There is a definite need in scientific and industrial practice for reliable devices for making high-temperature investigations and experiments. This paper describes equipment and a method for operating high-temperature apparatus developed* and successfully operated in the thermal-mechanical research laboratories of the All-Union Institute of Refractories.

The general view of the apparatus is shown in Fig. 1. It consists of an electric Tamman resistance furnace A, transformer B, a closing device for the furnace C, a device for feeding inert gas D, a microoptical pyrometer E, prisms and prism holder F, and a hauling device for loading and unloading specimens G having an attachment for measuring the temperature of the internal surfaces of the specimens.

The heater and working region of the electric furnace consist of carbon tubing 72/60, 220 mm long, which is tightly sealed into the lid of the furnace (Fig. 2) at two ends of the sleeve clamp made from carbon electrode.

The sleeves made from carbon electrode are used instead of the ordinary copper clamps in the Tamman furnace with the idea of improving the contact of the conducting cover with the carbon tube.

The brass lids of the furnace have water cooled channels. The water is fed from the bottom as shown by the arrow. During heating to a certain temperature, the furnace is covered at the bottom with a gate-valve 2. By rotating

Fig. 2. Electric resistance furnace.

The furnace is connected to the power in the second circuit (about 6 V) with a current in the primary circuit of about 30 amp. At the end of the heating cycle the voltage reaches 11-12 V and the current force 200-180 amp.

Heating the furnace to 2000° is done in 2.5 h. Where necessary the heating time can be reduced to 1.5 h.

The temperatures of the furnace zone are measured from about 800° with a microoptical pyrometer MOP-48 through a fully internal-reflection prism. The pyrometer of this type is designed for measuring temperatures of relatively small incandescent bodies in the range 800-2900° C. The optical system of the telescope provides magnification of 20; the arrangement of remote lenses permits us to measure temperatures at 125-1000 mm. Recording of the temperatures was done with a galvanometer graduated in degrees.

The device for loading and unloading the specimens (Fig. 3) consists of a metal table in whose center there is a fixed pipe 7 which is a guide for the moving pipe 8. The shaft 9 carries pulleys on to which cables 10 are wound connected to the pipe 8. The third pulley carries a cable 11 to which a counter weight 12 is suspended. A shaft 9 carries the flywheel with the handle 13.

At the top of the lifting pipe 8, there is a socket 14 with a sleeve 15 and a gasket 16. The sleeve contains the support 17 for the specimens.

The fully-internal reflection prism is placed on the prism holder over the sighting pipe at a distance of 250-300 mm. When it is necessary during the test to avoid a reducing atmosphere, before starting the test, the inert gas is fed through a rubber hose, through a flow-meter, then through a hose with quartz sheaths, into the channel of the tube with the open end. The gas input is controlled by a reducer.

We now give a description of the method of determining the thermal-shock (spalling) resistance and heating of the specimens. The specimens used to check spalling resistance consist of cylinders up to 35 mm diameter and up to 35 mm high. The specimens are placed on the support made from the carbon tubes of diameter 35 mm. Its height is selected so that the specimen is in the center of the furnace in the maximum temperature zone. The support is placed in the socket 15 of the tube 8 on a filling of corundum.

To prevent air being sucked into the furnace, an asbestos sealent 18 is placed on the gasket 16.

The specimen is rapidly introduced into the furnace at the required temperature with the lifting device, held in the furnace for the necessary time, then removed from the furnace, taken from the support and cooled in air or in water to room temperature. After cooling it is examined, and the state of the specimen determined (cracks, fusion or destruction). Undamaged specimens are subjected to repeated heating and cooling.

The characteristics of thermal-shock resistance of various refractories obtained on the equipment described are given in Fig. 4 and were published earlier [1, 2].