AUTOMATIC MILLING CONTROL

By G. G. ASHE

Introduction

The idea of automatic control of milling appears to be receiving quite a great deal of attention and thought, if the number of articles appearing in various sugar journals and proceedings are anything to go by.

This subject is not new in the Natal Sugar Industry either, but this is the first time it has been tried at Umfolozi and this paper deals mainly with the way the problem has been solved by us.

Each factory has its own peculiarities and what applies to one does not necessarily apply to another, therefore each mill has to be studied separately and a system worked out for that particular mill.

It is often argued that mechanisation and automation are replacing cheap labour and sooner or later we will have an unemployment problem on our hands. Another argument is that the capital cost of certain automatic instruments could pay the wages of the operators they replace for many years, but one loses sight of the fact that it is quality of end product, better results and more continuous operation of plant, which are obtained by the use of instrumentation and mechanisation.

Operation of Mills

No matter how well trained the operators may be, they are only human and their thoughts and actions are not tuned to their tasks every second of every hour of their shift; they have lapses and it is during this period that things usually go wrong. Their job is a monotonous one, eyes fixed on an ammeter or revolution counter or some other instrument and their hand on a wheel which is turned back and forth for eight hours.

It is said that the requirements of good milling is a steady supply of cane into the mill with no interruptions. It is the operator's task to see that these interruptions do not occur, and if this onerous job could be taken out of his hands then a great deal has been achieved.

Some causes of interruptions are: overloading of cane knives causing them to trip out and hence choking in the cane knives, choking of the mills due to incorrect speed of engine or carrier, or too heavy a feed. On the other hand it is very easy for the operator to speed up the mill engines and keep too small a feed into the mill in order to prevent a choke, and make his task a lot easier, especially during the night shifts.

All of these shortcomings can be and are prevented by some form of automatic controls.

Cane knife trips are prevented by using the amperage of the knives to control the speed of the main cane carrier.

Chokes on mills are prevented by controlling either the mill or intercarrier speeds by means of a "killer" plate. This also ensures that the mill does not run empty. Top roller lift has also been used as the sensing element for controlling the speed of the mill.

Control of 66 in. × 36 in. Mill

At Umfolozi we have two milling trains, the one consisting of two sets of cane knives, a two roller zig-zag crusher and six three roller mills. The crusher is driven by a horizontal Corliss engine, the first and second mills are driven by a single horizontal steam engine, the third and fourth mills each have their own horizontal steam engines, whilst the fifth and sixth are driven by a single steam turbine.

The main cane carrier on this mill is steam driven and the speed of this carrier is controlled by a killer plate in the feed chute to the crusher.

The killer plate, which hangs vertically in the chute is attached to a shaft across the chute, see Fig. 1, on the one end of the shaft is a pulley. This pulley has a length of ¼ in. wire rope passing around it, the one end being fixed to the pulley and the free end is led away to another pulley which is attached to the spindle of the valve controlling the steam to the carrier engine, the wire rope is wrapped twice around the pulley of the valve and the free end attached to a weight to keep the wire rope taut.

If the feed into the crusher chute becomes excessive the killer plate rises and rotates the pulley on the end of the shaft which in turn winds up the wire rope and in so doing rotates the pulley on the valve spindle, causing the valve to close and so slow up the engine driving the carrier.

Conversely, if the killer plate should drop due to too little cane, the valve would open and the carrier speeded up.

Normally automatic control of the main cane carrier requires an overriding control governed by the load on the cane knives, but in our case we are fortunate in having large motors on our knives and the knives are very rarely overloaded. Instead a solenoid operated steam valve has been inserted in the steam line to the carrier engine, and should the cane knives trip out the solenoid is de-energized and the valve closes, shutting off the steam to the engine, causing the carrier to stop before the cane is allowed to pack into the knives.

In order to overcome the different thickness of cane blanket required for the milling of various types of cane, a turnbuckle is fitted in the wire rope to enable the platform boy to alter the relationship between the killer plate and the steam valve opening.

