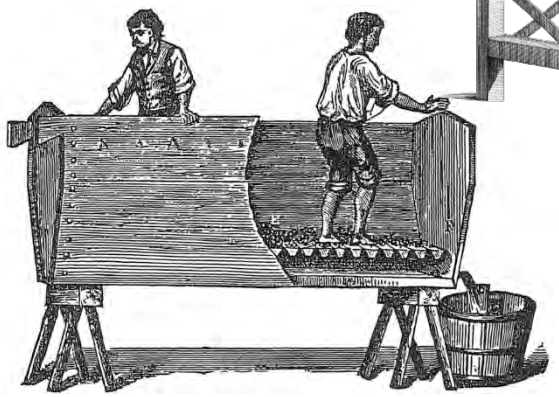
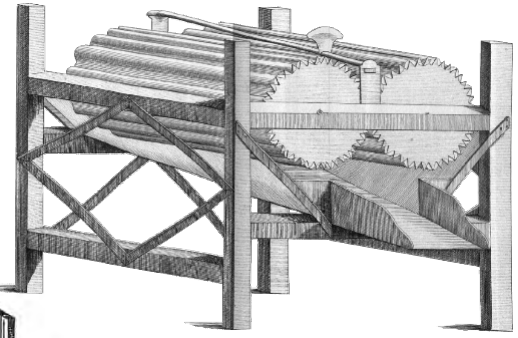
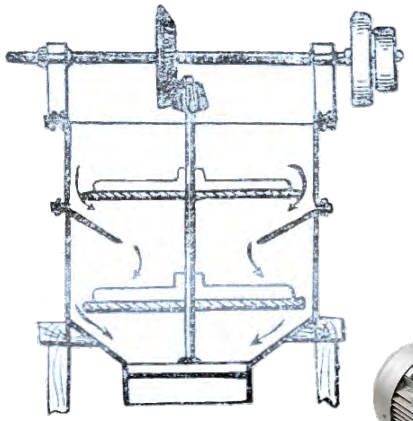
The Australian Wine Research Institute







Grape crushing - history and recent developments

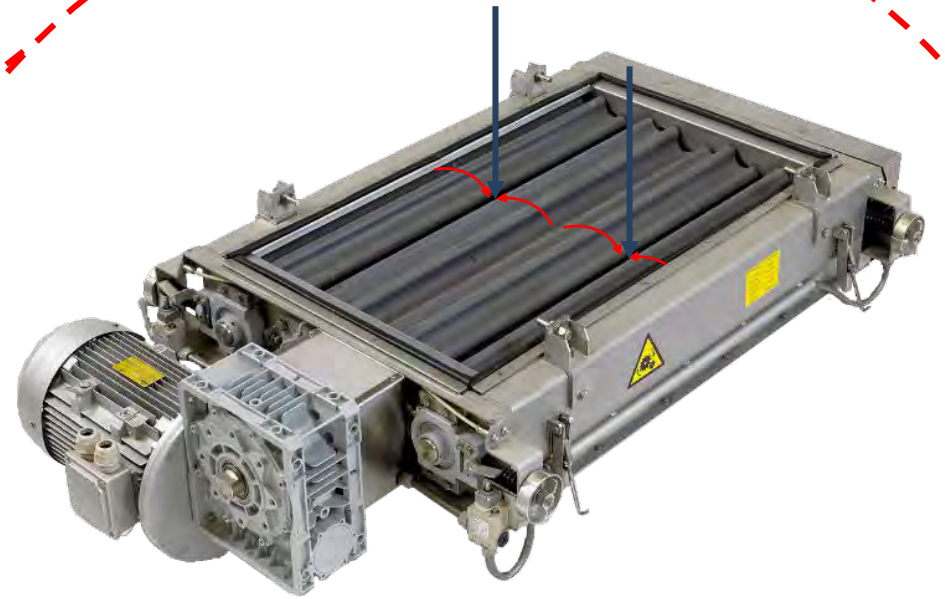
Simon Nordestgaard
simon.nordestgaard@awri.com.au

Why crush? & current standard method

The Australian Wine Research Institute

- Increases speed of juice release
- Increases speed of skin extraction
- Facilitates alcoholic fermentation

