The history of wine presses Part 1: Batch presses

In this article, **Simon Nordestgaard**, a senior engineer at The Australian Wine Research Institute, describes the types of batch processing mode pressing equipment that have been used in the wine industry since the late 19th century. A second article, to be published in the September issue, will cover continuous processing and provide some thoughts about the types of pressing technology that may be used in the future.

PRESSING is a critical operation in wine production. The equipment used influences quality, yield, and throughput. While most of the equipment to be discussed has been used for both red and white wine production, the focus of these articles is on pressing grapes for white wine production, which is more challenging than pressing red grapes that have already been broken down by fermentation.

THEORY

Figure 1 shows a basic structural model of the grape. During crushing and pressing, juice is most easily released from the weakest pulp cells in the intermediate zone of the grape, then from the pulp cells in the central and peripheral zones.

The peripheral pulp remains attached to the skin, which contributes some of its constituents as the juice is collected from this zone. Extreme pressing may release constituents from seeds and stems.

Batch pressing is performed not in a single step, but with several cycles of pressing interrupted by crumblings of the press contents to redistribute them and open new paths for juice drainage. Achieving low levels of suspended solids in the juice from the press is advantageous as it means fewer solids have to be removed by other processes prior to fermentation.

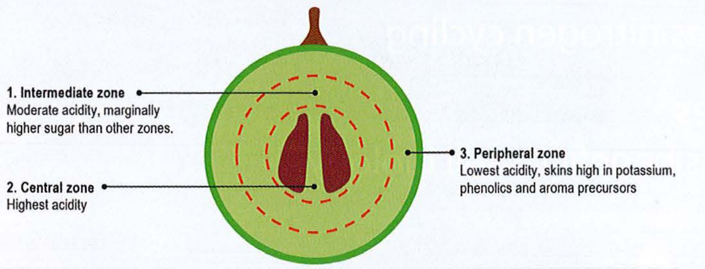

Figure 1: Typical order of rupture of grape pulp cells.

The suspended solids in juice are principally pulp cell walls, and the concentration of these in the juice leaving the press will depend on the amount that is in the juice released from individual grape parts minus the amount that is filtered out as the juice passes through the 'cake' (the mass of grape material) (Figure 2).

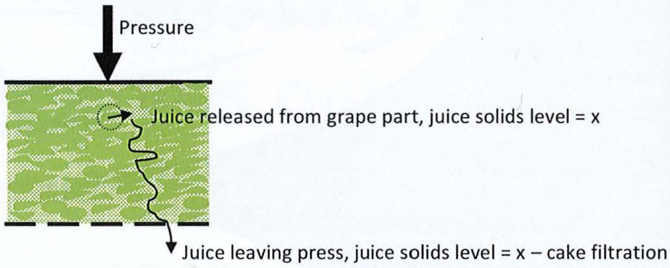

Figure 2: Juice released from a grape part in a press cake, and filtration of this juice as it passes through the cake to the outlet screen

DRAINERS

Grapes can be juiced directly in a press, but more commonly they are first crushed by rollers so that juice can be collected more quickly. Draining of the crushed grapes may be performed during filling of a press or it can be performed in a separate vessel with a screen – a static drainer.

Key advances in static drainer design were to have a cake with sufficient depth to provide a filtration effect and to have a way of automatically removing the drained cake without having to manually dig it out.

Many styles of static drainers have been used around the world.

The Potter and Miller drainers (Figures 3 and 4) were introduced in Australia in the 1960s and illustrate some typical features. Both devices allow for the formation of a cake that filters the draining juice.

In the Potter drainer, the central screen can be lifted to evacuate the drained grapes, while in the Miller drainer, twin-screws are used to evacuate the drained grapes.

The Potter drainer is a multi-purpose tank – it can also be used for fermentation and storage.

The Miller drainer can be pressurised with carbon dioxide to increase the speed and extent of draining and inhibit oxidation

The use of static drainers has diminished with the advent of pneumatic membrane presses with axial filling, which allow intermittent rotation and therefore efficient draining during filling.