The crusher engine is set at a constant speed and this controls the hourly throughput of the mill.

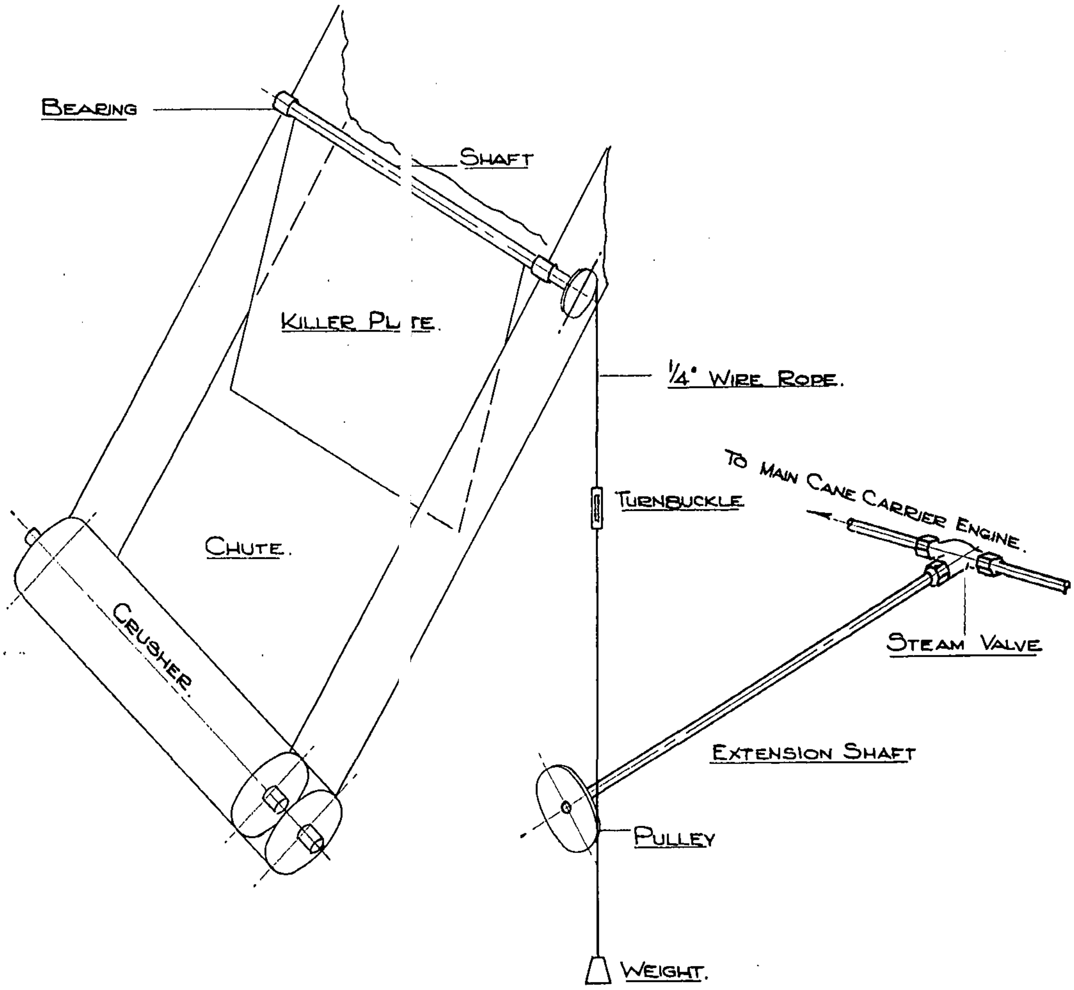

FIG. 1 MAIN CANI. CARRIER CONTROL

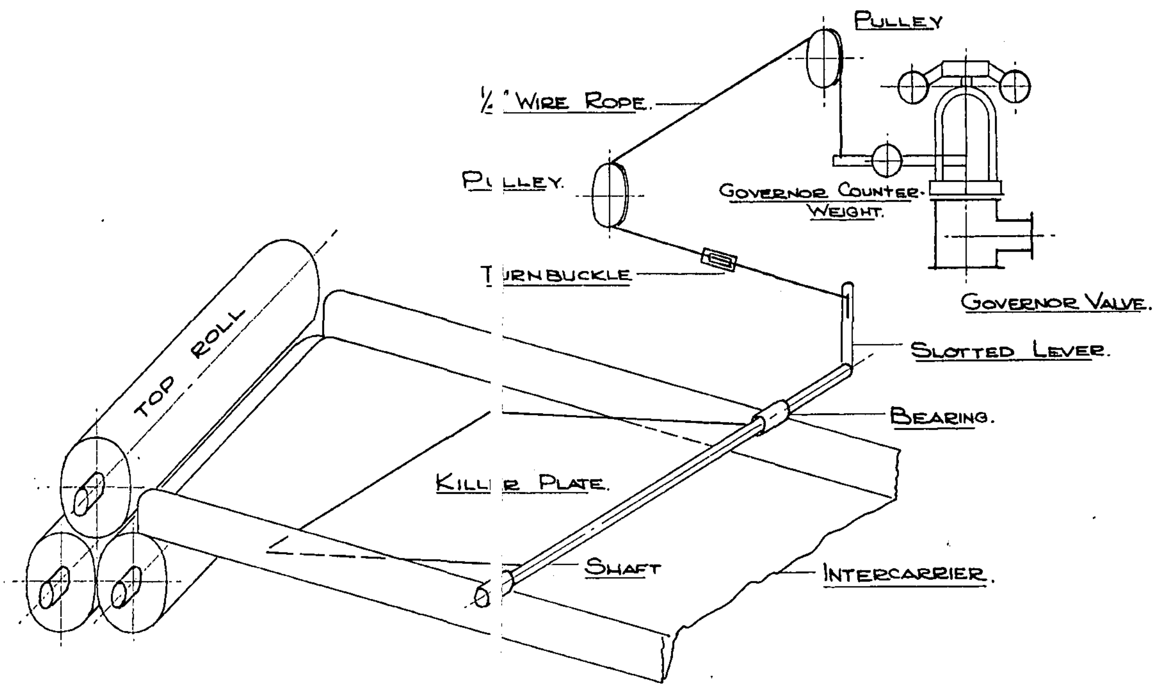

FIG. 2 MI .L CONTROL.

The main cane carrier driver has been completely dispensed with.

The feed into the mills is controlled by altering the speed of the mill engines. This is achieved as follows: a "killer" plate is placed across the intercarrier preceding the mill it is to control, see Fig. 2. On the shaft to which the killer plate is attached a slotted lever is fitted at one end. A $\frac{1}{4}$ in. wire rope is attached to the lever and led away over a system of pulleys to the mill engine governor and is fixed to the arm which carries the counter-weight of the governor.

The wire rope is tensioned by inserting a turnbuckle in the line, it also allows adjustments to be made to alter the relationship between the killer plate and the governor valve for various types of canes which require different milling speeds.

The operation of this system is as follows: the thickness of blanket is measured by the killer plate and should this become excessive the killer plate rises and rotates the lever which is attached to it, this in turn pulls on the wire rope which is attached to the counter-weight arm of the governor, causing the governor arm to lift and the engine to speed up. Conversley, when the feed is too thin, then the killer plate drops and the engine slows down.

The last two mills are driven by a steam turbine which has a Woodward governor. The governor has a servo motor for remote speed control and this motor has been made to operate from the "killer" plate fitted to the fifth mill. This is done as follows: the killer plate shaft has a lever which swings between two limit switches. The one switch speeds the turbine up, the other slows it down. A certain amount of free travel is allowed between the two limit switches. When the killer plate rises the lever swings toward the one limit switch which will speed the turbine up and, conversely when the killer plate drops it will slow the turbine down.

