

SOME NOTES ON WEIGHING PRACTICE IN SUGAR MANUFACTURE

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1.—INTRODUCTORY.

Weighing, sampling and analysis are a trinity in chemical control, and faults in any of the three will vitiate the results obtained, no matter how well the other two are performed. In general, weighing operations in the South African Sugar Industry may be said to be satisfactory and well controlled, but a few general notes on weighing practice should not come amiss. This paper is intended to provide a discussion on general weighing practice in sugar factories, and is not concerned with the mechanical problems of scales, nor is any attempt made to compare the relative values of different types of weighing machinery, except in the broadest terms.

2.—WEIGHT UNITS EMPLOYED.

The large unit of weight in general use in this country is the short ton of 2,000 lbs. This is an improvement on the long ton of 2,240 lbs. inasmuch as it lends itself easily to decimal division. It is unfortunate that a few factories and other organisations still persist in recording cane weights in tons and pounds, instead of the more satisfactory system of tons and decimals of a ton. The persistence of this habit may be due to the fact that makers almost invariably graduate their scale beams in pounds. It would be easy to have scale beams graduated in decimals of a ton, but, unfortunately, railway tares are always marked in pounds. As rolling stock for cane and sugar is also used for other merchandise, it is too much to hope that this might be altered. It is, however, strongly urged that the conversion from pounds to decimals be made in the weighbridge when the nett weight is determined, and that no record of pounds should be allowed to go further than this.

3.—LIMITS OF ACCURACY.

Another minor inconvenience arises from the fact that some cane scales in this country weigh to the nearest 10 lbs., others to the nearest 5 lbs. and in one case, to the nearest 2 lbs. This means that sometimes three places and sometimes four places of decimals are used, and when calculations are being made from figures from a number of factories, this difference is a nuisance in the operation of calculating machines. The maximum limit should be to the nearest 10 lbs. for cane. Mixed juice and water may also be weighed to the nearest 10 lbs. though most scales record to the nearest 5 lbs. The limits for sugar vary according to circumstances and are referred to later. The limits in the case of other materials are not of great importance.

The above refers to the units to be employed in recording weights and not to the sensitivity of the scale, which is stipulated in the Weights and Measures Act (Act 32 of 1922 Regulation p. 120) as follows:

Capacity of Scale	When fully loaded to turn with.
10,000 lbs.	4 lbs.
20,000 lbs.	6 lbs.
40,000 lbs.	9 lbs.
60,000 lbs.	12 lbs.
80,000 lbs.	15 lbs.
100,000 lbs.	18 lbs.

Self indicating instruments have a turning allowance 50% greater.

The 10 lbs. limit mentioned above is less than the stipulated sensitivity of weighbridges over 60,000 lbs., but in actual practice the sensitivity is well within this range.

The Regulations under the Weights and Measures Act are obtainable from the Government Assize Office for 2s., and should be carefully studied by all those responsible for weighing machines.

4.—TYPES OF SCALES EMPLOYED.

All scales in use for all sugar products are, or ought to be, based on the counterpoise system. Spring scales should be definitely barred. The metal of all springs is liable to fatigue and distortion, hence the slogan of the makers of grocers' scales "Honest Weight—No Springs." Some years ago a salesman tried to dispose of a spring scale to weigh cane bundles when suspended by the crane, but fortunately the device was never adopted.

5.—MATERIALS TO BE WEIGHED.

The various materials in sugar manufacture which should or might be weighed are:—

1. Cane.
2. Mixed Juice.
3. Imbibition Water.
4. Bagasse.
5. Syrup.
6. Molasses.
7. Filter Cake.
8. Sugar.

Of the above, 1, 2, 3 and 8 must be considered obligatory as affecting the weight of sucrose purchased and of the sugar sold. For this reason their accuracy is supervised by the Government Assize Department.

4. (Bagasse) is perhaps a luxury since the weight can be calculated from 1, 2, and 3. Of the others 5, 6 and 7 are useful aids to the determination of sucrose balances. Syrup is only weighed in a few factories, but the practice could be usefully extended. The weighing of molasses is not nearly as general in our industry as it should be, with the result that our published chemical control figures lack much of the comparison value that they might possess. If molasses is unweighed then undetermined losses cannot be calculated or identified.

7. (Filter Cake). Some may consider a luxury, since the quantity of sucrose involved is small and weights can be roughly estimated. It is, however, necessary for a perfect control.

6.—CANE.

