NOTES ON SHEET AND PLATE GLASS MANUFACTURE

By EDGAR H. BOSTOCK

The difficulty incident to contributing a paper to the Glass Division of the American Ceramic Society is that practically no technical work was done in glass in this country until very recently indeed; and of necessity all its developments have been commercial, or, more exactly, of the "get things done" method. As the growing needs of our country called for certain glass, we have filled the most obvious and profitable of these needs and have gone on importing glasses more difficult to make.

Even in those industries that we have established, a wealth of raw materials has lured us into wasteful methods and always into quantity and not quality production. It would seem that with the ideal fuel conditions that prevail with us, the best of sands and easy access to alkali productions, with the undoubted inventive genius among our engineers and adaptability of our labor, that we should now be able to make great progress in the production of better goods than we have heretofore produced. Particularly is this the opportune time as news is coming from Europe of the scarcity of labor and raw material over there, forcing up prices and making it possible for us to enter other lines of manufacture before this closed to us.

The writer's life and training has brought him into contact with the manufacture of flat glassware more particularly; and while I am not sure that this differs very much from other branches, still it is true that the chemist and physicist are almost unknown there. The progress made has been almost entirely the work of factory-trained men, and it is only within the last decade that the recently formed large combinations have made a start in the employment of search and research men.

The Sheet Window Glass Industry

The production of sheet window glass is very typical of the entire tale of American production and its future developments. Es-

tablished as a definite industry in the early 1800's according to the best practice of the times, for a century it was a wandering industry following cheap fuel, first the wood of New Jersey and the New York lake regions, then the bituminous coals of Pennsylvania and Pittsburgh, and, in the years succeeding the 80's, the natural gas of Ohio, Pennsylvania, West Virginia, latterly Kansas and Oklahoma. This rapid changing of location did not give time for developments of basic worth, and, with the exception of the adoption of the Belgian tank system of melting in 1888, no changes making for progress took place.

In 1894, John Lubbers, in New Kensington, Pennsylvania, was experimenting in the mechanical handling of cylinders and sheets in the flattening oven, and then conceived the idea of producing sheet glass mechanically. This process was based upon reproducing the methods employed by the hand blower mechanically. Many years and many millions of dollars were spent upon this process before it was commercially a success; but, as it eliminates the cost of highly skilled labor, it is now a great financial success and the process is used here and abroad.

The thought of all those who have studied the problem of sheet glass production always reverts to the drawing or producing of sheets directly from the molten mass without the intervention of any blowing or other process, and a great deal of work has been done and many patents granted and tried. Up to date the most successful would seem to be the Owens Company development of the Colburn process, which is producing glass in quantity and recently in fair quality.

The point to be overcome (other than the production of quality) is the elimination of "waves" in the glass due to it not being perfectly homogenous in the cylinder drawing processes, caused by the strain placed in glass when turned from cylindrical to sheet form, and in the Colburn process largely to the strain marks made when the sheet is turned from vertical to horizontal motion. Extrusion rather than drawing and direct production without turns would seem to be points of attack that promise results if persisted in.

The window glass factories seem to require very little help from the chemist, for with natural gas and excellent materials the writer

has seen glass melted in quality beyond compare. Perhaps they have not found or cared to use the ideal decolorants, and therefore, turn out glass of numerous green, yellowish and bluish tints due to slight impurities in the sands used.

There were, of course, certain specialties in sheet glass imported that recently we have had to produce, and thin, dry plate glass, microscopic slides and covers and similar thin goods are successfully made.

Fluted glass, so largely used in reflected lighting, is being made superior to the usual foreign article. This was flattened in Belgium in kilns heated with artificial gas, which would occasionally deposit a small film of "sulphur" upon the plastic sheet, invisible until the sheet was silvered when it detracted from the reflective value. Our glass flattened by natural gas, whose "sulphur" content seems nil, has a preferable surface.

