

IMPROVING THE CANE KNIVES

By D. J. L. HULETT

During the trials after the completion of the Triangle Mill, it was found that the cane knife arrangement was inadequate to cope with the type of cane peculiar to the Triangle Estates at a reasonable throughput, and it was necessary to improve the situation.

The cane knife arrangement at the time was as follows:

Primary Knives

These consisted of the old shaft from the Z.S.M. Mill having 36 knives made from 6 x $\frac{3}{4}$ hard steel flatbar. The knives were sharpened by chamfering to one side only along the tips and leading edges, making a cutting edge as that of a carpenter's chisel. They were hardened throughout and no hard surfacing tungsten carbide deposit had been applied. They were assembled on palms in such a way that 4 knives cut along the same path.

The assembly was mounted with its axis 3 ins. in front of the centre line of the head shaft of the auxiliary carrier and with the tips of the knives reaching to within 15 ins. of the carrier slats.

The knives were driven by a 250 h.p. 485 r.p.m. slipring induction motor.

Secondary Knives

These consisted of a brand new robust assembly of 84, 6 x $\frac{3}{4}$ hard steel knives, sharpened by chamfering the tips and leading edges to the centre, making a cutting edge as that on an axe.

The 84 knives were set up to cut 84 separate paths, spaced equi-distantly across the 66 ins. carrier and were set to reach to within 1 ins. of the main cane carrier slats.

The knives were driven by a 400 h.p. 580 r.p.m. slip ring motor.

The Carriers

Both main and auxiliary carriers were driven through Heenan and Froude eddy current couplings and both were arranged to slow the carrier speed in the event of the respective knife motor currents becoming excessive.

The First Run

The cane supplied to the mill at Triangle is clean, thick and essentially straight, arriving in bundles carefully stacked as neatly as matches in a box. This cane, when fed from the feeder table, fell into the auxiliary carrier, and occasionally one whole 3 ton bundle filled the carrier — again as matches in a box.

This bundle, on entering the primary knives, had nine grooves chopped into it by the nine sets of knives, and the main bulk of the cane built up to the axle of the assembly.

The motor current increased to its maximum, the carrier automatically stopped and the resulting choke had to be pulled out by hand.

The running of the mill at this stage was very erratic, and it was difficult to assess the throughput. However, it was estimated to be in the region of 65 tons cane per hour at ± 13 per cent fibre.

The current drawn by the second set of knives was not much more than the magnetising current of the motor and the overall preparation of the cane was disappointing.

The First Change

Seeing that the primary set of knives was struggling and that the 400 h.p. potential of the secondary set had hardly been tapped, it was decided to remove the primary knives altogether and do all the work with the large set. This was done during the week-end. The result of the change was disastrous!

The secondary knives by this time had become blunt and had great difficulty in handling the cane. The motor continually overloaded and blew fuses, while the preparation of the cane was appalling — whole bundles of cane being dragged through by the knives and hardly cut.

So bad was this run, that within the day, it was decided to replace the primary knives immediately. The mill was stopped and the primary knives were installed, but this time with a difference.

The Second Change

Before replacing the primary knives, half the knives were removed from the hub, leaving only two opposite knives in each palm assembly. The cutting ends of these knives were set slightly in opposite directions so that, instead of cutting nine narrow paths, they now cut across the whole front of the entering cane.

The knives were hard surfaced with Cobalarc I.A. on the flat or non-chamfered side of the knife. The hard surfacing beads were laid close together but not touching and the end of each bead looked directly into the cane as the knife rotated (see photograph No. 1). The idea behind this was that the softer metal of the knife itself would wear away and leave the ends of the tungsten carbide beads proud, as a number of sharp, pointed fingers. These points, at the cutting edge of the knife, tear into the cane and shred it (see photograph No. 2).

With the primary knives modified as described above and back in position, the situation improved tremendously.

No longer did the primary knives choke and the preparation of the top layer of cane was good. With the replacement of these knives, the load vanished from the secondary knives and the 400 h.p. motor current returned to its minimum. The overall preparation after this set of knives, however, was poor.

The shaft of the primary knives was mounted in 4 in. plumber blocks and it was obvious from the excessive whipping, that the shaft was too flimsy.

With this fact in view, and the poor preparation, it was decided to design and install a new heavy duty set of primary knives. These knives were designed and made and within two weeks were installed.