There is only one general type of scale in use for weighing cane, viz.:—the platform weighbridge in which the bridge is level with the ground or the bed of the railway line, and the counterpoise mechanism is in an underground pit below it.

Care of Weighbridge Pits.

It is important that this pit be kept entirely free of water, and as free as possible of dust and other rubbish. Wherever possible there should be a drain with a good fall, and wide and straight enough to be easily flushed. Where levels make direct drainage impossible a pump and a large sump should be provided. A low ridge or parapet a few inches high should be placed round the outside of the bridge, broken only to allow the passage of the rails or the wheel tracks. This is to prevent the entrance of drifting dust or surface water. The surface of the ground in the neighbourhood should have a fall away from the bridge. If it be feasible to have the whole mechanism, including the bridge, roofed over, so much the better.

The pit should be easily accessible through a manhole, preferably inside the scale house. By means of this access the knife edges should be regularly inspected and kept clean, and the beams dusted and kept clear of any trash, etc., which might fall through from the bridge above. It must be remembered that the counterpoise mechanism consists of a series of levers multiplying the displacement caused by the object weighed, so that any foreign matter falling on some intermediate beam would record an error in weight many times larger than its own weight. The effect of flooding is not merely to make the action sluggish by choking the knife edges and Vs with mud, but the buoyancy of the

submerged beams, appropriately magnified by the lever action, entirely falsifies the weighing. A glass covered spy hole giving the scale operator a view of the underground mechanism (suitably illuminated) would be a useful safeguard against unobserved flooding or fouling.

Location of Weighbridges.

The point has frequently been stressed by Committees of this Association that cane weighbridges should be placed as close as possible to the carrier, and this is the present tendency in most new installations. The purpose of this is to minimise the changes of weight occurring between weighing and crushing due to evaporation or rain. Such changes not only give rise to a false weight of cane crushed, but also affect the indirect determination of bagasse weight and thereby falsify the calculated weight of sucrose in cane. If the weighbridge and the whole of the carrier can be under one roof (as at Esperanza) this is most desirable.

Care of Weighing Mechanism.

It should be needless to say that all weighing mechanism should be kept scrupulously clean and clear of all extraneous objects (however light) such as pencils placed on beams or tobacco bags hung on counter weights (both of which have actually been observed). Whenever actual weighing is not taking place the mechanism should be locked, otherwise moving loads or persons walking over the bridge cause jolts which are liable to affect the delicate mechanism.

Types of Weighing Mechanism.

Three types of weighing mechanism are in use in this Industry:—

- (a) Hand-regulated beams (Steelyards).
- (b) Dial scales with visual reading.
- (c) Dial scales with electrical recording.

(a) Hand Regulated Beams (Steelyards).

These are the most commonly used. They have the advantage of being mechanically simple and fairly robust, but have the disadvantage of needing a certain amount of personal judgment in obtaining a balance and are subject to personal error in reading and recording readings.

Such beams are usually fitted with a device for stamping the weight on a ticket, though in many cases this mechanism is permanently out of action. The stamping is affected by pressing the ticket against steel figure-types embossed on the beam itself. When these types wear out they cannot be easily renewed as they are integral with the beam. It should surely not be difficult to have them embossed on a steel strip which could be bolted on to the beam

and removed for renewal. Ticket stamping devices are required by the Sugar Agreement.

(b) **Dial Scales with Visual Reading.**

These eliminate personal errors of adjustment, but retain personal errors of recording. The whole possible range of weights cannot be shown on one dial so that a hand adjustment to a suitable range must be made and the exact weight is then shown on the dial.

(c) **Dial Scales with Electrical Recording.**

These scales recently introduced into two of our factories mark a considerable advance on previous practice. The weight is indicated on a visible dial as in the previous type, and is also recorded electrically on a ticket and ribbon. A stiff ticket with an overlying paper slip and carbon paper is inserted into a slot. The weight is then stamped on the paper ticket (with a carbon copy on the card) as soon as the counterpoise mechanism has come properly to rest, but not otherwise. If the weight is beyond the range of the scale no record is made. Sequence letters and numbers are also recorded automatically for subsequent identification, and a similar record of weight and sequence number is made on a paper ribbon for checking purpose. With this mechanism the only possible scope for error left open to the operator is in recording and subtracting the tares. Operation is quicker than with hand-adjusted beams.

