

FLAP VALVE CAM AND FOLLOWER FOR ROTARY PUMPS

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Abstract

Excessive wear on the rotary pumps flap valves contact surface and rotor lobes prompted an investigation which resulted in the design of a flap valve cam and follower. Operating under factory conditions, the flap valve cam and follower were perfected resulting in an improved volumetric efficiency and subsequent pump capacity. The design and fitting of the cam and follower are discussed and results of preliminary tests are submitted.

Introduction

For pumping massecuites and magmas, the pump most commonly used in the sugar industry is the rotary pump. It is a positive displacement pump, consisting of a rotor of elliptical section rotating inside the pump casing and on which rests a spring loaded scraper, which performs the function of a flap valve. Once installed, they require a minimum of maintenance. The part which breaks most frequently is the spring which loads the scraper.

The spring may be under tension or under compression. In some more modern installations pneumatic cylinders have successfully replaced the conventional spiral springs, whereas in less modern factories tractor tube rubbers are used for the necessary tension.

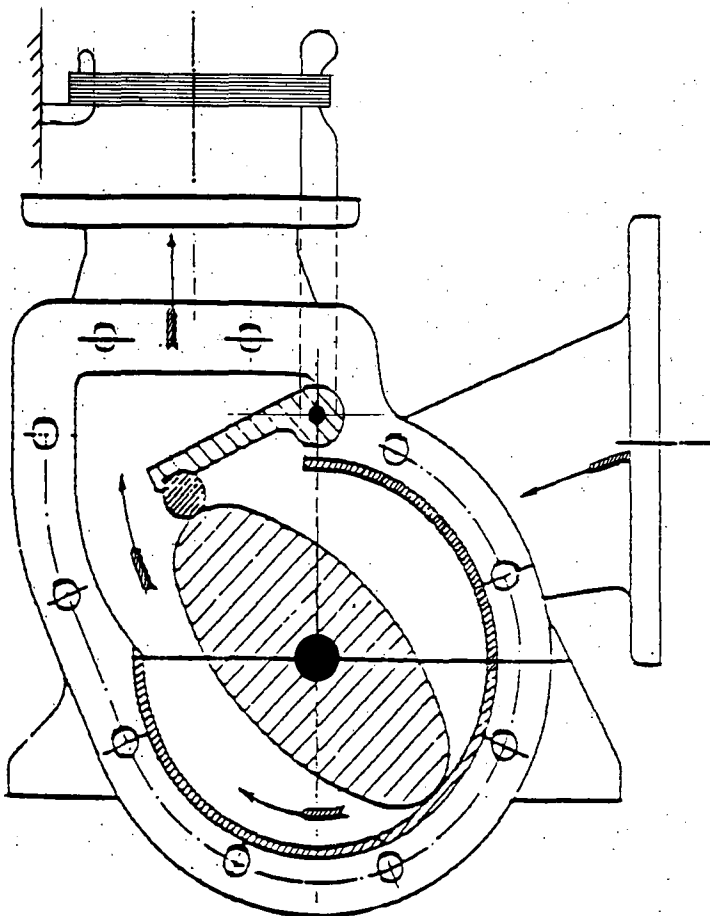


FIGURE 1 Rotary pump

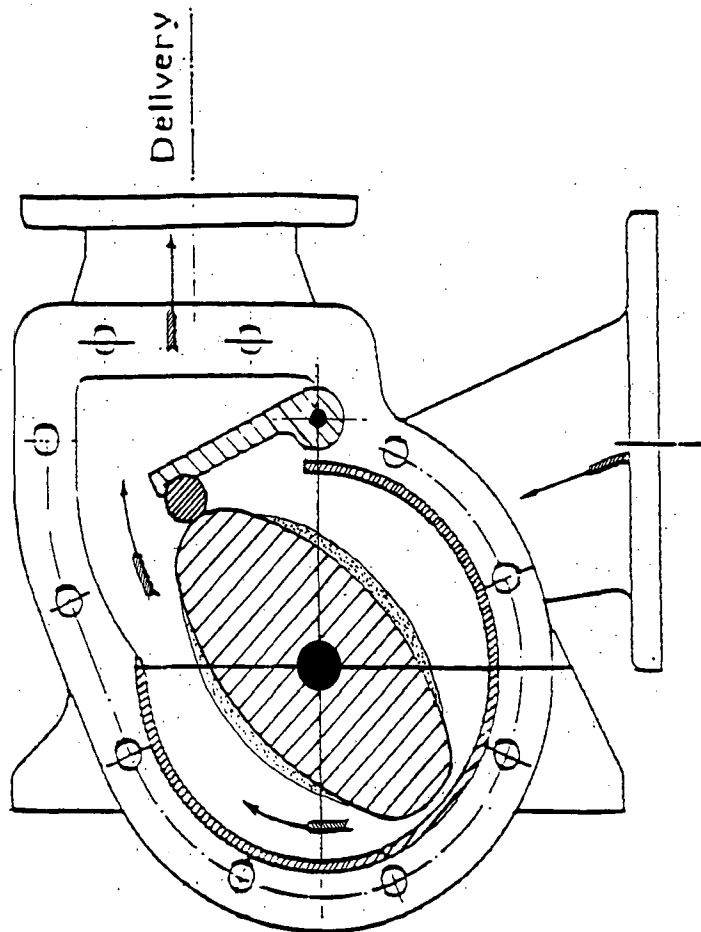


FIGURE 2 Layer of sugar on rotor

The effectiveness of the spring loaded flap valve (scraper) in clearing the elliptical rotor on each revolution is directly related to the pump's efficiency and subsequent capacity. (A greater effective swept volume becomes available when the valve remains seated on the rotor).

Cam Design

The Umzimkulu rotary pumps, when stripped down for reconditioning in the 1985 off-crop, were found to be excessively worn on the flap valve contact surface and on the rotor lobes. This is a direct result of using a spring or rubber bands to keep the flap valve in contact with the rotor. These rubber bands are tensioned so that the contact pressure, on the lowest part of the rotor, is sufficient to create a good seal.

