A RECORDING ROLLER LIFT INDICATOR

By A. VAN HENGEL

Nowadays, most of the factories use lift indicators to guide the mill operators in adjusting their roller speeds. However, it is not only important to keep the roller floating all the time, but as pointed out earlier,[1] great importance should be attached to the fact that the rollers should remain as closely as possible to a predetermined position, as any movement of the top roller affects the work ratio.

The necessity of keeping the top roller at its predetermined position prompted the S.M.R.I. to develop a reliable means of continuously recording the lift of a top roller. Further important considerations were the advantage of having an instrument that enables the staff to carry out a "from minute to minute" control, the fact that the S.M.R.I. intends to propose the initiation of a system of "Mutual Milling Control" and the fact that some investigations concerning moisture in final bagasse were being conducted at Illovo.

As direct recording was regarded as being impossible, due to the constant vibrations of a mill, an electrical system was selected.

Since it was considered essential to make measurements both at pinion and at pintle sides of the mill, a six-point recording mA meter was transformed into a two-point recorder by short circuiting the terminals.

Basically, the linear movement of the roller plus bearing is transformed into a rotating one by means of a chain, sprocket wheel and contraweight (all very cheap Meccano parts). A movement of 0.5" of the roller causes a rotation of 29° of the sprocket wheel, and as a potentiometer normally turns 290–300° between its extreme positions, the potentiometer was linked with the sprocket wheel by means of a 1:10 gear ratio (also Meccano parts). Hence, a movement of 0.5" of the top roller caused the potentiometer to rotate over its full range.

A rectifier with voltage stabilisation was built in order to make the reading independent of possible variations in the voltage of the mains, and the circuit decided upon is shown in Fig. I (see also Appendix).

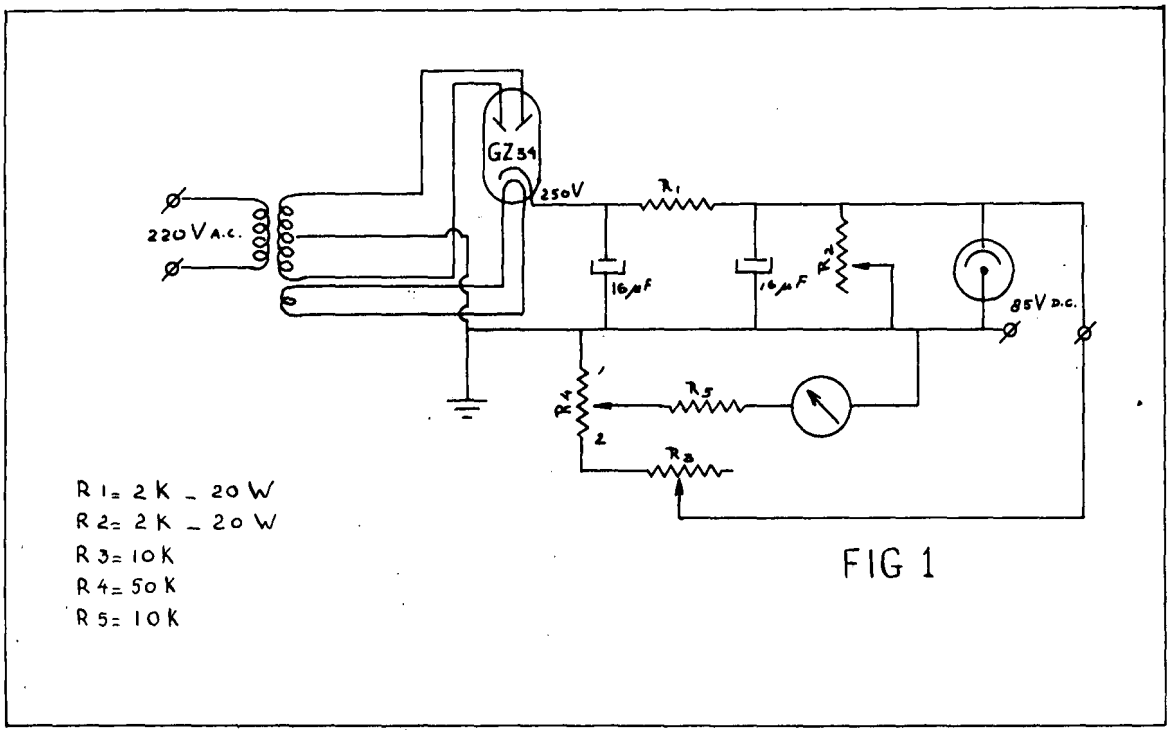

FIG 1

The "electrical" readjustment was accomplished by placing potentiometer R_4 in position 2 and moving R_3 so that the mA meter just gave a full scale reading. It will be clear that the reading with the potentiometer in position 1 will be zero.

The "mechanical" readjustment of the chain over the sprocket wheel was accomplished by means of a rigging screw. The degree of linearity of a normal production potentiometer is always within range of 10 per cent and as the average lift would

be 0.25″, the possible error is $0.1 \times 0.25 = 0.025$″ either side, a very small error.