Heavy Duty Primary Knives

These knives consisted of a mild steel palm assembly fabricated out of 2 in. plate, mounted on a $7\frac{1}{2}$ in. shaft and running in 7 in. bearings. The knives themselves were made from $6 \times \frac{1}{2}$ Benox flatbar and sharpened and hardened as previously described for the old primary knives — with the exception that the knives were left straight.

The assembly contained 36 knives, chopping in paths equally pitched across the 66 in. carrier. The knives reached to within 2 ins. of the carrier and were mounted on the same centre as the smaller knives had been.

In view of the small load drawn by the secondary motor, it was decided that a swap of motors be made. The 400 h.p. 580 r.p.m. motor would drive the primary knives and the 250 h.p. 485 r.p.m. motor, the secondary knives.

Secondary Knives

The $6 \times \frac{3}{4}$ secondary knives were replaced with $6 \times \frac{1}{2}$ Benox knives, hardened and sharpened in the same manner as the primary knives. The motor, due to the change over, was now only 250 h.p. and revolving at 485 r.p.m.

The preparation with this arrangement was very much improved. However, investigation revealed that the entire preparation was being done by the primary knives, the motor of which became fairly well loaded, while the secondary motor still only drew magnetising current.

The Third Change

Bent knives were tried on the primary assembly with little improvement in preparation. These were soon replaced with straight knives again, as the incidence of knives breaking became excessive due to the bent knives breaking from fatigue failure at the point where the blade emerges from the palm.

The Final Change

A 250 h.p. 960 r.p.m. motor, being available in the plant, was mounted to drive the secondary knives as a trial. This doubling of the speed had a remarkable effect as could well be expected.

The motor load increased to 200 amps and the cane emerged from the knife house, shredded.

Conclusion

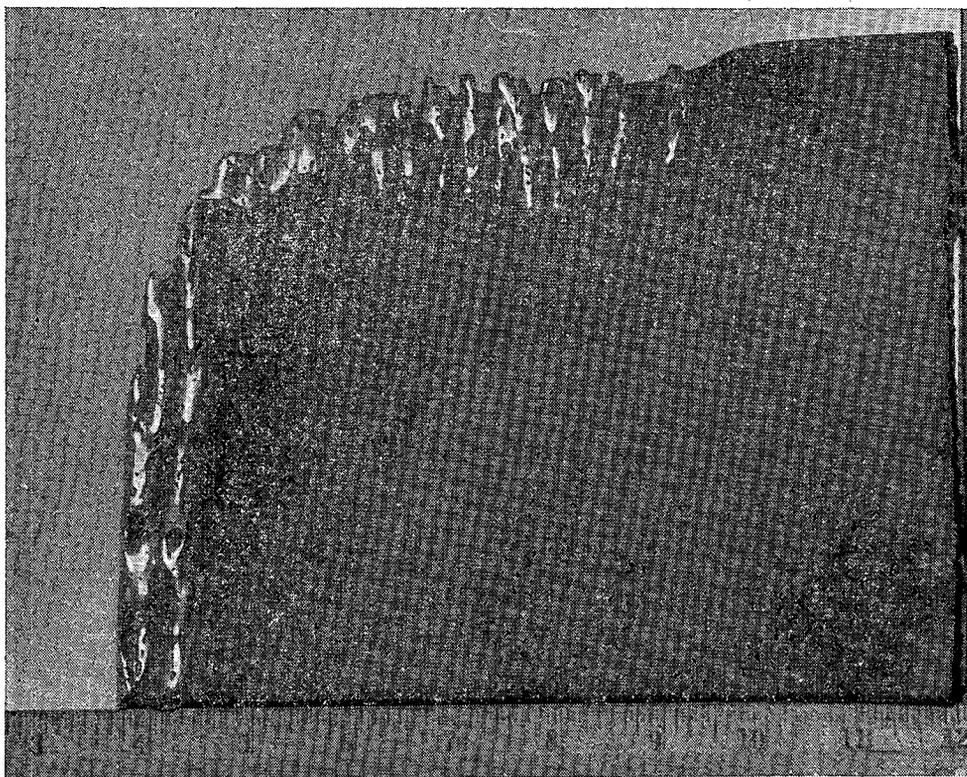
Although there are undoubtedly further aspects of the cane knives which should be investigated, particularly with respect to the elimination of the odd stick of cane which arrives intact in the mass of shredded cane, it is felt that the principle difficulties have been solved.

