

Fig. 1 Temperature Versus Resistance Change of 2.1 Per Cent Gold Chrome

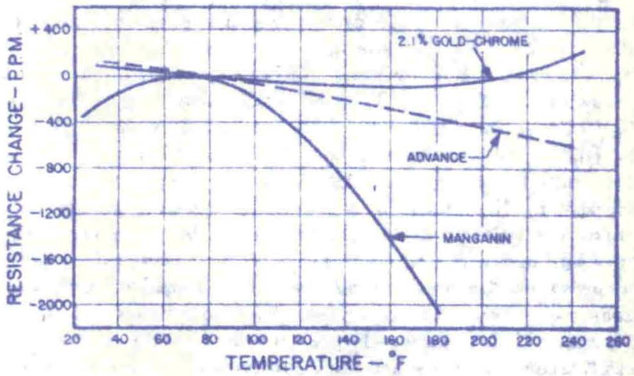

Fig. 2 Comparison of Temperature Versus Resistance Change for Gold Chrome, Advance, and Manganin

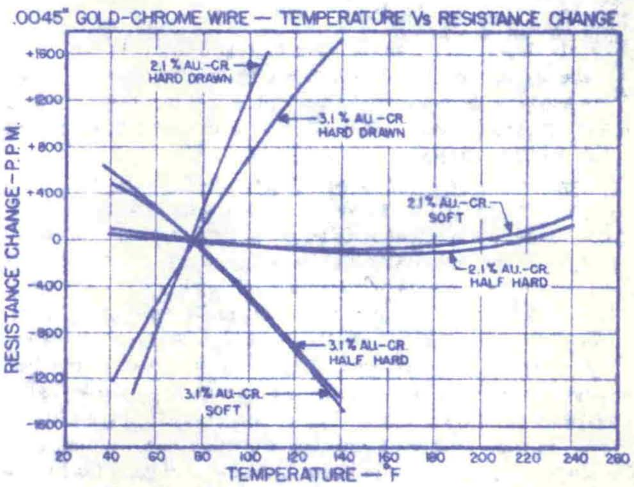

Fig. 3 Temperature Versus Resistance Change for 0.0045-In. Gold-Chrome Wire

Manganin coils were first stabilized by the use of the Bridgman cycle, and then exposed to several applications of pressure to a value greater than that for which they were to be used.

The gold-chrome wire was of No. 36 gage, and was specially covered with a quadruple layer of nylon. Coils also were wound noninductively, starting with a spaghetti core, and using a double layer of onionskin paper between layers to minimize the possibility of shorts and to make a firmer coil. Lacing of the coil with thread, as before, makes a firm structure.