Platinum in the Glass Industry

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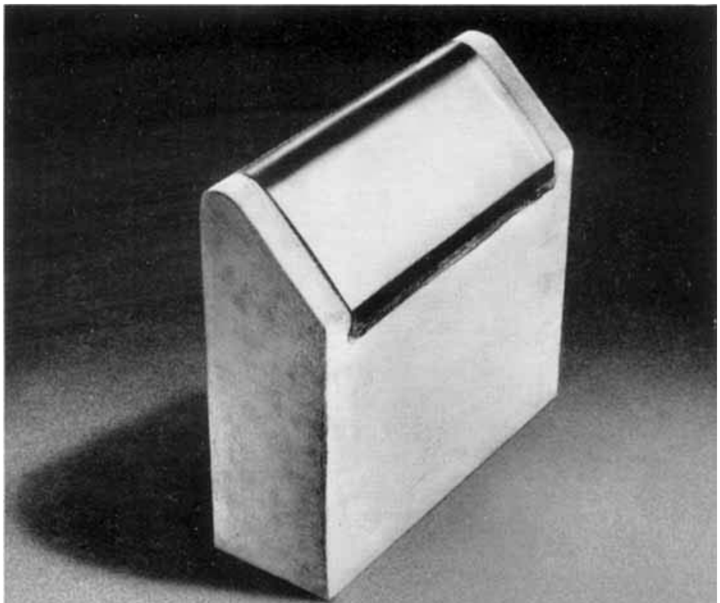
Concluding his article from the January issue of "Platinum Metals Review", Dr Preston deals with the application of platinum and its alloys as a means of protecting refractories from attack by molten glass, with the production of fibre glass through platinum bushings, and with other applications of platinum in glass melting practice.

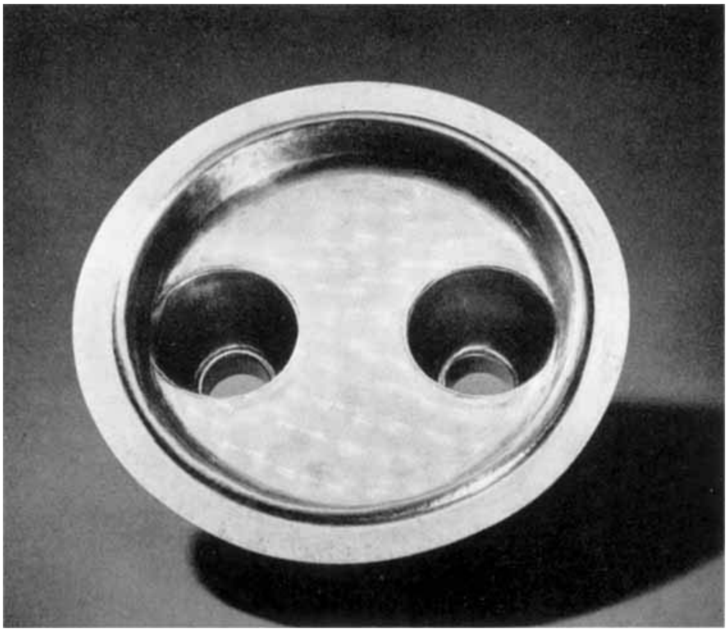
One of the greatest difficulties in the production of homogeneous glass of high quality is the effect of the corrosion of the refractory materials with which the molten glass is in contact. This reacts in two ways; first, solution of the furnace refractories by the glass means a shorter furnace life, and secondly the dissolving of the refractory material in the glass means the introduction of inhomogeneities, stones and cord, which in the later stages of melting and refining are extremely difficult to remove.

Many of the earliest applications of platinum and its alloys on a large glass melting scale were concerned with the protection of certain refractory parts of the furnace, or subsidiary refractory pieces which it was necessary to introduce into the glass for the particular process employed, not so much to protect the refractories themselves, but to remove the deleterious effects in the glass of the solution of such refractories. If, for example, at the gathering point in the working end of a tank furnace from which the glass is gathered by hand, or in a feeder channel just before the exit of the glass to the machines, there is any pick-up from the refractories that glass is very prone to be "stoney" or "cordy" and to give a product of inferior quality.

