MINIMISATION OF THE HUMAN ELEMENT IN MILLING

By D. J. L. HULETT

At Darnall it has long been our continuous problem to ensure that the milling train is kep well supplied with cane and that each individual milling unit is properly loaded so that a maximum throughput of cane is obtained, consistent with the highest possible extraction.

The various mill engine drivers found that if they continually maintained their engines at their maximum r.p.m., few chokes occurred and their work became comparatively easy. However, this practice of course, caused a fall-off in extraction and it has been management's problem for some years to eliminate this practice.

The obvious answer to this problem seemed to be the Australian "Killer Plate" idea and so a simple method of incorporating this with our Belliss & Morcom steam engine driving units was devised.

Then, to ensure that the milling train was fed with a continuous supply of cane it was considered essential to automate the difficult task of feeding the cane knives. The operator at this post had to keep the main cane carrier supplied with cane to a certain depth by varying the speed of the auxiliary carrier feeding cane to the revolving cane knives. This he accomplished with a liquid controller in the rotor circuit of the auxiliary cane carrier driving motor. However, this was not the only problem facing this operator. He had to keep a continual watch on the cane knife motor ammeter and regulate the cane feed accordingly, for an overload of this unit caused an electrical trip and a ten minute delay while the motor was re-started. Furthermore, should the main cane carrier stop, then he immediately had to stop the auxiliary carrier for fear of a "pile-up" of cane in the cane knife house.

With the aid of a few relays, second-hand spares from the centrifugal machines and a Hagan boiler control unit, a device was engineered to perform the duty of the cane knife feeding operator. After a few teething troubles had been overcome, this device turned out to be an extremely satisfactory arrangement.

The remaining problem to the feeding of the tandem lay in the diligent loading of the auxiliary cane carrier and this has been solved temporarily by employing a more intelligent type of Indian to supervise the cane yard. Ultimately it is hoped to operate the various carriers feeding the auxillary cane carrier by remote control from a central control tower. This, it is felt must result in a better co-ordination of the cane supply to the cane knives.

The "Killer Plate" Idea as applied to the Darnall Tandem

Sketch No. 1.

This apparatus consists of a float over the feed to each mill which actuates through an adjustable link mechanism, a standard Ford truck master cylinder. A hydraulic tube connects this to the equivalent of a wheel cylinder situated in the governor rod of the Belliss & Morcom Engine. This cylinder, incidentally, was made in a few hours in the mill workshop and incorporates standard wheel cylinder "U" rubbers.

The mode of operating is as follows:

As the mill fills with bagasse, the float on the bagasse blanket rises, forces oil from the master cylinder to the engine governor cylinder which in turn collapses a return spring and so shortens the effective length of the governor rod. This of course increases the speed of the engine and the level of bagasse is controlled. An interesting feature of the system is the negative feed-back afforded by the engine governor itself, for as the signal from the mill opens the governor valve, the increase in speed of the governor weight closes the valve to a new balance position. This makes the control extremely stable and no hunting at all occurs.

The Control Mechanism for the Feeding of the Cane Knives

Sketch No. 2.

The system used for the control of the feed to the cane knives is shown diagramatically in Sketch No. 2. It consists primarily of a liquid controller in the rotor circuit of the auxiliary cane carrier motor which is actuated by a standard Hagan power cylinder. This Hagan unit is a device which varies the position of its plunger according to the air signal applied to it, i.e. with a signal of 3 p.s.i. the piston will remain at one end of its stroke but, with a signal of 15 p.s.i., it will remain at the other end; with signals of between 3 and 15 p.s.i. it will take up relative positions between these two extremes.

The air signal to the Hagan is derived in the following manner:

A 15 p.s.i. constant supply of air is bled through an orifice to a manifold to which are connected the Hagan controller diaphragm, a pressure gauge and the atmosphere through a Martenair solenoid operated valve. The manifold is also vented to the atmosphere through a needle valve actuated by a float on the main cane carrier.