Types of Cane Loads weighed:

Cane may be weighed in the following forms of loads:

- (a) Railway trucks (S.A.R. Standard and narrow gauge).
 - (b) Tram trucks.
 - (c) Animal-drawn wagons.
 - (d) Motor lorries.
 - (e) Free bundles.
- (a) **Railway trucks:**

Precautions to be taken: As cane is usually loaded longitudinally, there is little danger of fouling the sides of scale houses, but badly loaded trucks may have cane interlocking with cane in an adjacent truck. In such a case the cane should be cut clear. Ideally each truck should be uncoupled when weighed. However, available time seldom allows for this, but in any case all couplings should be loose, neither in tension nor compression. Where the couplings of adjacent trucks are not on exactly the same level, compression or

tension of the couplings will tend to lift or depress trucks, and may affect weights to an appreciable extent.

Naturally care must be taken that all wheels of the truck are properly on the bridge before weighing. This sounds elementary, but cases have occurred where this mistake has been made. There is a particular danger of this occurring with the long B type truck the wheel base of which fits on to the standard bridge with only an inch or two to spare. To avoid this danger it is recommended that a notch be cut into one rail on the bridge in such a position that a wheel sinks into it when the truck is properly placed.

Sometimes the rail leading off the bridge is slightly higher than the rail on the bridge itself. In such case care must be taken that the leading wheels do not bear against the higher rail. In one instance investigated last year it was found that such a circumstance reduced the weight indicated by 17% to 19% of the gross weight.

There should be a window in the scale-house giving the operator a clear view of the whole of the bridge.

Tares of S.A.R. Trucks: It has been a common experience to find the tares marked on S.A.R. trucks considerably in error in either direction, some times by as much as 1,000 lbs. In addition tares are often very indistinctly marked, and often an old marking shows through a new one. Two instances have recently been brought to the author's notice of trucks with different tares marked on each side, in each case with a difference of 6,000 lbs. Unfortunately it appears to be impossible to get anything done about this, as the Railway Administration resolutely refuses to alter any tares, unless the truck comes into the workshop for overhaul or repairs. It is unfortunate that lack of facilities for reweighing empty trucks makes the use of S.A.R. marked tares necessary. Apart from the errors referred to above, there is always a considerable amount of trash and loose cane left behind in the truck, and this should correctly be included in the tare. One factory determines its tares by reweighing trucks.

Poles: Skilful loaders can load an S.A.R. truck to full height without the use of poles, especially for short hauls where no sharp bends are experienced, but the usual practice is to build up the sides of the truck with poles to retain the cane. It is seldom expedient to weigh these poles so the normal procedure is to determine the average weight of a pole,

and to multiply this weight by the number of poles used. Sometimes a gross tare is used for poles, but this practice is bad, as the number of poles used may vary from 10 to 40. The weights of different types of poles should be determined separately, as there is naturally a great difference in the weights of dry bamboos, strelitzias, and large gum trees. (In parentheses, because it has nothing to do with the subject of this paper, I would express the hope that the use of strelitzia or wild banana poles for loading cane trucks might be discontinued, because this practice is destroying much of the natural beauty of our coastal belt). The average weight of poles should be determined several times during the crop, as green poles cut early in the season lose much weight on drying out.

(b) **Trams.**

Precautions to be taken: As cane is usually loaded laterally on tram trucks care must be taken that overhanging cane does not bear against the scale house or trail on the ground. If it does the trouble should be remedied with a cane knife.

The same precautions for placing trucks properly on the bridge should be taken as for railway trucks. Here, too, a notch in the rail would be useful. Special care should be taken in the case of bogie trucks.

As with railway trucks all couplings should be loose, neither in tension nor compression. An ingenious system has been developed at some factories in Queensland for checking the weighing of small trucks. A bridge is used long enough to accommodate two trucks at once. Of a string of trucks the first is weighed separately, then the first two are weighed together and the weight of the first subtracted to give the weight of the second. Then the second and third are weighed together and the calculated weight of the second subtracted to give the weight of the third, and so on, until the end of the string, when the last is weighed separately. If all weighings have been correct the directly ascertained weight of the last will agree with its weight calculated by subtraction. If it does not agree the whole string is drawn back for reweighing. This procedure only necessitates one extra weighing for each string of trucks, but, of course, it means that a larger weighbridge is required.

Tares of Tram Trucks: The tares of tram trucks are usually determined annually, immediately prior to the commencement of the crop. If time and the exigencies of the work permit, it is advisable to retare trucks in the

middle of a long season. In any case it is essential that every truck be retared after undergoing repairs. Tares should be shown on the truck itself in a position easily legible from the scale house. Merely to show the numbers of trucks and to consult a table of tares corresponding with these numbers introduces further scope for error.