The three main factors which seem to have had the most influence are:

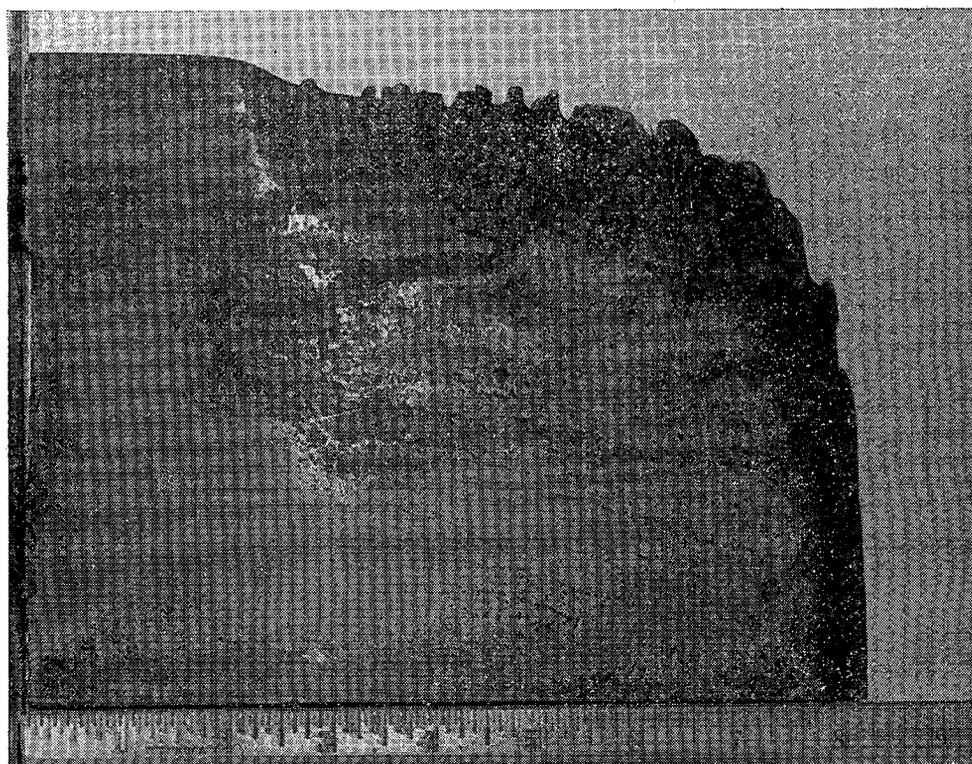
- (a) That the primary knives should chop right down to the carrier, thereby turning over all the cane and preventing long sticks creeping through both sets of knives in the clearance between the knife tip and the carrier slat.
- (b) That the speed of the secondary knives can be increased to 960 r.p.m. with a consequent improvement in the preparation.
- (c) That the method of hardening the knives, so as to make them self sharpening and jagged, plays an extremely important part in the preparation of the cane and the H.P. consumption of the knife motors.

