SOME NOTES ON MILLS AND MILL SETTINGS

BY D. B. B. MUNRO

Comparative Graphs of Mill Settings.

The article on milling, prepared in 1936, with its carefully compiled graphs of mill settings was notable because it disclosed the wide variations in the adjustment of rollers in the various factories.

Each mill has its own problems such as the quality of the cane crushed, the true capacity of the plant compared with the quantity of cane that it is expected to handle, the idiosyncrasies of each two or three roller unit and even of each single roller regarding grooving and gripping power of the metal consistent with the work it is called upon to do.

Great care should therefore be exercised by the individual suppliers of data so that a comparative graph of this nature may be of maximum value to the industry as a whole.

There are so many variables that only a carefully considered average of each mill's settings should be forwarded to the compiler of the graph; but the effort is well worth while as a comparative record of progress, experience and change since 1936.

When determining the average dimension for a setting, it is suggested that the following points be observed.—

(1) Record all roller setting adjustments, whether with positive or negative results and summarise these when figuring the area of the mill openings.

(2) While the standard point to bottom measurement of grooves is assumed to include a correction for wear of the metal during the season's work.

(3) If measurements are taken while the mill is empty, make an allowance for the average rise of the top roller, plus the difference in the actual position of all the rolls when under load, due to small amounts of backlash, wear on journals and brasses, etc.

(4) Record differences in roller speed caused by slowing down or speeding up the prime movers while handling various qualities of fibre and also take the season's reduction in diameter of rollers into consideration when stating the average surface speed of rollers.

(5) Check the trashplate setting by taking leads which are slightly compressed by the top roller when it is lowered into position and all other roller adjustments are completed. (Fig. 1) Add the correction due to the average lift of the top roller (as in para. 3) when figuring the area of entry between the top roller and the nose of the trashplate; and similarly at the other points of measurement. Record any trashplate adjustments made while operating, check up the amount of wear, including grooving cut across the surface of the trashplate and reckon this also in the estimate of the average seasonal trashplate settings.

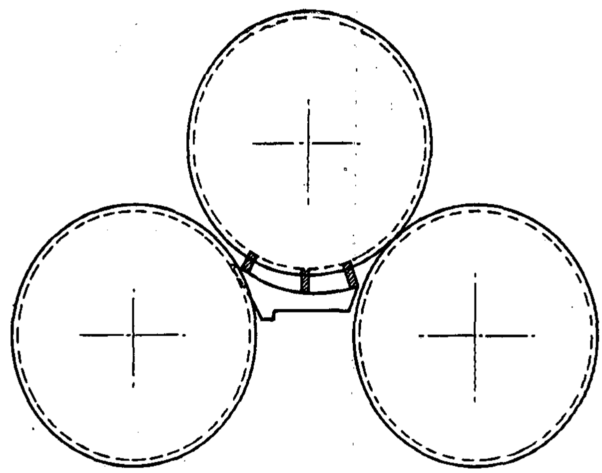

FIG. 1.

Top Rollers and Hydraulic Gear.

"Float" or the amount of rise of the top roller can be measured by means of a simple lever indicator with a 32 to 1 ratio and a suitable scale as illustrated in Fig 2; the bearing clearance being maintained at a known figure, say .001 per inch of journal diameter.

Unequal rising of the top roller is also indicated.

In order to allow the top brasses to move without friction, the point of application of the hydraulic pressure should be adjustable according to the feed and bagasse roller pressure in combination with the top roller.

Many mill housings are not provided with this adjustment, but it may be partly provided by machining out the snugs of the top caps and inserting fitting strips as shown in Fig. 3.

When this offset of the hydraulic pressure is carefully adjusted the side facings of the top brssses will show only very slight wear after several seasons with a constantly " floating " top roller.

Unequal wear of the cylinders and rams of the hydraulic gear is also reduced to a minimum when the offset adjustment is properly made.

bronze applied by the oxy-acetylene process and machining them to the correct fit, taking care to make a properly shaped support for the bottom of the leather. This method is satisfactoory even though the cylinders have bronze liners.