VERTICAL BASKET PRESSES

Around the 1830s central iron spindle vertical basket presses were introduced and by the late 19th century they were the predominant style of press.

There were a number of developments in how the pressing nut progressed down the spindle in this period. The most important of these was the ratcheting mechanism developed in 1869 by Mabille (Figure 5).

Marmonier developed a variation on this mechanism in 1874 (Figure 6), which is similar to those still in use today for small-scale winemaking.

Through compound leverage, these mechanisms allowed one or two people to manually press large quantities of grapes (e.g. Figure 7).

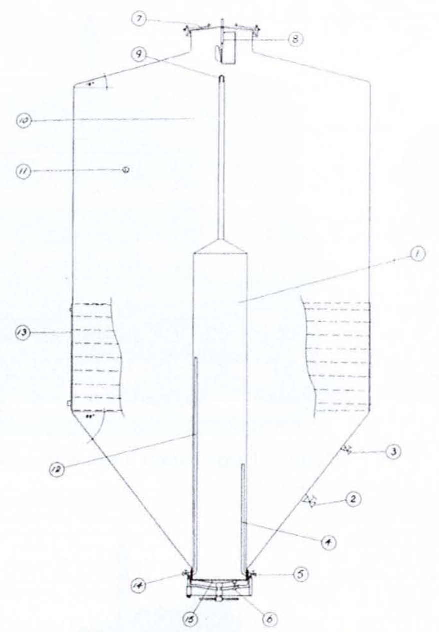

Figure 3: Potter drainer

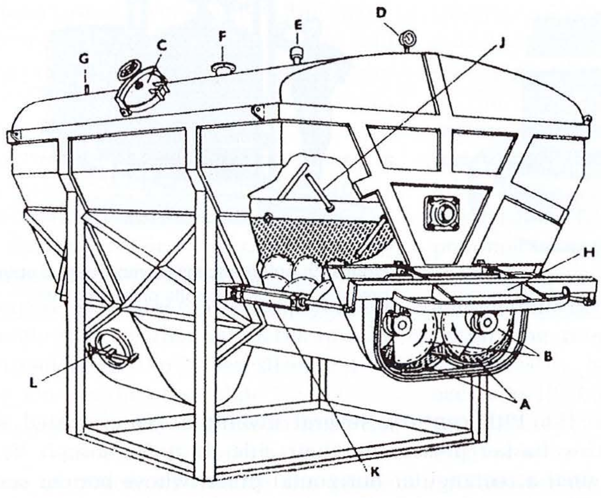

Figure 4: Miller drainer

The double ratchet aspect of the mechanisms also conveniently meant that the nut progressed both as the lever was pushed forward and as it was pulled backwards.

A further improvement was the addition of spring pressure accumulators to the press nut (Figure 8).

In vertical basket presses, a large pile of wooden blocks was usually stacked between the cake and the press nut.

The elasticity of the wood meant that as the juice flowed out of the press cake, the wood sprang back and continued to press the cake without the nut having to be immediately tightened. Spring pressure accumulators meant that the large pile of wooden blocks, that had been so labour-intensive to build and dismantle, was no longer required and because the springs were more elastic than wood the press nut needed to be tightened even less frequently.

Automatically driven systems followed (Figures 9 and 10) as did the use of hydraulics for pressing (Figure 11).

The use of mobile press baskets (Figures 10, 11 and 12) that allowed one basket to be filled or emptied while another was being pressed was another major advance.