During operation, because of the stiffness of the rubber bands, the massecuite head pressure on the flap valve and the length of the flap valve arm, the pressure exerted on the lobe is as much as five times the pressure exerted when the flap valve is on the lowest part of the rotor (Figure 1).

The rubber bands are often tensioned so much that the limit of elasticity is exceeded and hence the bands break. This overtensioning causes accelerated wear on the lobes of

the rotor and softening of the rubber bands. The result of the reduced effectiveness of the rubber bands, is reduced volumetric efficiency, as a gap develops between the rotor lobes and the pump casing and massecuite remains on the rotor as shown in Figure 2.

An arrangement was required whereby the pressure of the valve on the rotor would remain constant throughout the cycle. Some provision would also have to be made to compensate for wear and allow for variations of the rotor castings, as these differed from pump to pump.

After some thought it was decided to use a cam and follower. The cam would be mounted on an extended rotor shaft and the follower on an arm mounted on the flap valve shaft. Because of the movement of the valve relative to the rotor the distance from the centre of the follower to the flap valve shaft would have to be equal to the length measured from the valve shaft centre to the rotor shaft centre. The follower would also have to be on the opposite side of the rotor shaft to the valve. (Figure 3).

In order to obtain the cam profile it was necessary to plot the movement of the follower centre for one complete revolution of the rotor. This was done by mounting a card on the rotor shaft and a pen in an arm mounted on the flap valve shaft. The pen was set, with the valve on the lobe of the rotor, with space between the pen and rotor shaft to allow for the cam follower and the cam material (Figure 3). The follower decided on was a F.A.G. NUTD 25DZ.

The follower centreline profile was then taken and the follower drawn in for a number of positions as shown in Figure 4. The inner dark line produced is the profile for the cam. The cam was manufactured and mounted on the shaft with the marks correctly aligned.