A good quality of soluble oil seems to be quite suitable in the hydraulic system.

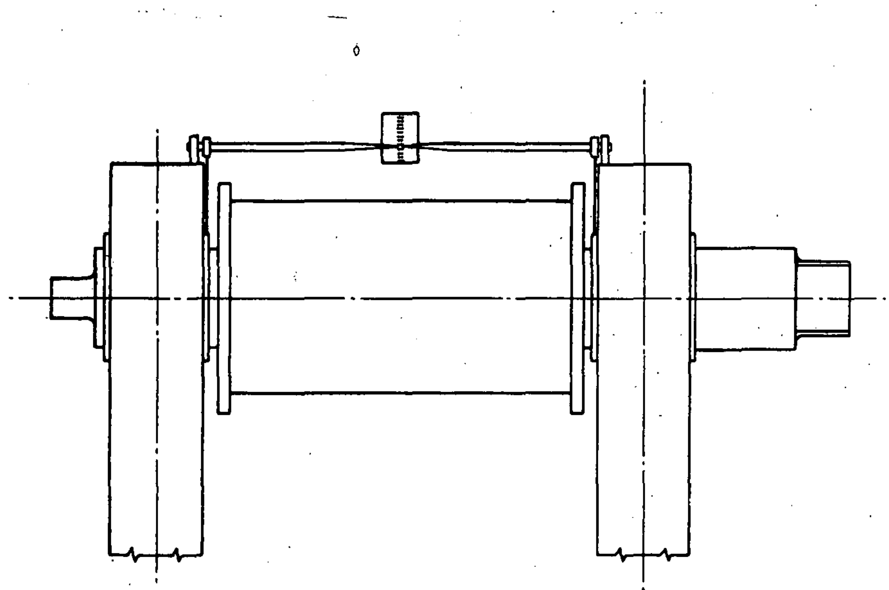

FIG. 2

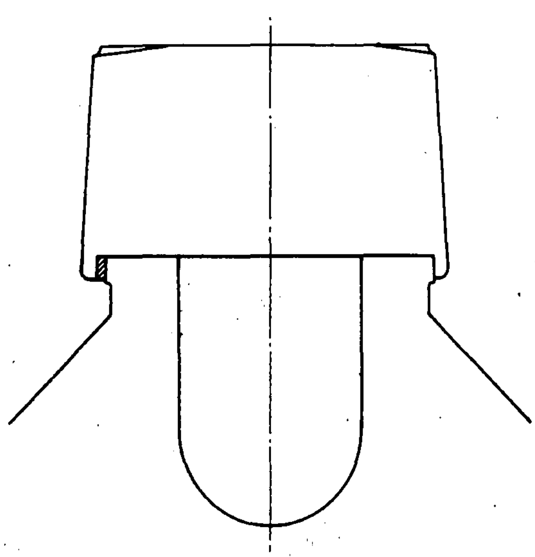

FIG. 3

Hydraulic rams can be maintained in perfect order by trueing up and polishing the cylinders, and building up the wearing parts of the rams with

Screwed plugs should be provided at all points where air is likely to be trapped while pumping up the accumulators so that the air can be released from the system.

Single S.E.A. Rings fitted in the approved manner, form an efficient seal in the glands of the hydraulic rods and cause the minimum of friction.

When rollers are machined to renew the grooving, the contact surfaces of the pinions should also be properly refitted. The difference in pressure between gear and off side hydraulic rams required to maintain the top roll in a level position has been recorded as hight as 35 per cent.

Differential Hydraulic Accumulators are now in use that automatically maintain a level top roller.

A pointer and a scale, mounted upon the frame of the hydraulic accumulator can be usefully employed to show the correct operating position of the weights.

While the mill is at rest, and the system fully primed with oil, the weights are pumped up to the height of the pointer.

