ELECTRICALLY DRIVEN CANE CARRIERS

By D. L. HUGHES

The primary role of the main cane carrier is to ensure a steady supply of cane to the crusher with a minimum of lost time due to chokes and cane knife tripouts.

Experience has shown that most chokes are caused by a set of knives tripping out, or an overload of cane jamming in the cane knife housing. Generally, cane carrier layout is such that an aux carrier feeds into a main carrier; this system lends itself to close control of the incoming cane.

Requirements of the Main Carrier Drive

The main carrier drive should fulfil the following functions:

(1) Provide a constant supply of cane to the crusher.

(2) Accelerate smoothly and be controllable over a range of speeds.

(3) Ensure that the cane knives are not overloaded.

In order to maintain a constant feed, the carrier should be rather heavily loaded and run at a slow speed, this allows the feed to catch up in the event of the carrier being held back by the cane knife overload relays. The amount of cane entering the crusher is sensed by a killer plate which controls the speed of the main carrier.

Smooth acceleration of the carrier is highly desirable in order to minimise excessive strain on the structure, etc.

Speed control over a range enables various crushing rates to be maintained and a reserve of speed ensures that the carrier will catch up on any feeding delays.

An overriding device operated by the current drawn by the cane knives is essential and it has been found that two stages of overriding is desirable. The first stage slows the carrier to a predetermined speed, while the second stage stops the carrier. The first stage speed is determined from operation experience and is set to pass 'slightly above average bundles' at approximately 80 per cent of full load knife current. The second stage is set to a point which will ensure that the cane knives will not trip out.

The Carrier System

The cheapest, but by no means the most efficient method of speed control on A.C. drives is by the use of a slipring motor with rotor resistance, or by a variable speed electro magnetic coupling using a squirrel cage motor.

Both methods suffer from the disadvantage that the slip power must be dissipated as heat, the overall efficiency of the two types of drive is, therefore, about the same. The main factor influencing the choice of a drive would be first cost and in this respect the slipring motor with rotor resistance would score, the complete installation being approximately 76 per cent of the cost of the variable speed coupling drive. This comparison is based on the assumption that the rotor resistance bank as well as the coupling is rated for continuous duty at low speed. Experience over the past season indicated an average carrier speed of 38 per cent of maximum.

The drive under discussion consists of a slipring motor controlled by a six notch contactor panel having the necessary cane knife overload relays. The notching is controlled by a killer plate sensing the blanket of cane entering the crusher. The linkage between the killer plate and controller is such that the full speed range is covered by a small amount of killer plate travel. This was found to be necessary to enable the carrier to catch up after being held back by cane knife overriding. A hydraulic dash pot was inserted in the controller linkage in order to prevent it following insignificant movements of the killer plate. Notching is controlled by timers thus eliminating any tendency toward rapid acceleration.

The main carrier is fed by an auxiliary carrier which has a similar type of drive but is controlled by the requirements of the main carrier. A set of equaliser knives is placed across the aux carrier, slightly past the head shaft. These knives level off large bundles of cane as they pass on to the main carrier. There are two stages of current overriding, set to a maximum of 100 KVA. A photo-cell is installed just ahead of the head shaft to ensure that there is always cane available at the equaliser knives.

Sequence of Operation

Cane is tipped into the aux carrier which passes it through the equaliser knives and onto the main carrier. The load sensing relays ensure that these knives are not overloaded. Should there be a gap in the cane on the aux carrier the photo-cell comes into operation and speeds up the carrier. The speed of this carrier is matched to that of the main carrier; mismatching occurs only when one of the overriding controls takes over.

The depth of cane in the main carrier is sensed by a killer plate located as close as possible behind the equaliser knives. This killer plate stops the aux carrier when there is sufficient cane in the main carrier. An inherent advantage of this killer plate is that each time it operates on a large bundle it holds the aux carrier back long enough to allow a gap to form behind the bundle. This gap provides the extra space required by the bundle as it breaks up on entering the cane knife housing. The main carrier feeds the cane through the main cane knives and on to the crusher. Overriding relays ensure that the main cane knives are not overloaded.

Observations

Operation over the past season has proved, without a doubt, the advantage of an automatically controlled carrier system over the manually controlled type. It has been possible to dispense with two units of labour, thus completely eliminating the human element from the control of the carriers.

The peak loads previously drawn by the cane knives have been completely eliminated, in fact there was not a single recorded trip out. The equaliser knives have contributed considerably to the smooth operation of the system and it has been found that the overriding relays on this set are continually operating. The average horse power drawn by the main cane knives has dropped noticeably, although the crushing rate has remained about the same.

The most substantial gains have been in the reduction of down time due to cane knife chokes and cane slipping, etc. as indicated by the following:

Season	*Time Lost*
1959/60	24 hrs. 05 mins.
1960/61	29 hrs. 25 mins.
1961/62	49 hrs. 30 mins.
1962/63	14 hrs. 35 mins.

Of the latter time, 6 hrs. 35 mins. was lost in chokes which occurred during the first few days of adjustments and should not be included. The operational time lost therefore becomes 8 hrs. 00 mins. It is of interest to note that of this down time 1 hour 20 mins. occurred within three days when the equaliser knives were lifted out and the aux carrier was manually controlled.

The control gear performed remarkably well throughout the season, the breakdown time amounting to 0.19 per cent of the available curshing time. A number of essential refinements will be incorporated for the coming season which should reduce the total down time even further.

Conclusion

The control system of this drive was designed and built in our factory workshops using as much existing equipment as possible. The automatic control requirements of each factory vary widely and therefore present a challenge to the ingenuity of each engineer.