Trucks should be tared with the number of chains normally used for securing the load.

(c) **Animal-drawn Wagons.**

The same precautions prescribed for railway and tram trucks apply in the case of animal-drawn wagons. If feasible it is preferable to reweigh the wagon (plus a number of chains equivalent to the number used with the load). Where this cannot be done, wagons should be retared at frequent intervals, especially during wet weather. Tares should be taken with the wagon harnessed, so that the weight of the disselboom is properly supported by the animals. The wheel animals must be quiet and not restive, while weighing or taring is taking place. Care must be taken that the wagon is free of heavy tools, extra chains, cooking-pots, etc.

(d) **Lorries.**

Lorries should be reweighed empty (with correct number of chains) every time. The varying quantities of petrol, oil, water, tools, etc., as well as mud under the mudguards and on the frame make established tares of little value.

(e) **Free-bundles.**

With free bundles in chains the bridge or platform must be large enough to take all the load without any overhanging parts of it touching the surrounding ground. The crane should be lowered until the bar carrying the chains is swinging free just above the load so as to include nearly the whole of the chains in the weight. To determine the tare of the chains, the correct number of chains should be suspended from the bar and the latter lowered to an equivalent distance above the bridge. If all chains used are of standard dimensions, one such tare should be adequate for all loads.

7.—MIXED JUICE.

Numbering of Tanks Weighed.

In weighing juice (and water) the keeping of a correct tally of the number of tanks weighed is every bit as important as obtaining a correct weight of each tank.

The principal methods in use are:

- (a) Peg-boards.
- (b) Stamped tickets.
- (c) Automatic counters.
- (d) Bristol recorders.

(a) **Peg-boards.**

This old-fashioned method should be discounted at once as being entirely unsatisfactory. It is far too subject to human error in the hands of workers who often have little sense of responsibility.

(b) **Stamped tickets.**

These are essential in terms of the Sugar Agreement. The figure-types of the mechanism should be kept in good order, so that a clear-cut mark is obtained every time. Too soft a ticket should not be used as these do not give a very clear marking. If the figures are not easy to read this can often be remedied by rubbing over the figures with a soft pencil, when the stamped-in figures will be left standing out uncoloured against a pencilled background. Stamping mechanism should be such as to allow for the marking of tares on the same ticket.

Tickets should be sequence numbered with a mechanical stamp and the sequences carefully checked before issuing. Where automatic counters are used the sequence numbers should follow the numbers on the counters.

It is useful to have a different set of tickets differently coloured for each weighing tank in use. This colouring can be put on to the thickness of the edges by painting (or inking) the sides of compact bundles of tickets. Where fairly thick tickets are used diagonal lines may be ruled across the sides of such bundles. When the used tickets are subsequently collected in the correct order any break in the sequence immediately becomes apparent by a break in the straightness of the lines. Tickets should not be used more than once each.

As soon as a ticket is stamped it should be placed immediately in a narrow box, so constructed that the tickets remain in the correct order. They should be inserted through a slot so that the operator cannot get them out again. If two sequences are being used there should be a box for each.

(c) **Automatic Counters.**

These are useful and indeed essential where scale tanks are filled and emptied by entirely automatic action (as in Maxwell-Boulogne and Simpson and Lienert scales).

Where filling and emptying is by hand action they are of less value, but may be used as additional checks on other methods.

(d) **Bristol Recorders.**

Instruments automatically recording the filling of tanks on a dial chart are, in this country, all of "Bristol" make, so that the word has come to have a generic significance, and may here be taken to cover any similar device. These should be fitted to all non-automatic scales used for weighing Mixed Juice and Imbibition Water.

In addition to indicating the number of tanks weighed in any period the charts also indicate partly-filled tanks, over-filled or partially emptied tanks and tanks in which the filling was interrupted. These can be identified and compared with the weight ticket or with the mill log or otherwise satisfactorily accounted for if necessary.

With a choice of the above methods of checking there should be no excuse whatsoever for mistakes in the number of tanks weighed.

Types of Scales Employed.

Three main types of mixed juice scales are used in this country, one hand-operated and two automatic.

- (a) Howe Scales.
- (b) Maxwell-Boulogne Scales (horizontal or vertical).
- (c) Simpson Scales.

