AN EXAMINATION OF POMPEIAN GLASS.

BY M. G. BONTEMPS.

Window glass, the utility of which is appreciated chiefly in northern countries, does not seem to have been used in remote antiquity. The silence of ancient Greek and Latin authors on the subject is a sufficient proof that it was unknown in their time; and, in any case, the wonderful expertness evidenced in glass manufacture many years before the Christian era, renders it surprising that no one thought of making glass windows. The first mention of them we find in the first century of the Christian era. Philon, a Jew, in the account of his embassy to the Emperor Caligula, has a passage relating to glass windows. On the other hand, Seneca assures us that glass windows were first adopted in his time. These assertions have long been disputed. Certain commentators argue that these windows were nothing but trellises, or a kind of Venetian blind, made of wood; others maintain that they were made of a fine talc, called specular stone; but since the discoveries at Herculaneum and Pompeii, there can no longer be any uncertainty touching this point. The architect Mazois, in his remarkable work on "The Ruins of Pompeii" (Paris, 1814, 1835, four vols. in folio), expresses himself thus (Vol. ii. p. 77, chapter on "Public Baths"):—

"If the question of the use of window glass among the ancients were still doubtful, we should find in this room evidence adequate to resolve it; for here has been preserved for centuries a bronzed sash filled with glass, showing not only the size and thickness of the panes employed, but also the manner of adjusting them. The figures 4 and 5, which give the appearance and the details of the sashes, show that the glass was fitted into a groove, and secured at certain distances by turning buttons, which pressed upon the pane and fixed it. The panes are 20 inches broad (0·54 millimètres), about 28 inches (0·72 millimètres) high, and more than 2 lines (5 to 6 millimètres) thick."

The employment of window glass at an epoch anterior to the year 79 of our era, the date of the eruptions of Vesuvius which buried Herculaneum and Pompeii being ascertained, glass workers became much interested in finding out how these panes, which are of considerable size, were made—whether they were blown into cylinders or plates, or whether they were cast in the same way as a mirror. I could clear up this point only by inspecting the fragments. These panes, which, from their size, could weigh not less than five kilogrammes, if blown could not have been the product of a single lifting of glass; for in this case we ought to be able to distinguish the glass of the different liftings. Were these panes formed by blowing a cylinder, afterward cut and spread out, the bubbles contained in the glass would be long and parallel with the axis of the cylinder. They would have been concentric if the panes were formed from a globe converted into a plate; and if the panes were molded the bubbles could have no uniform direction, but would be generally round and flat. Uncertain when I could go and personally examine the fragments of window glass found at Pompeii, I begged the Minister of Foreign Affairs to ask the Consul of Naples to entrust me with a few of these fragments; and a few weeks afterward the Minister informed me that the intervention of the Consul M. de Soulanges Bodin had been successful; that, in fact, the Superintendent General of the Museums of Naples, M. le Prince de San Giorgio, appreciating the usefulness of my investigations, would be happy to place at my disposal the fragments of window glass found at Pompeii.

These fragments measured ten centimètres, and after their examination, no doubt could remain of the manner in which the panes were made. The glass was cast free from knots and other imperfections; portions were free from bubbles; while in other parts these were present in great quantities, but not all caused by fusion. The thickness of the glass was unequal, in some places being five millimètres thick, and in others only three. This sign alone would not show that the panes were not blown. One surface bore the impression of the floor on which it was laid when hot. This might be the mark of the refractory stone on which the cylinder was spread, but the opposite surface did not resemble blown glass. Moreover, there were other indications yet more reliable showing that this glass was not blown. The bubbles were the result neither of a cylinder nor of a globe spread into a plate. It was evident that each pane had been cast; that this casting had not in some parts been carried sufficiently far; and that in others, on the contrary, the workman having reached the limit in this respect, has returned the glass on itself, and thus led to the interposition of air and the formation of a bed of bubbles. The unequal thickness shows that a metallic cylinder was not used to press upon the glass.

It is, then, probable that a metallic frame of the size of the pane it was desired to obtain—say 0·72 by 0 54 millimètres—was placed on a polished stone, slightly powdered with very fine argil. Into this frame the glass was then poured, taken from the crucible in spoons, probably of bronze, or even with canes, and the glass was pressed with a wooden pallet, so as to make it fill the mold. The ancients then came very near the invention of plate glass, which was not in vogue in France till seventeen centuries later; for they had only to pass a roller over the frames to obtain panes of equal thickness, which would then have required nothing but polishing—an operation familiar to them; for Pliny, in his "History of the World," says that obsidian was used as mirrors, and it is evident that it must have been previously polished.

The Pompeïan window glass is of a bluish green tint, like the common glass fifty years ago. The analysis made for me by M. Fred. Claudet, and of which I can consequently guarantee the exactitude, gave the following result:—

Silica	69·43
Lime	7·24
Soda	17·31
Alumina	3·55
Oxide of iron	1·15
Oxide of manganese	0·39
Oxide of copper	traces
	99·07

This analysis is remarkable, since it coincides exactly with that of the glass now made. In fact, take the analysis of window glass made by M. Dumas, and we find:—

Silica	68·65
Lime	9·65
Soda	17·70
Alumina	4·00

In the latter analysis, perhaps some traces of iron and manganese have been disregarded; but independently of these two elements, it is to be observed that the two analyses are almost identical.

