We changed the strength of the magnetic field in various parts of the cylinder and observed that the line discharge would follow the magnetic lines around a rather sharp curvature. This would indicate that the method would be valuable for use with the various complex magnetic-field geometries that have been proposed for controlled thermonuclear heating.

[1] J. M. Wilcox, F. I. Boley, and A. W. DeSilva, "Experimental study of Alfvén wave properties" Phys. Fluids (to be published). See also T. K. Allen, W. R. Baker, R. V. Pyle, and J. M. Wilcox, Phys. Rev. Letters 2, 383 (1959).

Simple Device for Growing Crystals at Low Temperatures in X-Ray Cameras

M. A. VISWAMITRA AND S. RAMASESHAN

Department of Physics, Indian Institute of Science, Bangalore 12, India

(Received December 29, 1959)

MANY pioneering attempts[1–4] have been made to grow *in situ* in x-ray cameras, at low temperatures, single crystals of substances which are liquids or gases at room temperatures. However, it is fairly well recognized at present that the methods that work most satisfactorily, particularly for crystal structure determination, are those developed by Fankuchen *et al.*[3,5,6] and Lipscomb *et al.*[4,7] Both these techniques resort to a cooling of the experimental liquid by controlled streams of air brought down to the requisite temperatures. The present note gives a simple method of growing single crystals at low temperatures, when one is more interested in such problems as temperatures of transformation, lattice expansion, etc. Since this method incorporates all the basic principles essential for growing good single crystals, it proves very efficacious for growing crystals even from liquids which are either viscous or which have a tendency to form glasses. The apparatus is illustrated in Fig. 1.

The crystallizing chamber is attached to a conventional goniometer head by means of a nonconducting Perspex block. A thin capillary, drawn to a point, filled with the experimental liquid is mounted at the center of a brass stud which is surrounded by a small electrical heater (6 w). The whole arrangement can be cooled to liquid air temperatures, by conduction, by allowing liquid air from a Lonsdale flask[8] to drip continuously on a brass receptacle which has two concentric grooves (0.3 cm deep) cut in it. A second heater (12 w) is supported by two legs 1 cm above the lower heater. The brass bobbin of the top heater has a central hole through which passes a copper rod which is in very good thermal contact with the heater. The rod can be moved up and down by a simple helical screw arrangement.

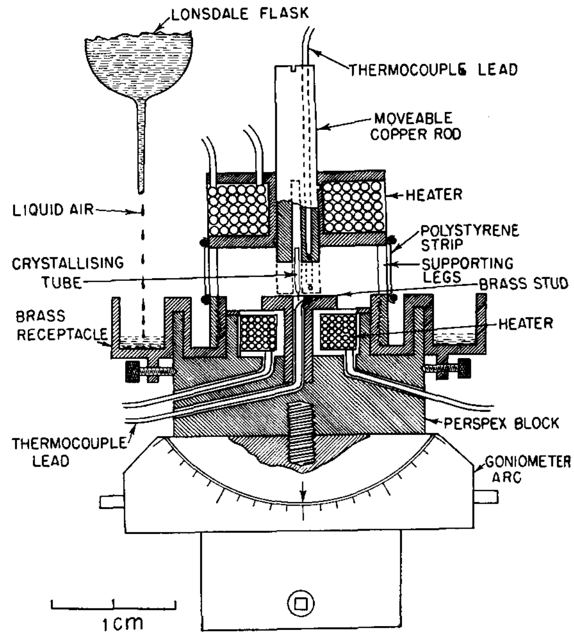

FIG. 1. Sketch of crystal-growing apparatus.

The copper rod has a hole at the bottom such that at its lowest position, it completely encloses the glass capillary. Two iron-Constantan thermocouples measure accurately the temperature at the bottom of the capillary and the temperature of the copper rod. A strip of polystyrene tied in the position shown in the figure not only prevents drafts of air in the crystallizing chamber but also completely avoids the deposition of ice on the specimen. The whole arrangement can be fitted onto any x-ray camera like the Unicam single-crystal goniometer.

The crystal is grown in the following way. The moveable copper rod is kept at its highest position. Liquid air is allowed to fall in the grooves of the brass plate, and it cools the lower end of the capillary to liquid air temperature. The rapidly evaporating liquid cools the upper heater bobbin and the copper rod and consequently the two thermocouples register practically the same temperature. The two heaters are then put on, and the currents are adjusted till the lower thermocouple indicates a temperature 5°C below, while the upper one is 10°C above the freezing point of the liquid. When viewed through a simple polarizing microscope, one finds that the liquid in the capillary has frozen to form a powder. The copper rod is next lowered to the maximum extent melting completely all the solid in the capillary. As the rod is slowly raised, one can view the formation of a single crystal and actually follow its growth. The moment any polycrystal begins to form, the copper rod may be lowered to the required level and the region melted and recrystallized. In this manner single crystals (1 mm diam, 6 mm long) can be grown within 2 to 3 min. Since in this method the freezing isothermal planes in the temperature gradient are not only strictly normal to the direction of growth, but also are maintained perfectly parallel during crystallization, the growing of single crystals becomes an easy and controlled process.[9]

Once the crystal is grown, the experimental chamber can be brought to any required temperature. By a proper adjustment of the currents in the two heaters, it is quite easy to get the same temperature throughout the chamber, the temperature gradient being never greater than 0.5°C/cm.

