Starkey Patent No. 736, 1879 is a wire-anchored stopper of earthenware or wood recessed on the underside of the head to house a rubber washer used to seal onto the finish lip (c. 1880-c. 1920).

B.C. and D. Cross No. 3548, 1892 is a cork lined metal capsule fitted with lugs which are made to engage an undercut moulding in the reinforcing collar when pressure is applied.

Felton and Grimwade Patent Nos 4333/4, 1893 relate to a glass stopper with a circular rubber washer in the lower face, sealing onto the lip by an external screw or swing-stopper fitting (c. 1893-c. 1920).

Examples of the Horner, Langley and Felton & Grimwade finishes have been found in Australia.

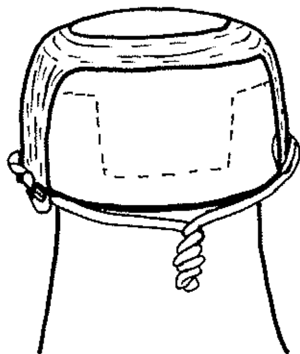


Figure 84. Horner patent.

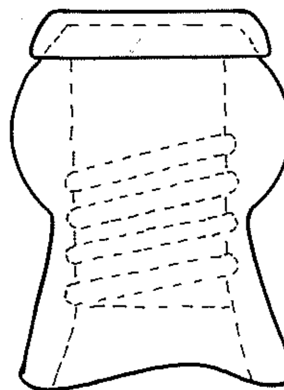


Figure 85. Langley patent.

5.11 Identification

The introduction of various forms of finishing tool (Figs 60, 73, 76), and of semi-automatic and automatic machines, resulted in the wide range of special finish designs outlined in Sections 5.2 – 5.10. Many of these are identifiable by **close inspection** of the lip, bore and neck of a bottle. Such identification of the form of closure often provides the most useful guide to the period of its manufacture and use.

Some changes, such as those for the anchoring and reinforcing collars and reinforcing on common 'black' wine bottles, took place over a period spanning up to fifty years. Thus, conclusions concerning their period of use are general. In other instances, for example, the adoption of the Codd, Lightening and Crown seals in the 1870-1900 period, where there is clear evidence of their immediate adoption after (and not before) patenting, it is often possible to place a precise limit on their age. The delay in introduction of these patents, such as those for milk bottles, may also be known.

In attempting to use the preceding evaluation of finishes, it is necessary to appreciate that widely differing forms of reinforcing or anchoring collars or

beads, moulded by hand, finishing tool or machine, were in use for different purposes at any one time.

Also, in common with other moulding methods, some applications in clear and coloured glassware were sometimes well ahead of similar developments in common bottles. Here again, there are likely to be advantages in giving closer attention to clear and coloured, as distinct from common 'black' glass artefacts.

6.0 FORMING AND MOULDING METHODS

In addition to the traditional methods of forming and moulding glassware (with or without aids) outlined so far, there are several alternative methods. These techniques are normally known by the names of the major process or processes used and are placed below in chronological order:

Pressing
Press-and-blow
Blow-blow
Suction

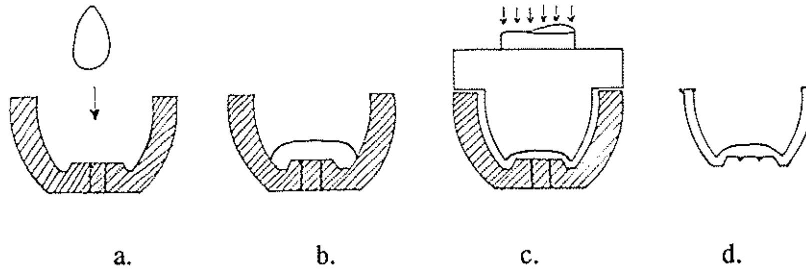
Each can result in a slightly different arrangement of mould seams and other characteristics, which may be used to identify the moulding method and on occasion place some limitation on the age.

6.1 Pressing

Small pressed glass cups and amulets are said to have been made in Egypt as early as 1400BC (Ref. 74). Similar examples of pressed glass have appeared from time to time, in common with the possible use of engraved moulds (11, 15, 17, 23, 29, 31). Some pressed glass stoppers were also made for decanters in the eighteenth century (Refs 62, 74). Indeed, Jarves (Refs. 59, 62) claimed that in the eighteenth century he imported pressed Holland salts and English candlesticks and table centre bowls '*plain, with pressed square feet, rudely made*' into the U.S.A.

However, the major modern development of this technique took place in the U.S.A. in a series of patents relating to the manufacture of glass door knobs in the period 1825-33, soon after the development of decorated figured 'historical' flasks from engraved moulds (Ref. 74).

6.1.1 Principles of pressing glass. The basic principle (Fig. 86) is very simple, as indeed was the original form of press in Apsley Pellatt's 1849 *Curiosities of Glass Making*. This type was followed successively by the side-lever press (1854) which exerted much higher pressure through a toggle; a steam-operated press (1864); a revolving table carrying several press moulds below a press head (1871); and various forms of fully power-operated mechanical presses (1873-75).



a. Hot glass drops into the mould
b. Glass settles
c. Plunger descends and the glass is pressed
d. Finished article with mould seam at lip

Figure 86. Basic principles of glass-pressing.

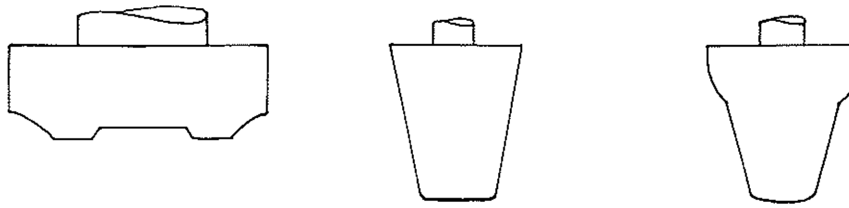


Figure 87. Typical plunger shapes for glass pressing - all have tapered sides.

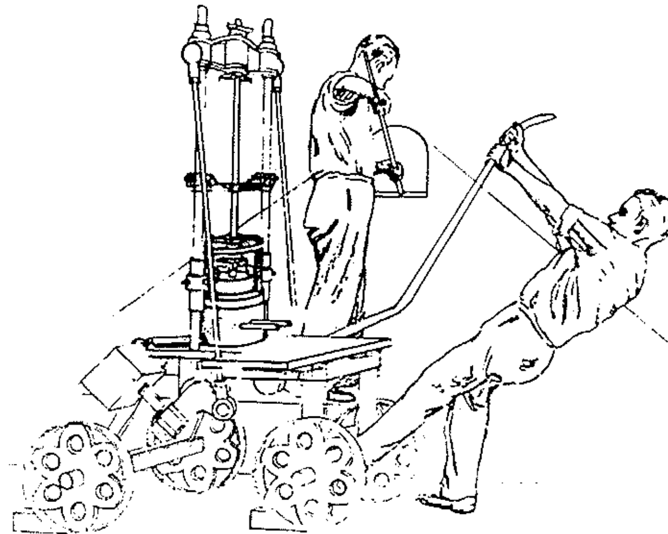


Figure 88. The side-lever press. (E. Meigh, *The Story of the Glass Bottle*, p. 32.)

The counter-weighted lever and spring-controlled upper plate (Fig. 88), and later modifications, do not alter the basic simplicity of this technique. It requires a regulated quantity of glass to be placed between the lower, patterned mould and a smooth, upper plunger. The precisely shaped and

patterned article is formed when the plunger is pressed down onto the hot glass in the patterned mould.

Figure 89. Round-edged appearance of pressed glass decoration under magnification.

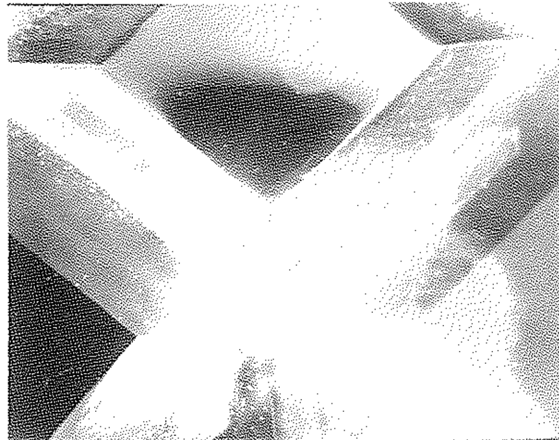


Figure 90. Sharp-edged appearance of cut glass decoration under magnification.

6.1.2 Identifying features. There are three identifying features of pressed glassware:

* All pressed glassware has a smooth internally tapered surface formed by the smooth plunger. The shape can vary (Fig. 86), but must allow the plunger to be lifted vertically out of the body of the pressed glassware (Fig. 87).

* All pressed glass articles have a mould seam at the upper, outer lip (Fig. 86d). Frequently, with high machining standards and the blending of the seam into the complex engraved designs on the outer surface, it is difficult

to locate and identify. A lens or finger-nail across the surface may be needed.

* The decorative designs appear on the outer surface and are all formed by the engraved outer and lower mould. The pressed glass decoration has a rounded-edge appearance (Fig. 89) due to the surface tension of the original hot glass. It is recognisably different from that of cut glass (Fig. 90) particularly when it is inspected under a lens. The rounded edges tend to distort and blur the reflected light so that the whole piece does not have the brilliance of cut glass.

  The flat-sided sharp-edged appearance of cut glass decoration will usually be distinguishable from that of pressed glass even if the glass has been buried for more than two years in damp conditions subject to the action of microbes which leach and round sharp edges.

  Within the above limitations on plunger design, pressing is quite a versatile process and split hinged moulds (Fig. 91) with additional vertical seams and complex fitted moulds with several seams are possible. All have the common features of a tapered plunger and a mould seam at the lip.

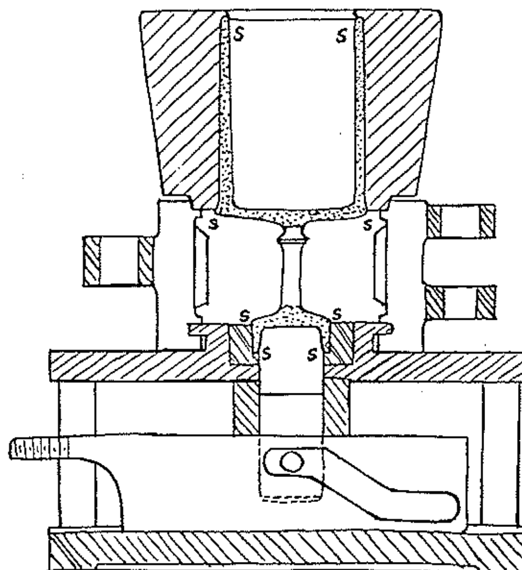


Figure 91. A student's diagram of a more complex press mould for a stemmed goblet (1937) with a lift-off cylinder, hinged shell-mould and push-up device. The mould seams correspond with points 's', together with two vertical seams down the stem.

With both simple **block moulds** (Figs 86, 87) and more complex moulds, a common feature is a push-up ejection device (Fig. 91) in the centre of the base which often leaves a small circular mould mark.

6.1.3 Imports and manufacture. The import of cheap pressed glass from the U.S.A. made the same great impression in Australia as it did in Europe. It was announced in block letters in sales advertisements in the Sydney Gazette in 1835. The first imports were highly decorated cruets (S.G. 14.2.1835, p.3, 19.3.1835, p.3). The development of pressing was closely linked with the increased use of engraved moulds. (See Section 4.4.5) Early moulds were of brass as cheaper cast iron moulds gave a rough surface finish. An iron mould was patented in 1821 (Ref. 66) and Ricketts evidently used cast iron three-piece bottle moulds (British Patent No. 4623, 1821) at that time (Ref. 17).

Figure 92. A selection of tableware, milk bar and restaurant glass (mainly pressed) made by Crown Crystal Glass Co. Waterloo (1920s-1960s) from the Crown Corning Collection. (Reproduced by the kind permission of the Trustees of the Museum of Applied Arts and Sciences.)

In Britain, pressed glassware started to replace the more expensive free-blown crystal tableware in the period c. 1835-c. 1865. The introduction of chilled cast iron moulds in 1866 (Refs 48, 66) resulted in cheaper, high quality engraving. From that time there was a rapid increase in the use of engraved moulds for the manufacture of a wide range of decorative lead crystal and common soda-lime-silica glass tableware.

The use of pressed designs expanded rapidly. Some three-hundred pages of diverse pressed designs of over seventy American companies and their detailed historical background, are summarised in A.C. Revi's *American Pressed Glass and Figure Bottles* (Ref. 74).

The corresponding expansion in Britain occurred mainly on the north-east coast. Three companies, Davidson, Greener and Sowerby-Ellison, manufactured and exported immense quantities from c. 1860-70 onwards to Australia and other parts of the world. The Sowerby-Ellison factory, which commenced in 1855, was described in 1882 as the largest pressed glass factory in the world.From c. 1876 onwards these three plants usually marked their products with small embossed trade marks about 6 millimetres ($^{1}/_{4}$ inch) long. Many of their designs were patented and also showed an embossed diamond registration (dating) mark (see Appendix 2).

Marjorie Graham (Ref. 55) provides many examples of imported and locally manufactured pressed glass and also a detailed appendix on Crown Crystal pressed glass products, similar to the selection illustrated in Figure 92.

The identification of pressed glass artefacts on an Australian site thus provides a definite time restraint (after 1835) but designs are so diverse that a case history approach is usually required to date individual examples. Many such Australian artefacts will date from c. 1860-70 when there was a large expansion in the production of pressed glass in Britain.

6.2 Press and blow

Free-blowing, two and three-piece moulding and turn-moulding of common bottles continued throughout the nineteenth century. These methods were gradually superseded by semi-automatic and finally fully automatic machine production in the period c. 1890-c. 1920. The glass industry was probably one of the first in the world to achieve full automation from raw materials to finished product.

6.2.1 Principles of press and blow. The first major concept of this process, described in an American patent by Arbogast in 1882, was the pressing of the finish and half-formed parison of a wide-mouth jar in a narrow funnel-shaped two-piece mould and its transference to a second larger and wider two-piece blow-mould. It was then blown to its final shape using compressed air (Fig. 93). Arbogast's press-and-blow technique was not commercially successful until 1893 (that is, after the blow-and-blow method described later). At that time the Enterprise Glass Co. took out a license under the patent and developed a machine to make wide-mouth Vaseline jars (Ref. 66).