The apparatus was installed at Illovo on the last mill. Ideally, a mill should be set in such a way that the roller lifts just 0.25″ all the time. The scale of the instrument was calibrated from 0″ (0—mark) to 0.5″ (100—mark). It was felt that it was of some advantage to install the potentiometer R_4 in such a way that at the pintle side the potentiometer was in position 2 and at the pinion side in position 1 when the top roller was at rest. This was simply achieved by reversing the direction of rotation of the sprocket wheels.

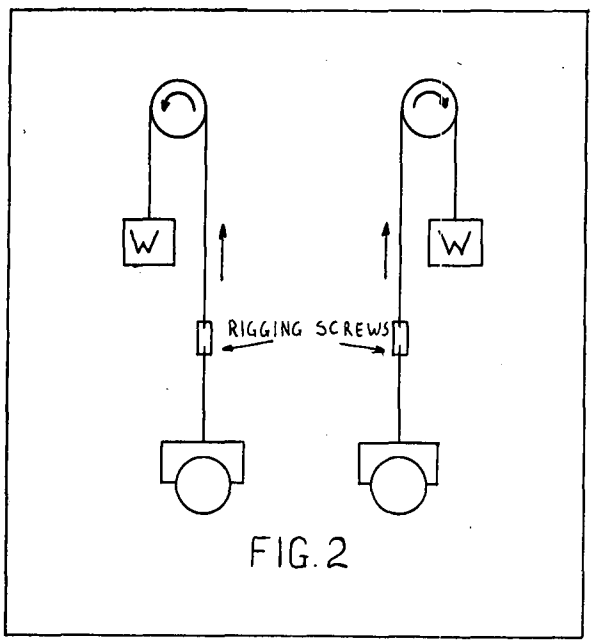

FIG. 2

By doing this, only one line in the middle of the graph paper would result if the roller was lifting 0.25″, any deviation being shown as two different lines and the further the roller moved from its ideal position the greater would be the distance between the lines.

The apparatus worked for a few months at Illovo and enabled us to ascertain the work opening of the last mill with a very high degree of accuracy. This accuracy made it possible to draw certain conclusions that will perhaps lead to a better understanding of the actual milling process.

Acknowledgements

I would like to express my gratitude to Mr. J. Bruijn of the S.M.R.I. who assisted me with the design of a suitable circuit for the recorder.. Further I thank Mr. E. E. Beesley of Illovo for his careful handling of and keen interest in the equipment. Finally, I thank the Management of Illovo for giving me the opportunity of trying the recorder on their mill.

APPENDIX

A characteristic of the mA meter is that it requires a maximum current of 0.1 mA for full scale reading and its internal resistance is 260 Ohms.

The internal resistance was increased by R_5 to 10K Ohms and hence a voltage of $\frac{0.1 \times 10{,}000}{1{,}000} = 1$ V is necessary between point 2 and earth. R_4 should be as small as possible to keep the influence of the internal resistance of the mA meter itself down to a minimum and therefore is 50 Ohms. The substitution resistance for $(R_4 + R_5)$ is therefore:

$$\frac{1}{\frac{1}{50} + \frac{1}{10{,}000}} = \frac{10{,}000}{201} = 49.8 \text{ Ohms}$$

This deviation is so small that it is negligible.

The total drop in voltage over R_4 and R_3 must be 85V and as R_4 is 50 Ohms, R_3 must be:

$$(R_4 + R_3) : 85 = R_4 : 1$$
$$85\ R_4 = R_4 + R_3$$
$$R_3 = 84\ R_4 = 84 \times 50 = 4{,}200 \text{ Ohms}$$

Hence an adjustable potentiometer of 10K Ohms will be very suitable.

R_1 is preferably 2,000 Ohms and therefore R_2 can be calculated from $(R_1 + R_2) : R_2 = 250 : 85$ as the tension at the "85 A_1" voltage stabilizer should be 85V.

$R_2 = 2{,}000 \times \frac{85}{165} = 1{,}030$ Ohms. A readjustable resistor of 2,000 Ohms will therefore be necessary.

REFERENCE

[1] A. van Hengel and K. Douwes Dekker: Some Notes on the Setting and Operation of Mills, Proc. S.A. Sugar Technologists' Congress, 32, 1958.

The President, Mr. Bentley (in the Chair) stated that Mr. van Hengel had given a very clear exposition of apparatus which would be advantageous to use in most sugar factories. The equipment could easily be made. His objection was that the equipment was made up with a view to minimum expense while he thought a more robust piece of apparatus would be more suitable.

Mr. Beesley wished to comment on Mr. van Hengel's paper. He said that the instrument as described, was in fact a prototype and that a lot of development still had to be done to it. For instance the recording part of it was not cheap, costing about £700, but there were other instruments which could be used instead of this very expensive item. In any case, he knew that Mr. van Hengel had a lot of ideas he intended developing in the future. Commenting on the usefulness of the instrument, he said that he thought it was basically a research tool, but that it had a lot to recommend it to the mill engineer, as for instance, he could get information on the correctness of his engine speed vs. mill settings much quicker than normally. It would be particularly useful where mills were coupled together and it was desired to run the second mill at slightly higher lift than the first. Finally he thought this type of instrument could be used to control the speed of the next mill in the tandem.