There were also advances in press cake crumbling, for example, devices into which the cake from one press basket could be loaded and it then crumbled and conveyed into another press basket for the next pressing (Figure 12). ▸

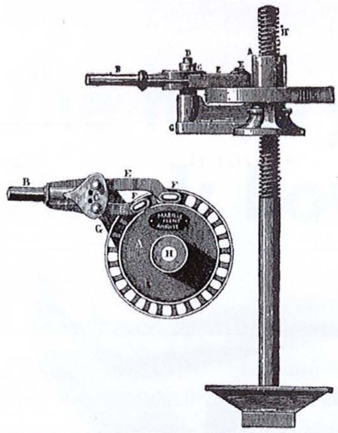

Figure 5: Mabille ratcheting press nut mechanism and spindle

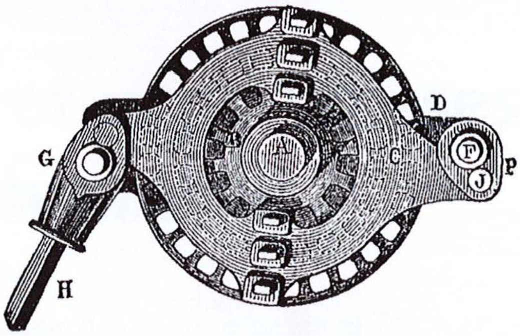

Figure 6: Marmonier multi-speed ratcheting press nut mechanism

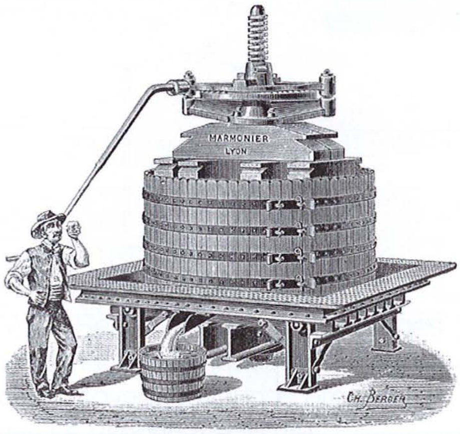

Figure 7: Large basket press with ratcheting press nut

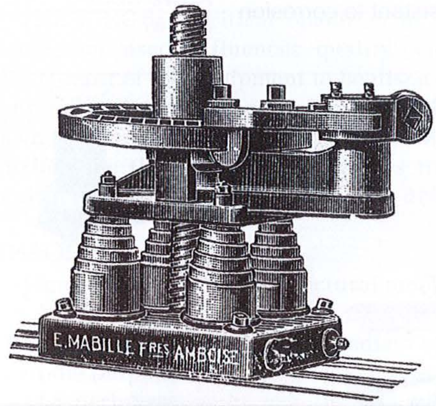

Figure 8: Ratcheting press nut with spring pressure accumulators

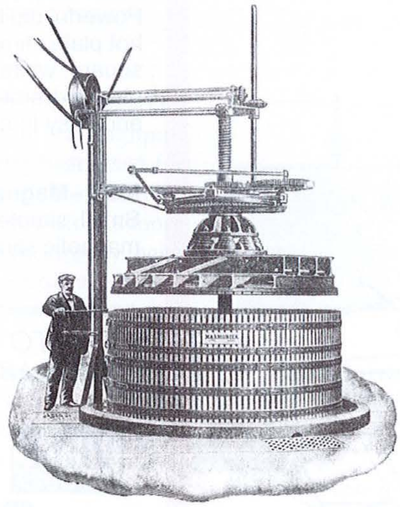

Figure 9: Line shaft driven basket press

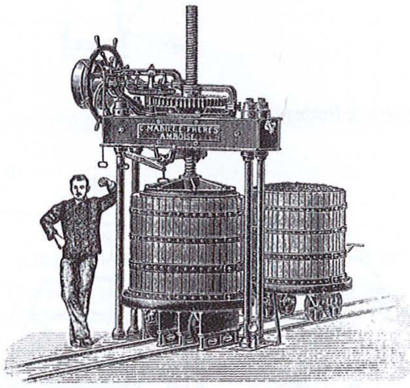

Figure 10: Automatically driven external spindle press system with mobile press baskets

HORIZONTAL PLATE PRESSES

Even with the advances described, vertical basket presses were still very labour intensive because of the need for manual management of cake crumbling and press emptying.