The method of operation of the control is simple and is principally an "on-off" control. In the cane knife motor circuit there is a current transformer energising a relay which in turn supplies power to the Martenair valve. This relay is arranged so that in the event of the cane knife motor current reaching a certain high value, the Martenair valve will become energised and open, venting the manifold to the atmosphere and reducing the pressure on the Hagan control to less than 3 p.s.i. This causes the plunger to travel to its extreme position and lift the dippers of the liquid controller out of the electrolyte. This of course, stops the auxiliary cane carrier motor and the feed to the cane knives. The relay automatically opens when the load on the cane knife motor reaches the low limit setting and the pressure on the Hagan builds up, restarting the feed.

The interlock for the main cane carrier consists of a centrifugal switch connected directly to the drive motor shaft. This switch closes when the motor ceases to revolve and energises the Martenair valve.

The float on the carrier acts as an overrider to the control so that should the main cane carrier become fully loaded, the float opens the needle valve, reduces the pressure in the manifold and so slows down the feed. This control mechanism was in operation throughout the last two months of the crushing season and appeared to control the feeding of the cane knives far better than the operator had done prior to its installation.

Unfortunately, as a sugar mill is a practical concern, it is not always feasible to try out one experiment at a time in order to determine exactly what benefit is derived from each arrangement. The performance of Darnall Mill did in fact improve after fitting the various controls but it is difficult to attribute any improvement directly to the installation of these devices. However, it is felt that, provided the arrangement seems reasonable as an improvement and is no disadvantage to the process, it should be incorporated.

A direct saving can be attributed to the control set-up and that is the possible saving of six units of labour on each shift, namely—two top roll boys, three engine drivers and one cane carrier driver.

The President, Mr. Bentley (in the Chair) said that the type of individual one had to operate a milling train tended to somewhat over-control it. He thought it very noticeable that most mills seemed to run far better during the late hours of the night and early hours of the morning than during the day. The reason for this was that when most of our engine drivers and mill boys saw a senior official walking around they pretended to be doing something and were inclined to get the mills running faster or slower, whereas at night when there was little supervision, they set the engines and sat down and everything ran much better. Control of the sort described, he felt, would assist greatly in eliminating the human error in milling that did, without doubt, occur. He said his only query was that on this particular type of engine drive he had noticed that in spite of setting the remote control in any given position except when running at full speed there was a tendency to hunt over a wide range.

Mr. D. J. L. Hulett said he did not find this. He had more horsepower in his engines, but with Tongaat engines, which normally have a top speed of 420, if one tried to control them they will hunt 20 r.p.m. either way, and that was a little unsatisfactory. In his case, where no hunting at all occurred, it was probably due to the control system. The engine speed did vary before he had this control. You set the engine speed at 350, as the load varied the engine must slow down before the governor could open and let in more steam. What amount you did get in cycle hunting through adaption of this control was due to the fact that at times there was a tremendous amount of feed pressure. He said they had 650 h.p. engines against Tongaat's 450.

Mr. van Hengel said he would like to ask Mr. Hulett why it was that when he took different measures at the same time he could not just show any improvement or slight improvement in extraction and other milling data. Did the introduction of this system lead to a better mechanical efficiency of his milling tandem? Did this lead to less breakage, etc. on his mill?

Mr. D. J. L. Hulett said that during the last month they had one of the highest mechanical efficiencies at Darnall, except for the last week when one operator forgot to oil the pump on the engine and they had also ran on one boiler, and again were running slowly and stopping for cane. Although they had a fine mechanical efficiency he could not say it had anything to do with the control. He said the extraction went up. He said they put on 55 per cent imbibition and that also improved the extraction. He said he could not find strictly that the control had improved efficiency, but he thought it helped, and it cost very little.

Mr. Beesley said that he had noticed that certain canes tended to fluff-up and others to compact, when knifed or shredded and asked Mr. Hulett if he had experienced similar canes at Darnall. If so, whether he had found that the float operating the needle valve working the Hagan controller (Sketch No. 2) tended to give variations in crushing rate?