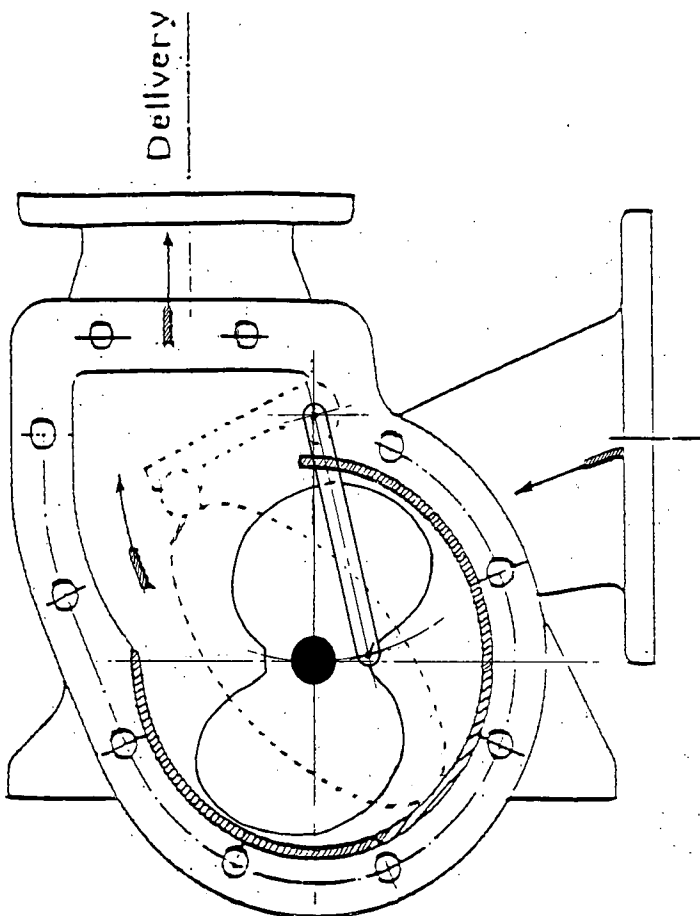


FIGURE 3 Cam design

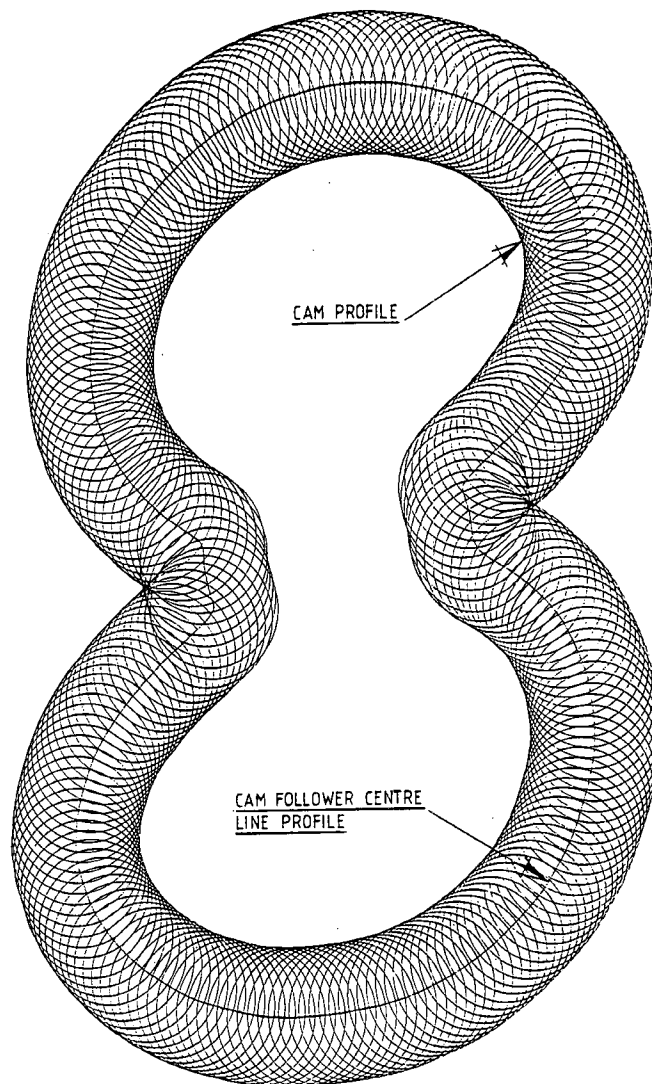


FIGURE 4 Cam profile

The follower arm was made with a rubber block and adjustment screws for tensioning and wear adjustment. (Figure 5). The pump was assembled and dry run on a large lathe to ensure correct positioning of the cam before final commissioning.

Results

Hugo quotes volumetric efficiencies of 60 to 70 % while manufacturers now give figures of 65 to 85 %.

Using the simple capacity equation-

Capacity (m³/hour) = rpm × 60 × displacement × vol efficiency, a unit increase in volumetric efficiency from 70 to 80 % results in a 14 % increase in capacity.