This setting should be checked at every opportunity when the mill is empty.

The amount of "float" of the top roller is registered on the indicator (Fig. 2), and the relative rise of the rams in the mill caps to the rise of the accumulator weights is shown on the scale, under normal load.

Naturally, the calculated rise of the hydraulic weights will not be realised, but this result can be approximated, again provided that the mill concerned can reasonably handle the tonnage expected of it.

Approximately accurate roller opening areas under operating conditions, as compared with the measurements taken when the mill is at rest, can be made by stopping the plant at a suitable time with a normal blanket of cane between the rollers.

Beginning at the last mill, or pair of mills, a portion of the blanket is cleared away close to the feed opening and towards each end of the roller and slabs of lead of suitable size laid down in the blank spaces.

The readings of the roller rise indicator and of the scale on the hydraulic accumulator are taken and the mill turned until the leads pass out and are picked up.

The process is repeated, but the mill is stopped when the second set of slabs is well into the feed opening only. The mill is then reversed sufficiently to get the leads clear.

The leads thus taken have an impression of the actual openings between the rollers, provided that they originally were of a suitable size to be squeezed completely into the grooving.

A section is cut out of each sample and calipered, and the total area of the openings worked out.

These actual openings; the rise of the roller as shown on the scale of the roller indicator; and the position of the hydraulic weights (which should come down to the pointer when the mill is emptied) are then correlated and errors found and corrected as well as possible.

Modern roller metal leaves little to be desired regarding wearing qualities and gripping ability; and the 55° included angle grooving is quite satisfactory.

Rectangular shaped grooves, slightly deeper than the Vee grooving, cut at three or four inches pitch in the same manner as chevrons, across the roller, fill up with bagasse and form an efficient gripping medium, particularly on the top rollers of the later milling units where the Vee grooving is half an inch pitch.

These rectangular grooves are superior to the ordinary chevrons because the surface of the roll presented to the incoming blanket of bagasse is practically continuous, the gaps due to the chevron type groove being eliminated.

Top Roller Scrapers can be set to allow a small amount of " fur " to adhere to the Vee grooving with a beneficial result to gripping ability.

Feed Rollers.

Some method of pre-compressing the blanket of bagasse in order to introduce it to the feed opening is essential.

A type of carrier, upon which the cohesion of the bagasse, as discharged from the previous mill, is disturbed as little as possible, should be used in conjunction with the pre-compressing device.

The next step is free escape for the expressed juice.

Deep drainage grooves are absolutely necessary for this purpose in feed rollers.

In order to preserve the crushing surface of the rollers, deep drainage grooves should be as narrow as possible in relation to the quantity of maceration applied.

On smaller sizes of mills a 5/32 inch groove with ⅛ inch scraper has been successfully used.

9/32 inch grooves with ¼ inch scrapers, gradually wearing to 13/32 inch with ⅜ inch scrapers during the life of the roller shell, at 3 inch pitch, should be satisfactory, but if the rollers are protected from tramp iron a closer pitch and smaller Vee grooving is an improvement.

The method of supporting the scrapers with a view to reducing wear, merits a good deal of attention and improvement.

Good milling results depend upon efficient work being done between the feed and top rollers.

Eighty per cent to ninety per cent of the juice extraction is being obtained by the first expression in a three-roller unit.

If the capacity of the mill allows, chevrons (involving pockets of poorly crushed cane) in the feed rollers should be dispensed with.

Bagasse Rollers.

Particularly where very close adjustment of top and bagasse roller openings is necessary, accurate matching of the Vee grooving and equalization of the diameter of the combination of rollers is well worth any extra time and expense involved.

The closer the setting, the more damage is likely to be caused by tramp iron, etc., and deep drainage grooves in bagasse rollers also renders them very liable to breakage; therefore an electro-magnetic apparatus for removing this menace should be fitted to every cane carrier.