SUMMARY

| | MOTOR | | | KNIFE DETAILS | | | Tons cane at $\pm 13\frac{1}{2}\%$ fibre | Preparation | Remarks |
|-----------------------|--------|------|----------------|---------------------------------|---|--------------------------------|---|-------------|---|
| | R.P.M. | H.P. | Amps Drawn | Knife Steel—in ins. | How Sharpened | Position of Carrier—in ins. | | | |
| Initial Set-up | | | | | | | | | |
| Primary Knives .. | 485 | 250 | 100 to 250+ | $6 \times \frac{3}{4}$ | Chisel—No hard surfacing | 15 | 65 | Poor | Choking. |
| Secondary Knives .. | 580 | 400 | 150 | $6 \times \frac{3}{4}$ | Axe—No hard surfacing. | 1 | | Poor. | |
| Change I | | | | | | | | | |
| Primary Knives | | | | | | | | | |
| Secondary Knives .. | 580 | 400 | 400—600+ | $6 \times \frac{3}{4}$ | Axe—No hard surfacing. | 1 | 65 | Very Poor. | Motor tripping out. |
| Change II | | | | | | | | | |
| Primary Knives .. | 485 | 250 | 100—200 | 6×3 | Chisel—bent finger hard surfaced—straight | 15 | 110 | Good. | |
| Secondary Knives .. | 580 | 400 | 150 | $6 \times \frac{3}{4}$ | Axe No. H.S. | 1 | | Poor. | |
| Change III | | | | | | | | | |
| Primary Knives .. | 580 | 400 | 250—400 | $6 \times \frac{1}{2}$ Benox | Chisel with finger hard surfacing—bent. | 2 | 110+ | Good. | Bent knives breaking. |
| Secondary Knives .. | 485 | 250 | 100 | $6 \times \frac{1}{2}$ Benox | Chisel with finger hard surfacing—straight | 1 | | Poor. | |
| Final Change | | | | | | | | | |
| Primary Knives .. | 580 | 400 | 250—400 | $6 \times \frac{1}{2}$ Benox | Chisel—finger hard sur- facing—straight. | 2 | 110+ | Good. | |
| Secondary Knives .. | 960 | 250 | 200 | $6 \times \frac{1}{2}$ Benox | Chisel—finger hard sur- facing—straight | 1 | | Shredded. | Cane appears as shredded —contains small % un- chopped stick. |



Photograph No. 1.



Photograph No. 2.

Mr. Grant considered that in some cases if the primary knives were set to cut right down to the carrier the cost would be excessive, especially with the very much harder cane in South Africa as compared with that at Triangle. Much depended on the loading of the carrier so as to avoid excessive loads.

Mr. Hulett said that the knives at Darnall cut down to within two inches of the carrier and the motor used was of only 450 h.p. At Darnall twice as much fibre was passed through whereas at Triangle 400 h.p. was used. He considered that knives should cut right down to the carrier but if the carrier were split this would help by rearranging the cane at random so that all of the cane could be cut by the second set of knives.

Mr. Gunn stated that it had been found at Maidstone if the first part of the carrier were not fed very heavily good preparation by the knives was not obtained.

Mr. Hulett said the way the carrier was fed played a very important role in preparation by the knives as well as the milling thereafter. At first the carrier was completely automatically controlled, arrangements being made that the feed was not so great as to choke the second set of knives while the first knife motor was the over-riding control so the first set could not choke either.

It was found that if the auxiliary carrier which fed the primary knives was over-filled this caused the knives to cut a hollow in the cane while the rest built up until the motor tripped out. The preparation in this case was extremely good but the mill could not be kept fed and an operator had to be employed to over-ride the automatic control so that the layer of cane kept to a suitable level.

Mr. Saunders asked if any extra support was given under the carrier when the knives were set to cut to within one inch of it.

Mr. Hulett said that at Triangle this was not done as yet and resulted in the carrier slats being bent and damaged. Support would be provided as soon as

possible to obviate this. At Darnall, where the knives cut right down to the carrier, big re-inforcing plates were placed under the carrier and the primary knives cut over a solid drum shaped to allow the chain to pass over it.

Mr. Dent said he had been told that in Australia, pneumatic tyres had been placed under the carrier to provide the necessary support.

Mr. Buck asked how long a set of knives lasted.

Mr. Hulett replied that the primary set of knives had got six rows of knives and he found he had to replace two opposite sets of knives every week. The other set, he thought, had eight sets and two rows had to be changed every week.

Mr. Camden-Smith agreed with the author that the knives should cut as low as possible but he had found that the speed of the knives had a great bearing on the horse-power required. Usually knives were mounted in the form of a helix and he wanted to know if the result was that the cane accumulated on one side of the carrier.

Mr. Hulett replied that he had set down in his paper the power required. The secondary knives had originally to chop into a two-foot blanket of cane and had little to do. They had therefore to be speeded up to do their part in preparation.

The knives were chamfered down on the one side and were so arranged that the one knife threw the cane one way and the next the other way so that there was no piling on the one side of the carrier. Where the knives came out of the palm and cut one way, they exhibited a fatigue crack, but when they were bent this became worse. Now the knives were no longer bent and only one or two were broken weekly on the primary knives and on the secondary set none were broken at all.

Mr. Chiazari (in the Chair) said that obviously this subject interested every engineer and this accounted for the numerous questions asked.