Mr. W. H. Walsh asked if any of the older hands at Illovo could tell us of an apparatus which was developed some years ago by Mr. Wheeler. He asked how the apparatus now described compared with that put up by Mr. Wheeler. He realised a recorder would be rather a big problem, but Mr. Wheeler certainly accomplished something with his previous apparatus at Illovo. With the advent of the turbine driven mills and varying roller speeds, the piece of apparatus, such as described by Mr. van Hengel, would be most useful. In the case of a turbine drive it was important to keep speed at its most economical pitch.

Mr. Beesley said that all the mills at Illovo were equipped with lift indicators and he thought that these were what Mr. Walsh had referred to.

Mr. W. H. Walsh said this was not what he meant. It was somewhat similar to the present instrument in that it was connected to a potentiometer. Mr. Wheeler's apparatus was similar to the one described by Mr. van Hengel except that it did not have a recorder.

Mr. van Hengel said that in reply to a second question by Mr. Walsh there was no improvement in the moisture content of bagasse or extraction. The recorder, however, enabled them to determine that the maximum possible pressure was placed on the rollers. He indicated that pressure by itself was not the only thing to be considered.

In connection with turbine drives, he said that in this case it would be more necessary to know how to set the mill so that the top roller could run in a predetermined position.

Mr. Rault said that when Mr. Wheeler went to Illovo there was an immediate increase in extraction. He did not know exactly what Mr. Wheeler had done to accomplish this, but he did show results.

Mr. Beesley said that the best extractions achieved at Illovo were those obtained in recent years.

Mr. van Hengel explained that it was not possible to print the dots shown on the recorder. These however showed that the movement of the top roller was most irregular. He said the recorder also indicated that on the pinion side the lift was consistently much higher than the pintle side and the roller was never really level.

Mr. D. J. L. Hulett said we could tell with this machine that the roller was riding on the bagasse. On every mill they had at Darnall there was a recording pressure gauge. This was worked from the Munson hydraulic pressure accumulator. He said it had been mentioned that a recorder could be used to govern the engine speed. He said this has been done at Darnall from the hydraulic system. He said this worked, but perhaps not very satisfactorily.

Mr. Rault said that a mill, being essentially a machine for crushing a bagasse dry, the moisture content was a sure criterion for judging its mechanical performance. He would accordingly like to know the variation in moisture content of different parts of the bagasse, when it was found that the roller was not level.

Mr. Beesley said that for the short period during which the recorder had worked on the last mill at Illovo, the gear side had shown more lift than the pintle side, however tests on the bagasse from both sides had shown no difference in moisture.

Mr. van Hengel said that over 50 lbs. per cu. ft. escribed volume was the ideal volume to be aimed at but at Illovo they only achieved some 44 lbs.

Dr. Graham said that if the recorder showed that the top roller was continuously moving up and down as was found at Illovo, this would mean that the feed to the mill was very uneven. This could contribute towards the low extraction obtained.

Mr. van Hengel said the amount of fibre could alter considerably in spite of the fact that the amount of cane being fed into the first mill might appear constant. So, constant feed of the milling train is not the same as keeping the rollers in their predetermined position. In order to ascertain how great the variations could be, a recorder would be of great assistance.

Dr. Douwes-Dekker said that a statistical interpretation of Java data had shown that best results were obtained when a first mill was fed at a rate of 35 lbs. of fibre/cu. ft. e.v. and a last mill at 55 lbs. Obviously these figures had to be checked for Natal conditions. To calculate the e.v. over a period of say one week, it was necessary to know accurately the average lift of the top roller over that period. The lift indicator described in Mr. van Hengel's paper was a first attempt to find the average lift. It had been applied at the last mill at Illovo and it was found that the fibre content of the final bagasse did not reach the expected value. But neither had it been possible to reach the target figure of 55 lbs. of fibre/cu. ft. e.v. At 46 lbs. the top roller was already lifting freely and pushing more fibre into the discharge opening would only result in a higher lift, not in a higher figure for lbs. of fibre/cu. ft. e.v.

Why 55 lbs. could not be attained was not clear, it might be due to a too large mill ratio, or to the grooving of the rollers. Obviously more data are required and the S.M.R.I. had approached the milling companies asking whether they would be prepared to co-operate in the introduction of a mutual milling control system. The replies from the factories had been quite satisfactory.

The main points of the new system would be the determination of the essential data indicating the performance of each unit of the tandems of the participating factories.

As such we had to see in the first place the regular and accurate determination of lbs. of fibre/cu. ft. e.v. and of the fibre percentage of the bagasse of each mill. This required recording instruments. The one used at Illovo was too expensive to be used in large numbers and the S.M.R.I. was now trying to build a much cheaper type. Until a satisfactory instrument had been developed, we had to ask the participating mills to be patient. It was, however, the intention to convene a meeting soon of the chief engineers and chief chemists to discuss the whole problem.