In the 19th century, several inventors experimented with putting basket presses on their side. In 1856, Joseph Vaslin patented a rectangular horizontal press, whose bottom screen could be opened and the press cake more easily emptied.

Then in 1925 and 1927 his grandson (also called Joseph

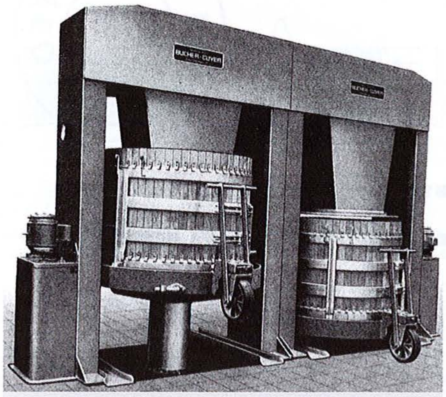

Figure 11: Hydraulic presses with mobile press baskets

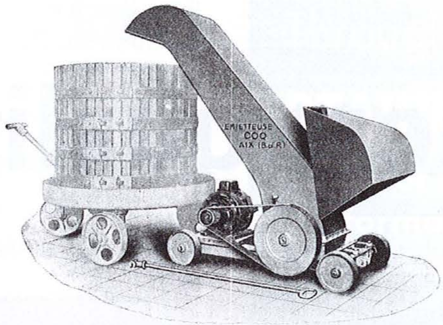

Figure 12: Automated press cake crumbler

Vaslin) patented a revolutionary cylindrical horizontal plate press that could be rotated. Aided by in situ cake breaking chains/rings, rotation of the basket would now automatically crumble the cake.

These presses were refined and mass-produced after 1945 when Vaslin sold his process to Gaston Bernier, founder of Constructions Méca-Métalliques Chalonnaises (CMMC).

An early CMMC-Vaslin press is shown in Figure 13, and its operation is illustrated in Figure 14.

It features two press nuts/plates on the internal spindle. Half of the spindle is threaded in one direction to accommodate one plate and the other half of the spindle is threaded in the other direction to accommodate the other plate.

The plates move on guide rails on the basket, such that rotation of the basket in one direction will cause the plates to move together and press the cake, while rotation of the basket in the other direction will cause the plates to move apart and crumble the cake.

Later models of the CMMC-Vaslin press became increasingly sophisticated.

The spindle could be turned independently of the basket – allowing rotation of the basket without plate movement or faster plate movement during pressing and crumbling.

The door could be located in a fixed section at the end of the cage while the rest of the cage could still be rotated, allowing for improved draining during press filling (similar to an axial filling pneumatic membrane press).

There were also increasing levels of automation, culminating in the first self-optimising programs that would adjust the pressing program in real time for each specific batch of grapes in a similar way that a very experienced and attentive manual press operator might.

This worked principally by measuring the speed of pressure decrease at a plate when the plates stopped moving ▸