Damaged rollers can pass an appreciable amount of sucrose, spread over several months, and the nature of the metal makes repairs by welding to most rollers very difficult.

Regarding deep drainage grooves, mill operators, who are reasonably sure of obtaining 80 per cent or over of the juice extraction by the first expression of the mill unit under consideration might be wise not to have the bagasse rollers deep grooved.

On the other hand, when heavy tonnage per hour combined with high fibre and heavy imbibition is expected to be crushed the conditions of feed roller setting necessary for at least 80 per cent first expression may not be possible, a compromise, including deep drainage grooves in the bagasse roller, will have to be arranged.

Some mill operators will, no doubt, have the bagasse rollers fitted with drainage grooves, and will take the opportunity to remove the scrapers during periods when the quality of the cane crushed allows this to be done.

Mill Settings.

New cane varieties with less fibre and more juice than Uba have made the reduction of moisture in bagasse for fuel purposes an urgent problem, and good extraction means minimum moisture and sugar in bagasse at every milling unit.

That the checking of actual openings by test leads, and the employment of roller indicators can be useful in an improvement in milling is demonstrated by the following illustration:—

"Normal" Top Roller Position.

Assuming that friction on side faces of top brasses, hydraulic plungers and rod glands; and the backlash and wear of journals and brasses, etc., has been reduced to a minimum; and the roller indicator is showing the true amount of "float" of the top roller; and the hydraulic accumulator weights are taking up a position somewhat approximating the correct one relative to the amount of rise of the rams; a normal operating position can now be decided upon, and this position clearly marked upon the roller indicator scale.

Individual unit extraction tests are carried out and the best relative positions of the feed and bagasse rollers determined, and test leads taken of this setting.

Juice and fibre variations are then handled by adjusting the surface speed of each mill (or pair or mills) to maintain the top roller as nearly as possible at its normal operating position.

The superiority of individual mill drive is here clearly seen but as probably the majority of mills are driven in pairs, the roller settings of each pair will require to be synchronised..

For this surface speed control variable speed motors are excellent, but the ordinary mill engine can be used to great advantage by fitting a simple type of variable speed governor, its driving motor being controlled by push button from the operator's place of observation on the mill platform.

This engine drive, of course, assumes that power is available at lower speeds and that dangerous flywheel stresses, etc., will not be developed at higher speeds. However, most engines are capable of fairly wide range of speed.

As an example of the use of the roller indicator and variable speed control on a 26 inch x 54 inch mill during five consecutive days in September, 1938, the following figures reveal the rather exceptional conditions that can occur in a small mill crushing 34 per cent. Uba and 66 per cent. New Canes.

	Maximum	Minimum	Average
Fibre	15.69%	9.10%	12.74%
Surface Speed	22.0 ft. per min.	17.5 ft. per min.	20.8 ft. per min.
Moisture in Bagasse	51.0%	46.0%	48.0%
Extraction	96.1%	92.0%	93.6%

A survey of the four hourly periods over which these figures are taken shows that:

9% of the cane had	10% or less fibre	
27% " " " "	10% to 11%	"
14% " " " "	11% to 12%	"
27% " " " "	12% to 13%	"
18% " " " "	13% to 14%	"
5% " " " "	14% and more fibre.	

While these figures may represent more than usually severe milling condition, they are useful as an example of what the Mill Engineer has to consider when setting mills.

They are also a strong argument in favour of more flexibility in driving units and for a general increase of surface speed for crushing the harder canes, so that the normal speed will not be too low and reduce the power of the driving engines, while keeping the mills fully loaded, while crushing low fibre canes.

Many mills in Natal and Zululand have housings in which the top roller must rise in a vertical direction or tip the brasses and jamb the floating action.

The Puunene and other housings were designed to overcome this disability, but strictly considered, maximum efficiency and freedom of float can only take place within small limits of roller setting while crushing normal canes.

Any variation outside these limits will cause a disturbance of the relationship of pressure between top and feed, and top and bagasse rollers.

