Continuous Melting of Optical Glass

PRODUCTION IN PLATINUM FURNACES AT JENA GLASSWORKS

The development during the last few years of greatly improved optical glasses has necessitated the solution of several problems in their manufacture. Most of these newer glasses cannot be produced by melting in the traditional refractory crucibles since they are liable to attack the refractory material quite actively, and while platinum was the obvious choice for a containing vessel it could not simply be substituted as a crucible material on account of its relatively low mechanical strength at the high melting temperatures involved. Further, the greater cost of melting in small platinum crucibles made this technique uneconomical, and a new approach to the manufacturing method had to be adopted.

Direct Manufacture of Lenses

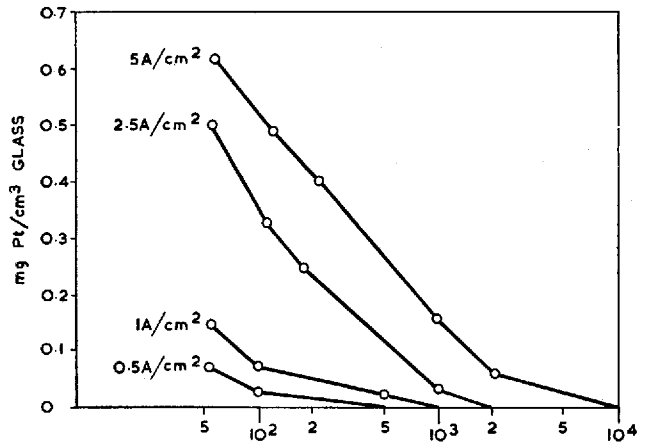
The successful development of new industrial melting processes for these high quality glasses at the Jena Glassworks at Mainz has recently been described by their director of research, Dr Carsten Eden [(*Glastechnische Berichte*, 1961, 34, (3), 120).] The investigation began from the requirement that any new method must not only improve the actual melting technique but must also, by permitting the manufacture of lenses direct from the melting furnace, replace as far as possible the very expensive method of producing semi-finished products from a cast glass.

These considerations led to the continuous melting of optical glass in a furnace completely lined with platinum.

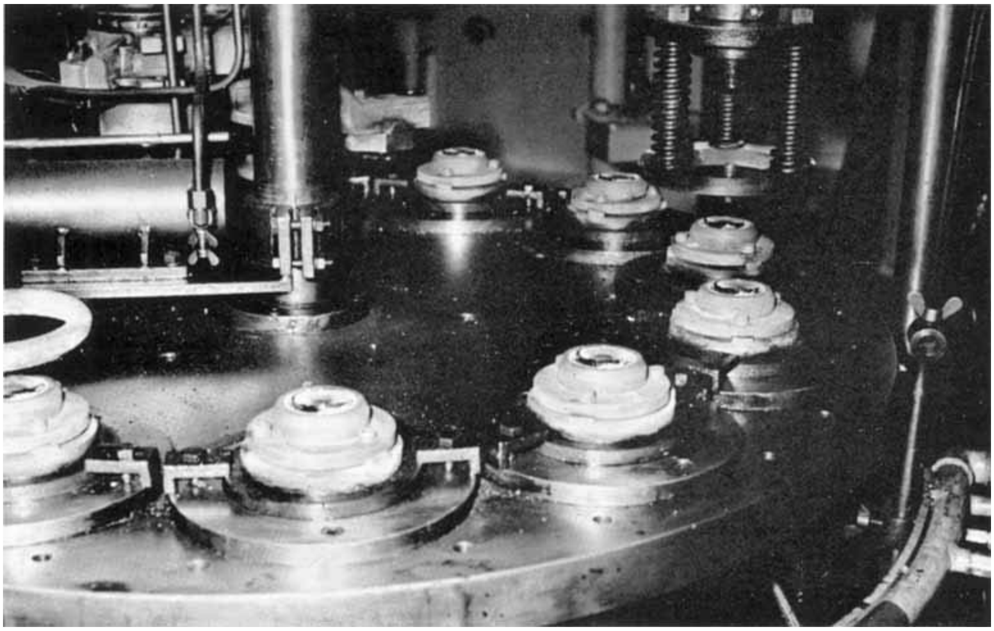
Continuous glass melting units of this kind are naturally not of the size normally associated with the manufacture of window and bottle glasses, but neither are they smaller versions of such large units; the use of platinum was found to allow of completely new constructional possibilities.

High Frequency Heating

The method of heating had also to be changed from the normal gas firing to an electrical method. Radiation, induction and resistance heating were all investigated, and a most interesting study was made of the effect of increasing frequency of the alternating current used for the last method. When normal 50 cycle current is passed through a glass melt



The colloidal dispersion of platinum in a heavy crown glass as a function of frequency for various current densities. Temperature 1290°C, duration of test 30 minutes. At 10 kilocycles per second measurable dispersion of platinum from the electrodes ceases.



An automatic machine in the Jena Glassworks at Mainz for the manufacture of lens blanks direct from the platinum furnace

from platinum electrodes, a colloidal dispersion of platinum is produced, causing an unacceptable contamination of the glass. Research into the physico-chemical processes occurring at the platinum-glass interface showed that this colloidal dispersion is dependent on the migration velocity of the ions in the melt. This made it possible to influence the dispersion by using higher frequencies for the heating current. The results of this study are given in the graph, which shows the amount of platinum dispersed in the glass as a function of frequency for various current densities with a melt of a heavy crown type having a barium oxide content of more than 25 per cent. It will be seen that the colloidal dispersion decreases sharply as the frequency increases, so that at 10 kilocycles per second, even with a high current density, measurable dispersion of platinum ceases. At this order of frequency, furthermore, bubble formation at the electrodes is also eliminated.

Attention was also given to achieving perfect homogenisation of the glass by intensive stirring with platinum paddles. By this means an extremely good cord-free quality is obtained. After homogenising, the glass is cooled to working temperature as evenly as possible and again in contact only with platinum. An automatic machine, shown in the photograph, can then be used to press lenses, having a uniform weight and diameter, direct from the platinum furnace. In addition, the continuous production of glass bars has proved of value where larger pieces of optical glass are required.

Improved Quality of Glass

This continuous method of melting was developed initially for the newer glasses of very high optical quality, but it soon became evident that with this method substantial improvements could be obtained in the quality of a great many types of glass previously melted in refractory crucibles. The use of platinum eliminates all reactions between refractory and the glass melt that give rise to bubbles and cord, while manufacture becomes more economical, especially in the production of large quantities.