To avoid the ill effects of late contamination by the refractories, the practice is steadily growing of completely covering cer-



A skimmer block faced with platinum to prevent erosion of the refractory and contamination of the glass



A platinum liner for a double-gob orifice ring

tain essential refractory pieces by sheet platinum or platinum alloy. Typical examples are gathering rings for the production of cathode ray tubes where the complete absence of stones is essential, floaters for glass level indicators, and gates in the Danner tube drawing process, these gates being raised and lowered in the glass stream to regulate the flow of glass to the tube drawing machine. In glass feeders the bowl of the feeder may often be lined with sheet platinum to prevent pick-up of stones at the last moment before the delivery of glass to the forming machines.

In the United States the complete lip of a sheet-glass tank has been covered with platinum to avoid the pick-up of small stones and the introduction of lines in the glass due to an irregular contour of the edge of the lip as the glass stream issues from the furnace on to the drawing table.

In many processes it is undesirable to take what is known as surface glass and it is frequently skimmed before entering the feeder. This is done by means of a skimmer block. There is a danger, however, that the skimmer block, while holding back any surface scum on the glass, may itself be attacked by the glass so that it becomes a source of stones and cord. Such skimmer blocks are not infrequently covered with sheet platinum, as illustrated on the facing page, to avoid their becoming a source of contamination.

Even at the very last moment when, in gravity feeding, the "gob" of glass issues from the feeder orifice to the forming machine, be it a bottle machine or press, the glass may be rendered defective and rejectable by the pick-up of small stones or by the effects of wear on the orifice. In cases where the same orifice size is required for long periods it is economic to cover the orifice plates with sheet platinum as indicated in the illustration above, which shows a platinum covering for a "double gob" orifice ring.

The Manufacture of Fibre Glass

In all cases where platinum or platinum alloy materials are employed in commercial glass manufacturing processes as a component part of the furnaces the object is always the same, to minimise or remove entirely the effects of refractory corrosion which either has an adverse effect on the quality of the glass and the efficiency of the process, or entirely prevents the successful operation of that process with consequent heavy expenditure in stoppages and replacements. There is no more striking example of this than in the modern production of fine fibre glass. It is safe to state that without the use of platinum and its alloys such a process as the production of glass fibre would be one of great difficulty.

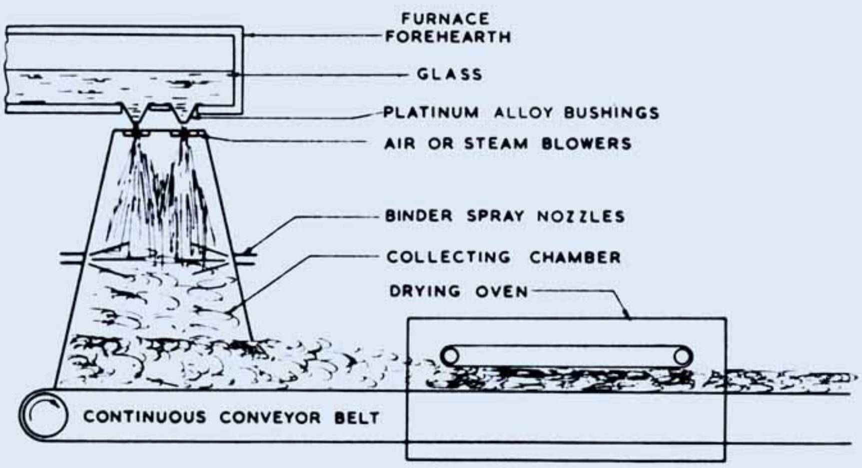
These fibres are often made of a glass completely free from alkali, or containing only a small proportion of alkali compared with bottle and sheet glasses, for the very fine fibres having a great surface to volume ratio are particularly susceptible to attack by moisture unless they are produced from low alkali glass, or are bonded in some way to minimise this surface attack.