Roller crusher

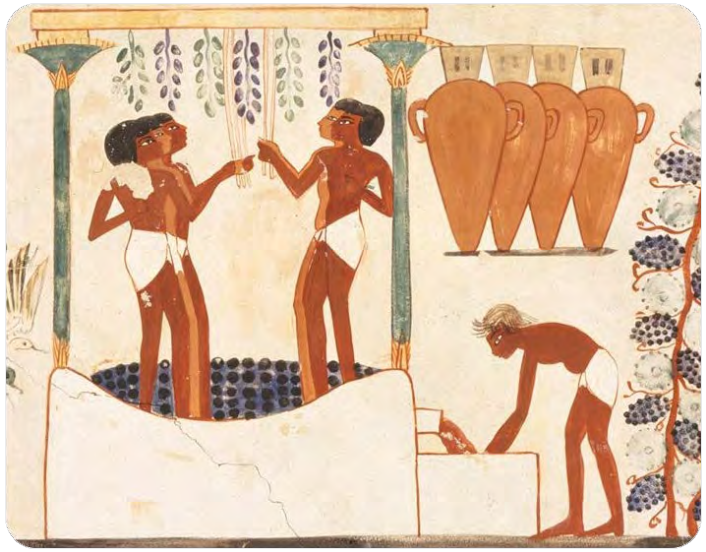


- 1 or 2 pairs of rollers
- Overlapping rubberised lobes
- All rollers at same speed
- Gap adjustable
- Spring-loaded & safety switches
- Quite often bypassed (roller cassette moved aside)

Treading

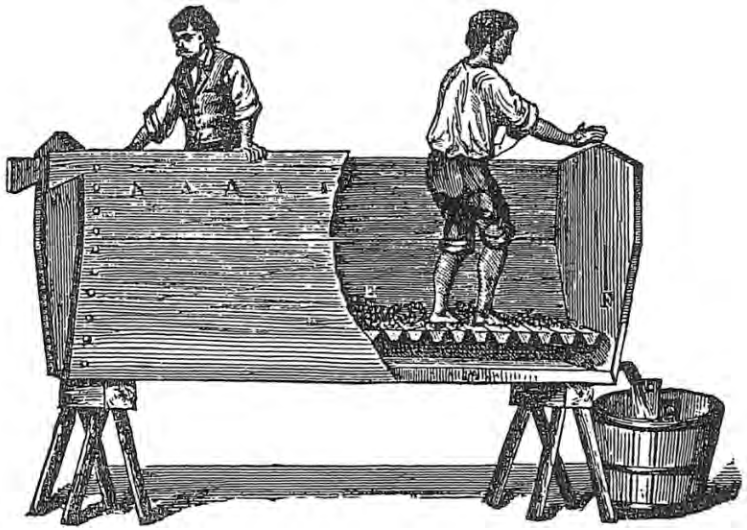
"The instruments nature provided for the purpose"

– Hugh Johnson



Nakht's tomb, c. 1400s BC.

