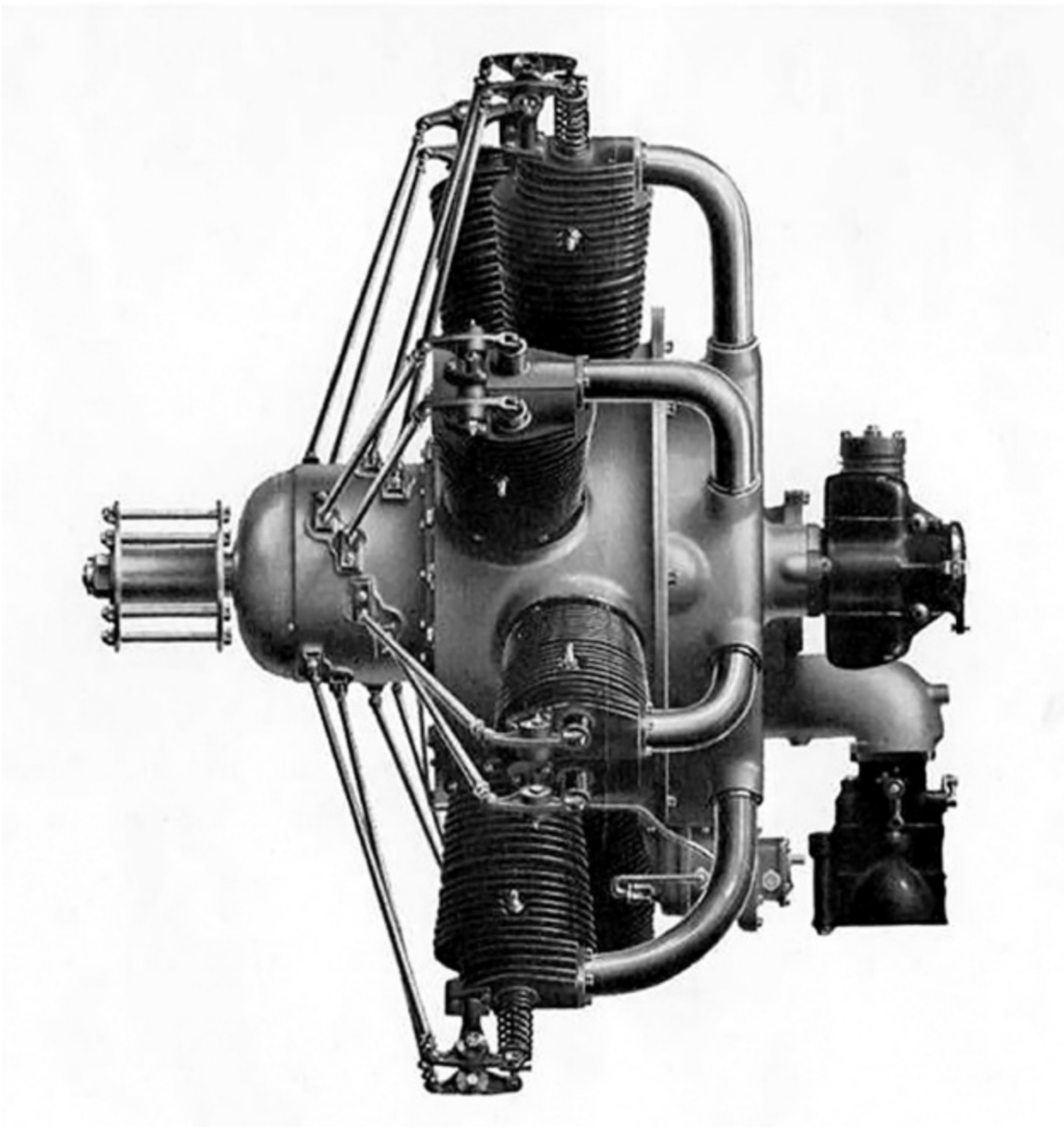
Estimating historical dimensions of the Marchetti Engine



Marchetti cam engine (1927), source: oldmachinepress.com

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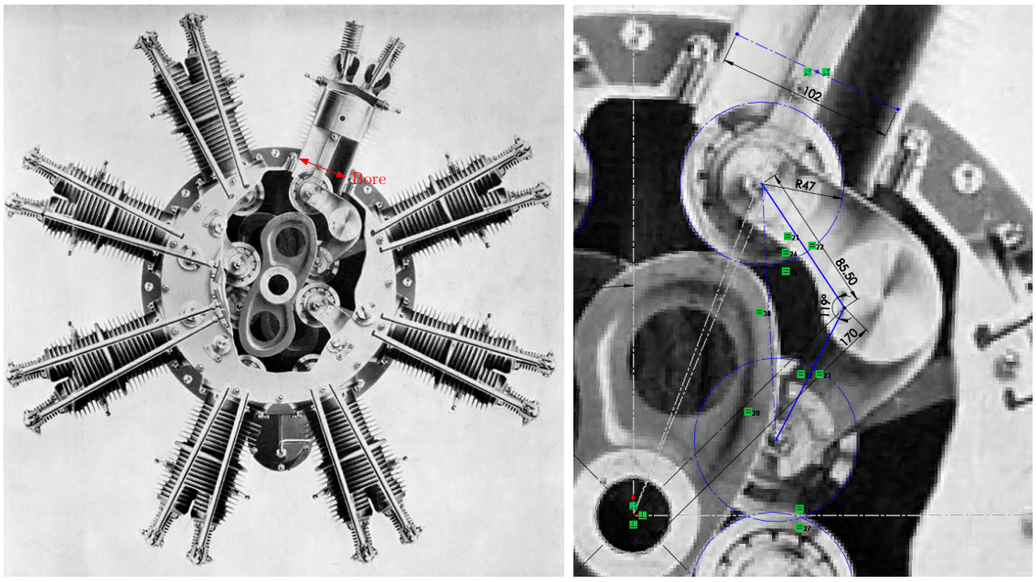
Estimation with the mathematical model