An important improvement, based on the British patents by Windmill (1886) and Rylands (1889) and already in use, was made in 1896 by Charles Blue for the Atlas Glass Co. It allowed the press mould to fall away and leave the glass hanging within the final blow-mould (Fig. 93).

6.2.2 Identifying features. Press-and-blown bottles have wide-mouths, usually above 38-51 mm ($1^{1}/_{2}$-2 inches). They show the double parison and blow-mould seams, typical of a machine-made bottle (see Section

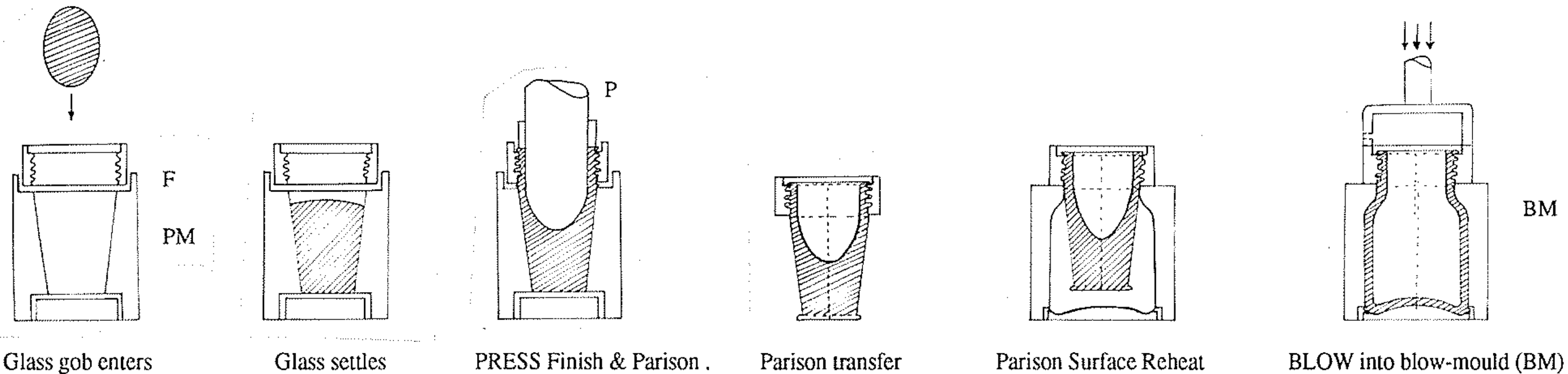


Figure 93. PRESS and BLOW forming sequences for machine-made containers.
F = finish mould, P = plunger, PM = parison-mould, BM = blow-mould

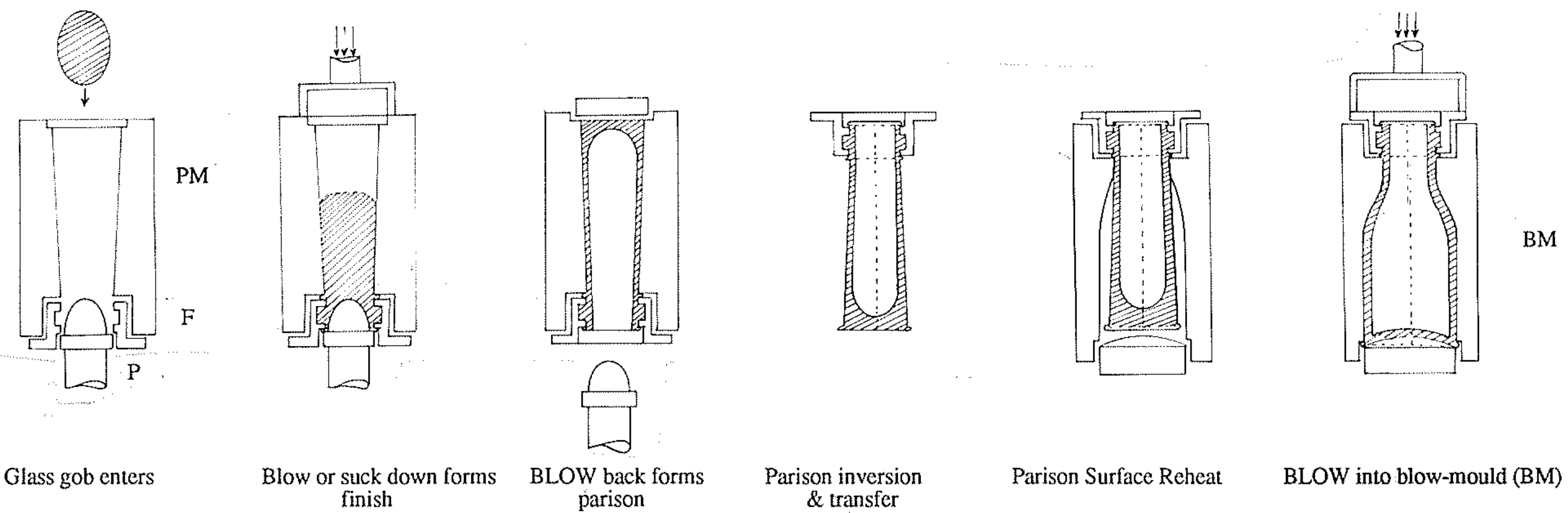


Figure 94. BLOW BLOW forming sequences for machine-made containers.

6.5). In particular, the inner join (IJ, Fig. 8b) of the traditionally made bottle is absent, the finish and body of the bottle being one continuous piece of glass.

6.2.3 Manufacture and imports. One 'Blue Machine' was in operation in Britain by 1900 while many were in use in the U.S.A. particularly for producing Atlas and Ball Bros fruit jars. The adoption was quite rapid and rose to between 167 and 233 press-and-blow wide-mouth machines in the U.S.A. between 1906 and 1917 (Refs 33, 34). A similar type of machine was developed by Schiller in Germany in 1905-07.

Arnold states that Mount, the governing partner of the Melbourne Glass Bottle Company, visited the U.S.A. about this time (c. 1895-1900) and imported two hand-operated wide-mouth machines that used compressed air (Ref. 41). Presumably these were for bottling jars, in which the company was then very interested (Patents 4333/4, 1893 to Felton, Grimwade and Mount). By c. 1906 they also had a press machine for making glass liners (Fig. 82) for bottling jars. Murray & Vader (Ref. 69) also claim that Vance and Ross (1904-15) machine made an improved Mason bottling jar. These local details require more precise verification.

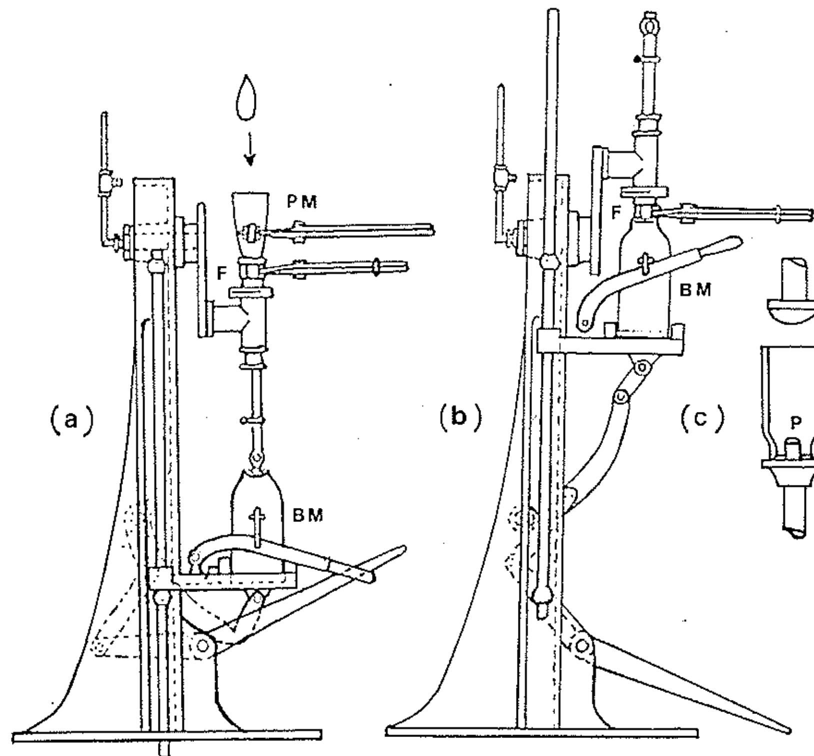
As American preserving jars were imported and widely advertised between 1880 and 1900, press-and-blow type jars, both imported from Britain (Rylands), the U.S.A. or locally manufactured in Melbourne, may well be found in Australia from their inception i.e. from c. 1890-95 onwards.

6.3 Blow and blow

The British patents by the engineer Ashley in 1886-89, followed up the much earlier suggestion of the local village postman, Josiah Arnall to Edgar Breffit, of the Aire and Calder Glassworks, in 1866, to entirely reverse the bottle-making procedure used by hand-workers (Ref. 12).

6.3.1 Principles of Blow and blow. The finish, narrow mouth and bore, which were previously made by the laborious process of applying additional hot glass to a bottle supported on a pontil or holder, were formed first (not last), around a small plunger (P) in a two-piece finish-mould (F) (Fig. 95). Secondly, after withdrawing this plug, a pre-form parison shape was blown by compressed air in a two-piece funnel-shaped parison-mould (PM). Finally, after inversion, whilst being held by the finish of the half-formed bottle, the pre-form was blown to the final shape in the two-piece blow-mould (BM) (see Fig. 94). In the original form of this machine (Fig. 95), its various parts were mounted on a vertical plank, hence its popular name of the 'Ashley Plank' machine. The glass was hand-gathered and fed into the parison-mould (PM). Both the finish-mould (F) and parison-mould had long pincer-like handles for their removal by hand at the appropriate time.

6.3.2 Identifying features. These bottles have a narrow mouth, usually less than 38 mm ($1^1/_2$ inches). They also have the double mould seams, finish-mould seam and absence of an inner join (IJ, Fig. 8b), which is typical of all machine-made bottles (see Sections 6.2.2, 6.5).



P = plunger F = finish-mould BM = blow-mould PM = parison-mould

Figure 95. The Ashley 'Plank' blow-blow machine.

6.3.3 Manufacture and imports. Although Ashley disclosed the basic semi-automatic blow-blow procedure in 1886-89 and his company operated twenty-two machines in Castleford, Yorkshire, before 1894 (Ref. 21), his machines and their developments, were largely brought to commercial success between c. 1894 and 1914 notably by Cannington Shaw, St Helens, in Lancashire, Bagleys, Lumbs, Rylands and Kilners, all in South Yorkshire. They were developed further by Horne (U.K. 1897), Boucher (France, 1897), Simpson/Bradshaw (U.K. 1901), Schiller (Germany 1903), and Sweeting/Hardman (U.K. 1923). In excess of seventy-nine such machines were in operation in fourteen companies in Britain by 1907 and one company was operating almost entirely semi-automatically by 1914 (Ref. 33). Although the Owens suction machine was in use by 1904, blow-blow methods were not used in the U.S.A. until 1908 after which the number of these machines then rose rapidly from 19 in 1909 to 292 in 1917 (Ref. 34).

It seems reasonable to suggest that the Melbourne Glass Bottle Works and Vance and Ross in Sydney used a form of these semi-automatic

blow-blow (as well as press-and-blow) machines from c. 1905 to 1918. After the consolidation of the Glass Manufacturing Company with Vance and Ross in 1915, Mr. W.J. Smith and Mr. W. Kennedy of Australian Glass Manufacturers visited the U.S.A. in 1917 (Ref. 90). On their return they installed rotary four-blank, four-mould, gather and trip 'Boy' machines which commenced operation in 1918. These machines only required one 'boy' to gather and then trip the machine, thus bringing Australia close to American and European practice at that time.

6.4 Suction (suck-and-blow)

The third major development in forming and moulding methods was by Owens in the U.S.A. in which a fixed quantity of glass was sucked up by vacuum into the two-piece parison and up into the two-piece finish-moulds and around the plug, directly from the molten glass surface in a specially constructed part of the melting furnace.

The hot glass was sheared off by a rotating knife blade below this parison-mould, leaving **the major identifying feature** of a shear scar (Fig. 96). Finally, this hot pre-form or parison shape was blown by compressed air into the blow-mould. Apart from the method of filling the parison and forming the finish by suction, the process and identifying features are identical to the preceding blow-blow process.

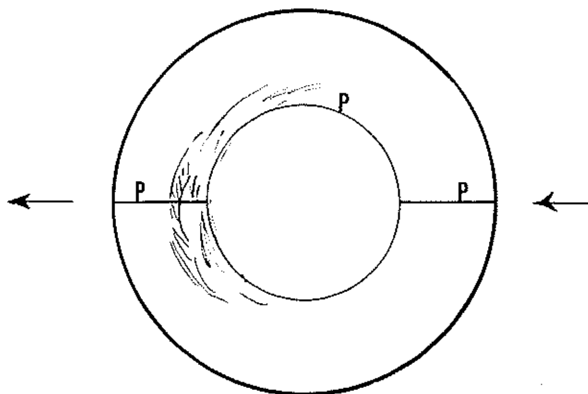


Figure 96. Suction scar on bottle base resulting from the smearing of hot viscous glass by cut-off knife below parison-mould.

P = parison-mould seams
<- = Direction of original cutting causing scar.

The initial work on this project began in 1898 using a simple piston in a cylinder, attached to a plug and parison-mould assembly. This led very rapidly to the development of a highly successful six-arm rotary machine in 1903 and later to multiple-arm machines, many of which continued in operation until c. 1940-50. By 1911 over one-hundred Owens machines produced more than four-million bottles per year in the U.S.A. alone and there were 172 machines in operation in North America by 1913. Owens set up a machine in the Trafford Park area of Manchester in 1906, followed by an organisation which resulted in forty machines operating in ten European countries by 1913 (Ref. 34). Owens machines were never used in Australia probably because of the high capital cost.