(a) **Howe Scales.**

These are in the form of cylindrical conical-bottomed tanks suspended from a counterpoise mechanism with a hand regulated scale beam. In order that juice weighing may be continuous two scale tanks for alternate use are employed. It is essential that juice should never be allowed to enter a scale tank at the same time that it is discharging. For this reason the levers operating the inlet and outlet valves are interlocked, so that juice can only be admitted into a tank when its outlet valve is closed. One throw of one lever diverts the inlet flow from one tank to the other, so that there is no interruption.

Great care must be exercised to see that all valve seatings are well-ground and clean, and that there are no other causes of valve leakage. Leakage past inlet and outlet valves of scale tanks have been somewhat frequently observed, though not so often recently since inspection has become more regular.

If possible the tank should be so suspended and the operating platform so placed that the operator is able to see into the open top of the tank and also have a view of the outlet valve. Where this is impossible the tank should be provided with a float and pointer to indicate when the tank is nearly full. It is a common practice to set the poise on the beam at a little short of full weight and then to cut over the juice when the beams kicks up. This point may be indicated on the beam with a spot of paint. Nowadays counterweights are properly secured and locked, but a case comes back to memory from many years ago when one scale was found to be giving very different weights on alternate shifts. Careful watching revealed that the first action of one Indian operator when coming on shift was to collect all his loose change from his pockets and place it for safe keeping in the hollow counterweight, which was covered with a loose plate!

Tares of Howe Scales: The best way to establish the tares of the scale tanks is to have no tare at all. To achieve this the inside of the tank should be washed down with unweighed water (preferably hot) after each weighing, and the water allowed to drain away before the tank is refilled. This can be done with a hose pipe, but better still a perforated pipe (quite clear of the suspended tank) can be placed round the inside of the upper rim of the tank with the perforations pointing outward and downward. Steam can also be used with such a pipe. The scale should be adjusted with the inside surface wet. This obviates the use of any tare. In addition to obviating the use of tares this method ensures that the tank is always clean and free from contamination.

If, however, it is not possible to have the scale tanks washed after every weighing, then the mud and scum remaining after emptying must be weighed and this weight subtracted from the gross weight. When all the juice is out of the tank and the frothy scum has almost ceased to flow, the outlet valve may be jerked up and down a few times to aid the removal of the last of the scum. The outlet valve should then be closed and a weighing made and recorded.

The Recommended Methods of the South African Sugar Technologists' Association states: "In any event the scales should be tared once each shift." (Chapter II 3). One might add: "in any event the scale tanks should be washed down each shift."

(b) and (c) **Automatic Scales.**

Both types of automatic scales are based on the overbalancing counterpoise system, retaining a small quantity of juice to give a fixed tare after every weighing. The vertical Maxwell-Boulogne scale and the Simpson scale have an advantage over the horizontal Maxwell-Boulogne scale in that the latter tips right over off its axis and is checked suddenly by chains, which give a severe jolt to the whole mechanism. The other two types, which do not tip, but are emptied by the opening of valves, operate much more smoothly. Automatic scales should be placed in a good light where the mechanism can easily be watched. They should never be placed in pits. With horizontal Maxwell-Boulogne scales care must be taken to avoid loss of juice by splashing during tipping. The correct determination of the weight of each tip is very important, as any error is cumulative, being multiplied by the number of tips. Usually this weight is checked every week-end. The usual method is to fill the scale with water and to weigh the water discharged in barrels on a platform scale. The final dribble from the valves or tip should be kept small to ensure an exact cut-off. Bristol recorders are not really required with automatic scales. The use of automatic counters is entirely adequate, since the operation of these scales is automatic and positive. An automatic scale cannot deliver anything but a full load.

8.—WATER.

The weighing of imbibition water is in most respects the same as the weighing of mixed juice. With Howe Scales only one scale is required, and this is usually of smaller capacity than those used for juice. If the scale is adjusted when wet inside, no tares need be determined. Both Maxwell-Boulogne and Simpson scales can be used for weighing water, and in addition another type of automatic scale—the Lienert—is in common use. These are used in pairs operating alternately. Care must be taken that the front and back sides of the Lienert scale are always quite vertical while filling, otherwise there is a displacement of the centre of gravity of the load, and the accuracy of the scale depends on exactness of the distance between this centre of gravity and the tipping axis. The vertical position of the scale tank can be affected by wear in the stop which brings the tank to rest on its return. A difference of 1 mm. in the positioning of this stop will cause an error of 15 lbs. in a scale delivering 2,500 lbs. It should be noted that the Lienert scale while quite adequate for the weighing of water is not suitable for the weighing of mixed juice for the following reasons:—

- (a) The small quantity of retained juice is of constant volume not of constant weight. Changes of density in this juice and accumulating dirt on the sides will, therefore, cause an appreciable error in tare. The error due to dirty sides will be accentuated by the fact that the tank is suspended eccentrically and dirt at the forward end of the tank will have an unduly large turning moment.
- (b) Heavy impurities which settle, such as sand, will tend to accumulate between the sump and the front of the tank and will exert a large turning moment which will affect the weight to an extent many times as large as its own weight.