Although any glass can be drawn into a fibre there are only about six types of glass compositions in general use for the production of fibres for various purposes. The most important application is as glass wool for thermal or acoustic insulation; next in importance is the textile field, which includes the manufacture of glass fibres for the reinforcement of structural plastics, for electrical insulation, and of yarns for decorative materials; another group of uses is concerned with filtration, while the use of glass fibre is also important in the reinforcement of coal tar or bitumen enamels used to protect buried steel pipelines from corrosion.

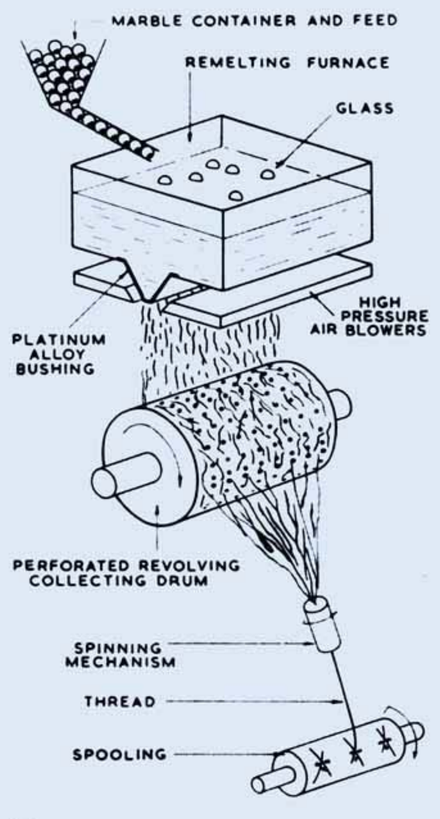
Fibre glass is produced today by four fundamental processes, all of which have in common the operation that by some means the glass is drawn away at high speeds and so attenuated into fine threads. The diameters of the different types of fibres may range from less than 0.0002 up to approximately 0.010 inch depending on their ultimate usage. The processes are:

Air or steam blowing
Flame blowing
Spinning
Drawing

In the blowing process the fibres are produced by the impingement of powerful jets of air or steam on the molten glass stream as it issues from the furnace. The sketch below illustrates diagrammatically the production of glass wool. The glass flows from the furnace through platinum bushings in the form of troughs having a number of small orifices in the base through which the glass emerges. These bushings may be attached to the melting furnace itself, as shown in the diagram below, or may be placed in small



Diagrammatic representation of the operations in manufacturing glass wool



The sequence of operations in the manufacture of textile fibres

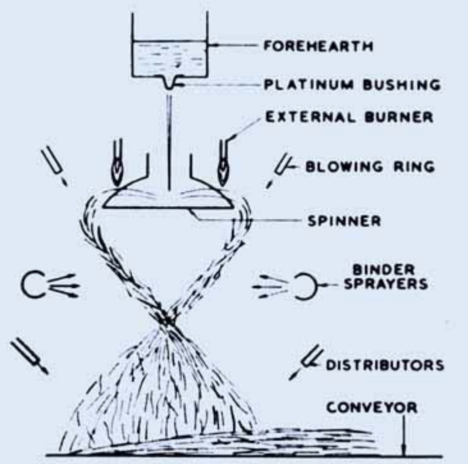
remelting furnaces in which the glass in the form of marbles is remelted. One great advantage of the remelting technique is that the process may be carried out quite independently of the actual glass melting operation.

A binder or lubricant is sprayed into the tangled mass of fibres just before they are deposited on the conveyor belt taking the "mattress" of wool to the drying oven, after which it is cut into pieces of convenient size for storage and dispatch. As much as 100 tons a day may be produced by this technique.