While the degree to which semi-automatic machines were used by Australian Glass Manufacturers and others between c. 1900 and 1918, does not appear to be well-documented, the same does not apply to the use of hot glass feeders. These successfully formed and sheared pieces of hot glass (gobs), flowing from a controlled orifice in a specially constructed part of the smelter called a 'feeder-channel', and fed them successively to the parison-moulds of machines. These 'feeders' ensured that previously semi-automatic forming machines could be made fully automatic and operated without hand-gathering on a blow-pipe.

The forming of glass bottles finally ceased to be a craft-based operation and commenced to be a fully automatic engineering process. The first paddle and needle feeder was purchased by Australian Glass Manufacturers from the Hartford Empire Co. in the U.S.A. in 1918 (Refs 33, 34), thus comparing favourably with the adoption between 1914 and 1918 of Rankin, Miller, Peiler and other feeders overseas.

These three semi-automatic, or fully automatic, press-and-blow, blow-blow, and suction methods are usually referred to as the machine-made processes, in that bottles produced by these methods differ in several respects from those made by the older hand-made processes.

6.5 Characteristics and dating of machine-made bottles

Based on the preceding historical outline and the detailed assessments by Turner (Refs 33, 34) and Moody (Ref. 21) of the development and application of bottle-making machinery, Table 5 summarises the first likely dates of finding machine-made bottles or jars in Australia, from the three main sources of Europe (mainly Britain), the U.S.A. and local manufacture.

TYPE	ex EUROPE	ex U.S.A	ex AUSTRALIA
Wide-mouth jars (Press-and-blow)	1890-2	1892-4	1895-1900
Narrow-mouth bottles (Blow-blow)	1890-95	c1910	c1910-15
Narrow-mouth (Suction)	c1910	1904-6	None

Table 5. Summary of likely dates of first appearances and origins of machine-made bottles on Australian sites.

The identifying features of machine-made bottles are illustrated by a modern wine bottle in Figure 97. They follow from the use of the two-piece parison and blow-moulds and two-piece finish-mould and plug assembly given in Figures 93 and 94 and are:

* The finish of the bottle is an integral part of the neck and body (Fig. 97a). There is no inner join (Fig. 8b) of glass added to make the finish, as in hand-made bottles and the bore is smooth and has no uneven ridge corresponding to a join of added glass.

* The finish does not have turn or tool marks (Fig. 8a). The surface has the same appearance as the rest of the neck or body, as both have been moulded.

* Looking down on the top of the container, the finish has two concentric circular mould seams: one just inside the bore (not visible in Figure 97 a) and the other (F) around the outside of the lip clearly visible in Figure 97 a. These identify the glassware, such as a bottle, as clearly being machine-made. The two mould marks correspond with the inner junction of the collar and plunger and the outer junction of the collar and finish-mould halves (Figs 93, 94). These mould seams are made in the first pressing of the finish and bore.

* The neck, body and base have two sets of mould seams often referred to as 'double' or 'ghost' seams:

  The set due to the two halves of the parison-mould and its base (called a baffle-plate), formed in the pre-form or parison, consist of well-defined diametrically opposed vertical lines (P) (Fig. 97 b). These lines are well-defined near the neck and the heel, but, due to the blowing out of the final shape, are fainter, more ghost-like or non-existent in the body, and in a circular baffle-plate mark (BP) in the base.

  The corresponding set (B) are due to the two halves of the final blow-mould and its base-plate. They consist of well-defined diametrically opposed vertical marks in the body and a circular circumferential mark on either side of the heel (Fig. 38), depending on the form of base-plate used. The vertical body seams become ghost-like or disappear in the neck, where the final shape is effectively formed in the parison.

  The two sets of mould seams are usually close to each other, but not coincident, as the parison shape usually swings or moves slightly during transfer between the parison and final blow-moulds.

* The mould seams are much more clearly defined than earlier hand-made bottles due to the use of greater pressing and blowing pressure.

* There is also a circumferential seam (F^{1}) between the finish and the neck corresponding to the join of the parison-mould and the finish-mould (Figs 93, 94). This seam is better defined and nearer the finish than any blow-over mark (Fig. 34) from a full-length hand-blowing mould, or from the effects of turning in a finishing tool. Finally, there is the vertical seam (F^{11}) between the finish-mould halves.

Although this last feature is typical of machine-made glassware, it is not a unique identifying characteristic particularly for wide-mouth jars. Robert Hemingway, in his American patent No. 30063 in 1860, used a mould with separate 'finish-moulds', which opened by lifting, to make the groove for fruit jars.

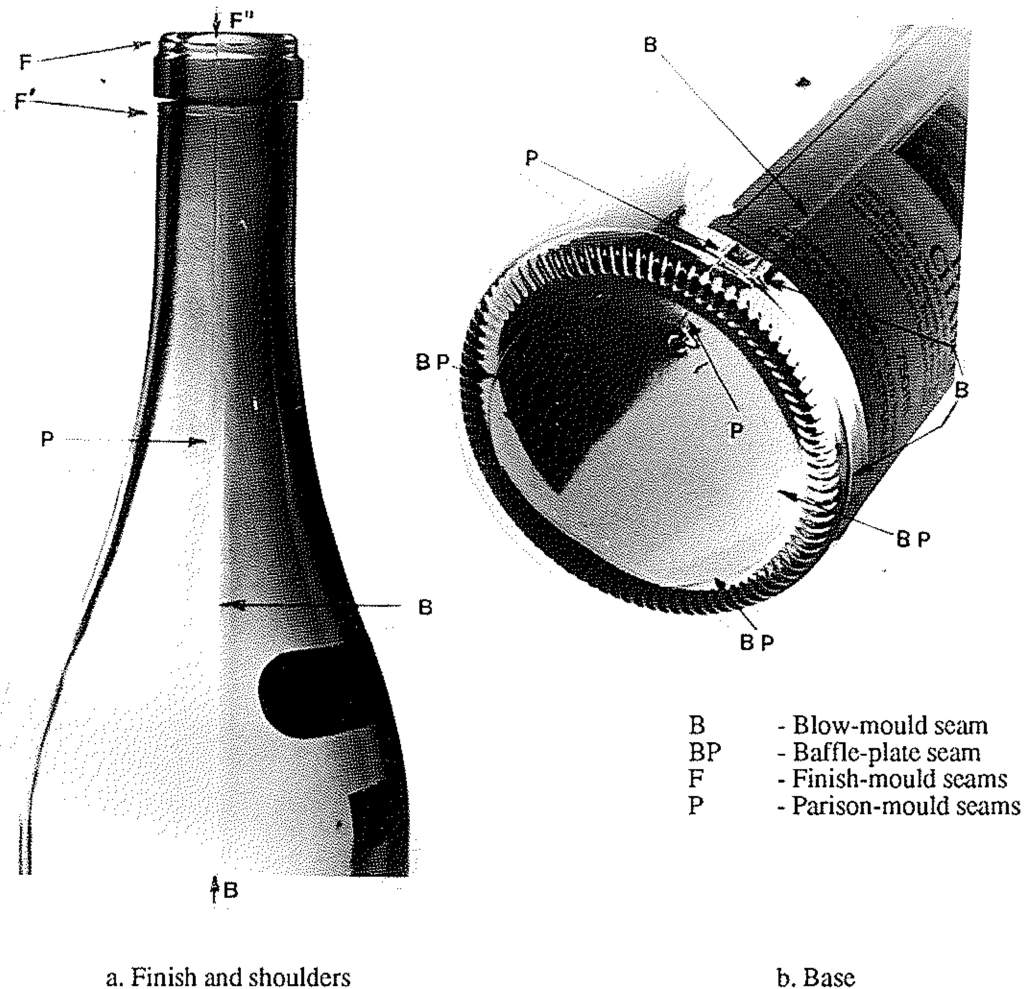


Figure 97. Base and shoulder of a modern machine-made wine bottle.

The above features are common to all forms of machine-made glassware with the exception of spun paste-moulded bulbs etc., or more recently, centrifugally cast tableware. The identification of these characteristics in glassware, or in a broken artefact, decisively identifies the glass as being relatively modern – after c. 1890-95 (Table 5).

Also, as a consequence of machine-moulding, when dealing with large quantities of broken glass, statistically, the proportion of identifiable mould seams in the bulk would be expected to rise markedly on a site after c. 1895-1905.

A suction scar in the base of an artefact places the glass after c. 1905-10 (Fig. 96).

6.6 Mould seam assessment

In practice, the identification of different mould markings and the other effects of manipulation described in this publication, require very careful inspection and assessment, using a hand lens if necessary. Mould, tool and turn marks vary in depth and 'sharpness' depending on the pressure applied and fluidity of the glass as it stiffens and cools at each stage of the forming process.

The contrast in sharpness between the hand-blown, dip moulded wine bottle in Figure 34, where the blow-over mark on the shoulder is just visible; the deep holder marks on the base of the square case gin in Figure 31; and the precise moulding of the modern wine bottle in Figure 97, all serve to emphasise the large differences that can occur.

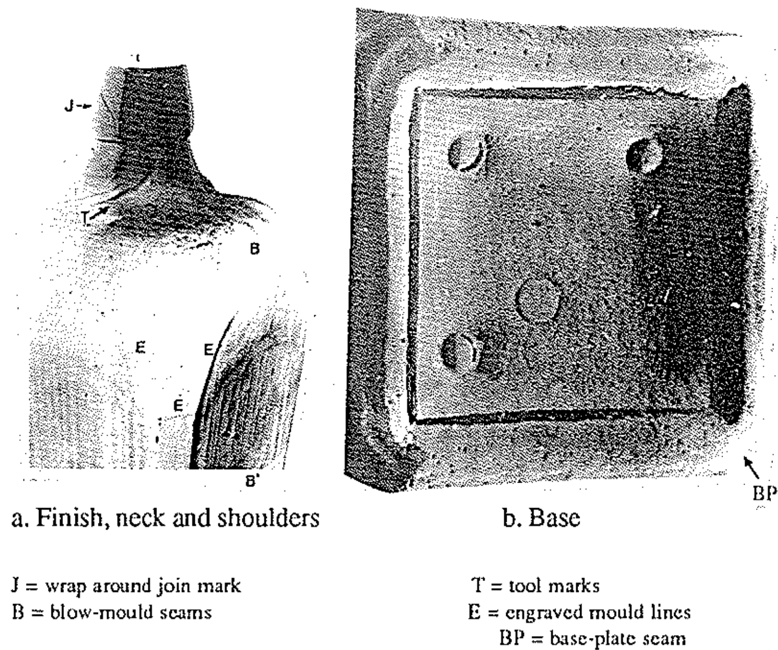
The markings on hand-blown glassware can be quite light and not always well-defined because the pressure applied by mouth blowing is low and some movement of the glass often takes place during the final stages of blowing and setting of the glass. Indeed, by giving a short puff and then placing his thumb over the end of the pipe to entrap the cold air, the craftsman can adjust this pressure precisely (as the air heats up) and allow the glass to distend gradually to just touch the mould or attain a given size. Skilled artists in the craft become very sensitive in using this type of technique.

In contrast, very high pressures are available in glass pressing or in machine operation using compressed air both of which result in clear seams and clear embossed designs.

The prominence or faintness of the seam can also provide evidence of the stage in the process when it was formed as Figure 97 clearly shows. At the top of the bottle, the finish-mould seams (F and F^1) and the parison-mould seam (P) are clearly defined but the blow-mould seam (B) gradually disappears above the shoulder - thus indicating that the final shape of this part of the bottle was formed in the early stage of the process.

In the body of the bottle, the parison-mould seam (P) becomes ghost-like and the blow-mould seam (B) becomes prominent. This indicates that the hotter glass in the body, after the surface reheats, is blown up into the blow-mould and the stretching of the glass surface partially eliminates the parison-mould seam (P).

At the base of the bottle (Fig. 97b), the markings of the parison (P) and the baffle-plate (BP) are still faintly visible even though the position of the mark BP has 'swung' off centre on inversion of the parison during transfer (Figs. 93 and 94). The vertical blow-mould seam (B) under the label, is even clearer near the base than in the body, as is the circular seam between the blow-mould and base-plate. This indicates that the hotter glass in the base is relatively readily moulded even in the final blowing stage.



a. Finish, neck and shoulders b. Base

J = wrap around join mark
B = blow-mould seams
T = tool marks
E = engraved mould lines
BP = base-plate seam

Figure 98. Finish, neck, shoulders and base of a square case gin.

The moulding of an unembossed pale-greenish amber 'case' gin bottle (Fig. 98) is not so easy to assess. This example will be detailed to illustrate aspects of inspection that can be of value as such plain bottles are most difficult to date accurately.

a. **The appearance of the finish**. The wrap around join-mark (J), the surface tool marks (T) in the neck, the join of the added glass (not visible but identified inside the bore) and the uneven line of the finish, all identify this as a typical 'hand-blown' type of bottle and thus it is placed before 1920.

b. **Measurement of the dimension of the finish**. These show that the lip has an external diameter of 24 mm (approximately 1 inch) and the bore is 17 mm ($^3/_4$ inch). This bore was used to accommodate the half-inch filling tube common in the nineteenth century. The deep 20 mm ($^8/_{10}$ inch) finish height is typical of that adopted after c. 1850-60 (see Figs 20, 59).

c. **Inspection of the base** (Fig. 98b) shows that it is not pontilled which again places the bottle after 1860/70 (see Fig. 32). The three raised circular embossed 'knobs' in the corners could be a trade mark or indicate the type of contents. However, they are much more likely to be locating seatings for some type of gadget holder (Fig. 30). The fainter, circular surface marking ('O') is too shallow to be an engraved letter and is probably a repair peg of metal inserted in a blow-hole (i.e. a defect) in the metal base-plate of the mould. This 'O' mark is precisely like that produced by an air-vent, or push-up ejection device in the bottom of a press-mould (Fig. 91) but these are normally in the centre of the base. Finally, the existence of a precisely moulded base-plate, seam BP, confirms that it was made in a metal mould. For such a common bottle, this again implies that it is likely to have been made after c. 1860.

d. **Inspection of the body and shoulders**. The mould seams were by no means immediately obvious as is the case with a machine-made bottle. After close inspection with a spotlight inside the bottle it became clear that the blow-mould seams were diametrically opposed starting on the shoulder, at B, and surprisingly going down the centre of the flat panel to B'. They were **not** along the obviously engraved mould lines (E). It was noticeable in reflected light, that the faint mould mark came across both shoulders, at B, and that there was a slightly rough point where this seam met that of the base-plate on each side of the base.