Counting Tanks Weighed.

The same procedure should be followed for keeping a tally of tanks weighed as is adopted for mixed juice.

Water Meters.

The Recommended Methods of Chemical Control of the S.A. Sugar Technologists' Association allow for the determination of the quantity of water by any form of meter approved by the Government Assize Department (Chapter II 2). In spite of this permission the use of water meters is not to be recommended.

Water meters are of three general types.

- (a) Orifice.
- (b) Weirs.
- (c) Displacement meters.

Orifices and weirs work well only with absolutely clean water, and weirs are very susceptible to derangement by vibration; both are affected by the temperature of the water. Orifice meters depend on pressure readings, the instruments for which are not always reliable. Displacement meters work well when they are in perfect condition, but when a leak occurs past the packing they continue to function without the error being detected, until it becomes unduly severe, and then it is impossible to say how long the error has been occurring. Without exception the determination of imbibition water should be by weighing.

9.—BAGASSE.

As stated earlier in this paper, bagasse weighing is perhaps something of a luxury. So far it has been tried out in an experimental way at one factory only. Nevertheless, it would have definite advantages if it were introduced. The determination of sucrose in cane is made from the analyses and weights of mixed juice and bagasse. The indirect method of determining the weight of bagasse is subject to any error of weighing of cane, mixed juice, or water, as well as all errors in the

true weight of cane crushed, due to drying out or wetting or loss of cane between weighing and crushing, and any errors in the true weight of mixed juice due to leakage, spillage, or the removal of solid matter such as sand, etc.

If bagasse were weighed, the weighing of water could be dispensed with. The percentage of imbibition could be determined by indirect calculation, or by measuring, or by the use of a meter, since the quantity of water used would no longer be a figure affecting the price of cane. A few years ago a bagasse weigher was tried out at Doornkop consisting of a longitudinally suspended drum with two longitudinal chambers alternately overbalancing right and left. I understand that this proved successful as a weighing device, but it was subsequently abandoned owing to the irregular supply of fuel to the furnace occasioned by its use.

A device that would seem to be worthy of investigation with a view to its adaption to the weighing of bagasse is the Blake-Denison weigher, which is largely used for the weighing of coal and ore and other bulk shipments. In this the material to be weighed travels up a moving belt resting on idler rollers. Part of this belt is carried on idlers which are fixed to a frame which is suspended from a weighing mechanism. Every time this section of the belt travels its own length the weighing mechanism comes into action, and the weight of material on the suspended section of the belt is automatically determined and aggregated. This method of weighing would not interfere with the supply of bagasse to the furnaces.

10.—SYRUP AND MOLASSES.

Syrup is not often weighed. To weigh it enables losses to be correctly allocated to juice preparation and evaporation, or to the pans. Final molasses ought to be universally weighed, but unfortunately this is not often done in this country. The vertical Maxwell-Boulogne scale is a suitable instrument for weighing syrup or molasses and it will work for long periods without attention. The horizontal type would not be suitable, as the viscous material would soon get on to the outside of the drum. Molasses is not sold by weight, but the weight is very important for proper chemical control.

11.—FILTER CAKE.

The usual procedure for determining the weight of filter cake from plate and frame presses is to weigh the cake from a number of representative frames, and then to multiply the average weight per frame by the number of frames opened. This very rough procedure is necessitated by the nature of the cake, which often comes from the presses in such a sticky condition that it has to be removed with the help of water, and the trucks into which it falls are soon fouled, rendering the use of tares difficult.

With the increasing use of rotary filters which deliver cake in a much cleaner and more manageable condition there should be no difficulty in weighing the cake in trucks.

The trucks may be reweighed after emptying or washed with a jet of water and pre-determined tares used. No great degree of exactness is required in weighing filter-cake, since the amount of sucrose is small, and no sale is involved.