- Crush pulp and skins
- Do not crush seeds or stems

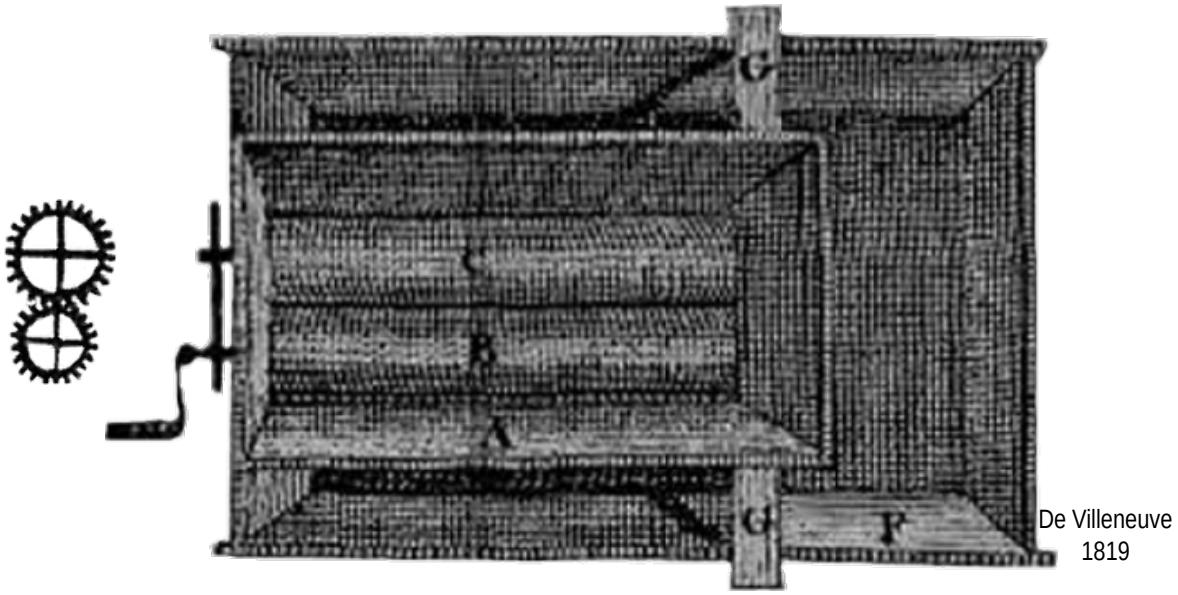


France, c. 1800s AD

Roller crushers – early 1800s

The Australian Wine Research Institute

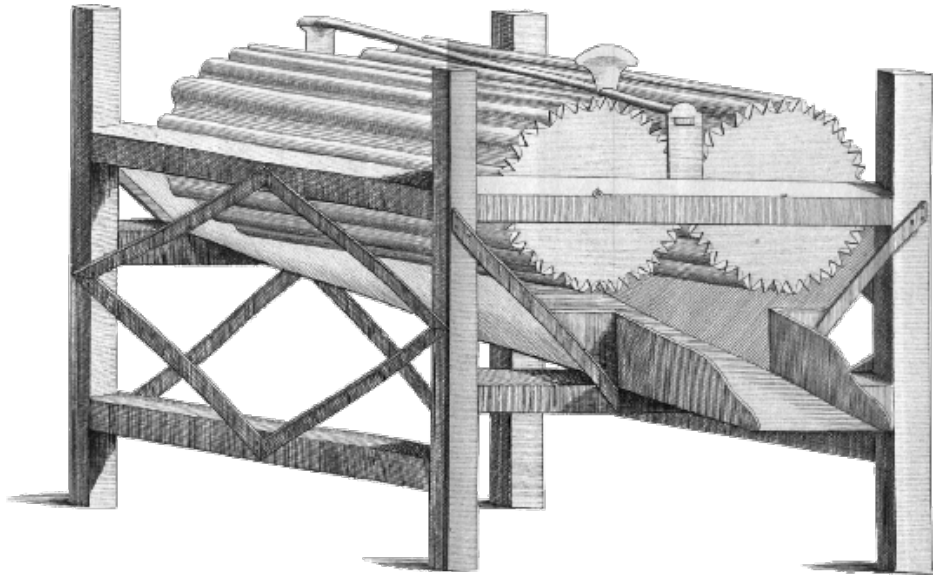
Guerin
differential speed roller crusher



De Villeneuve
1819

- Differential roller speed creates an additional stripping crushing effect

Lomeni
overlapping lobe roller crusher



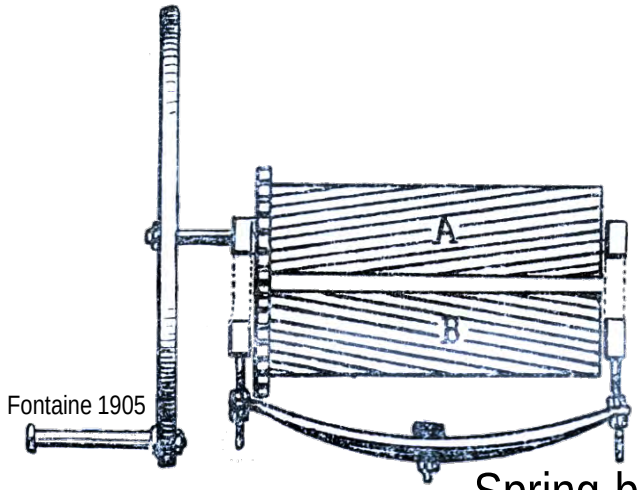
Lomeni
1825

- Many similarities with modern designs

Roller crusher developments – early 1900s

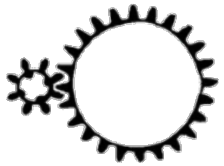
The Australian Wine Research Institute

Differential speed roller crusher most widely used crusher in France in early 1900s



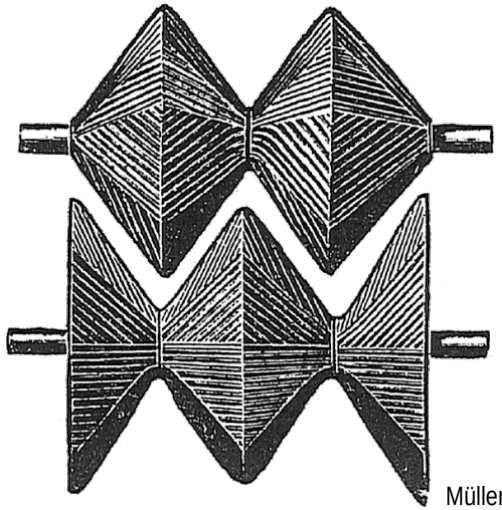
Fontaine 1905

Spring-bar



- Typical speed ratios: 3/1 – 5/1
- Corrugations on at least one roller
- Adjustable roller gap
- One roller often now spring-loaded

Conical rollers



Müller 1930

- Another effort to enhance feeding and maximise capacity

Gears in image are not to scale. References for speed ratios: Roos (1900), Laborde (1907), Ventre (1929)