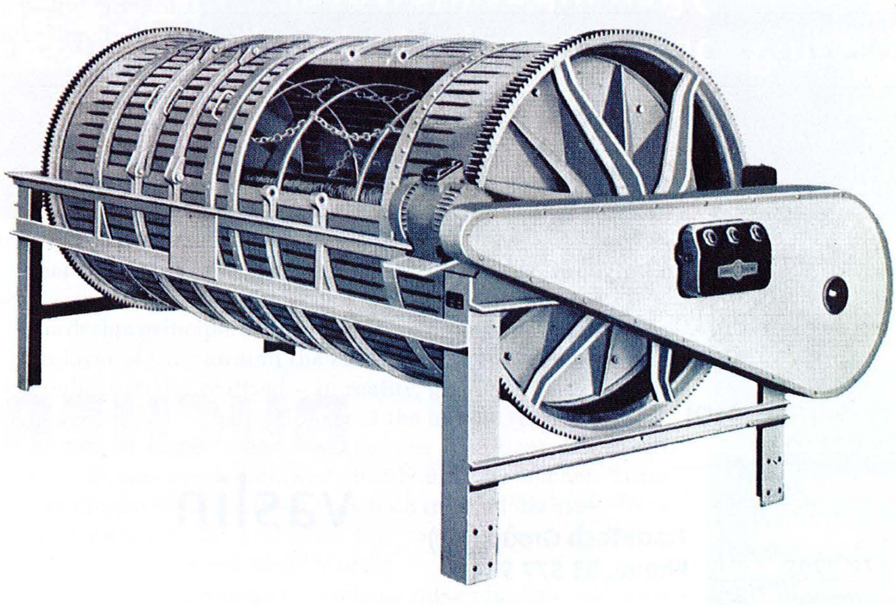

Figure 13: CMMC-Vaslin rotating horizontal plate press

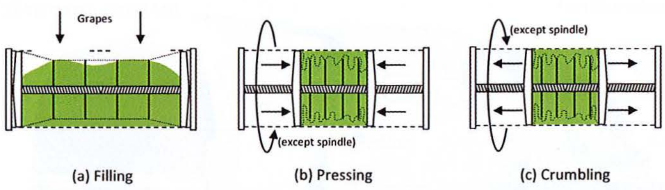

Figure 14: Operation of the CMMC-Vaslin horizontal plate press

(indicative of juice flow rate), and adapting the program accordingly.

Essentially the logic is that if the juice flow rate is low at the current pressure set-point, the set-point might as well be raised or the cake crumbled, because otherwise time is being wasted.

On the other hand, if the juice flow rate is high, there is no reason to raise the pressure set-point or crumble the cake and risk generating extra solids.

The advances described would have made the horizontal plate press increasingly appropriate for larger operations; however, there were apparently practical limits that competing pneumatic pressing technology did not have.

In horizontal plate presses the direction of compression is perpendicular to the direction of juice outflow, which is advantageous in terms of preventing extrusion of solids through the screens.

However, this configuration does not transmit pressure well from the plates to the core of the cake and this effect is exacerbated with larger presses (the largest Vaslin press I have seen in old advertisements is 12.5 m3).

In 1986 Bucher acquired CMMC and their horizontal plate presses stopped being constructed in 2001 as pneumatic membrane presses became the preferred technology.

Much of CMMC's technical know-how, particularly in juice flow-rate mediated self-optimisation, transferred to the pneumatic presses that are now produced under the banner of Bucher-Vaslin.

PNEUMATIC PRESSES

Pneumatic presses use an inflatable diaphragm instead of plates to press grapes. The original horizontal rubber bladder pneumatic press was introduced in 1951 by Willmes (Figure 15).

The bladder was arranged centrally in-line with the drum axis. A key design principle was that as the bladder expanded it would press against a relatively thin layer of cake evenly distributed around the entire drum circumference, and this thin layer would be able to be pressed quite quickly.

As with horizontal plate presses, crumbling was performed via rotation of the press drum. Horizontal bladder presses were good but there were some drawbacks.

During press rotation, the unsupported rubber bladder was exposed to considerable mechanical stress by the press cake, and this could result in punctures.

There was also some tendency to extrude solids through the press screens, which then needed to be manually cleared.

The design principle of the centrally mounted bladder pressing a thin layer of cake around the entire drum circumference was also only partially realised – in reality, gravity meant that the cake layer ended up being thicker at the bottom than the top.

In 1974, Willmes introduced the now dominant pneumatic tank/membrane press, followed shortly after by Bucher. These presses employed an enclosed tank with internal drainage ducts that somewhat better protected the contents from oxidation than the open-screened bladder press.