Mr. D. J. L. Hulett said that when he first thought about this whole scheme he visualised this float

being the actual control. As you could see it was arranged to work a needle valve. He said he had to abandon the use of the float and adjust on a purely overriding control. It only worked when the carrier filled up too high. Speed control was mostly by the cane knife current which was set to shut off at 350 amps and start again at 250 amps. He found that he was not getting enough cane through and had to increase to up to 450. Average cane knife current is 350 amps. A big bundle of cane sent the current higher than 350 amps. If the cane is loaded properly on the auxiliary cane carrier the drive would reach full speed. When the feed was regular the cane knife current would hover at 250 to 350 amps until one got a big bundle coming along and then it stopped the carrier. When the cane is fed into the auxiliary cane carrier in big bundles the control does not work well and one got a few humps in the main cane carrier. This would pile one bundle on top of another.

Mr. Sharvell asked for some idea of the range of speed over which the mill engines operated under the influence of the "Killer Plate" controls .

Mr. D. J. L. Hulett said each individual mill did not vary enormously. No. 5 mill speed did not vary from say about 340 to 375 or 400 r.p.m. This depended on how the mill was set. It would keep about that speed and if not pulling its weight it was then tightened up to bring it into the operating range. He could not operate below 280 r.p.m. The governor at that speed had no control. The governor weights were right in and had no control then or at a very high speed when they were right out. Mr. Hulett said he had seen a mill operating under 280 on the hydraulic alone without any help from the governor but it was very unstable and hunted badly.

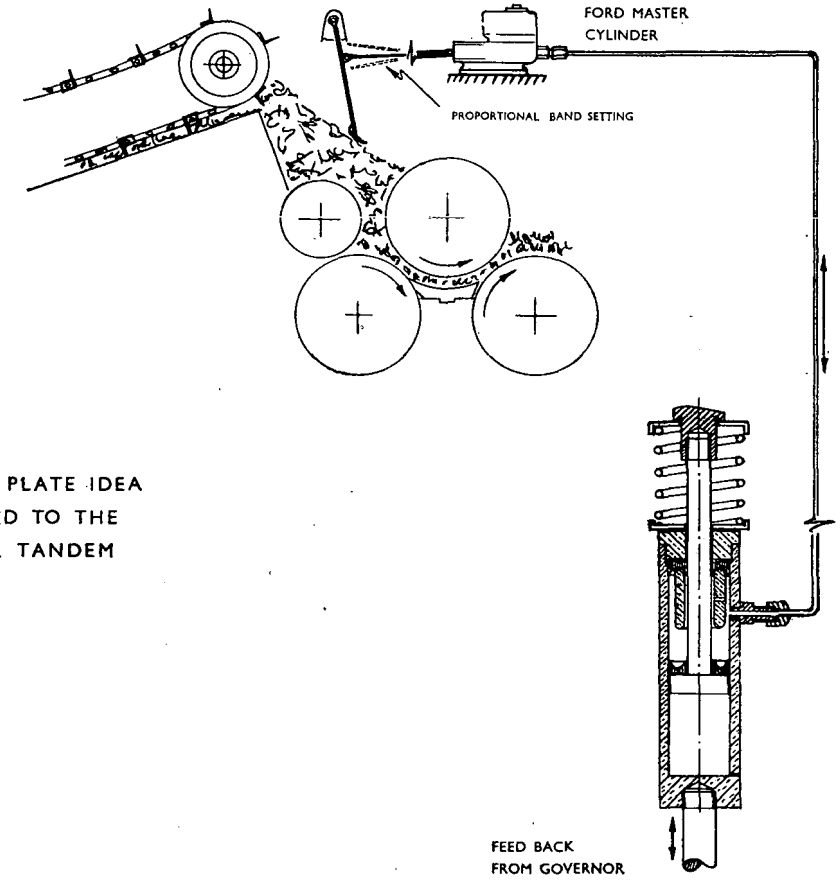
Mr. W. H. Walsh asked whether the limitations of the present governor affected the control. He said he felt the control would be more effective if another type of governor, which was more stable, was used.

Mr. D. J. L. Hulett said they had governors driven by weights but the oil controlled type was such a nuisance that they went back to the old governor.

Mr. Gunn said he believed that Darnall had put their shredder in front of the 1st mill and he wondered whether Mr. Hulett had any ideas of regulating his main cane carrier and controlling it by the shredder motor.