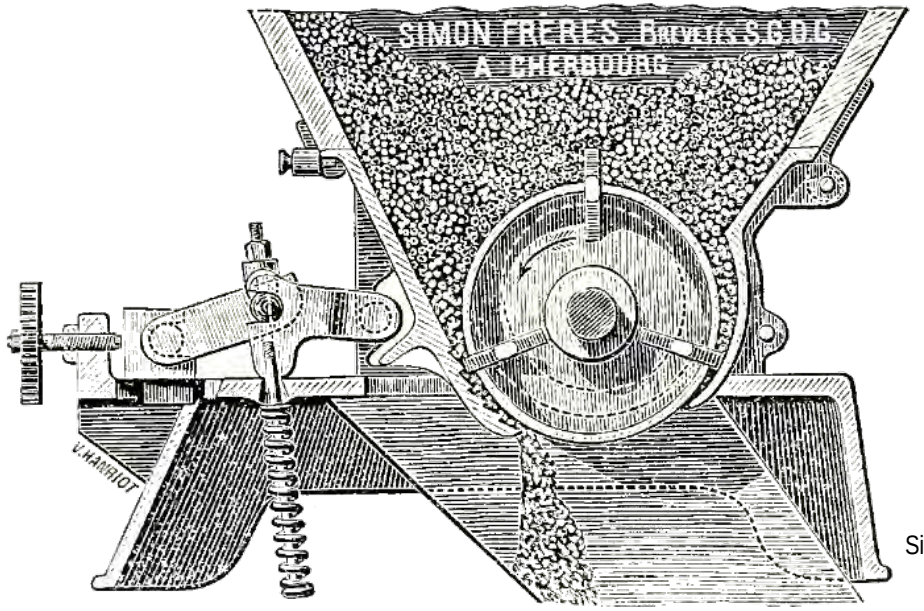
Single roller-plate crushers – 1800s-1900s

The Australian Wine Research Institute

Acher/Thiébaut de Bernaud
Nail roller-plate crusher

Thiébaut de Bernaud 1829

Simon Frères
Reciprocating blade roller-plate crusher



Simon Freres 1894

- Blades move in and out of roller to feed and crush the grapes against the plate
- Not as common as twin roller crushers

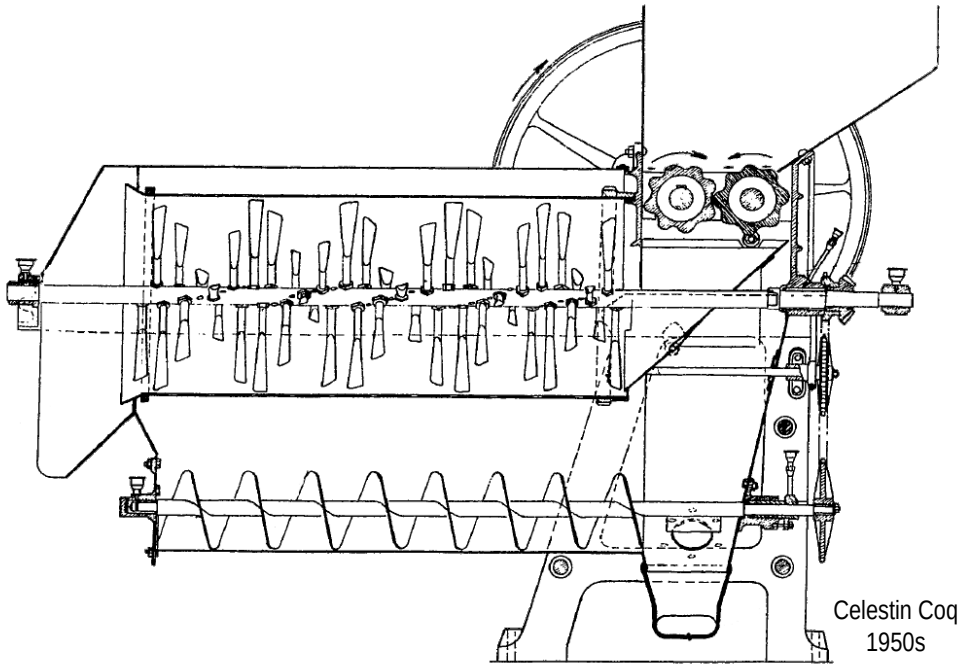
Overlapping lobe roller crushers dominant from ~1950s

The Australian Wine Research Institute

Why did overlapping lobe rollers overtake differential speed rollers?