During the 1985/86 season the performances of three massecuite pumps were compared. On one pump, the flap valve return was by elastic rubbers, on the second by springs and on the third by the cam arrangement described above. As far as was possible the pumps were mechanically similar over the test period.

Table 1 gives the results obtained by physically measuring the pump's output with a drum and stopwatch.

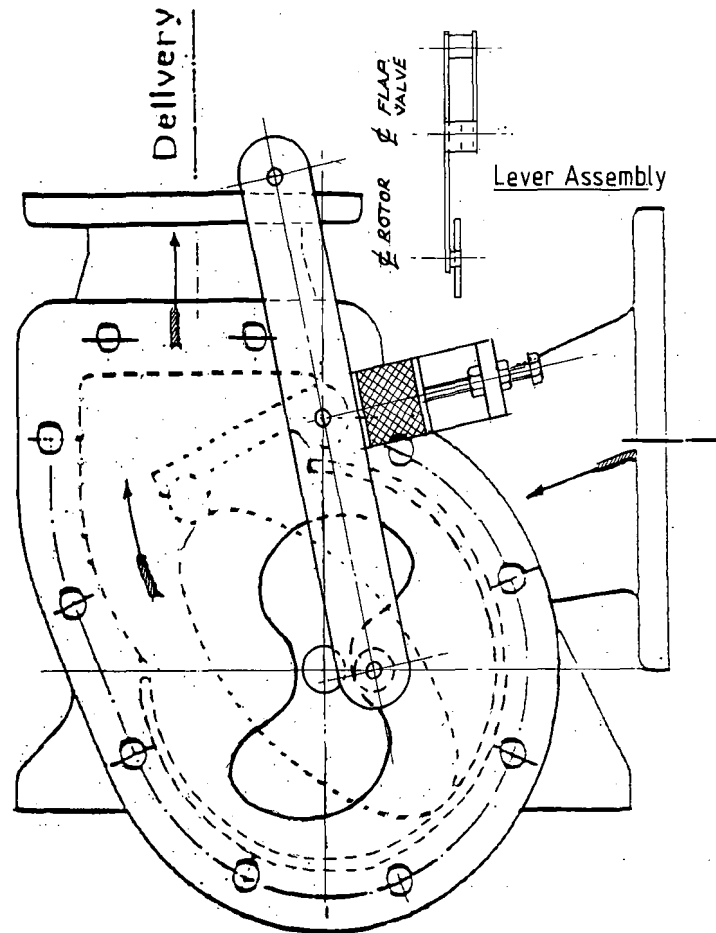


FIGURE 5 Cam assembly

Table 1

Results obtained by physically measuring the pump's output with a drum and stopwatch

Test No.	Mass Brix	Rubbers m ³ /h	Springs m ³ /h	Cam m ³ /h	Increase m ³ /h	% Inc. Vol. Eff.	Vol. Eff.
1	92,3	35,5	36,6	39,5	4,0	8,1	
2	92,5	33,0	33,2	37,3	4,3	9,3	
3	92,0	36,5	35,8*	42,0	5,5	10,8	*Spring under compression
4	92,2	35,0	36,1	40,1	5,1	10,4	
5	96,0	7,0	7,2	7,5	0,5	5,1	Slow curing
6	96,2	7,5	7,6	8,3	0,8	7,1	
7	96,6	7,2	7,0*	8,1	0,9	8,9	*Spring under compression
8	96,5	8,0	8,3	9,0	1,0	8,9	
9	96,0	8,5	8,8	9,5	1,0	8,4	
10	92,0	33,0	33,5	37,0	4,0	8,6	Slack massecuite

The increase in capacity has been calculated on the difference between the rubber actioned scraper valve and the cam loaded scraper.

Conclusion

The cam loaded flap valves produced an average increase in volumetric efficiency of 9,4% with the lower brix material (A - massecuite) and 7,7% on heavier brix material (C - massecuite).

Power requirements will increase with the greater volume of material pumped. An increase in amperage was measured while pumping with the cam operated scraper. Both A - and C - massecuite pumps are driven by 18,5 kW motors, but there was a greater proportionate increase in the C - massecuite pumps amps during this experimental period. This is thought to be due to the greater value of the positive cam return system with the higher viscosity product.

Acknowledgements

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