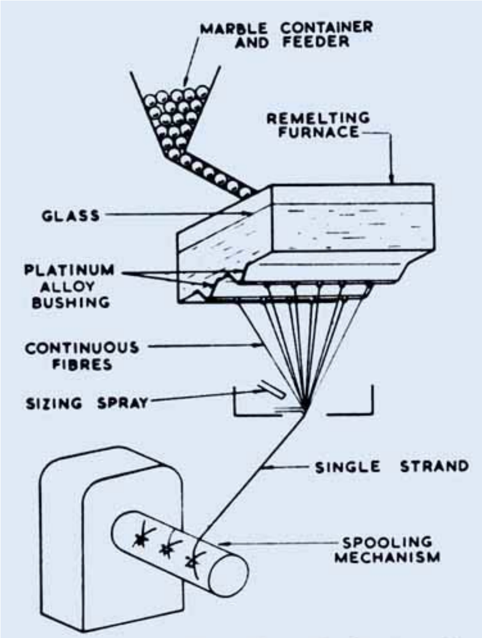
It is calculated that the velocity of the fibres as they are torn away by the blowers may be as high as 30,000 feet a minute, or about 350 miles an hour. These fibres are relatively short, seldom exceeding 6 inches in length, and contain a certain amount of what is known as "shot". The presence of this shot—small spheres of glass—constitutes one of the difficulties in steam-blown fibre glass production and detracts from its insulating and other properties. This comparatively coarse wool contains fibres in the diameter range 0.0003 to 0.0006 inch.

For the production of finer fibres for fabrication into textiles, the remelting technique is generally employed as illustrated here diagrammatically. These remelting furnaces are electrically heated, glass marbles being fed into them automatically to maintain a constant depth of glass. The glass streams which issue from the platinum alloy bushings are again subjected to high pressure air jets which attenuate the fibres to three to four times the length of the coarse wool and having diameters in the range 0.00025 to 0.0004 inch. In this case the fibres are collected on a revolving drum from which they are spun into a single thread, much as in cotton spinning, and wound on to a spool for subsequent processing into yarn.

The flame blowing process differs somewhat from the air or steam blowing technique. In this process individual coarse fibres are drawn continuously by mechanical



The recently developed Fibreglass Crown process for the production of bonded glass fibre insulation material