- Good feeding capability → throughput
  - Lobes draw in grapes (avoid slippage and bridging)
- Gentleness on stems and seeds
  - Destemming was less common than it is now
  - Historically when destemming performed, was often after crushing, so gentle crusher important (often no rubber covers on differential speed rollers as well)

Crusher before destemmer

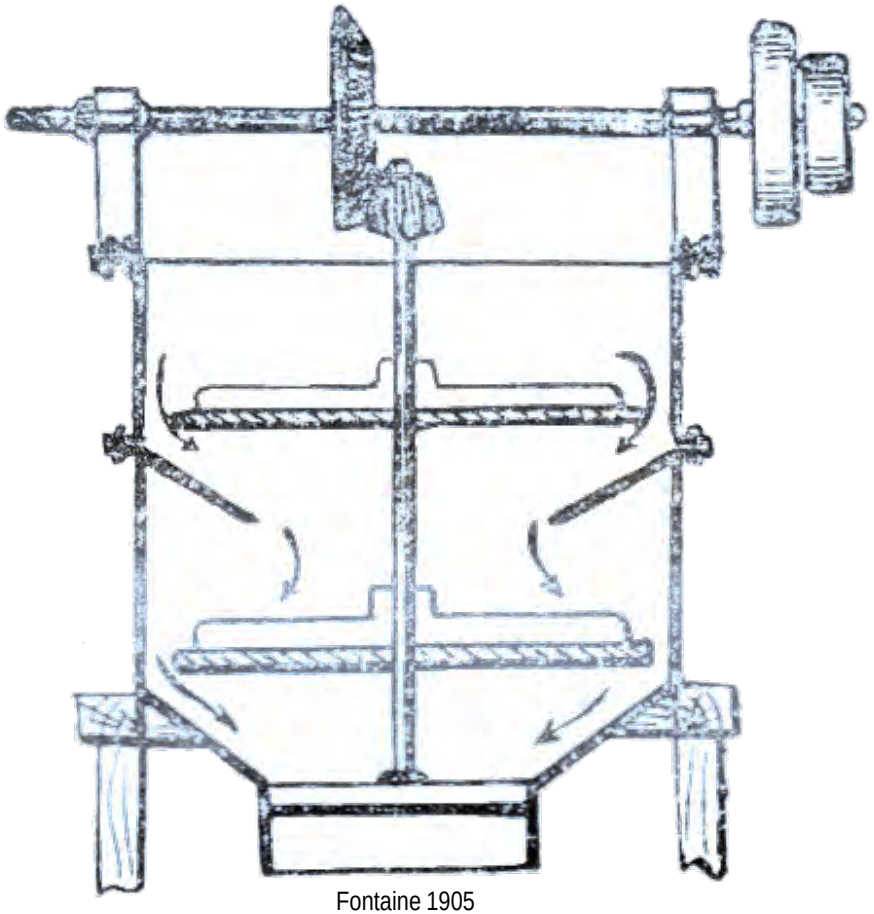


Celestin Coq
1950s

Centrifugal crushers – late 1800s

The Australian Wine Research Institute

P. Paul
centrifugal crusher



Fontaine 1905

- Grape bunches thrown off grooved fast rotating disc into wall crushing them
- Pacottet (1915):
  - Seeds and stems not damaged
  - Substantive lees, requiring many rackings
  - Serious disappointment when trialled for quality wine production
- Used in many large wineries in Southern France and Algeria in the early 1900s

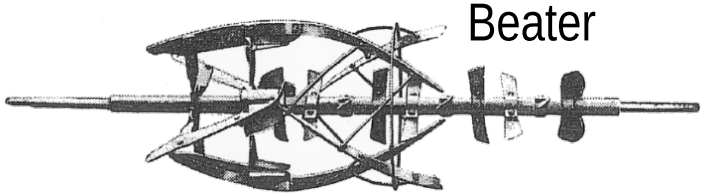
Beater centrifugal crusher-destemmers – mid-late 1800s