Far from being an entirely hand-made bottle (the first impression) this common bottle had been blown into a two-piece metal mould with a slightly cupped, well-fitted base-plate (Fig. 38 c). Checking with a straight edge showed that the flat panels were slightly hollow indicating that the craftsman had avoided blowing them up fully so that the unsightly mould marks down the centre would not show. The surface of the glass was whittle marked. These markings are typical of this partly unblown condition and/or blowing the glassware in a cold mould.

The use of such a closely-fitted two-piece mould, with a cup-bottom plate rather than the three-piece tapered mould commonly used in the 1860-1920 period, suggests that this bottle was made later rather than earlier and probably in the 1890-1920 period.

e. **Capacity.** The capacity proved to be 850 mL (30 fluid ounces) to a reasonable filling point of 50 mm (2 inches) below the lip and 1000 mL (35 fluid ounces) brimfull. After c. 1800-20, British bottles became more and more standardised on the reputed quart (approximately. 750 mL, six to the gallon, $26^{2}/_{3}$ fluid ounces) (Ref. 22). This fact would favour the bottle being of European origin.

f. **An unusual feature** and the original reason for the inspection of this particular bottle, was the presence of an old cracked-off piece of glass stuck inside the bottom of the bottle. The piece was evidently left over from hand-blowing.

Such is the accumulation of information that can be gained from one very 'nondescript' bottle. Strictly, it is only possible to say it was likely to have been made between the outside limits of 1860 and 1920 and in all probability in the latter part of this period. In this instance however, the information is almost sufficient to suspect that someone might be trying to make the bottle 'look old' using relatively modern well-fitted mould equipment - a practice not unheard of in recent years when old square case gins sell for dollars not cents! As the moulding methods change from simple free-blowing to the more complex double-mould machine production, the preceding examples indicate that, by careful inspection, the moulding history is, in effect, often written on the glass surface. Detailed and methodical inspection can provide some guidance on the dating of glass artefacts in widely varying degrees for the different processes.

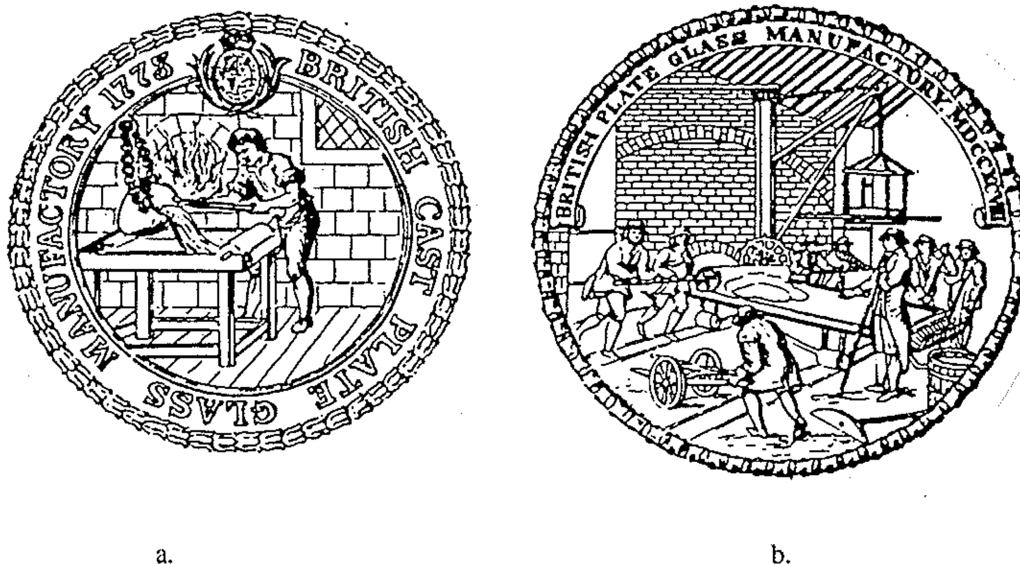
7.0 FLAT GLASS

Flat glass was imported to Australia from first settlement. Indeed, in 1788 Governor Phillip requested window glass '*not less than 10 inches by 8*' (254 mm x 203 mm (HRA 1, Vol 1, 9.7.1788, p. 59) while six cases of window glass and two cases of looking-glasses were landed in the *Friendship* in 1800 (HRA 1, Vol 2, 25.9.1800, p. 572).

7.1 Forms of flat glass

The methods,and their developments, for the manufacture of window glass and plate glass for mirrors differ considerably. Window glass was first made in Europe largely by the 'Broad glass' process while the 'Crown glass' method was usually preferred in Lorraine and Britain. The Broad glass technique was a simple form of cylinder cutting and flattening. It was later improved and increasingly larger sizes were made by the 'Flattened cylinder' and 'Machine cylinder' methods. The continuous 'Direct drawing' and 'Float glass' processes were developed early in and midway through the present century respectively.

Plate glass for mirrors, shop fronts, and decorative purposes, must be ground and polished. Crown glass was too thin for this purpose and often broke during grinding. Broad glass was often used, despite its limitations on plate sizes. At the end of the seventeenth and early in the eighteenth century, under royal patronage, French workers developed the casting process. This process was later adopted by the British Plate Glass Co., St Helens, in 1773. Hartley's 'Patent plate' and 'rolled sheet' were developments of this basic casting process.



a. b.

Figure 99. Engraved seals of the British glass manufactory, 1773, and of the British plate glass manufactory, 1797.

Dating of these products is even more difficult than for commercial and artistic glassware as there are few changes in appearance that result from the different techniques. The different methods are described below, in part to ensure an understanding of the terminology used and also to try and highlight the few differences between the products.

7.2 Window glass

7.2.1. Broad glass was described by Theophilus in the thirteenth century as a process for making glass plates for mediaeval church windows. It changed little over the centuries (Ref. 48). A heavy free-blown cylinder was opened up and flattened before placing it in an annealing furnace to cool slowly. Owing to the flattening process, the finished sheet did not have a bright fire-polished surface. The size was limited by the diameter and length of the blown cylinder to approximately 30 inches (750 mm). This method is still in use for small quantities of flat glass (Ref. 89).

7.2.2 Crown glass was preferred by Lorraine and Normandy glassmakers who founded many aspects of the British trade. From several successive gathers of glass on a blow-pipe, a flattened bulb was formed by variations of the free-blowing methods. (Fig. 100).

The re-heated glass shape was spun so rapidly on the pontil in front of the furnace (or specially heated 'glory hole') that, by centrifugal force, the glass was transformed into a thin disc (Ref. 56).

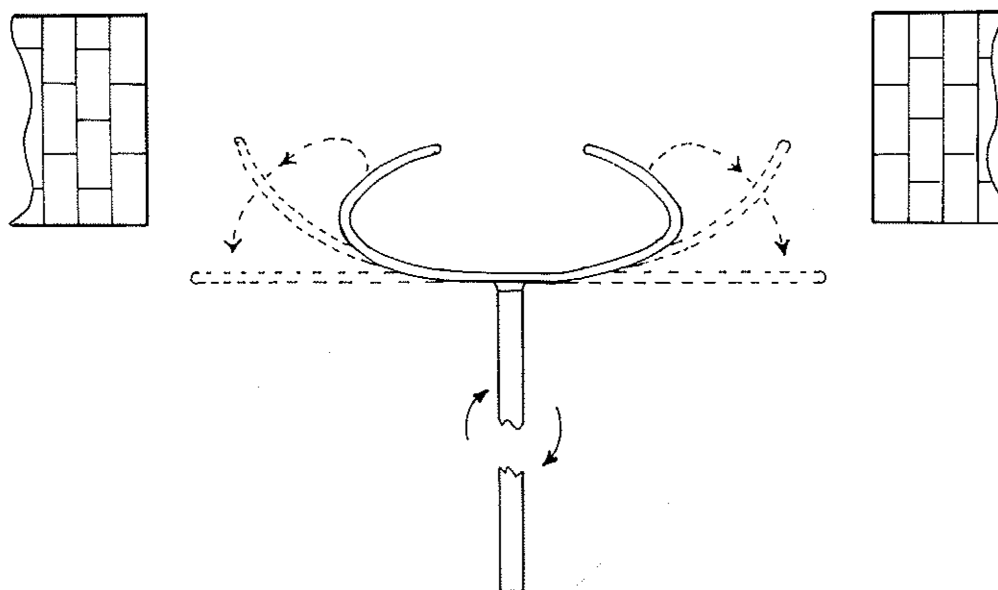


Figure 100. The Crown process in which the glass flattens by centrifugal force during rapid spinning.

A simpler variation of this process in which a flattened glass bulb was spun on the blow-pipe, rather than the pontil, was still in use by Chance Bros of Smethwick in the U.K. to produce flat optical glass discs (Crookes glass) in 1949 (Ref. 91).

Discs 4 feet to 4 feet 6 inches (1200-1400 mm) in diameter were made by the Crown method (Ref. 56). A typical cutting pattern used to avoid wastage, Illustrated in Figure 101, clearly shows why Crown glass panes were usually approximately 16 inches (400 mm) or less in size with an extreme maximum length of the order of 20-24 inches (500-600 mm).

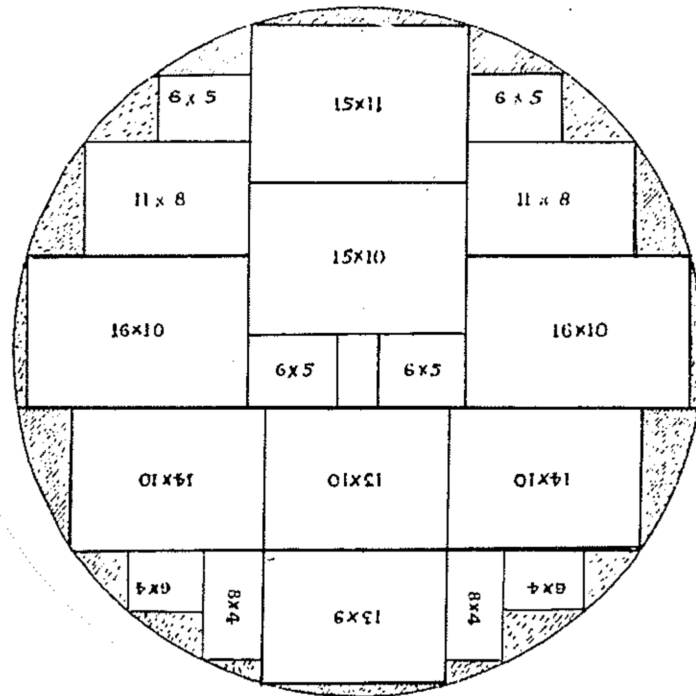


Figure 101. Typical cutting pattern of Crown glass to avoid wastage (in inches).

Throughout the early 1800s, the excise duties in Britain favoured the production of Crown rather than the Broad (flattened) glass. Indeed, in 1813 the only type of window glass exported from Britain was Crown glass (Ref. 48) on which an exceptionally severe manufacturing duty of thirteen pounds thirteen shillings and six pence per hundred weight was charged. A rebate of four pounds, eighteen shillings per hundred weight was granted on this duty for finished cut-up panes for export.

The duties were levied by weight, so there was a real commercial incentive to make the discs as thin as possible compatible with their use in windows. The thin Crown glass bore less duty, even allowing for wastage, than the thicker Broad (flattened) glass. The thickness of the Crown glass was limited to a maximum of $^1/_9$ inch (2.8 mm) by the Excise regulations (Ref. 48), but it is not uncommon to find small Crown glass panes 2 mm thick or less.

When considering the likely use of such early thin glass artefacts, it should not be overlooked that the pressure to cause fracture increases as the size of the pane is reduced. Consequently, such small, thin panes, approximately 2 mm or less thick, would be nearly as practicable for windows as the much larger thicker (3-4 mm) panes adopted after c. 1835-65.

The bulk of window glass imported into Australia before 1834 was thin Crown glass from Britain, with severely limited pane sizes. Indeed, during the austere period of the Napoleonic wars, no window glass over 15 inches (380 mm) in size was reported in the *Sydney Gazette* (Fig. 103).

As a consequence of the method of manufacture and the influence of the Excise duties, Crown glass has the following characteristics:

* An originally smooth fire-finished surface.

* Curved striae and flow lines in the glass.

* The crown glass panes are not truly flat but have slightly concave/convex surfaces (Ref. 44).

* The pane is normally approximately 2 mm or less thick, with a maximum of 2.8 mm ($^1/_9$ inch).

* Normally the pane is less than 400 mm (16 inch) square, but extreme lengths up to 500-600 mm (20 - 24 inch) are possible.

7.2.3 Improved flattened cylinder. This process was developed in Britain in 1831 by Bontemps at Chance Bros Smethwick, Birmingham. Using several gathers of glass on a blow-pipe, a large heavy cylinder was formed (Ref. 89) by variations of traditional-blowing methods (Fig. 2), using a deep trench in which the heavy globe of hot glass was swung and stretched. The cylinder was cracked off the pipe (Fig. 102), allowed to cool, slit longitudinally with a hot iron rod or diamond cutter, and then re-heated in a flattening oven with a semi-cylindrical block of poplar wood on the end of a long rod (Ref. 89).

In 1831, Chance Bros of Birmingham realised that the rebate on exported Crown glass was available whatever the process of manufacture. They invested in this European flattened cylinder process with the additional flattening ovens and netted a substantial profit to pay for their investment before the excise authorities modified the rebate.

While there is evidence that they exported the poorer quality products to 'protected British possessions' (Ref. 48), presumably including Australia, Chance Bros made wider cylinders than those made by the original European Broad glass process and improved the colour of glass to compete with the small bright, fire-finished Crown glass panes.