One problem allied with sheet production so far seems to have escaped us—the making of colored sheet glass successfully. This is a complicated problem, for the chemist's help in furnishing formulas for the making of any and all colors does not entirely solve it. Due to the reheating in flattening a cylinder to a sheet, some queer problems in heat treatment are presented, especially in ruby glasses; and again when these colors are "flashed" or coated upon crystal glass, we have the problem of having the color coat and the body with about the same coefficient of expansion, so that both in working and in use they may stand temperature changes. Moreover, the manual difficulties under the conditions of producing sheets of even thickness are such that we have not yet solved them. At least two firms are bravely attacking these problems.

The Plate Glass Industry

The plate glass industry has been able to make a better showing of progress than most branches of the industry. Of necessity it is organized into large units with large companies controlling them, who have worked for progress. When selected and graded properly, their product leads the world. For glazing purposes it is superior, for melted from a little more refractory material, its

surface is harder and more resistant to abrasion by wind-blown particles or cleaning.

When the need arose our supply of optically perfect plate for instrument work proved ample.

Possibilities of Development

Possibly our greatest progress has been and needs to be the filling of our needs in the many small articles made from sheet glass by reworking. As instances we may mention what is known as non-shatterable or duplex glass for gas masks and eye-protecting goggles, wind shield glass for submarine chasers, airplane cowls, port holes, instrument faces and so forth. The most usual means of production is by welding two sheets of desired thickness with an included sheet of water white pyralin under pressure and steam heat. Why may not this included sheet be any desired color or carry the numerals of any desired dial and in goggles the necessary corrective color for the eyes?

There has been and must be more intensive development of machine beveling for thousands of beveled meter and instrument faces, for the trying of watch glass bevels and similar work.

Drilling for the insertion of posts, pivots and so forth is an important art. Recently the writer had occasion to investigate the large percentage of breakage in drilling flashed glass and was amazed to find how little information was in possession of those engaged in the work.

Production of light-correcting and diffusing glass from sheet glass by means of acid working and staining, whereby absolute control of color is obtained, should be developed.

One development of which the writer is aware promises an entirely new method of production of electric heat, by the use of a glass coated with a metal deposit which will carry a certain type current and heat the glass to any desired point.

The production of glasses for the filtering of different light rays is of great interest, and much work remains to be done in glass to allow only colors true to the spectrum to penetrate, and for the exclusion of ultraviolet and red, and also for X-ray work.

This paper would seem to indicate that we have done no work but that all together commercial; but curiously enough, to ou

credit is the only altogether new note in art glass, that known as opalescent and used in ornamental window work to reproduce absolutely any desired picture. For many years there had been glasses rolled which were mixtures of color with opal, but the late John La Farge doing window work in the 80's wondered if it were not possible to mix colors in glass while molten even as he would mix color on his palette. It was attempted and led to the establishment of a new industry which produced so numerous color and tone mixtures that anything in nature or art might be reproduced.

One of the greatest problems is the production of the proper types of light-directing and diffusing glasses. Prismatic glasses with various angles designed to turn the light into a plane parallel with the floor of any building have been worked out and largely used in practice. However, they are worked up and glazed frequently without reference to these rules, and the great defect to-day, other than this, seems to be that they are usually melted from common green-colored glass when at very little extra expense for decolorizing a clearer glass might have been produced, adding greatly to their efficiency.

Regarding diffusive sheet glasses almost the first study, and certainly the most exhaustive, was given to this during the development of the lighting plan for the Panama Pacific Exposition. All available glasses were studied and while the ideal glass was not made for the desired purposes a fund of knowledge was accumulated.

Two types of diffusive glass would seem to be called for, one with great specular reflection and one with little reflection but the maximum diffusive and transmissive values. A glass of the former type is available but the latter is still wanting.

It was found that the same thing is true of these glasses as was said of prismatic glasses; that no great care had been taken as to the color and luster of the glass. It would seem for the slight expense involved that manufacturers would try to produce a better quality glass in these lines.

Diffusion by means of deflection within the mass, as in varying type of light opal glass carrying deflective particles in suspension, has reached a high stage of development and for light-enclosing purposes works very well.