I ought to state that the glass analysed by M. Dumas was not so good as now generally made. The window glass used at present gives on an average the following:—

Silica	72·50
Lime	13·10
Soda	13·00
Alumina	1·00
Oxides of iron and manganese	0·40
	100·00

REFINING PETROLEUM.

The following description of refining petroleum, and crude coal oil is from the *Philadelphia Coal Oil Circular*:—

The crude oils may at once be submitted to chemical treatment; but as a general rule, and especially when they are heavy and contain much tar, they should be first distilled. This distillation is made in a common iron still, protected from the action of the fire by fire brick, which equalizes the heat, consequently the expansion of the metal, and lessens the risk of fracture.

The "change" of oil prepared as above, may be run into the still and distilled without the use of steam. But when it has been "run off" to four-fifths of the whole quantity, or when the part remaining in the still will be a thick pitch when cold, common steam should be gently let into the neck or breast of the still. The steam immediately produces an outward current through the condensing apparatus, and brings over all the remaining part of the oils, leaving a compact coke as the only residuum. Furthermore, it gradually diminishes the heat of the iron and prevents it from breaking. When the steam is thus let in, the fire is to be removed from beneath the still.

Common steam under moderate pressure has been introduced into stills, both above the charge and into it throughout the entire distillation. In the latter instance the steam soon becomes superheated after the lighter oils have been run off. Again, steam previously superheated is driven into the charge during the distillation, and for the distillation of the heavy oils and paraffine this mode has the preference; yet steam is advantageous however applied. When it is superheated the condensing apparatus should be extensive.

In the first distillation of the crude oils, as they come from the retorts, and in subsequent ones, the oils may be slowly admitted into the stills after it has become sufficiently heated and the oils begin to flow freely from the worm or condenser. By the adjustment of a cock, a stream of the crude product may be permitted to flow through an iron tube into the still while it is in operation. The tube should dip beneath the oil in the still, the in-flow of oil into which must not exceed the out-flow from the condenser. A greater amount of heat will be required for this operation than for the common method, as much of it is taken up by the cold oil constantly flowing inward. By this mode a still working 1,000 gallons may be made to run double that quantity without interruption, and steam may be applied in any manner before described.

The first distillate of the crude oil should be separated into two parts, each of which requires somewhat different treatment. The first part is that which distills over from the commencement of the run until the oils in the receiver have a proof of 30° by hydrometer, or a specific gravity of 0·843.

These light hydro-carbons and the eupion they contain, form the lamp oil. The quantity produced will depend upon the quality of the coal, or, whence they have been derived. This part of the distillate being pumped from the receiving tank, the remainder, or second part, is allowed to flow on till it assumes a greenish color at the end of the worm pipe, when steam, if not previously employed, may be let into the still and continued until the whole distillation is completed; the fire in the furnace beneath the still being withdrawn. A quantity of coke will be found to remain, amounting to ten or fifteen per cent of the whole charge. When steam is not employed in the residuum the still must not be run down lower than a thick pitch. Coking in the still without steam is unsafe and hazardous to the iron.

The first part is then to be placed in an iron cistern, and therein thoroughly agitated from one to two hours, with from four to ten per cent of sulphuric acid, the object being to bring every particle of the impurities in contact with the acid. The quantity o acid to be used depends upon the character of the oils.

If two much acid is applied the oils will be partially charred and discolored; if two little, the impurities will not be oxidated, and the oils will change color. After the agitation of the oil and acid is completed, the mixture must remain at rest from six to eight hours, when the acid, with the chief part of the impurities, will have settled to the bottom of the vessel. They are then to be drawn off, and the remaining oil to be washed with ten or twenty per cent of water. The water removes a part of the remaining acid, and carries off the soluble impurities. After the water is withdrawn the charge is to be agitated two hours with from five to ten per cent, by measure, of a solution of caustic potash, or soda of specific gravity 1·400—caustic soda is generally preferred. Like the acid, the strength and quantity of the alkali must be varied according to the quality of the oils. After a repose of six hours or more, the alkali is to be withdrawn from the oil, and further impurities washed out with water. When the water is withdrawn from it, it is to be run into a still for final rectification. During the whole of these operations the oils and the several washes applied to them are to be kept at a temperature not lower than 90° Fah. This is done by means of steam coils fixed at the bottoms of the tanksin which the agitations are made. Finally, the oil is to be carefully distilled, with or without steam. A small quantity of the lightest product or eupion, which comes first from the condensing worm, is usually discolored, and may therefore be transferred to the succeeding charge.

The last distillation should be made slowly and with care, avoiding all fluctuations produced by an unsteady heat. If desired, the eupion may be taken off at the commencement of the distillation. It