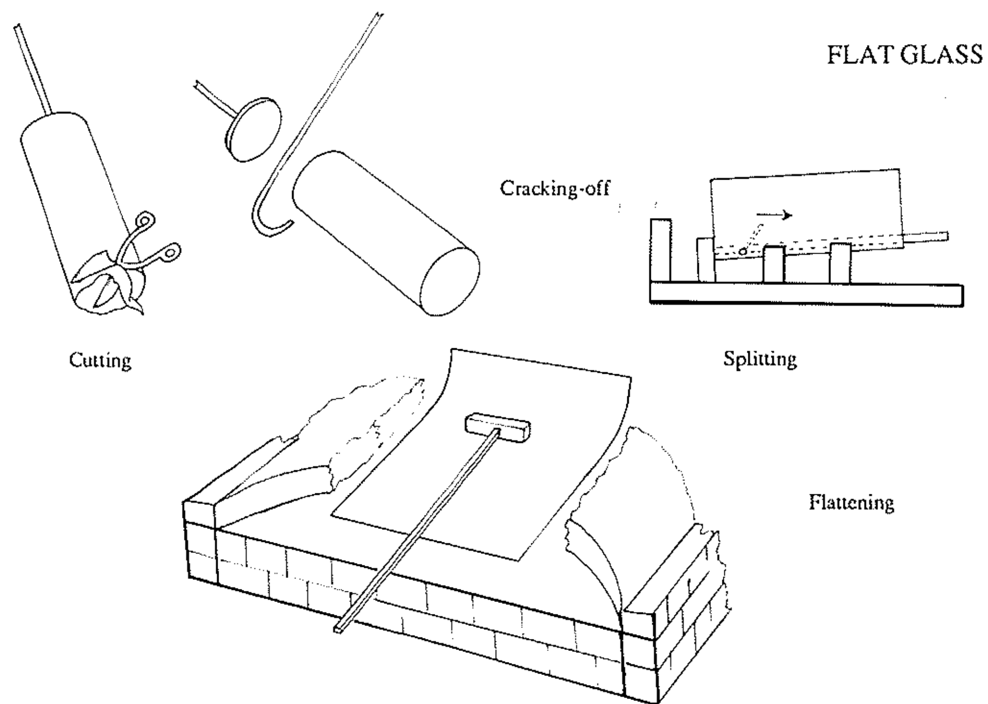


Figure 102. Flattened cylinder method showing the processes of cracking-off, splitting and flattening.

The initial imports to Australia of this thicker glass from 1834 onwards followed these developments in Britain. For example, the Sydney Gazette reported: *Sheet window glass differs from Crown glass ... first it is half as thick again* [i.e. 3.0-4.2 mm], *second the colour is much better, thirdly it is flatter ... the best ever imported.* (S.G. 26.6.1834, p.3), *Chance and Hartley's British Sheet Glass, which is much superior to Crown, being a third thicker* [i.e. 2.8 - 3.8 mm], *clear and cut.*' (S.G. 10.9.1835, p. 4). This window and picture glass was available in a variety of sizes up to relatively square pieces 30 x 25 inches (i.e. 755 x 635 mm) or longer narrower pieces up to a maximum of 36 x 22 inches (i.e. 915 x 560 mm).

The thinner Crown continued to compete with the thicker flattened cylinder glass, even though there was by then a record that the thinner glass broke readily during Australian hailstorms. Governor Macquarie made a supplementary estimate for window glass in 1814 (HRA Series 1.Vol. 8, 28 May, p. 261) following a storm in Sydney. After another storm in Sydney, an advertisement in the 1847 *Sydney Morning Herald* advised customers to use the thicker British glass and avoid the evil results that attended the use of common glass (S.G. 24.2.1847, p. 1).

Specimens, presumably of Crown glass, of a standard window size of 254 x 303 mm (10 x 12 inches), but of very poor quality only 1.5 mm (0.06 inch) thick, were found on the wreck of the *James Mathews* in 1841; and again pieces presumably of Crown 2.5 mm ($^1/_{10}$ inch) thick and plate 5 mm ($^1/_5$ inch) thick, appeared on the 1852 wreck of the *Eglinton* (Refs 84,85). By 1860 Crown glass was evidently becoming scarce, though it was still appreciated probably for its fire-polished appearance. A glazier advertised: '*CROWN GLASS and PATENTED PLATE WANTED, sizes 22 x 21* [inches], *a larger size not objected to.*' (S.H. 10.1.1860, p. 8).

There was only one mention of the import of Crown glass in the following two months of the 1860 *Sydney Morning Herald.* Nevertheless, Crown was still being specified for painters and glaziers government contract schedules in 1864 in sizes up to 500 x 440 mm (20 x 16 inches) (Ref. 88).

Although Crown glass survived much longer in Britain (and evidently also in Australia) than in Europe, its use finally declined in the 1860s (Ref. 48) as other methods such as thick 'patent' plate and flattened cylinder glass grew in importance.

It is evident from the sizes of glass panes advertised in papers at the time that the flattened cylinder glass, first introduced in 1834-5, gradually replaced Crown glass with the largest sizes ranging between 3 feet 6 inches and 4 feet (1067 x 1219 mm) by 1860 (Fig. 103). Corresponding changes would be anticipated in the maximum window sizes of dwellings during that period.

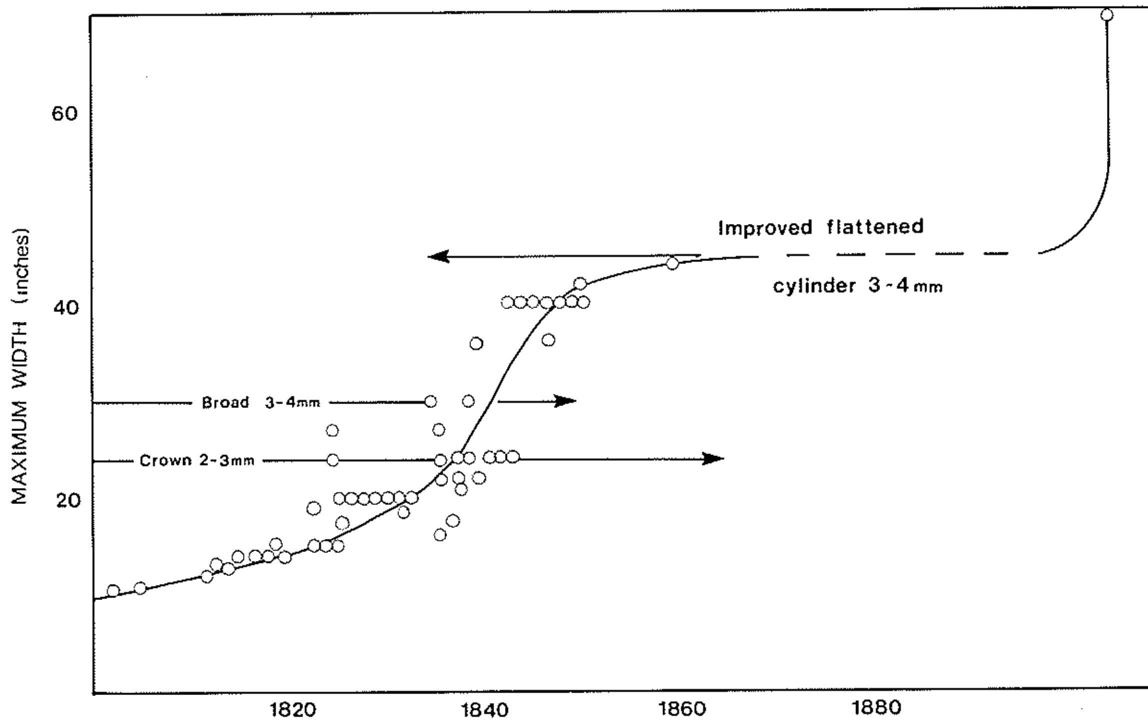


Figure 103. Graph showing the maximum dimensions of window glass advertised in the *Sydney Gazette* 1804-40 and *Sydney Morning Herald* 1840-60.

Chance Bros continued to develop this process for special optical glasses right up to c. 1950 and in fact, still used the original French terms introduced by Bontemps in 1831 for much of their equipment (Ref. 91). Figure 104 provides some concept of the five-foot heavy-nosed blow-pipe, weight of glass gathered in excess of fifty-pounds (approximately 25 kg), methods of support during manipulation over a trench, and the press button (P) control of the blowing air, eventually used by this company. Cylinders up to 1300-1800 mm (50-70 inches) long and 300-500 mm (12-20 inches) wide were eventually possible by this process.

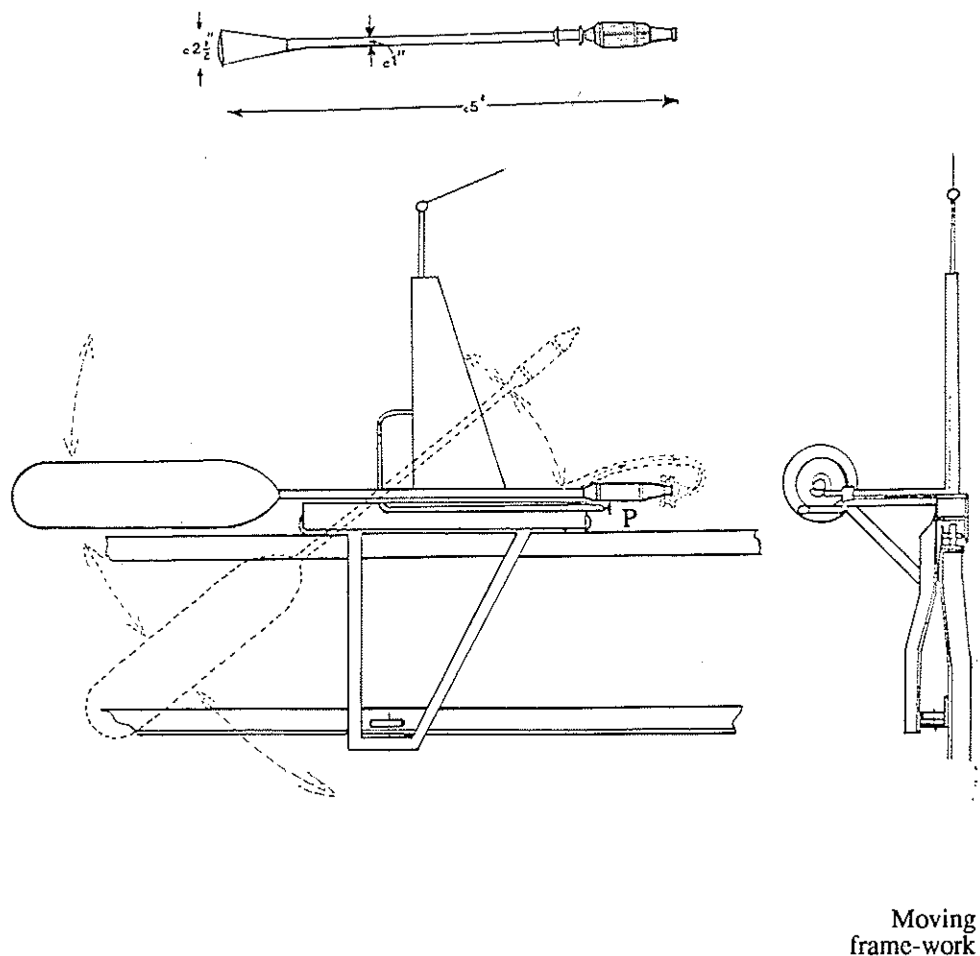


Figure 104. Sketch illustrating final form of improved flattened cylinder process.

7.2.4. Lubbers machine cylinder. This process patented in 1896 was brought to commercial production in 1905 by the American Window Glass Co. and used in Britain by Pilkington Bros between 1910 and 1933. Cylinders produced by this process were over 7.5 m (25 feet) long and 530-600 mm (21-24 inches) in diameter (Ref. 45). Thus, pane widths up to 1800 mm (6 feet) were possible in Australia by c. 1910.

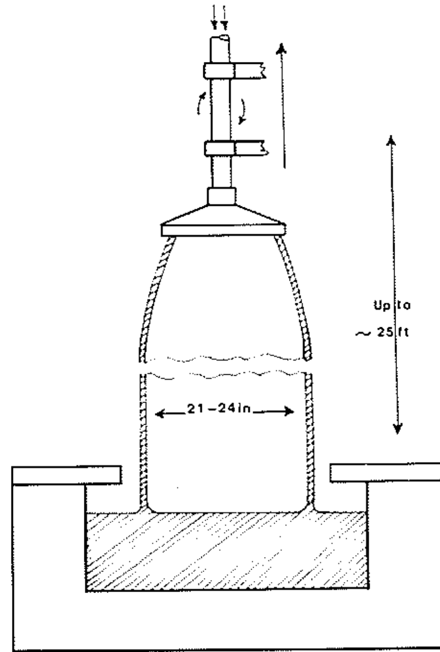


Figure 105. The Lubbers machine cylinder process.

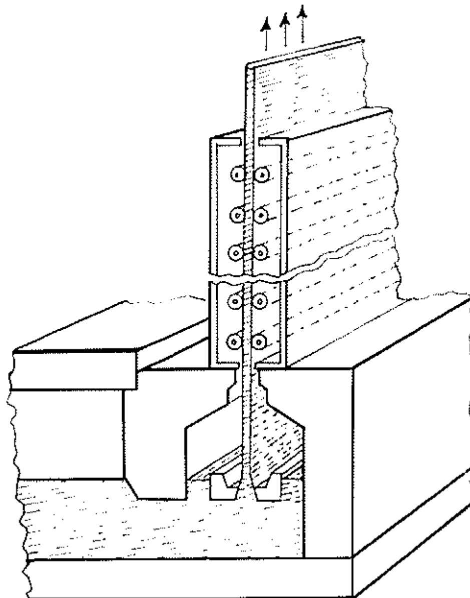


Figure 106. The Fourcault continuous drawing process.

7.2.5 Continuous drawing process. This process was first introduced by the Belgian Fourcault in 1914 but only brought into more general use after 1918 (Ref. 24).

In this method, the glass is forced to emerge from a shaped slit in a partially submerged fireclay boat, (the debiteuse) and continuously drawn up through water-cooled rollers.