This matter has been very fully dealt with by Kopke in his articles on Effective Pressure.[1]

As an example of how variations from the adopted top roller operating position can effect crushing efficiency we will assume that the setting of an 54 inch mill with one inch grooving in the feed roller and a half inch pitch grooving in the top and bagasse rollers gives a feed opening of 48 square inches and a bagasse opening of 24 square inches, according to the impressions in the test leads. The ratio of feed opening to the bagasse opening is 2 to 1.

The mill is emptied and the bearings being a good fit cause the roll to fall almost vertically. There will not be a large variation due to the angular position of the two lower rolls so we may presume, for example, that the rollers are each $\frac{1}{8}$ inch closer to the top roller when the mill is at rest.

The ratio of feed to bagasse opening now varies 0.3 from the normal being 2.3 to 1.

Again, assuming that the roller is forced above the normal setting it will rise almost vertically with a tendency to tip and jamb the brasses, but if we assume that the openings are both increased approximately $\frac{1}{8}$ inch from normal or $\frac{1}{4}$ inch from rest, the position is that the top roller is no longer floating freely and the ratio of feed opening to bagasse opening is now 1.7 to 1.

Therefore, actual operating conditions, and calculations of pressure relationship between the rollers must be based only on a known dimension, that is, the normal operating position of the rollers as shown by the indicator and test leads.

Juice extraction efficiency tests can be put on the same comparative basis.

Trashplates.

As with rollers, modern developments of wear resisting metal to suit the conditions is making the problem of correct maintenance of trashplate setting less difficult; but all trashplate metal wears, more or less.

Here, again, the use of a roller indicator is beneficial, because a normal operating position can be adopted at the beginning of the crop which will allow for adjustment to a lower position during the latter part of the season, thus compensating the wear of the trashplate and keeping the distance of the trashplate from the top roller approximately correct.

Alignment with Gearing.

When the operating position of the top roller has been established, the friction losses and wear on mill couplings can be reduced and freedom of " float " assured by providing suitable packing under the gearing bearing pedestals to bring the gearing shaft into close alignment with the top roller under its normal load and in its working position.

Finally.

Though this article may seem to be of rather an elementary nature to many mill operators, its purpose will be fulfilled if a free discussion on milling and mill settings is promoted.

The CHAIRMAN (Dr. Hedley): We are getting quite a number of papers on Mills and Milling.

I am glad of this, as the subject is one of the most important in the work of the sugar factory.

The paper is written by Mr. Munro, Mill Manager at Doornkop.

If you take the figures given in the Annual Summary of Laboratory Reports for the Doornkop Mill you will see that Mr. Munro has put into practise a good deal of what he has said, with very efficient results.

1. Kopke, E. W. (1932). Constantly Effective Pressure: A Problem in Milling. Facts About Sugar, **32**, 259.

He drew attention to moisture in bagasse, and this figure at Doornkop is one of the best for the season—48.62%.

Many mills have moisture figures of 53 and 54%. It needs no argument to tell you what this means.

The extraction at Doornkop is also good—92.25%, while the sucrose % cane is not low, it is 13.71.

Therefore, I think the paper comes from one who knows what he is talking about.

I hope there will be a full discussion on Mill Setting problems.

The paper is now open for discussion.

Mr. MOBERLY suggested that it would simplify procedure if the Report of the Committee on Milling, Machinery and Practice were now read. and followed by discussion on the two papers.

Dr. HEDLEY: We will do that. I hope there will be a very good discussion, but in discussing Mr. Murray's paper, don't let the things that Mr. Murray says overshadow what Mr. Munro has said.

Mr. MURRAY: The Report of the Committee on Milling, Machinery and Practice is here presented. This Committee met rather late, and it was impossible to call the Committee together to draft the report. I have taken upon myself to write the report, and I am afraid some of the members of the Committee won't agree with it. It was done with that intention.