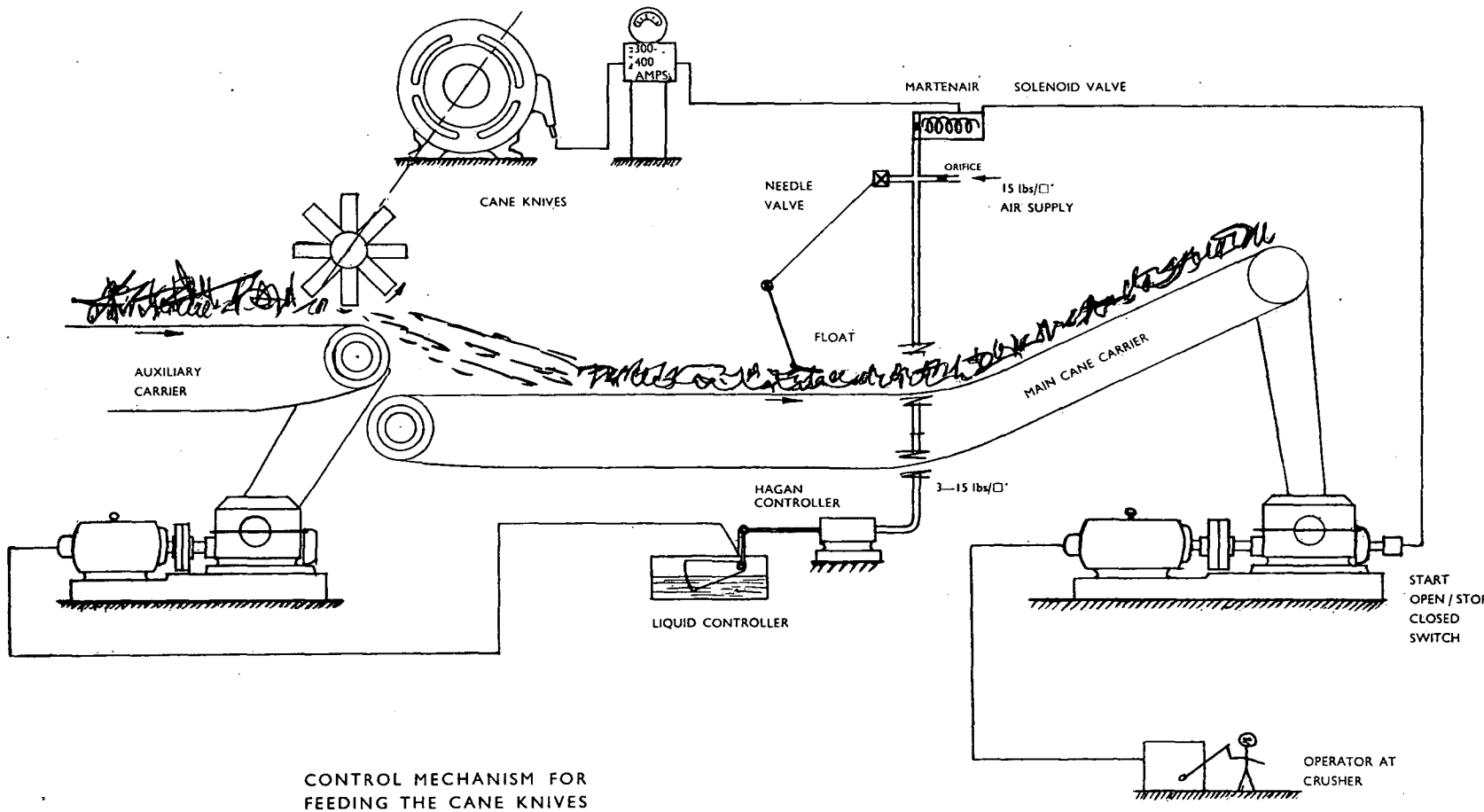
Mr. D. J. L. Hulett said the problem was to keep the feed to the shredder constant. They had a control through the cane knife motor. The shredder motor was a synchronous motor but the ammeter movement was so much that it was impossible to employ this for control.