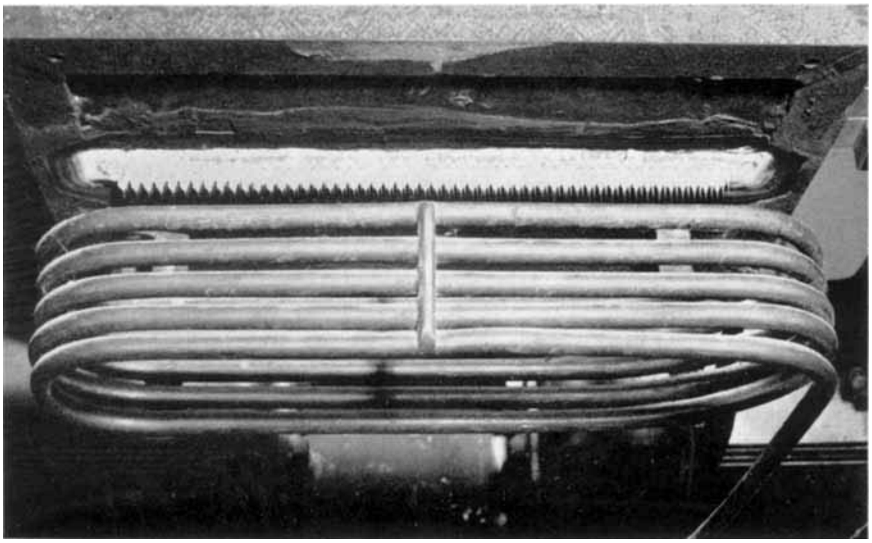


Operations in the mechanical drawing of textile fibre

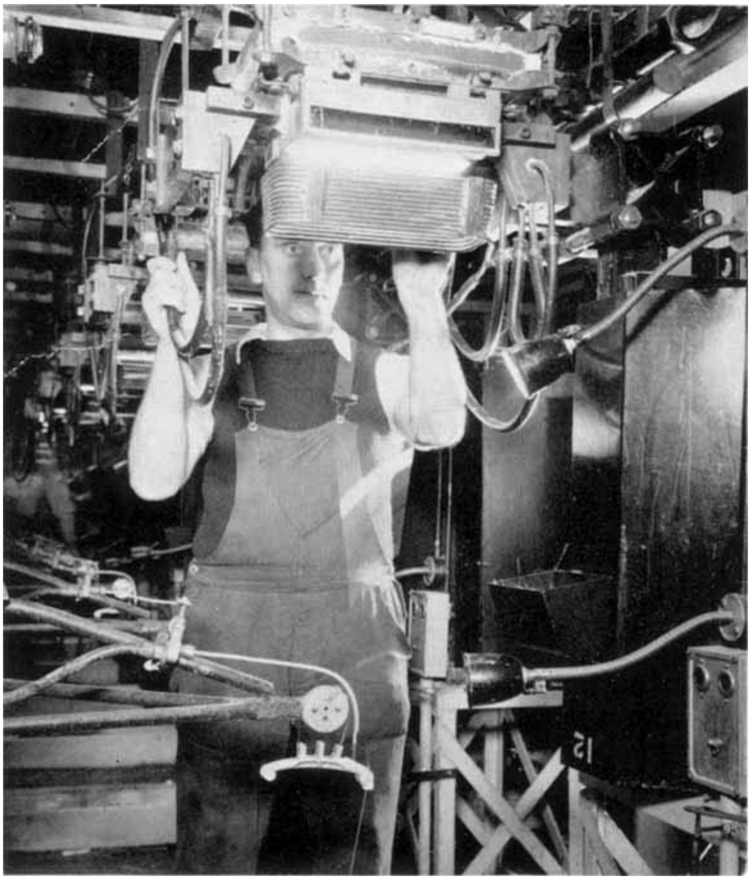
means from the orifices. These fibres are then fed into a chamber where they pass through flames of high velocity. In passing through the flames the individual threads of glass are remelted and the velocity of the flame itself, taking the place of the air jets in the coarse fibre process, draws out the fibre.

From this point onwards the process is essentially the same as the production of glass wool, except that where the very fine fibres are intended for paper making no lubricant or binder is added. Some of the finest fibres, as fine as 0.00005 inch in diameter, are produced by this means and the technique has the advantage that the product is virtually free from "shot" or small glass nodules.

The spinning technique is best typified by a recent development known as the Fibreglass Crown process. Here the fibres are attenuated by centrifugal force. Briefly, the glass issues from an orifice into a rapidly spinning chamber of nickel-chrome steel which has a large number of fine holes round its periphery through which the glass threads are flung. Again platinum plays an essential part in the system. Obviously should the glass issuing from the feeder contain any small stones (inclusions of refractory material) then these will block the minute orifices and in time cause a cessation of the process and demand replacement of the spinner. This process is illustrated diagrammatically on page 51.



A close-up view of glass fibre emerging from an incandescent rhodium-platinum alloy bushing at the Camberley factory of Glass Yarns and Deeside Fabrics Ltd



Continuous filament production in the works of Fibreglass Ltd at St Helens

This process produces a shot-free and finer fibred product than the air or steam blown material. Apart from improving its insulation properties against heat and sound, the product is much easier to handle and has greatly improved resilience.

Mechanical drawing of fibre glass is very largely employed for the production of fibres for the textile and electrical fields, especially in the low alkali or alkali-free glasses. The sequence of operations is shown in the diagram on page 52. Again, the source of glass is preformed marbles which are fed at a controlled rate from a container to the remelting furnace. The molten glass issues as before through the platinum alloy bushings in a number of continuous filaments, about 200 from each bushing, which are treated with "size" and combined into a single strand which is drawn off at high speeds on to a winding tube or spool. The winding speed may be as high as 12,000 feet a minute and the fibre diameter from 0.00025 to 0.0004 inch. "Sizing" is necessary to provide both lubrication and a bond to retain the individual fibres in the strand.

Rhodium-Platinum Bushings

From the foregoing descriptions of the essential process of fibre manufacture it will be apparent that the glass working temperatures are comparatively high and for the accurate maintenance of fibre diameter it is essential that the orifices from which the fibres emerge must remain constant in diameter. The normal refractory materials are therefore ruled out of consideration and rhodium-platinum alloys are universally used

Welding rhodium-platinum alloy bushings in the works of Fibreglass Ltd at St Helens

for this type of glass manufacture. By whatever means the glass is supplied to the final outlet from the furnace, this outlet always takes the form of a platinum alloy bushing or trough, the design of which may vary in detail but the bushing always contains a large number of fine orifices through which the molten glass emerges. An exception is the Crown process in which a single and larger platinum alloy orifice is used to feed the spinner. It is essential to the success of the processes that these fine orifices shall maintain their accuracy of size for long periods at working temperatures as high as 1400°C.