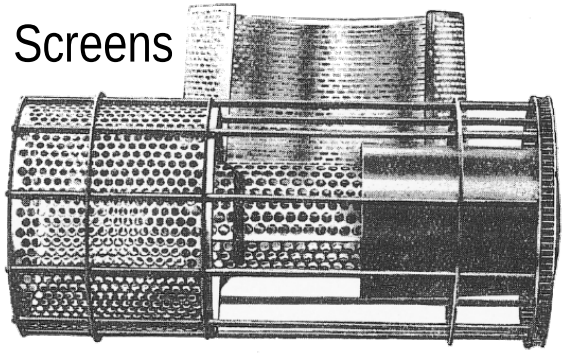
The Australian Wine Research Institute

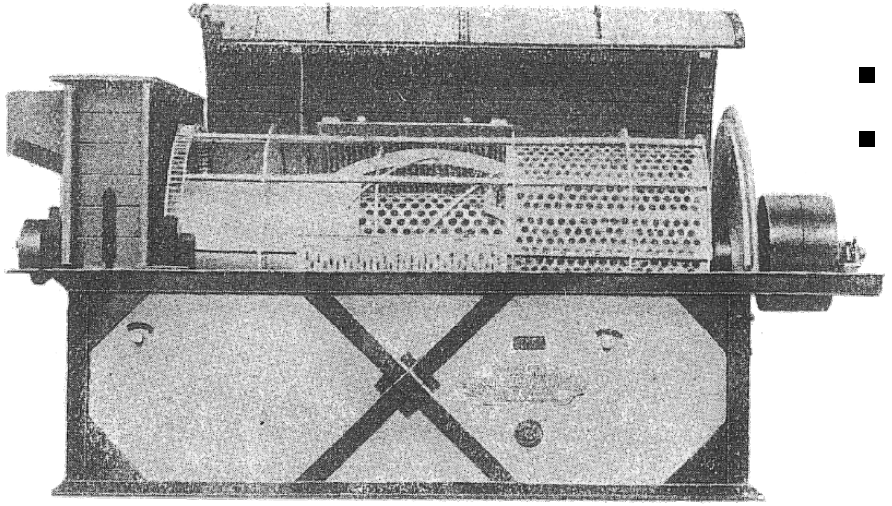
Bagshaw (Australia) beater crusher-destemmer

- Beater crushes and destems as it rotates against a fixed screen

Garolla (Italy) beater crusher-destemmer







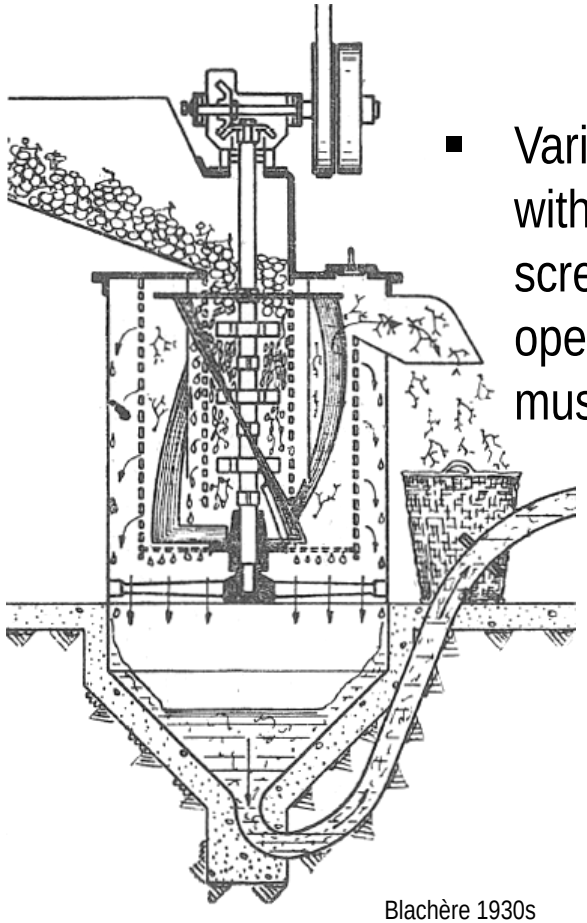
Garolla 1940s

- Twin screens rotate slowly
- Beater rotates faster and has elements in inner screen to destem and elements between screens to vigorously crush the destemmed grapes

Vertical centrifugal crusher-destemmers – early-mid 1900s

The Australian Wine Research Institute

Top-fed centrifugal beater crusher-destemmer



Blachère 1930s

- Variations also existed with sections in the outer screens that could be opened to retain stems in must when desired

Bottom-fed centrifugal beater crusher-destemmer

Siprem 1970s

- Grapes could be directly fed from a hopper on the same level
- Crusher-destemmer didn't need to be in a pit

Centrifugal devices – summary of historical experiences

The Australian Wine Research Institute

- Commonly used until mid-late 1900s in large scale wine production but were gradually replaced with modern destemmer-crushers with lobed rollers

- High throughput ✓
- High yields ✓
- High aeration ✓ or ✗
- Evaporative cooling ✓
- Faster/more skin extraction – tannins & colour ✓ or ✗
- Large amounts of lees ✗
- More residual stem fragments ✗