Drawing equipment, similar in principle, was later devised by Colburn in the U.S.A. and, without using a debiteuse, by the Pittsburgh Plate Glass Co. For many normal sheet glass thicknesses, these methods increased the maximum pane widths still further to between 1.8-3.0 m (6-10 feet).

7.3 Plate glass

The second form of flat glass is called plate glass. For many purposes it must be ground and polished.

7.3.1 Cast and rolled plate. Small pieces of cast plate were made from time to time by the Romans, Venetians and others. The modern development in Europe dates from 1676-88, when, under royal patronage, a monopoly was granted to several Frenchmen to manufacture and export cast plate glass. By 1691 satisfactory thick plates over 1.8 m (6 feet) long were produced. By 1725 St Gobain produced 711 tonnes (700 tons) and by 1760 about 1168 tonnes (1150 tons) of plate glass per year.

The glass, melted in large pots, was ladled into smaller 'cuvettes' and from these cast (poured) and rolled on a metal table (Fig. 99 b). Any excess hot glass went into the water trough at the end of the table which itself was cleaned with a water-soaked wooden tool, shown on the floor in the figure, between each cast. The rolled plates, up to 4000 x 750 mm (160 x 30 inches) in size, were annealed, ground by hand with fine grades of sand and powdered glass and finally hand-polished with powdered 'rotten stone' and rouge applied with a felt roller!

Such a laborious and expensive process, involving extensive melting, annealing and grinding equipment, was only established in Britain at St Helens on the South Lancashire coalfields in the period 1773-92 (Ref. 43). By the 1860s three firms in this area produced over two-thirds of Britain's plate glass. Pilkingtons, the surviving company, achieved a monopoly in this field by 1910.

Mirrors ('Looking glasses') made from plate glass, were imported and auctioned in early Sydney. The *Sydney Gazette* of 1803 advertises:

> *'Selling off, ... at the House lately occupied by G. Croffley, Looking-glasses, Capital square, pillared and oval best French plate looking glasses, beautifully gilt and ornamented, of different sizes.'* (S.G. 15.5.1803, p. 3).

'Mr. Lord selling ... part of the household furniture of Mrs. Reibey, who is moving from her present residence ... a pier glass 5 feet x 2 feet 6 inches [1524 x 762 mm] ... ' (S.G. 9.1.1826, p. 3)

As would be expected, many early examples were of French origin and there was no practical limitation on the sizes for normal household use with imports or sales up to 1.7 m (5 feet 6 inches) in length being recorded before 1830. Such rolled plate was normally between 3-6 mm ($^1/_8$-$^1/_4$ inches) as it is today, but there was no definite limit in size.

Prior to 1840 such mirrors were made by means of a process which employed an amalgam of tin and mercury (Ref. 49), first used in Venice in 1317. This was replaced in the early 1840's by a process of deposition of silver from a warm solution of silver nitrate in distilled water, to which a reducing agent, such as Rachelle salt (a sodium-potassium tartarate) was added. R.J. Stone appears to have been the first to set up shop, initially at the Kings Arms in Sydney (S.H. 19.10.1843, p.3) as a *glass polisher and silverer*, and many mirrors from c. 1845 onwards would be identifiable by being silvered.

7.3.2 Patent plate. During the 1840s James Hartley of Sunderland produced thin cast rolled plate, using direct ladling of the glass from the melting pot in the furnace on to the casting chamber, thus eliminating the intermediate stage of refining and transfer in a cuvette. Hartley's 'Patent' plate, with a minimum thickness of about 3 mm ($^1/_8$ inch) was often made of coloured glass and impressed on one side with patterns. The glass sheets were left unpolished for many purposes such as skylights, roof glass and church windows. Along with Chance Bros products, Hartley's glass was continuously advertised from 1835 onwards. Crimson, purple, green, blue, yellow and amber stained glass was also imported in this period (S.H. 2.9.1842, p.1).

Frosted glass was also advertised at that time (S.G. 28.4.1838, p.3), but it was probably referring to glass surfaces dulled by rough abrasion with sand or to roughly cast glass with an 'obscured' surface. The more modern form of frosted glass followed from British patent No. 1489 to C.D. Gardissal in 1856. In this patent the glass was etched with white acid (a mixture of hydrofluoric acid with soda or ammonium carbonate). The remainder of the glass was protected with a 'resist' made from mixtures containing carbon black, resin varnish and red lead. This form of frosted decoration was used extensively on free-blown tableware particularly by Richardson and Northwood in Stourbridge (Refs 49, 82). The difference between obscured glass surfaces made respectively by rough casting, abrasion and etching are identifiable by inspection, but would be clear from electron micrographs as abraded surfaces have numerous microcracks.

Crown and flattened cylinder glass were both just below or above 3 mm thick and were therefore difficult to grind and polish without fracture.

Chance Bros met this difficulty at the time by making a smaller but thicker Crown disc (Fig. 100) and then selling it as *Patent thick crown* presumably about 3-4 mm thick.

In 1838, J.T. Chance finally overcame the difficulties in grinding and polishing by placing the sheets on slate beds covered with water-soaked leather. By 1845, Chance's 'Patent' plate, which was evidently midway in thickness between Crown (approximately 2.5 mm), and ordinary plate (approximately 4-5 mm), was in great demand for coach windows, mirrors and pictures.

7.3.3 Rolled sheet. In 1884, Mason and Conqueror patented a machine in which the glass was poured down an inclined plane and passed between a pair of rollers. This process was not brought to a commercial success. However, in 1887 Chance Bros devised a machine for rolling and also introduced wired rolled sheet in 1905 in which an iron-nickel alloy wire mesh was embedded in the glass sheet. The methods of Mason and Conqueror were made successful in the early 1920s in the Bicheroux process (Fig. 107).

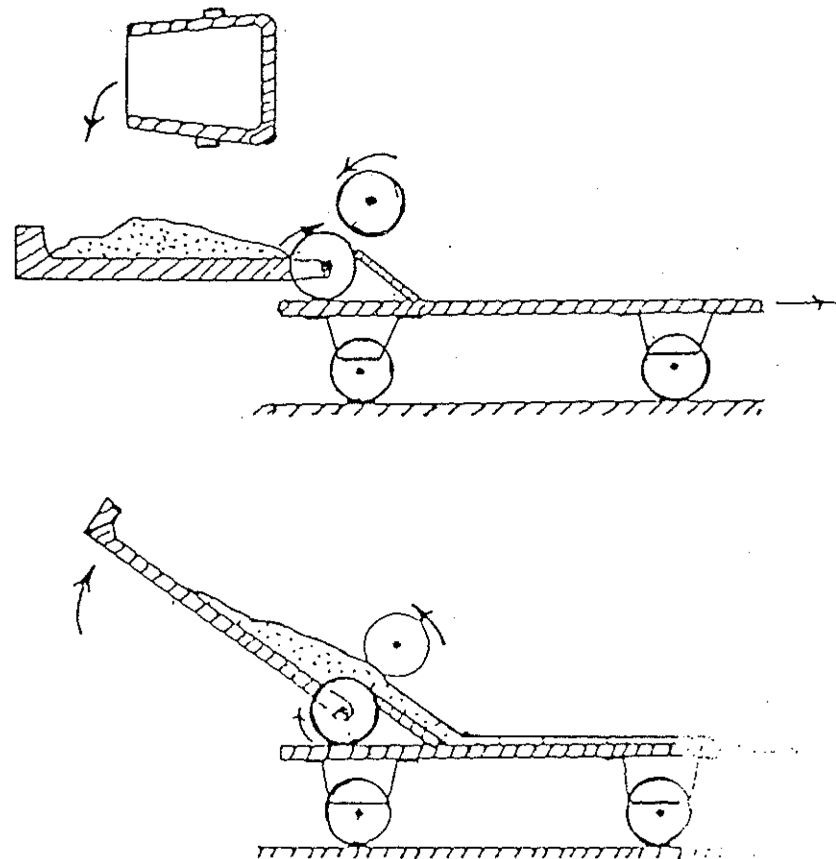


Figure 107. The Bicheroux process. Sketch from unlabelled patent specification.

These melting, rolling, grinding and polishing processes were eventually made completely continuous in the 1920-40 period in huge plants each about half a mile long by companies such as Ford in the U.S.A., Pilkingtons in Britain and St Gobain in Europe.

7.3.4 **Float glass.** In 1959 Pilkingtons introduced the revolutionary Float glass process in which a stream of molten glass flows on-to, and floats on, a bath of molten tin in an oxygen free atmosphere, so producing an optically flat sheet (on both sides). This process combined the advantages of drawn sheet, which always has a slight distorting surface 'wave' and truly flat polished plate glass. It also eliminated entirely the costly grinding and polishing processes. This type of glass is identifiable by the very slight deposit of tin on one surface which is visible under a microscope.

Since 1970 a variety of coloured and solar-protecting flat glasses have been developed by Pilkingtons from the basic Float process using electro-chemical migration of added colouring ions from the molten tin into the setting flat glass.

The standard thicknesses of modern drawn sheet, polished plate or float glass and their approximate weights per unit area are available in standard texts (Refs 71, 75). It is apparent that the maximum dimensions of sheet by these continuous processes rose beyond 2.5-3 metres (100 inches).

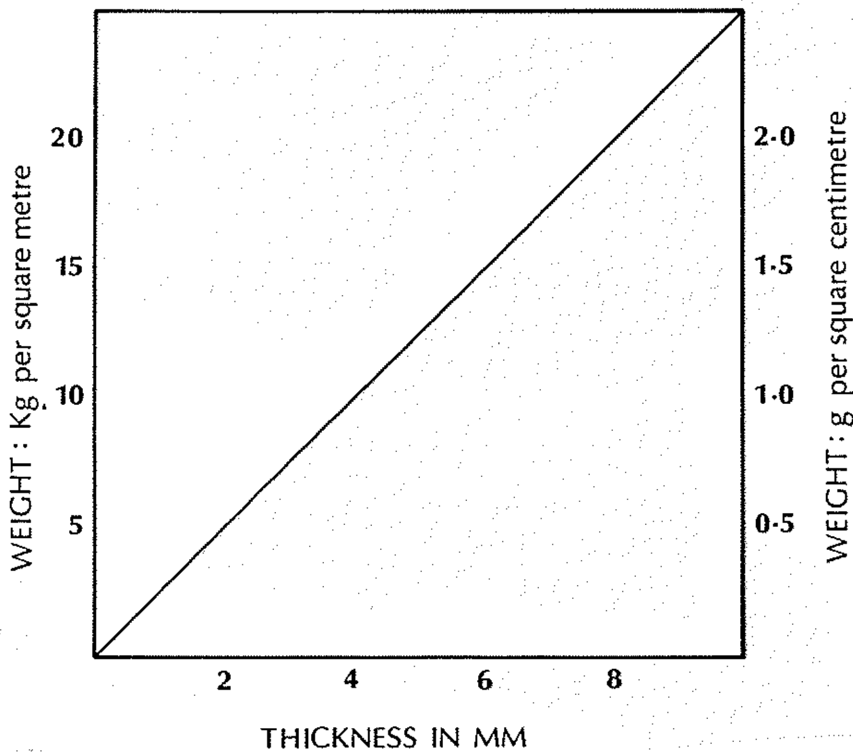


Figure 108. Weight per unit area of flat glass of varying thickness.

7.4 Identification and dating

The common feature of all these flat glass products is the difficulty of differentiating between them, even in large sheets, by casual inspection. From the preceding historical outline, it will be evident that, providing there is other supporting evidence on site, some guidance on dating and identification may be obtained from the following features:

7.4.1 Thickness. Thicknesses of glass to be expected from the different processes have been summarised in Table 6 together with the approximate dates of their introduction into Australia. Thicknesses can be measured by vernier calipers or alternatively by measurement of the area of the sheet, the normal weight per unit area curve given in Figure 101 or the fact that the glass normally has an approximate density of 2.5 g/mL.

TYPE	PERIOD	THICKNESS
Crown	Up to c. 1870	Below 2.8mm ($^1/_9$ inch)
Broad & flattened cylinder	Up to c. 1910	3-4mm ($^1/_8$-$^5/_{32}$ inch)
Hartley's patent plate	After c. 1840	3-4.5mm ($^1/_8$-$^3/_{16}$ inch)
Chances patent plate	After c. 1840	3-4mm ($^1/_8$-$^5/_{32}$ inch)
Lubbers cylinder	After 1905	3-4mm ($^1/_8$-$^5/_{32}$ inch)
Rolled sheet	After 1890	Above 4.5mm ($^3/_{16}$ inch)
Wire rolled sheet	After 1905	Above 4.5mm ($^3/_{16}$ inch)
Drawn sheet	After 1920	Up to 6mm ($^1/_4$ inch)
Float glass	After 1960	Up to 6mm ($^1/_4$ inch)
Cast & rolled plate	Throughout	Usually to 32mm (1$^1/_4$ inch)

Table 6. Approximate thicknesses of different forms of flat glass.

7.4.2 Other guides. Other guides to dating flat glass are:

* The increased import of coloured glass and surface impressed patterns in Patent plate (3-4 mm) from Hartley's in London in the 1840s.

* The introduction of similar patterns which gave rise to the 'figured rolled sheet' (usually 5 mm) in the 1890s.

* The silvering of mirrors after the 1840s.

* In buildings, the rise in the size of windows possible between c. 1840 and 1870 (Fig. 103).

* Toughening of glass (e.g. for car windows) which can produce blunt-edged shattered pieces (4-5 mm) from the 1930s on (Appendix 4).

* The introduction of float glass into Australia in the 1970s.

7.4.3 Surface characteristics. Direct visual inspection of the different forms of flat glass is not often very informative. However, it is possible to differentiate between truly flat polished plate and other forms of window glass which slightly distort vision. Nevertheless, some surface differences must exist on a microscopic or submicroscopic scale between ground and polished, flattened, rolled, spun and drawn flat glass. Suitable forms of lighting for surface inspection of glassware are described by A. J. Holland (Ref. 14).

As far back as 1934, F.H. Zsacke recorded some differences resulting from the etching of glass surfaces with a solution of diluted hydrofluoric acid (10 parts), sulphuric acid (5 parts) with 100 parts of water for periods of 10-60 minutes (Ref. 36). Briefly, the surface differences he recorded were:

* **Broad glass, flattened cylinder and Lubbers glass**. There will be irregular distortion of an object viewed through it or by reflection. The surface which has been in contact with the stone table during flattening is uniformly dull and covered with fine holes on etching.