SKETCH No. 1



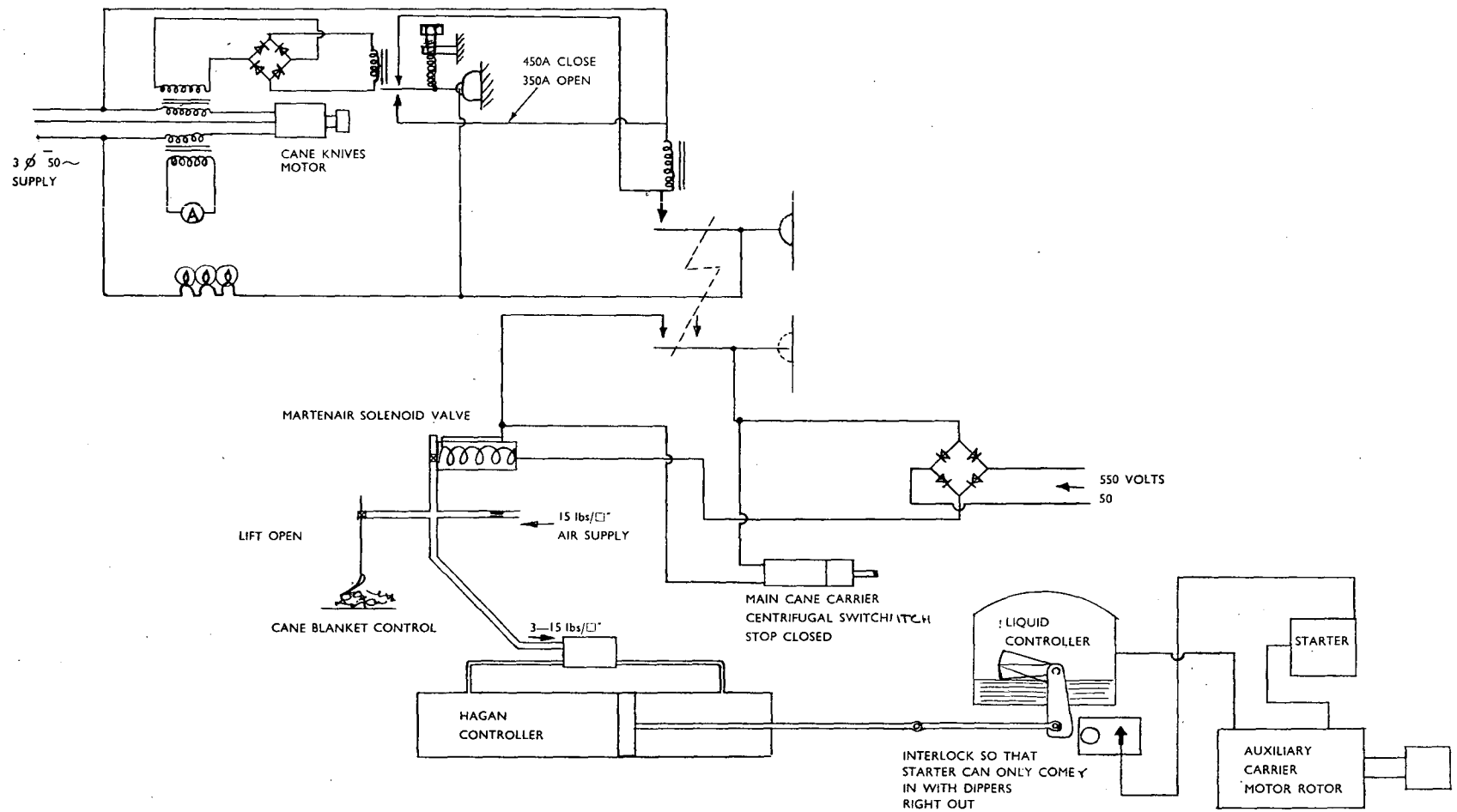
THE KILLER PLATE IDEA
AS APPLIED TO THE
DARNALL TANDEM

SKETCH No. 2



CONTROL MECHANISM FOR FEEDING THE CANE KNIVES

SKETCH No. 3



CIRCUIT DIAGRAM OF AUXILIARY
CANE CARRIER CONTROLLER