The mathematical solution, published on marchetti-engine.com is used to approximate the geometry that the mechanism originally had. A more precise set of dimensions was found to be impossible to retrieve or obtain because currently available information does not include sufficient details about the geometry of the mechanism. Therefore an approximation is made in metric units, based on information from the following sources:

- `https://oldmachinepress.com/2014/09/28/marchetti-cam-action-engines/`
- `http://www.aerofiles.com/_ma.html`

The sources mention that the engine had a 4.0 in (102 mm) bore, a 4.25 in (108 mm) stroke and a total displacement of 427 cu in (7.0 L) for all eight cylinders. The cylinder diameter is used as a reference to measure other relevant parameters of the Marchetti engine. With the help of a CAD program, a line of length 102 mm is placed at the position indicated in Figure 1a and at an angle of 22.5° degrees. Then, Figure 1a is imported in the CAD model and scaled in size until the cylinder diameter in the picture matches the length of the line.



(a) Cutaway view (b) CAD measurements in mm

Figure 1: Cutaway view of the Marchetti cam-action engine source: oldmachinepress.com

Geometry can now be directly measured from point to point. Note the location of the pivoting point A of the rockers. The rockers are suspended on what appear to be eccentric cam adjusters, shown in the figure for the left, lower left and lower right. The resulting measurements are shown in Figure 1b and summarised as follows:

Parameter	Value	Description
R_A	170mm	Main radius to the rocker pivoting point
R_B	85.5mm	Rocker arm length
R_C	47mm	Wheel radius
β_{tot}	119°	Angle between both rocker arms

Reference is made to the mathematical solution in which the equations below are derived. The known cylinder stroke of 108 mm is used to calculate the angle $\Delta\beta$:

$$\begin{aligned}\Delta\beta &= 2\arcsin\left(\frac{L_S}{2R_B}\right)\\ &= 2\arcsin\left(\frac{108}{2\cdot 85.5}\right)\\ &= 78.333\\ &\approx 78\,\frac{1}{3}^{\circ}\end{aligned}$$

When one rocker arm is at its lowest point then the other is at its highest point. Therefore the total angle between the rocker arms equals $\beta_{tot} = 2\,\beta_{min} + \Delta\beta$. This is used to obtain β_{min}, β_{max}:

$$\beta_{min} = \frac{1}{2}\left(\beta_{tot} - \Delta\beta\right) = 20\ \frac{1}{3}^{\circ}$$

$$\beta_{max} = \quad \beta_{min} + \Delta\beta \quad = 98\ \frac{2}{3}^{\circ}$$

The geometry of the Marchetti cams is defined by the five parameters R_A, R_B, R_C, β_{min} and β_{max} which are now known. These parameters are substituted in the full equation that is published on marchetti-engine.com.

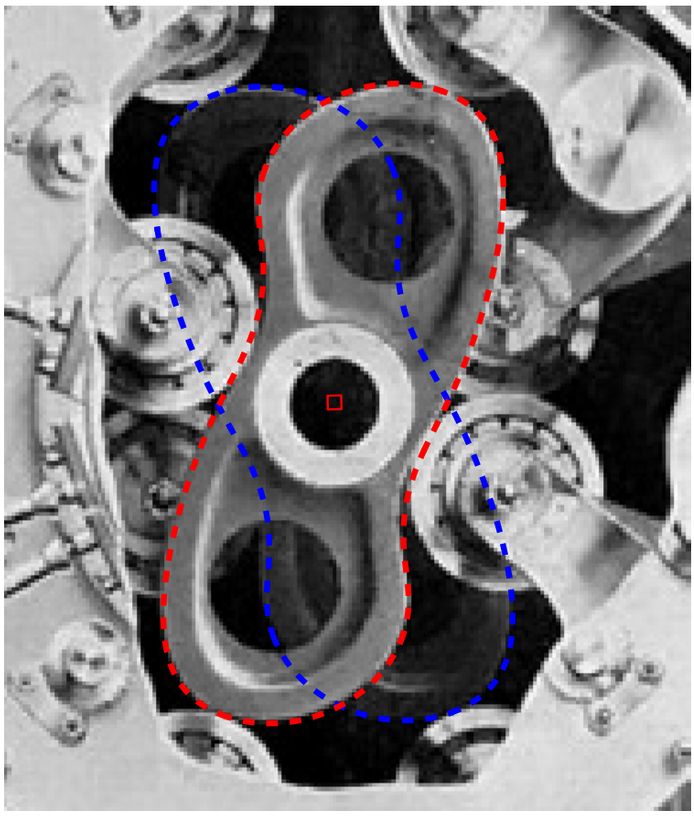


Figure 2: Comparison of the estimated geometry and the original engine

Figure 2 above shows the solution compared to the historical picture of the engine. Some slight deivation from the original picture can be observed, especially at the point closest to the origin.

Discussion and conclusions

A list of possible reasons for the error observed in Figure 2:

- Error in the measurements shown in Figure 1b
- The drawing in the original advertisement differs from the actual engine
- A non-sinusoidal movement of the rocker arms
- Less precise manufacturing methods available around the year 1927

The manufacturing methods available at the time are interesting to further research. Due to a lack of computer controlled machines, it is possible that the milling setup looked very similar to the engine itself. So the milling head could have been mounted on a swinging arm, connected to a rotating workpiece through gears. However at the time of writing this article, no evidence for this has been found to support the idea.