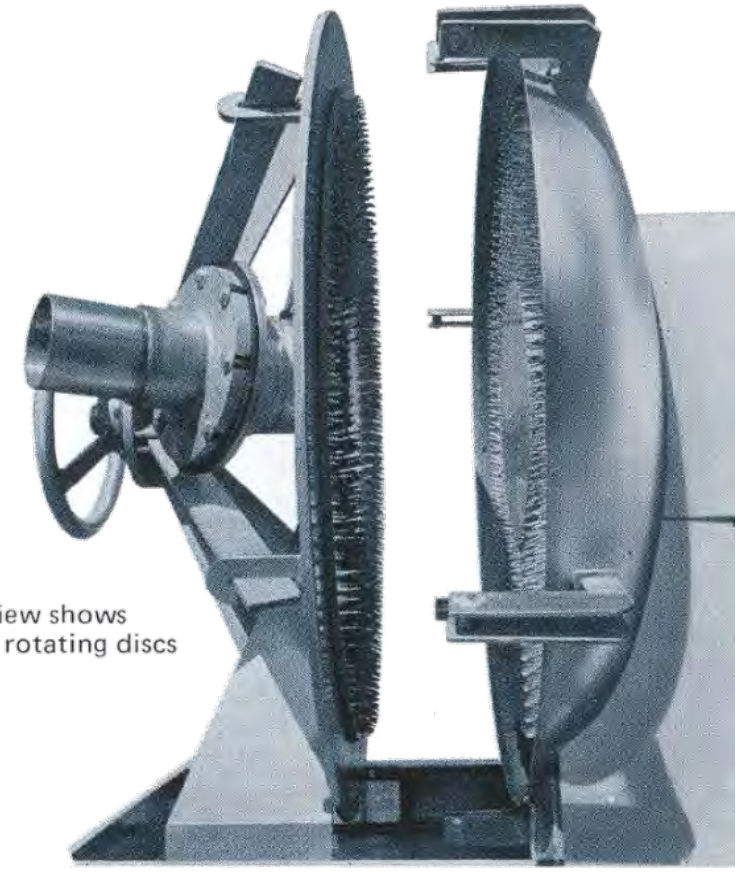
Centrifugal crusher-destemmers "should be rejected for quality winemaking"
– Peynaud (1984)

Roller crushers "are more suitable for the production of table wines"
– Rankine (2004)

Secondary crushing – 1970s

The Australian Wine Research Institute

Pin-mill secondary crusher after normal destemmer-crusher



Interior view shows fixed and rotating discs

Rietz 1976

Malan et al. (1978): Pin-mill as a secondary crusher

- Further stripped pulp from skins
  - Seeds were not damaged
- Extra solids partially blocked static drainer screens
  - But final yield was higher after mechanical draining/pressing
- Tannin and colour higher in finished red wines that were drained/pressed very early
  - But with longer skin contact times, colour intensity was sometimes lower than control
- Ultimately, technique was not widely adopted

New crushing devices - drivers

The Australian Wine Research Institute

- Reduced skin contact time for red wine production to make better use of fermenter capacity
- Increased (stable) colour for red wines from some varieties

Pellenc Extractiv' centrifugal crusher – c. 2012

The Australian Wine Research Institute

45% max speed

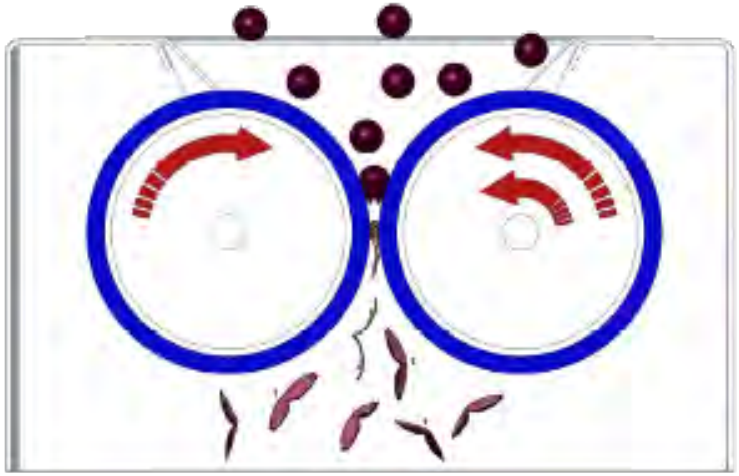
70% max speed

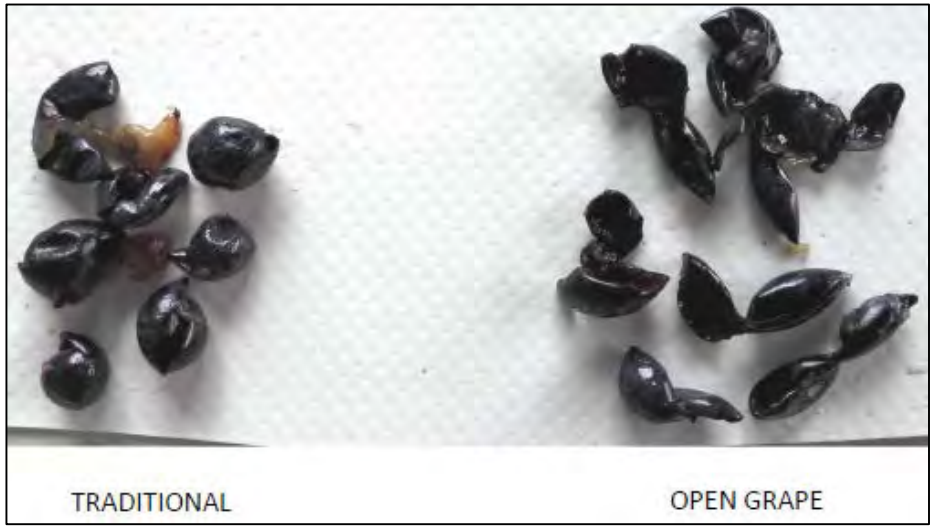
Merlot, 5 t/h (Pellenc)