12.—SUGAR.

In weighing sugar the problem is somewhat different, or is approached from a different direction. With other products it is necessary to determine the weight of a given mass of material, but with sugar the material has to be made up into units of a given weight. Here again counting is a matter of importance.

Weighing sugar can be separated into three headings:—

- (a) Sugar for refinery or export.
- (b) Sugar received at refinery.
- (c) Sugar for direct consumption, either from the factory or the refinery.

(a) Sugar for refinery or export.

In this case the purposes of weighing are:—

- (i) Factory control;
- (ii) Railway freight charge;
- (iii) Check against refinery weights, either local or overseas.

Sales are made on weights at the refinery, and ocean freights are paid on weights discharged. Railway freights are charged in large units. The main importance of factory weighing of refinery and export sugar is, therefore, for factory control. The same degree of accuracy is not required as in the case of weighing for sale.

Raw sugars are not suitable for use with automatic scales as the sugar tends to cake in the mechanism, and lumps make it difficult to adjust the final dribble. The usual practice is to run sugar from the hopper into a bag placed on a platform scale, to fill to overweight and then to adjust by hand with a small hand-scoop. If a beam scale is used the beam should be set to the required weight (210 lbs.+bag tare) and the bag filled until the beam kicks up. If a dial scale is used it is useful to have this graduated to show underweight and overweight with the overweight graduated in quarter pounds.

Counting is usually done by a checker watching the bags placed on the railway truck. Mechanical counting would be useful at this stage. This can be done by means of

a mechanical counter actuated by a trigger on the chute, or by means of a photo-electric cell illuminated by a beam of light which is intercepted by the passage of the bag along the chute.

(b) Sugar received at Refinery.

Sugar for refining is paid for on weight as received at the refinery. These are determined by passing the bags in succession on to a platform scale with a visible indicating dial. The bags on leaving the railway trucks are placed on a roller runway leading to the scale, the platform of which is provided with similar rollers. No lifting of bags on or off the scale is required. Bag tares are automatically deducted by setting the tare weights on a special beam provided for this purpose.

The weights are recorded and counted by a checker. An electrically recording scale such as has been described for cane would be useful at this point. The photo-electric cell and the trigger cum-counter are used for counting bags. An electrically recording scale would give a further check.

(c) Sugar for direct consumption.

The weights of bags of sugar for direct consumption must be carefully controlled to conform with the provisions of the Weights and Measures Act. Granulated sugar is suitable for use with automatic scales since it does not clog and should contain no lumps. At the refinery, however, automatic scales have been discarded in the case of 100 lbs. bags as the scales were found not to be sufficiently accurate at the required speed of operation. 100-lb. bags are filled on platform scales with underweight and overweight dials, the overweight being graduated in $\frac{1}{4}$ lbs. and $\frac{1}{4}$ lb. overweight deliberately included. The final dribble is adjusted by hand.

Automatic scales are used for fractional pockets. In this case the sugar is weighed into a small hopper and discharged therefrom into a bag held below. The tare of the bag, therefore, does not have to be included, as a nett weight is delivered. Automatic scales need frequent cleaning, as sugar dust deposits on all horizontal surfaces of the mechanism.

Weights of bags filled from the automatic scales are checked by taking occasional bags from the carrier and placing them on an underweight-overweight dial scale graduated in $\frac{1}{16}$ oz. $\frac{1}{4}$ oz. overweight is allowed.

Both the photo-electric cell and the trigger-cum-counter are used at the refinery for counting bags of refined sugar.

(Note.—I am indebted to Mr. F. W. Hayes for information with regard to weighing practice at the refinery.)

13.—OPERATORS AND SCALE HOUSES.

In conclusion I would make an appeal for an improvement in the status and working conditions of weighing operators, especially in cane weighbridges. The work may not require a high degree of skill, but it involves a considerable amount of responsibility. Nowadays in addition to weighing and calculating nett weights and keeping weighbridge books, the operator is expected to recognise mixed cane, and to draw attention to consignments marked with the wrong variety, and to observe all cases of spilled cane, and to report any other unusual conditions. With weighbridges near the carrier weighing is nearly continuous, and twelve hours is too long a shift. In many cases the work is left in the hands of inexperienced men not considered good enough for other work, or juniors, or Indians not of the most reliable type. Under such circumstances it is not surprising that many complaints are received of doubtful weights, or trucks wrongly allocated.