* **Drawn glass**. The distortion, particularly by reflection, takes the form of waves or lines parallel to the direction of drawing. Similar lines are formed on etching.

* **Ground and polished plate** shows a network of fine lines after etching, due to the remains of fine cracks formed during grinding.

* **Rolled sheet** has a slightly rippled surface due to the effect of the rollers.

* Initially, the **Crown glass** surface will be fire-finished and relatively free of surface markings.

Clearly, these laboratory methods are not usually feasible on site. The reflection and distortion effects are only visible on a reasonably large pane. Scuffing during burial may well affect both the corrosion that takes place over a long period and any etching results in the laboratory. The recent work on the interpretation of layering and accelerated pitting of Roman, Mediaeval and modern glass by R.G. Newton in particular, does suggest that this field warrants further investigation (Ref. 25).

8.0 SUMMARY OF CRITERIA FOR DATING COMMON BLACK AND FLINT GLASS BOTTLES

The following summary of the findings in this Research Study by the Heritage Council is along the lines of a brief summary presented at the International Ceramics Conference held in Sydney between August 21st and 26th, 1988 and published in Materials Science Forum, Volumes 34 - 36, 1988, pp1105 - 1109.

The identification and dating of glass artefacts from Australian sites can contribute to our knowledge of the period of occupation and extend our appreciation of the social and commercial background. The European occupation of Australia is so recent that the development is often well-documented from the official records (Ref. 2) and early newspapers. The styles and shapes of tableware (Refs 55, 78) and bottles (Refs 22, 26, 30) from early wrecks (Refs 84, 85, 86), historic sites and collectors have been assessed in relation to such documentary evidence. The sales and imports reported in early copies of the *Sydney Gazette* and the *Sydney Morning Herald* proved particularly useful.

8.1 Effects of British glass tax

The major source of early imports, before local manufacture commenced by Ross in Sydney (1866) and Grimwade in Melbourne (1872), was from Britain. The tax on all British glass between 1746 and 1845 and the rigid laws, regulations and excise controls associated with the tax caused almost a complete separation of the highly taxed clear 'flint' from the lower taxed common 'black' glass trades (Refs 28, 32). Effectively, the manufacturers were not able to make both types of glass in the one factory or make small bottles under six-fluid ounces (170 mL) in 'black' glass. Engraved metal moulds and more complex moulding techniques were both adopted earlier for 'flint' than for 'black' glass bottles. Water-soaked wooden tools and moulds remained in use for large traditionally blown 'black' bottles until as late as 1860-70. In consequence, the dating of these two types of glass artefacts has to be assessed separately.

8.2 Common 'black' glass bottles

The major identifiable changes in the appearance of large common 'black' glass bottles, used mainly for wine and beer, are well-documented (Refs 22, 26). Dated Australian examples (Refs 84, 85, 86) conform to these findings which are as follows:

8.2.1 Shaping methods:

Traditional blowing	Before 1820-40
Traditional blowing + 3-piece moulding	1820-40 – 1900-20
Turning in wooden moulds	Some before 1880
Turning in paste-moulds	After 1880
2-piece moulding with base-plates	After 1900-20

Table 7. Summary of dates of shaping methods for common 'black' glass bottles.

Traditionally blown bottles are identified by the absence of mould seams, the horizontal join under the applied finish and an asymmetrical shape. The bulging of the base corner in British bottles was eliminated by 1820-30 (Ref. 17). Two main types of 'black' bottles occur: the low shouldered wide 'beer' shape and the taller high-shouldered 'wine' shape (Ref. 26). Up to 1800-20 the Imperial Quart (1140 mL, 40 fl oz.), Queen Ann Wine Quart (940 mL, 33 fl oz.) and the Reputed Quart (758 mL, 26⅔ fl oz.) were all in use side by side (Ref. 22). Gradually the Reputed Quart was adopted (SG 22.3.1817, p. 4) (Ref. 22) and recognised legally as one-sixth of the new Imperial gallon in 1824 (Ref. 22). Long narrow bottles with sloping shoulders, the so-called 'Hock' type, were imported after 1840-45 (SH 19.9.1843, p. 3).

Three-piece moulded bottles are identified by one circular and two vertical seams on the shoulder. Turn marks identify turn-moulded glassware. Except for Ricketts type moulded bottles from 1821 onwards (H. Rickett British Patent 4623, 1821) (Ref. 17), embossed lettering and designs only occur on the shoulder until complex two-piece machine-moulded bottles permitted embossing on the body after 1910-20.

8.2.2 Push-ups and pontil marks:

Conical push-up (rounded apex) + open pontil mark up to 30 mm diam.	Up to c. 1750 for British bottles
Dome-shaped push-up + sand-pontil mark up to 40-70 mm diam.[1]	1720-50 – 1850-70
Conical push-up - ridges round push-up and base from capped or uncapped wooden tools.[2]	1820-40 – 1860-70
Rickett's push-up.[3]	1820-30 – 1850-70
As above without pontil mark	1830-70 – 1900-20
Ring-pontils usually in non-British wine, champagne and case bottles	Up to c. 1850-60
No pontil marks due to the use of holders	After c. 1830-70

[1] Centre of push-up may be distorted by circular or quatrefoil impression caused by push-up rod.

[2] A central mamelon shape is often due also to a valve or pusher in three-piece moulding.

[3] Rickett's push-up (Ref. 17) gives embossed name between circular seams round the pontil.

Table 8. Summary of dates for push-up types for common 'black' glass bottles.

Thus the shape of the push-up, the appearance (or absence) of a pontil mark and the location of push-up tool marks or base-plate seams, all form useful guides to age.

8.2.3 Forms of finish

Single collar below cracked-off lip	Before c. 1700-20
Single collar to reinforce lip developed	During c. 1720-80
Double stringing & reinforcing collars developed	During c. 1780-1820
Double collars lengthened to approx. 25 mm	1820-40 – 1900-20
Foil-covered single collar turn-moulded by finishing tools after 1840-50 (SH 20.1.1843, p.3 & 10.11.1843, p.3)	1840-50 – 1900-20
As above machine-made	1900-20 to date
Perry-Davis machine-made double collar	1900-20 to date

Table 9. Summary of dates of forms of finish for common 'black' glass bottles.

The main identifying features of the finish of a traditionally blown or moulded bottle are the horizontal join under the applied finish and any surface tooling. Machine-made bottles do not possess these features but have finish-mould seams. Turn marks distinguish finish-moulded bottles after c. 1840-50.

8.3 Clear 'flint' and pale-green bottles

Simple two-piece moulding with embossing (Refs 27, 29) and two-piece moulding with base-plates (Ref. 17) were adopted for the highly taxed flint and pale-green bottles as early as c. 1750 and c. 1820-40 respectively. Other differing developments from 'black' glass are:

8.3.1 Shaping methods

The major identifying features are: Simple two-piece moulded bottles have a diagonal seam across the base. Embossing increased after the development of easily engraved mild steel in 1860. Two-piece moulding with post or cup-bottom plates are identified by circular seams in the base or heel respectively. Machine-made bottles are identified by the presence of finish, base-plate and vertical blow-mould and ghost parison seams. Suction type bottles also have a shear scar in the base.

Shaping method	Date
Traditional blowing and turn-moulding e.g. for Apothecaries' bottles and show globes.	Up to c. 1900-20
Two-piece moulding and embossing.	1750-80 – 1900-20
Two-piece moulding + use of bottom-plate.	1820-40 to date
Three-piece moulding for round bottles.	1820-40 – 1900-20
Machine-made wide-mouth Press and Blow.	After c. 1895
Machine-made narrow-mouth Blow and Blow.	After c. 1900-20
Machine-made narrow-mouth Suction.	After c. 1910-20

Table 10. Summary of the dates of shaping methods for clear 'flint' and pale-green bottles.

The diverse changes in style and shape of flint glass bottles, such as mustard squares (1821), octagonal and square pickles (1835), ovate soda-water (1834), cylindrical Maugham type (1845), plug (1870) and marble-sealed (1875) soft drinks, plate-moulded medical flats (1880) and pressed-and-blown fruit bottling jars (1890) etc. can all provide useful dating criteria.

8.3.2 Push-ups and pontil marks. The use of improved empontilling techniques appears to have been more widespread for 'flint' glass and often 10-20 years earlier than for large 'black' bottles:

Feature	Date
Pointed push-ups in small phials and oil bottles.	Before c. 1800
Conical push-up (rounded apex) + open pontil mark up to 30 mm diam.	Before 1830-60
Bare iron pontil marks	Between c. 1845-70
Ring pontil marks (in flasks & medical bottles particularly).	Before c. 1850-60
No pontil marks due to use of holders.	After c. 1835-70

Table 11. Summary of dates of push-ups and pontil marks for clear 'flint' and pale-green bottles.

Bare iron pontils sometimes show reddish/black ferrous/ferric oxide deposits in the circular depression formed by the iron rod; a feature shared with metal-capped wooden push-up pontil marks in 'flint' and 'black' bottles. The ring-pontil leaves undisturbed any mould seams or embossed lettering inside or outside the ring.

8.3.3 Forms of finish. The diverse forms of finish, mouth, bore, internal ledges, grooves and plugs in flint glass bottles often provide detailed and sometimes quite precise information on their age, particularly after 1860-70 when many patented closures were introduced (Refs 30, 54). A summarised assessment of the period of use in Australia of a selection of the main types is as follows:

Form of finish	Period of use
Cracked-off or burst top	1600-50 – 1910-20
Flared lip	1600-50 – 1910-20
Flared lip with pewter or other metal cap	1600-50 – 1910-20
Ground glass stopper	1700-50 to date
Single applied or machine-made collar	1720-80 to date
Double stringing & reinforcing collars	1780-1820 to date
Foil-covered single collar	1840-50 to date
Spherical ('blob top') collar	1860-70 – 1900-20
Barrett (Hogben) long plug	1870-72 – 1900-05
Lamont/Valet type plug	1870-75 – 1905-10
Original Codd (marble)	1873-75 – 1885-95
Codd variants (marble)	1880-85 – 1930-35
Coloured finishes on Codd type	1890-95 – 1905-10
Gledhill (rubber ball)	1875-80 – 1890-95
Hutchinson plug	1885-90 – 1905-10
Swing (Lightening) type stopper	1875-80 – 1945-55
Crown-cork	1895-1900 to date
Internal screw	1880-85 to date
External screw	1885-90 to date

Table 12. Summary of dates of forms of finish for clear 'flint' and pale-green glass.

Dates before 1788 refer to bottles on early wrecks. Dates after c. 1910/20 usually imply a machine-made finish.

8.4 Some Technical implications.

The survey has shown the need for a detailed assessment (and 'library' of examples) of the different shaping methods, push-up shapes, tool and pontil marks and forms of finish, for bottles from wrecks and dated sites. Dating bottles by these means requires the differentiation between tool marks (initially folds in the hot viscous glass) and mould seams. Inspection by suitable lighting, inside or outside the bottle, or of the shadows so formed, is useful (Ref. 14). The broken glass pieces with mould seams on a site may be a useful guide. For 20 mm square pieces the frequency of occurrence should be of the order of 1 in 6, or 12, or 25, for 2-piece, 3-piece and dip moulding respectively.

LIST OF TERMS

This preferred List of Terms is provided to clarify some of the variations in nomenclature and meaning which exist in the terms presently used by glass manufacturers, archaeologists and collectors. Although primarily adopted to achieve consistency in the text, it should be considered as a first attempt to standardise these terms.

Added glass — See: **Collar** and **Finish.**

Aerated — Less preferred term for **carbonated.** See: **Carbonated.**

Amber — A transparent golden brown colour common in beer and wine bottles.

Anchoring — Tying down a cork with wire or string. See also: **Collar.**

Annealing — The slow controlled cooling of newly formed glass, normally from 550-600°C to room temperature.

Apothecary — Old name for pharmacist or chemist.

Applied lip — See: **Collar** and **Finish.**

Automatic — Where the hot glass passes automatically to the bottle making machine and the bottle is completely formed on a continuously operating machine.

Baffle-plate — Part of the **parison mould** assembly (Figs 93, 94, 95) which shapes the half-formed bottle and produces a **baffle seam,** usually circular, in the base of the finished machine-made bottle.

Base-plate — Part of the final **blow-mould** assembly (Figs 93, 94, 95) which shapes the finished bottle or jar. It produces a **base-plate seam,** usually circular, in the base ('**post-bottomed**') or heel ('**cup-bottomed**') of the bottle (Fig. 38a, c).

Black — The dark-green colour, due to iron oxide, darkened considerably by deep amber (caused by carbonaceous impurities) in many early beer and wine bottles. For convenience, the term used here is a generalisation rather than as a specific indication of colour.

Blank — Less preferred term for **parison.** Blank is used extensively in the automated bottle making industry. See: **Parison.**

Blister — Large bubble of gas or air trapped in molten glass.

Block mould — Less preferred term for **cup mould.** See: **Cup mould.**

Blow-blow — The two stage method of making a bottle by forming a half-blown **parison shape,** allowing the chilled surface of the glass to re-heat, and blowing the final shape in the **blow-mould** (Figs 93, 94).

Blow-mould — The wooden or metal mould pieces used to form the final shape. (Figs 33-42). Forms blow-mould seams.

LIST OF TERMS

Blow-pipe — A hollow iron tube with mouth-piece - usually approximately 13-38 mm ($^{1}/_{2}$-$1^{1}/_{2}$ inches) in diameter and from about 0.9 m (3 feet) upwards in length. The tube is thicker and wider at the end on which the molten glass is **gathered** and blown.

Blow-pipe pontil — Less preferred term for **ring-pontil**. See: **Ring-pontil.**

Bore — The narrowest part of the inner surface of the neck of a bottle through which the filling tube, usually 12.7 mm ($^{1}/_{2}$ inch) diameter, must pass freely. Consequently, many bottles have a bore of approximately 19 mm ($^{3}/_{4}$ inch).

Bottom-plate — Less preferred term for **base-plate**. See: **Base-plate.**

Broad glass — Flat glass made by an early method of flattening a split, **free-blown** cylinder.

