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SUBJECT: Review of CAP theses by Joshua Wellwood, Samuel Coombes and Colan MacGregor

TO: Eric Isokangas

FROM: Robert Beatty

DATE: 5 January, 2024

Introduction
These reports studied the Coaxial Pipe Conveyor equipment with a view to using it in mining applications where introducing continuous haulage offers significant productivity improvements.

Further to my memo of 6 August 2022 concerning the two initial reports covering the CAP150 project.

Colon has now increased the depth of study by successfully including a DC drive in the central idler frame. The CAP runs, but tends to gather loose folds of the belt at the delivery point.

The friction aspects of the CAP system were measured previously and found to be high due to the drive belts having slightly different lengths on the CAP75 model available for inspection.

I have recently considered the spring drive in more detail:

Figure 1 shows the CAP spring drive system curved to fit the delivery load belt, as discussed at https://bosmin.com/CAP/CAP_DesignDetail.pdf.

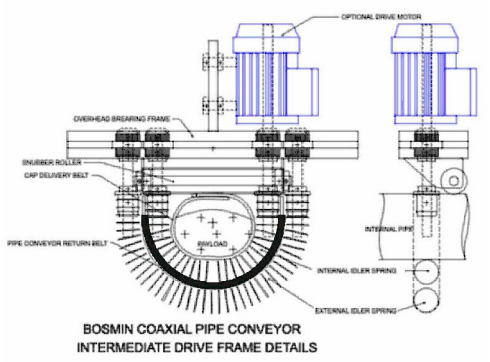

Figure 1

The curved part of the return conveyor is highlighted with a dark line.

When the spring is straight and rotating, the centre of rotation lies, at the spring's axis. However, when the spring is curved and rotating, the centre of rotation lies outside the spring coils, near the centre of the load profile. This has the effect of making the coils operate as per Kepler's second law of planetary rotation. See Figure 2: https://en.m.wikipedia.org/wiki/Kepler's_laws_of_planetary_motione

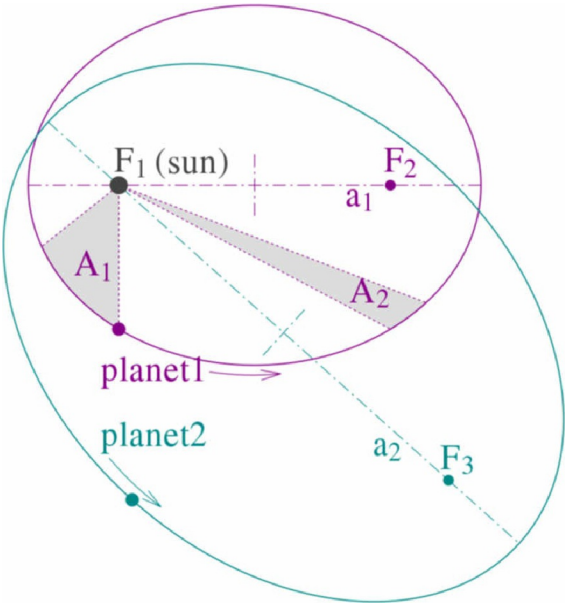

Figure 2

Where the slower planets operate remotely from the sun and the faster planets are nearer to the sun.

This has important implications for the CAP drive system, because the delivery belt is travelling slightly faster than the return belt. This occurs because the centre of rotation at the trunnion points has moved to the centre of the CAP spring radius, where the spring is curved.

The difference in speed is equal to the difference in pitch between the inside and outside coils, of the helical spring. So the inside belt is driven faster than the return belt. The difference in speed is taken up in slip on both runs of the belt - albeit slip in opposite directions on either side of the belt. This adds to the CAP drive power requirements, so it is important to condition a new belt by rubbing talcum powder onto the surface, to reduce speed differential friction loss.

However, the difference in belt speed is controlled at either end of the CAP by the horizontal roller operating between the two belt runs. This is evident in the video show of an operating CAP75 at http://www.bosmin.com/CAP/CAP5.mp4. So the terminal drives at either end of the CAP play an important role in mechanically synchronising the speed of the conveyor runs, and should not be ignored.

The larger the diameter of the drive spring, the larger will be the difference in drive velocity between the forward and return sides of the CAP belt.

The return idler spring should be connected to the drive trunnion mechanism as well, because the trunnions trap the return belt in the constriction where both trunnions are operating at the synchronous speed of the CAP.

The main use for the outside idler is for cornering the conveyor. In this mode the outside spring keeps the return belt aligned and acts as a nip point drive where the two drive trunnions operate as an axial drive combination. However, the curved elements of this spring operate at a slower speed than either side or the inside spring. Therefore the outside spring should be set at a loose fitting to the return belt, with the only tight fitting at the trunnion points.

Robert Beatty BE FAusIMM(CP) (ret)
76-78 Hayes Ave. Camira, Qld. 4300
Ph: 07 32883101
Ph. Int: +617 32883101
Web: https://bosmin.com
Reply email: bobbeatty@bosmin.com

Thesis by:
Sam Coombes https://bosmin.com/CAP/CoombesCAPreport.pdf
Josh Wellwood https://bosmin.com/CAP/WellwoodCAPreport.pdf
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