It is difficult to over-estimate the importance of this industry, which has greatly improved the performance of electric motors, dynamos and generators and revolutionised the techniques of heat and sound insulation. Platinum has played a very essential part in the development of the different processes. Even in the best available refractory materials the nozzles would quickly become enlarged by the combined corrosive and erosive effects of the molten glass passing through them at such high speeds and almost daily replacements would be required. The platinum alloy troughs such as those illustrated have a life of many weeks before replacement is necessary.

Large Scale Tank Furnace Melting of Glass

Mention has already been made of the use of platinum alloys in the protection of skimmer blocks and the covering of orifice rings, but there are many other applications in tank melting practice.

One of the most common faults in tank melting is a variation of the level of glass in the tank, which, apart from introducing feeding difficulties, accelerates the wear on the surface of the refractories at the glass surface level. To avoid these ill effects a "glass level controller" is almost invariably employed. This generally consists of a platinum probe which is caused to rise and fall mechanically at a regular rate. As soon as the probe makes contact with the glass surface in the feeder channel the electrical circuits reverse the direction of motion until the probe is ready to descend again. In this way a continuous record of the glass level in the furnace is obtained and to maintain the glass level the controller causes the rate of feeding in of the raw materials to be increased or decreased as required by accelerating or decelerating the speed of the batch charging mechanism.

Platinum-clad Stirrers and Tank Blocks

To render the glass more homeogeneous and thereby obtain better quality and production it is not infrequently the practice to stir the glass in the feeder channel.

The refractory stirrers used may be so subjected to attack by the hot glass in the feeder channel that their object would be defeated if they were not given some surface protection. In the United States perhaps more than in this country the practice has grown of coating these refractory components with platinum or platinum alloy, a sheet of about 0.25 mm in thickness usually being adequate.

Even within the melting compartment of the tank furnace itself platinum alloys frequently find application in protecting vital tank blocks from the combined ill effects of corrosion and erosion. Often the life of a tank is determined by the failure or imminent failure of a particular block or small number of blocks, and the life of a furnace may be considerably increased if protection by platinum sheathing is given to areas such as the throat and bridge wall which separates the melting from the refining end of the furnace.

Two other interesting applications of quite recent introduction are in the provision of electrodes for the technique of electric boosting of furnaces, and the formation of bubbler nozzles for stirring the glass and obtaining homogeneity in the melting end more rapidly than by relying on the thermal movements of the glass which are comparatively slow.

The advantage in using platinum electrodes is that the metal does not dissolve in the glass as occurs when molybdenum electrodes are used, and further no precautions have to be taken against oxidation where the hot metal comes into contact with air.

Platinum Bubbler Tubes

Similar considerations apply to the use of bubbler tubes which if constructed in, or covered with, platinum or a rhodium-platinum alloy stay in position during the life of the furnace and need no replacement, for they are unattacked by the molten glass and there is no reaction with whatever gas is used as the bubbling medium.

Such bubbler tubes are normally placed through the siege of the melting end of the glass tank furnace. It is only the last few inches of the tube, however, which require to be constructed of platinum, for it is made up in much the same way as an all-metal clad thermocouple, the platinum section being then welded to a nickel tube or one of heat-resisting stainless steel. The joint between the platinum and the base metal should be at such a position that its temperature under operating conditions is well below the working temperature of the weld. For example, if the siege block is the usual 12 inches in thickness, then the bubbler tube would be positioned in the block so that the weld comes somewhere within the outer six inches of the block thickness. There is a good mechanical reason for this to avoid deformation of the bubbler tube if, for any external reason causing a failure in the system, it is necessary to remove the bubbler and replace it with a new one.

Enough has been written to show that in the glass industry of today platinum and its alloys are accepted as essential tools in the successful production of a wide variety of glassware from the humble bottle to the finest optical glass. It is a record of more than a century of progress and almost daily new developments and applications are being found.