Some modern scale houses leave little to be desired, but only too often they are dirty, draughty, overcrowded, poorly lit and badly ventilated shacks. Sometimes they have no floors, usually no ceilings, and being made of unlined corrugated iron are either unbearably hot or uncomfortably cold. No man can work well under such conditions. Scale houses should be of brick, with wooden or concrete floors, and wooden or fibre-board ceilings. They should have a large window overlooking the bridge and at least one other large window in another wall to give a good light on the beam and on the desk. For night work a good strong light should be provided for the scale and another strong light with a tinted bulb for the desk. The neighbourhood of the scale house should be kept as clean as is reasonably possible (this is admittedly difficult) and well drained to be clear of mud. It is a very rare thing to find an adding machine in a scale house. An expenditure of between £30 and £40 would surely be justified as a safeguard against errors of calculation, and to save the valuable time of the weighbridge staff.

It is an almost invariable practice to employ Indians to operate mixed juice and water and other scales. If this is done only good, reliable men should be employed. Operators on mixed juice tanks are usually required to take mixed juice samples, and this requires care. Here, too, good lighting is essential.

The weighing machinery in a modern factory is usually good enough to deserve good operators working under good conditions,

14.—WEIGHBRIDGE CHECKERS.

The employment of checkers by the second party to keep a check on the weighing of cane has now been largely (though not entirely) discontinued. The various checks and controls in an up-to-date weighbridge render this kind of checking superfluous. The correct determination of weights is only a secondary matter in the determination of the price of cane, the weighing of mixed juice being more important, though the allocation of consignments to the individual suppliers remains a matter of importance. This is a matter which is largely in the hands of the suppliers themselves, who should exercise greater care in the marking of truck tickets and the compilation of consignment notes.

In any case the use of weighbridge checkers seldom operates in the intended manner. Almost invariably it results in a mere division of labour, whereby one man weighs the cane and the other records the weight, and there is no real check.

The employment of checkers might well be discontinued altogether if all weighing practice were brought up to the standards recommended in this paper.

15.—SUMMARY.

Units and Limits: Tons and decimals of a ton should always be used and never tons and pounds.

Cane and Mixed Juice and water should be weighed at least to the nearest 10 lbs.

Weighing of Cane: The care of weighbridge pits and weighing mechanism is described, and the location of weighbridges as near as possible to the cane carrier is recommended.

General types of weighing mechanism are discussed under the headings of:—

- (a) Hand regulated beams.
- (b) Dial scales with visual reading.
- (c) Dial scales with electrical recording.

The advantages of the last-named are pointed out.

The procedure of weighing and the determination of tares are discussed under the headings:—

- (a) Railway trucks (S.A.R. and narrow gauge).
- (b) Tram trucks.
- (c) Animal-drawn wagons.
- (d) Motor lorries.
- (e) Free bundles.

The discussion on tares of S.A.R. trucks includes a consideration of the weight of loading poles.

Weighing Mixed Juice and Water: Methods of keeping a tally of tanks weighed are fully discussed and the following recommended:—

Stamped tickets for non-automatic scales.
Bristol recording for non-automatic scales.
Counters for automatic scales.

The procedure for operating non-automatic scales and the determination of tares is discussed, as well as the determination of weight of each discharge from automatic scales.

The Lienert scale is referred to, and its unsuitability for weighing mixed juice is explained.

Water meters are referred to, but are not recommended.

Weighing Bagasse: The experimental scale at Doornkop is referred to and a consideration of the Blake-Denison scale is recommended.

Weighing Syrup and Molasses: The use of a vertical Maxwell-Boulogne scale is recommended.

Weighing Filter Cakes: The weighing of cake in

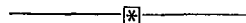
trucks is recommended when rotary filters are employed.

Sugar: The procedure of weighing sugar and the counting of bags weighed is fully discussed under the headings:—

- (a) Sugar for refinery and export.
- (b) Sugar received at the refinery.
- (c) Sugar for direct consumption either from the factory or refinery.

Operators and Scale Houses: An appeal is made for better working conditions for weighing operators, and an ideal scale house is described.

Weighbridge Checkers: The employment of weighbridge checkers is considered unnecessary.



The PRESIDENT opened the discussion by saying that Mr. Moberly had raised a number of very valuable points as a result of his experience as supervising Technologist.

The President continued by saying that he hoped Mr. Moberly would bring the contents of the paper to the notice of the right authorities through the Central Board. He asked for a hearty vote of thanks to be accorded Mr. Moberly for his paper. (*Applause*)