Conclusion

The beauty of these systems is their simplicity and their low cost. They have been in use for one and a half seasons and have enabled us to achieve a constant hourly throughput with good results. The number of units of labour has been reduced from 6 to 2 per shift.

The lost time due to chokes and cane knife trips has been considerably reduced this season compared with the previous season.

Control of 84 in. × 40 in. Mill

The 84 in. × 40 in. milling tandem was also converted to operate automatically but this was done during the latter part of the last season and will be completed this off-season. The results obtained with the experimental equipment used were very encouraging and permanent equipment is being installed at present.

A similar system to the one described earlier was used on the main cane carrier but the steam engine was such that it would not start in any position. This was replaced with an electric motor and control gear designed by us.

The mills are fitted with killer plates as well and these act as the sensing unit for an electronic control which in turn feeds a servo motor on the mill engine governor valves. The mill engines are high speed vertical steam engines.

Further details regarding the design and operation of this system will be presented at a future date.

Mr. Gunn, in the chair, asked the author to state which position on the inter-carrier the "killer" plate should be placed; should it be placed near the preceding mill, in the middle of the inter-carrier, or at the mouth of the mill into which the bagasse was going? He also asked whether the author considered it necessary for the "killer" plate to control the speed of the preceding mill or that of the mill into which the bagasse was going? He wanted to know also whether the author had considered that the "killer' plate had dangerous possibility with regard to the mill gearing, due to its causing low speed and high torques to be transmitted by the mill gearing?

Mr. Ashe said that on his old tandem which was a slow-speed one, he found it necessary to put the "killer" plate at the very beginning of the inter-carrier so that it could control the mill into which the bagasse was going. This obviated any blanks in the carrier. On the large mill he found that with the higher milling speed and the shorter carriers it was necessary to put the "killer" plate at the top or on the head-shaft of the inter-carriers. He was not worried about the low speed and high torques which were developed on the old mill because its gearing was designed with a much higher factor of safety than was used today. With regard to the present new mill he had fitted a limit switch on his engine governors which at a pre-set speed, negatived the effect of the "killer" plate and prevented low speed and high torques being developed on his mill gearing.

Mr. Saville enquired as to whether automatic milling as used at Umfolosi caused chokes.

Mr. Ashe replied that the total chokes for the whole season could not have amounted to much more than one hour. Any chokes were noticed by the platform attendants and were cleared by them and the mills themselves did not choke.

Mr. Perk stated that if the Umfolosi mills did not choke he suspected that those mills were not being fed with the correct amount of cane and that it was easy to have a record of no chokes if the mills were run too fast.

Mr. Ashe said that the beauty of the automatic control was that the speeds of the milling units could be set so that they were almost on the point of choking but did not do so. Therefore under these conditions, if the control was sufficiently responsive, the mills would not choke but would be fed with the correct quantity of cane.

Mr. Kramer asked what happened when the cane slipped but the mill did not actually choke?

Mr. Ashe replied that all chokes began through the mill slipping and the cane piling up in front of the mill. The "killer" plate immediately sensed this and increased the speed of the mill, and although the mill was slipping, more units of cane went through and the choke eradicated. The height of cane in front of the mill then dropped, and the mill slowed down to its normal speed. He explained that his crushing rate was so regular that the variation on the small 66 inch milling train was plus or minus 5 tons of cane per hour. In answer to questions from Messrs. Rault and Hulett he stated that since he had installed the automatic controls on both the milling tandems the extractions had increased although no other mechanical changes had been carried out.

Mr. Gunn congratulated the author on the simplicity of his automatic controls and the effectiveness of these controls. The ultimate aim in automation was to govern the operations of the mill from the continuous weighing of the cane on the main carrier of the mill. In the beet industry this was now achieved. Under such conditions one could achieve a steady through-put and this would facilitate the work of the back end of the factory.