Carbonated — Term used to describe liquids, such as soft drinks, that have been impregnated with carbon dioxide gas under pressure.

Cast glass — Flat glass that has been formed by pouring hot, viscous glass onto a heavy metal table (i.e. cast) prior to rolling it to form cast glass (Figs 99, 107). See: **Rolled Glass.**

Closure — Device used to enclose or seal the contents of a bottle or jar, e.g. a stopper, cork or lid.

Codd — Used to describe various forms of soft drink bottle in which the main feature is a glass marble stopper. The marble is held in position by gas pressure against a hard rubber washer in the bore. The original type was patented by Hiram Codd in 1870.

Cold mould marks — Wavy, irregular markings caused by blowing hot glass into cold moulds. The marks may be associated incorrectly with the grain in wooden moulds (Fig. 98).

Collar — Used to describe two distinct parts of a bottle top - firstly the anchoring or holding collar (often called a **string-rim**) on which the cork is wired (Figs 4, 20, 55-58); and secondly, any reinforcing glass collar used to strengthen the neck or lip, minimise cracking or leakage, or protect the skirt of a bottle cap. Either one or both collars may form the whole **finish**. It may be formed traditionally using additional hot glass (Fig. 4), and hence is often described by the less preferred term **applied lip**, or it can be formed by **pressing** and moulding at the beginning of a machine-made process (Figs 93-95).

Cradling tool — Less preferred term for **holding tool**. However, some designs of this tool can also be used to carry, as well as hold, hot glass articles. See: **Holding tool.**

Crown-cork — A form of bottle closure (Fig. 65).

Crown finish — Finish shape used with **crown-cork** cap (Fig. 65).

Crown glass — Early form of window glass flattened by rapid spinning (Fig. 100).

Crystal glass	Brilliantly reflecting glass with a high refractive index. The term usually refers to glass containing high proportions of lead and/or barium oxides.
Cup-bottomed	Shape of a **base-plate** in the **blow-mould** assembly (Fig. 38c).
Cup mould	Wooden cup mould, usually of beech or pear wood, used to shape or 'block' glass (Fig. 5i).
Cut glass	Glass decorated by cutting, using wet, rapidly spinning grinding wheels or diamond impregnated wheels (Fig. 90).
Density	See: **Specific Gravity**
Dip mould	Solid, internally tapered mould which allows the hot glass shape to be lifted out vertically (Fig. 33).
Drawing	The stretching of hot viscous glass sheet or rod; e.g. drawn sheet glass (Fig. 106) or drawn glass tubing.
Embossing	Moulding in relief so that designs stand out on the surface of the glass.
Engraving	Inscribing the surface of the glass with small abrasive and cutting wheels to form shallow surface decoration.
Etching	Decoration of patterns (previously inscribed through a wax resist on the glass surface) by corrosion of the glass using acid fluoride mixtures.
Feeding	Process of placing or directing hot glass into a forming machine either by hand-**gathering** or by an **automatic** feeder.
Finish	The whole of the additional glass finally applied to the cracked-off top to 'finish' a bottle in the traditional process (Fig. 4). The term is still used for the same part of the bottle top, moulded in the modern machine-made process. In the latter process the **finish** is moulded at the outset in the small finish mould (sometimes called a **neck-ring mould**), which is part of the **parison** mould assembly (Figs 93, 94, 95). It consists of the glass above the **finish-mould** seam and may have a holding or reinforcing **collar** or collars, an external screw thread or other design. See also: **Collar, Finish-mould, Neck-ring mould.**
Finish-mould	Part of mould assembly forming the **finish.** See: **Finish.**
Fire-finished	Glass that has been heated and cooled, usually in a flame, to give a naturally smooth, highly reflective surface.
Fire-polished	Alternative term for **fire-finished.** See: **Fire-finished.**
Flat glass	General term for **Plate, Sheet** and **Float** glass.
Flattened cylinder	Alternative term for the early, predominantly European **Broad glass.** An improved form of this **flattened cylinder** glass, with larger and thicker panes, was later imported into Australia from Britain after 1835. See: Fig. 102.

LIST OF TERMS

Float glass — Glass that is truly flat on both sides and has been formed by the modern method of floating it on a bath of molten tin in an oxygen free atmosphere.

Flint — Describes high quality, clear glass. The term was derived from the original use of washed flints rather than sand, in melting. In optical and tableware manufacture, the term usually implies a lead crystal glass.

Forming — Moulding and/or manipulating of a glass shape.

Frosted — Matt surface on glass produced by fluoride acid **etching**.

Free-blown — Glassware blown using a blowing iron and shaped by traditional methods (Fig. 2), *without the use of a final mould.* In its strictest sense this term is used for glass freely blown in air without the contact of any tools or moulding surface.

Gathering — The taking up of molten glass on a **blow-pipe** or iron by rotating its thickened end just below the hot glass surface.

Ghost seams — The adjacent double mould seams from the **parison mould** and from the final **blow mould** in machine-made bottles (Fig. 97).

Glass-tipped pontil — A **pontil** rod that has been dipped into hot glass. Also used to describe the mark it leaves on the base of a bottle. See: Less preferred terms **Open pontil** and **Plain Pontil.**

Hand-blown — Less preferred term for **traditionally blown.** See: **Free-blown** and **Traditionally blown.**

Heel — The area near the corner of the base and sides of the bottle.

Holding tool — Tool used in place of a **pontil** to hold and usually rotate glassware while applying additional hot glass (Fig. 30).

Iridescence — Rainbow-like reflections on the surface of the glass caused by corrosion, either by water during weathering or in decorative processes, by the attack of metal vapours.

Join — The area where initially separate pieces of hot glass meet and adhere.

Kick-up — Less preferred term for **push-up.** See: **Push-up.**

Layering — Long term weathering (corrosion) resulting in layers of slightly different composition and reflecting ability.

Leer — Less preferred older term for **lehr.** See: **Lehr.**

Lehr — A long tunnel-like **annealing** oven through which hot, finished glassware passes.

Lip — Either the upper, usually rounded, edge or the shaped pouring lip of a vessel. Bottle collectors also use the less preferred term **applied-lip** for the whole of the additional **finish** and **collars** in traditionally formed bottles. See: **Collar** and **Finish.**

Mallet — Common bottle shape used between c. 1730 and c. 1800 (Fig. 20 h-j).

Mamelon — A teat like protuberance in the centre of the base of a bottle.

Marble-bottle — Less preferred term for **Codd** bottle. See: **Codd.**

Marvering — Rolling and shaping hot glass on a smooth metal or stone table called the **marver** (Fig. 2b).

Moil — Less preferred term for **moyle**. See: **Moyle.**

Mould-mark — Alternative term for mould **seam**. See: **Seam.**

Mouth — The upper opening at the top of a bottle or jar.

Moyle — The surplus glass adhering to the **blow-pipe** after the shaped glass has been cracked-off.

Necking — Reducing the thickness of surplus glass remaining on and near the **blow-pipe** and for forming the neck (Fig. 2d).

Neck-ring mould — Less preferred British term for **finish mould**. See: **Finish, Collar** and less preferred shorter term **Ring-mould.**

Onion bottle — Bottle shape used between c. 1650 and 1750 (Fig. 20 d-f).

Open pontil — Less preferred term for **glass-tipped pontil mark**. See: **Glass-tipped pontil.**

Parison — Preferred older term for half-formed shape in the traditional glass-blowing process (Fig. 2). (The less preferred American term **blank** is usually used to describe the same half-formed shape in modern automatic bottle-making practice.) **Parison** is occasionally used to describe the metal mould pieces which mould this shape. (Figs 93-95), but the term **parison mould** is preferred. This mould forms **parison** mould seams on the finished glassware (Fig. 97).

Paste-mould — Cast iron mould in which the inner surface has a coat consisting of a charred mixture of linseed oil and charcoal or saw dust, initially applied as a paste. The wetted paste-mould allows rotation of the **blow-pipe**, giving **turn-marks** and eliminating mould seams (Figs 6, 20, 43).

Pattern mould — Mould with the inner surface engraved or ribbed to produce a pattern on the glassware. (Fig. 33).

Phial — Small, slim, cylindrical bottle for medical preparations, rarely more than 100 mm (4 inches) high.

Pitting — Small usually round marks sometimes caused by weathering (corrosion) of glass.

Plain pontil — Less preferred term for **glass-tipped pontil mark**. See: **Glass-tipped pontil.**

Plate glass — Thick, **flat glass** with flat, polished surfaces that has been either **cast** (Fig. 99) or **rolled** (Fig. 107).

LIST OF TERMS

Plate-mould	Mould fitted with an interchangeable **embossing** plate enabling different designs to be produced from the same mould. (Figs 48, 49)
Plug	Less preferred term for **plunger**. See: **Plunger**.
Plunger	Part of the **finish-mould** assembly used to form the **mouth** and **finish** of a machine-made bottle (Figs 93-95). See also: **Pressing**.
Polishing	A process of smoothing glass surfaces using a wheel fed with rouge or cerium oxide pastes.
Pontil	A plain iron rod used for holding an article by the base during hand manipulation (Figs 2j, 2k, 3).
Pontil mark	The mark or scar left when the **pontil** is broken away from the base of an article. Such an article is said to be pontilled.
Post-bottomed	Shape of a **base-plate** in the **blow-mould** assembly (Fig. 38a).
Press	The equipment used in glass **pressing**.
Pressed	Glass formed by **pressing**.
Pressing	Pressing hot glass into a mould with a metal **plunger** to form a **pressed** glass design (Figs 86-88).
Press & Blow	The two stage **pressing** of a **parison** and, (after allowing the surface of the glass to reheat) final blowing of the shape in a **blow-mould** (Fig. 93).
Pucellas	Shaping tool used to widen the **mouth** of a piece of glassware during **traditional blowing** (Fig. 5f).
Push-up	Form of bottle base which is pushed-up mainly to ensure that the base sits evenly on a flat surface (Figs 21-24).
Pyrex	A heat and chemically resistant borosilicate glass used extensively in industry and as ovenware.
Pyroceramic	A ceramic product, initially shaped and formed from molten glass containing crystal nucleating agents, which is then heat treated to form a fine interlocking crystalline material used as ovenware.
Refractive index	A measure of the change in direction (and speed) of light on passing into a transparent material. Brilliant, sparkling glasses, such as lead **crystal**, have a higher index than common glass.
Reheat	The reheating of glass shapes during manipulation (Fig. 2m). Also used to describe the time required for surface reheat to allow the final blowing in machine-made bottle procedures.
Reinforcing collar or ring	See: **Collar** and **Finish**.
Resist	Resinous cover that resists acid fluorides during the **etching** of glass surfaces.

Rim	The finished edge of glassware. See also: **Lip, Collar** and **Finish** and **String-rim.**
Ring mould	Less preferred term for **finish-mould.** See: **Collar, Finish, Finish-mould** and less preferred term **Neck-ring mould.**
Ring-pontil	The circular mark formed on the base of an article when a metal tube or **blow-pipe** is used as a **pontil** rod. See: **Pontil.**
Rolled glass	**Flat glass** formed by a continuous rolling process. See: **Cast glass** and **Plate glass.**
Sandblasting	A process of abrading glass by means of sharp sand impelled by a jet of steam or compressed air. The process is used for decoration.
Sand-pontil	A **glass-tipped pontil** dipped in sand. The term is also used to describe the mark left by the **sand-pontil** on the base of the bottle.
Scuffing	Abrading of glass surfaces during use.
Seal	Design or initials pressed into a blob of molten glass which is attached to the shoulder or body of a bottle. See: **Closure** for alternative meaning.
Seam	A general term used for any mark on a finished glass surface caused by the very small air gap between two separate but matching mould parts (Figs 37, 38, 41). Hence - **Parison-mould seam, Blow-mould seam, Baffle-plate seam, Finish-mould seam** etc.
Seed	Small bubble of gas or air trapped in molten glass.
Semi-automatic	Bottle machine **fed** by hot glass which has been **gathered** by a **blow-pipe.**
Shaft and Globe	Early bottle shape used between c. 1630 and c. 1670 (Fig. 20a).
Shear mark	A **shear mark** is a discolouration or streak of bubbles caused by oil lubricants, or the sheared tail of glass wrapping over to form a fold on the surface.
Shears	Manually or mechanically operated scissors used to cut hot glass.
Sheet glass	Often used as a general term for **flat** glass. Specifically, it refers to glass drawn upwards through water-cooled rollers from a tank of molten glass (Fig. 106), hence drawn sheet glass. See: **Drawn, Flat** and **Float** glass.
Silvering	The depositing of silver on the surface of glass to form a mirror using reduced silver nitrate solution.
Slump	Deformation of glass under its own weight.
Specific Gravity	Mass ('weight') per unit volume. e.g. The metal lead has a higher specific gravity and is denser than glass. For many purposes the less preferred term **density** is used, although technically they are not precisely identical.

Streak Less preferred term for **striae**. See: **Striae**.

Striae A line of bubbles or glass of different composition which can show the glass flow lines and thus assist in assessing moulding methods (Fig. 6).

String-rim Less preferred term for part of the **anchoring** collar or the whole **finish** in some early bottles. See: **Collar, Finish.**

Suction-blow Alternative two stage method of making a bottle (Figs 93, 94). Forms a typical suction **scar** (mark) in the base or **heel** of a bottle due to the cut-off knife (Fig. 96). See: **Blow-blow.**

Tableware Glassware used to serve food or drink.

Tempering Strengthening glass, usually flat glass, by force-cooling the surface with uniformly distributed cold air blasts.

Tongs Shaping tool used during **traditional blowing** (Fig. 5f).

Turn marks Circular marks on glassware caused by contact with a wooden former or **paste-mould** during rotation (Fig. 6, 20n, 43b).

Turn-mould A wooden or **paste-mould** in which hot glass is rotated during blowing. See: **Paste-mould.**

Vial Less preferred term for **phial**. See: **Phial.**

Viscous Stiff, sticky, slow moving (of a liquid such as glass).

Whittle-marks Less preferred term for **cold-mould** marks. See: **Cold-mould marks.**

Wired Plate Cast or **rolled plate glass** in which wire mesh is embedded.

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