Mr. Hulett (in the Chair) said he could appreciate that many difficulties had been experienced at first with this ingenious electrical device as he had found much trouble with the electronic controls at Triangle Factory. At Triangle it had not been found possible to eliminate any labour on the carrier control.

He asked Mr. Hughes, as he had eliminated both labourers on the carrier controls, how, if there was a choke half-way down the mill, the carriers were stopped from feeding.

Mr. Hughes replied that the main carrier which was controlled by the mill requirements controlled the auxillary carriers. Whatever the main carrier does the auxillary carrier would follow. The controls were operated as separate units but each was completely dependent on the previous one in the train. If the previous control stopped the feed the subsequent ones followed suit.

Dr. Douwes Dekker said that he would like to know the effect of more regular feeding of the feed to the first mill on the extraction of this mill. It would be interesting to know this.

Mr. Ashe said that the extraction at the crusher had decreased as the knives were no longer required to cope with big bundles of cane on the carrier and did not disintegrate the cane as well as before. To combat this poorer preparation by the knives, these were lengthened as much as possible but this was still not enough to overcome the problem. This coming season the knives would be lowered almost to the carrier to give better preparation than had been achieved ever before.

Another point was that the fibre content of the cane was some 2 per cent higher than before and this would result in a reduction in extraction by the first mill.

Mr. Hughes said that cutting down of lost time at the mills must be balanced against any small loss in extraction when viewing the whole problem from a financial angle.

Dr. Douwes Dekker said he was satisfied with the replies given and while maximum efficiency had not yet been obtained, he felt that next season's work would be considerably better.

Mr. Farquharson said at Maidstone there was a third type of control in conjunction with a two-cylinder steam engine driving the carrier. Points in its favour were (1) the steam engine obviously used less power when it was not running at full load and speed. (2) As the engine was already *in situ*, it was used, and only a simple control was required, consisting of contactor relays which motivated the solenoid air operated steam valves and these could be set at different positions to obtain the best results. He thought that the most suitable control system could only be found by practical tests designed to suit the different mills and milling conditions; what applied economically to one milling plant would not necessarily apply to another plant. The form of relay control used at Maidstone was similar to that used by Mr. Hughes and had produced a very regular feed to the shredder with little or no maintenance.

Mr. Hughes said that the steam engine used previously was unsatisfactory because sometimes when it stopped it had to be rocked to start it again.

However, two redundant identical motors were available and one was installed in place of the engine. In that case all that had to be provided as a suitable resistance to make the control gear simple.

It was found necessary at short notice to provide automatic control as the equaliser knives installed had to be enclosed and the operator could not see how the main carrier was being fed. There was no time available to study the drive before it was installed and this caused difficulty as assumptions had to be worked upon while keeping up throughput.

The new reactors ordered could be connected in at any time and change thus made simply from ordinary resistance control. Next season the main control gear would not be done with relays as last year. A choice could be between relays and electronic gear, the latter of which he favoured and intended installing as the relay gear required maintenance. While the contactors could not be cut out completely those working in the normal speed range could be eliminated.

He felt the system at Umfolozi could be applied to any mill with an auxilliary carrier feeding the main carrier.

In reply to a question he said that while the slip-ring motor with rotor resistance would not be ideal in a plant not required to produce large quantities of exhaust steam this did not apply to a sugar factory which had this requirement and in which efficiency of prime movers was not so very important.

Initial cost was of course less with slip-ring motor with rotor resistance.

Mr. Grant said every factory operator endeavoured to apply automation as far as possible but he did not agree that automation in feeding the first crushing unit was entirely correct. The killer plate operated at one level but the feed depended on the type of cane being crushed and the amount of trash accompanying it. If cane was shredded prior to milling then the application of automation was more suitable.

The main yard-stick was the extraction gained and 1 or ½ per cent extraction at the first unit if this could be held to the end was more important than say 14 hours of shut-down time.

Mr. Hughes said the question of cane quality had been studied and this coming season a special change-over switch would be provided so that the operator could alter the controls so that the plant requirements were met.

Another way of control was to utilise the load drawn by the main carrier motor for any depth of cane to control the auxilliary carrier by means of a special circuit. The killer plate could be adjusted by the operator to suit the depth of the cane on the carrier.

Mr. Gunn recommended that people worried about different quality of canes should install a shredder in front of the rest of the crushing plant. A problem was to know how to control the main carrier when this was feeding the shredder.

Dr. Douwes Dekker said that for mills subsequent to the first crushing unit a constant supply of fibre was required but for the first unit it appeared that something between cane and fibre was required.

Mr. Hughes thought that there must be a balance between the money coming out of the crusher against that put in as power. The chest pressure in the engine driving the crusher was at times equal to the line pressure but at times it was considerably less, indicating that the crusher was not doing as much work as it could so that a control would have to be introduced to take care of this aspect.

Mr. Kramer said he had seen in another country a torque measuring device on the coupling of the first milling unit which was used in the feeding control of this unit.

Mr. Hughes answering a query by Mr. Rault, said he had found a through-put of 120 tons per hour suddenly jump to 150 tons per hour and this led again to the thought that the power required by the first mill should govern the feed, thus utilising the full power the mill could take throughout the season.

Mr. Hulett considered the power input of a mill drive could not be assessed in terms of money. The capital had already been invested and by utilising the full horsepower no extra money was being used.

He also thought that the speed of the main carrier was not so all important and other factors, such as preparation of the cane, had to be taken into account. At Darnall the whole mill train depended on the crusher speed. If the mill over-filled lower down the train the speed of the crusher was rediced slightly.