This arrangement can be used for taking oscillation, rotation, and back-reflection pictures and attempts are being made to adapt it to a Weissenberg camera. The apparatus is extremely economical in liquid air consumption, one liter lasting for almost 2 hr. The apparatus has been used successfully for growing single crystals both above and below room temperature.

It may be remarked, that, using a similar apparatus of larger dimensions, it is quite easy to grow very much bigger crystals at low temperatures for other experimental purposes.

The authors wish to thank Professor R. S. Krishnan for his interest in this work. Thanks are also due the Council of Scientific & Industrial Research, India, for financial help.

[1] M. Ruhemann, Z. Phys. **76**, 368 (1932).
[2] W. H. Keesom and K. W. Taconis, Physica **2**, 463 (1935).
[3] H. S. Kaufman and I. Fankuchen, Rev. Sci. Instr. **20**, 733 (1949).
[4] S. C. Abrahams, R. L. Collins, W. N. Lipscomb, and T. B. Reed, Rev. Sci. Instr. **21**, 396 (1950).
[5] B. Post, R. S. Schwartz, and I. Fankuchen, Rev. Sci. Instr. **22**, 218 (1951).
[6] H. Steinfink, J. Ladell, B. Post, and I. Fankuchen, Rev. Sci. Instr. **24**, 888 (1953).
[7] T. B. Reed and W. N. Lipscomb, Acta Cryst. **6**, 45 (1953).
[8] K. Lonsdale and H. Smith, J. Sci. Instr. **18**, 133 (1941).
[9] S. Zerfoss, L. R. Johnson, and P. H. Egli, Discussions Faraday Soc. **5**, 166 (1949).

Quick Connector for Multipoint Thermocouple Assemblies

Roy C. Kurtzrock

Region V, Bureau of Mines, U. S. Department of the Interior, Pittsburgh, Pennsylvania

(Received December 11, 1958; and in final form, January 22, 1960)

A THERMOCOUPLE connector has been developed for bench-scale application where frequent assembly and dismantling of equipment are necessary. This connector, incorporated as an integral part of a reactor or vessel, will afford ample protection from the disturbances known to affect a thermocouple's calibration. All thermocouple materials can be used without introducing a dissimilar metal into the circuit, and any multipoint contact arrangement can be accommodated. Size and weight reductions afforded by integral design can be advantageous, especially if the reactor is made of glass. Construction is possible in the laboratory, using a small lathe and drill press.

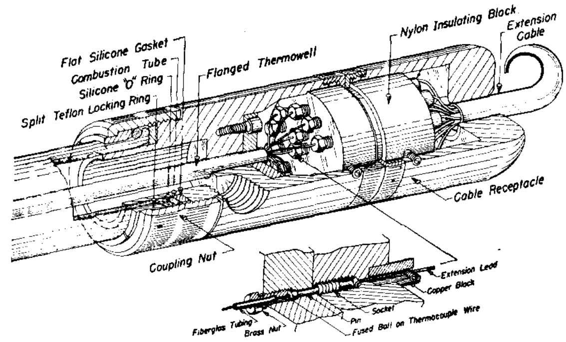

FIG. 1. Breech block with integral connector.

The connector has been used on two types of bench-scale reactors. One reactor is of silica glass, operating at 700°C and atmospheric pressure; the other is of metal and operates at 800°C and 40 atm. The connectors are the same internally except for the number and orientation of the pins. The body details vary according to the application.

The low-pressure reactor consists of a silica-glass combustion tube 30 in. long, with special breech blocks for closing the tube ends. The thermocouple connector (Fig. 1) is an integral part of one of these breech blocks, and the reactor thermowell, containing a six-thermocouple assembly, is attached to the same breech block, providing a totally enclosed assembly. Because each thermocouple is a 2-wire circuit, a connector with 12 pins is required. However, if the installation permits making one wire of the thermocouple circuit common to all the circuits, a reduction in the number of pins and the size of the connector is possible.

The pins (Fig. 1 inset) are made from 8-gauge wire (0.128 in.), with the plug end reduced to 0.093 in. The sockets are formed by wrapping 22-gauge wire, turn against turn, on a 0.090-in. diam mandrel. The insulating blocks are of nylon but could be made of any machinable insulating material. The pins are oriented in the insulating block in a manner so as to make it impossible to insert them in the wrong socket, thus preventing a mismatch of the circuits. The wrapped-wire sockets screw into 8-32 N.C. threaded holes in the insulating block, forming a firm socket that provides positive contact with the pins. The contact resistance of oxidized Chromel and Alumel thermocouple wires when used for the pin sockets was 0.11 ohm for the Chromel wire and 0.07 ohm for the Alumel wire. The use of bright finished wire reduced the contact resistance to 0.05 ohm for the Chromel wire and 0.02 ohm for the Alumel wire. Although the wrapped wire socket forms a simple but satisfactory connection, a solid split-end