A reinforced membrane instead of a rubber bladder was used and this was mounted on the tank wall instead of centrally. This mounting method exposed the diaphragm to less mechanical ▸

Figure 15: Willmes pneumatic rubber bladder press

Figure 16: Modern pneumatic membrane press

Figure 17: (a) Internal view of a pneumatic side-mounted membrane press, and (b) close-up of drainage ducts

stress during drum rotation.

Side-mounting of the membrane opposite drainage ducts is still the most common membrane press design today (e.g. Figures 16 and 17), but it is not universal.

Presses with supported central membranes or with side-mounted membranes but central juice drainage ducts are also available (Figure 18).

Proponents of each of the three different configurations sometimes claim benefits over other designs in terms of faster juice drainage, lower solids content, lower risk of membrane damage or easier membrane replacement.

However, there are no definitive independent published studies on which configuration is superior and it is plausible that they can all be operated to provide similar outcomes.

From their inception, pneumatic membrane presses have been offered in large sizes and presses with capacities of 75 m3 are now available.

As already discussed, the advent of axial filling allowing intermittent press rotation during filling meant membrane presses could be used as effective drainers prior to pressing, leading to a decrease in the use of separate drainers.

Developments to limit juice oxidation in pneumatic presses have been another advance.

One approach has been to introduce inert gas prior to press filling and during retraction of the membrane prior to cake crumbling.

To minimise inert gas use, two prominent Italian winemakers patented a system in 2003 that uses a flexible bag to store and recycle the inert gas.

They sold the process to Bucher-Vaslin which uses it in their Inertys presses.

Other inert gas minimisation strategies employed by press manufacturers include the use of press programs with multiple pressure steps between each crumbling that minimise the number of crumblings required and therefore the number of times that the inert gas atmosphere has to be recharged, or only

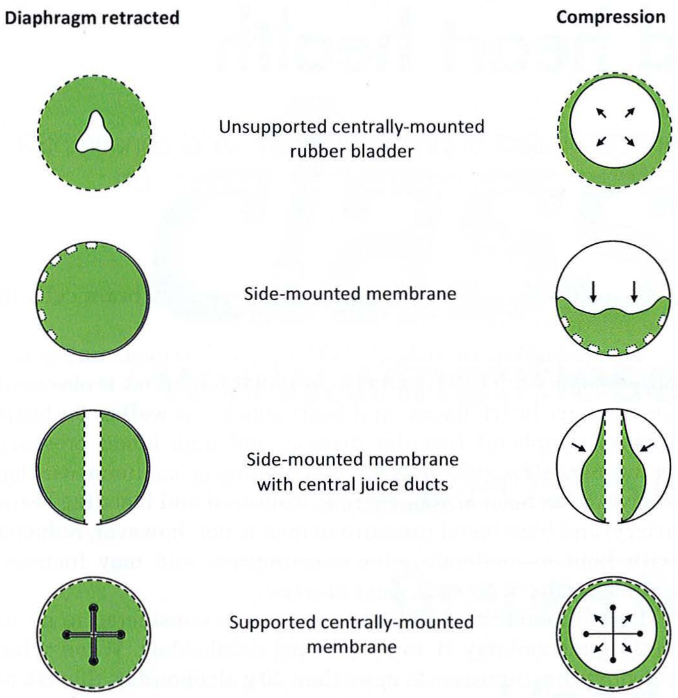

Figure 18: Pneumatic press arrangements (end view, simplified)

employing inert gas during some parts of the press program.

An alternative approach to limiting juice oxidation, implemented by Pera, is a system that sprays small amounts of a sulfur dioxide solution into the press during each crumbling.

CONCLUSION

The modern batch pneumatic membrane press is a considerable improvement on the vertical basket presses of the 19th century.

Pneumatic membrane presses are able to produce high yields of high quality juice at much higher throughputs than was previously possible with batch presses.

However, throughput is still considerably lower than some continuous pressing technologies that have been employed for wine production.

A second article, to be published next issue, will describe the continuous pressing equipment that has been used in winemaking and provide some thoughts on what the future might bring.

Acknowledgements

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