- Up to 25 t/hr
- Used after destemming
- Speed easily varied

Diemme Open Grape differential speed roller crusher – c. 2016

The Australian Wine Research Institute





- 13 t/hr (2 rollers) & 45 t/hr (4 rollers)
- Used after destemming
- Rubberised rollers with profile to aid feeding
- Roller speed differential easily varied
  - Separate motors on each roller
  - Advocating low speed differentials (e.g. 1.3/1 & 2/1 in marketing material)

ACE stick blender secondary crusher – c. 2015

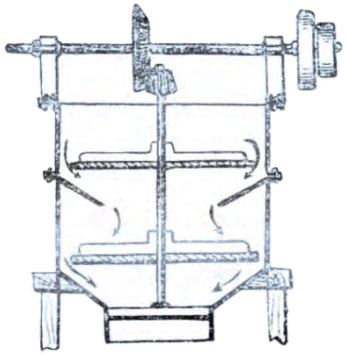
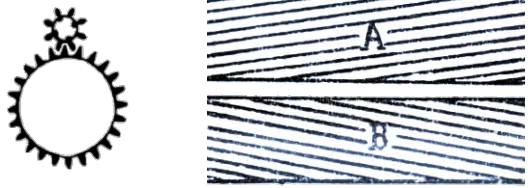
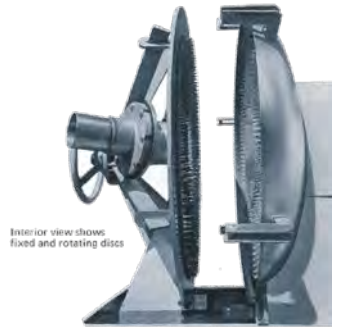
<u>Sparrow (2016):</u>

- Device used after normal destemmer-crusher

- Seeds not damaged
- Red wines produced in 2016 vintage after treatment and early draining/pressing received similar quality scores to untreated wines drained/pressed at normal time

Comparisons - new and historical alternative crushers

The Australian Wine Research Institute

	CENTRIFUGAL	DIFF. SPEED ROLLER	SECONDARY CRUSHER
OLD			
NEW			

- New Pellenc/Diemme devices have a greater ability to vary speed/differential than old devices and advocate lower settings
- History tells us that if new designs were run at high speeds/differentials the results would likely be bad
  - Results at lower speeds? - Can we get increased stable colour without bad tannin and lees?

Tannins with intense crushing – just more or are they different?

The Australian Wine Research Institute

- If you crush more intensely, generally you are likely to increase the rate of extraction of tannins from skins
    - Are they the same tannins that would have been extracted with gentle crushing and a longer maceration period?

*Energetic crushing "promotes the extraction of inferior-quality tannins" that "impart vegetal and herbaceous tastes" but "**no measures are currently available to confirm this fact**"*

-Ribéreau-Gayon et al. (2006)

Conclusions

The Australian Wine Research Institute

- Trend in wine production has been towards gentle crushing with lobed rollers or no explicit crushing
- Very aggressive devices were used historically, but discarded for reasons, including:
  - Low throughput
  - Stem fragments
  - Excessive lees
  - Screen blockages
  - Excessive and/or bad tannin extraction
  - Excessive aeration
- New devices now being introduced that work on some of the same operating principles, but with greater ability to vary speed and therefore crushing intensity
- Conservative approach is to stick with what we are already doing, but it could be worth experimenting with some of these new devices if we want to optimise production
  - Need to keep in mind why historical analogues failed and ensure new devices don't cause the same issues
- Our understanding of crushing & mechanical actions on grapes during red ferments is quite basic
  - Improved understanding may allow improved product quality, consistency, and throughput

Acknowledgements

I would like to thank suppliers who kindly provided background information:

- Pera-Pellenc
- Diemme
- Bucher-Vaslin
- Della Toffola
- Ridgelea
- Winequip
- IMMA

Disclaimer

The information contained in these slides should be considered general in nature, and viewers should undertake their own specific investigations before purchasing equipment or making major process changes.

None of the information presented in this article should be considered as an endorsement or dis-endorsement of any product by the AWRI.