SOME INVESTIGATIONS ON ROTORVANE MANUFACTURE

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There are an increasing number of estates in the Island today who are purchasing Rotorvane machines and the majority of teamakers have little, if any, idea as to the correct manufacture procedure which should be adopted to suit Ceylon conditions. No one can be blamed for this lack of knowledge, for this new machine was designed in 1949 by the Indian Tea Association Experimental Station at Tocklai primarily for use in CTC and Legg-cut methods of tea manufacture. It was never originally intended for Ceylon type manufacture where much harder withers are taken for orthodox rolling.

On Aislaby Estate experimental work has been carried out since May 1963, both on the "A" series Rotorvane and more recently on a handed pair of the latest "B" series. These experiments have proved beyond any shadow of doubt that, in the case of Aislaby, Rotorvane rolling has numerous advantages and this more modern approach is superior to the outdated and more expensive orthodox rolling procedure. The Rotorvane can be readily adapted to Ceylon tea manufacture and the machine is used to best advantage during the early stages of rolling, in preference to the later stages as in India.

An initial roll reduces the bulk of the withered leaf and gives it a twist. Once the leaf has been through the Rotorvane, fermentation starts in earnest and as the dhool is taken away from the roll breakers in the normal plastic containers, it is then spread on the floor or fermenting tables. Provided the correct fermentation period has been established, fermented dhools can be taken to the drier within a minute or two, at the most, from the optimum. The old batch system with its several disadvantages has now been replaced by a procedure much closer to continuous manufacture.

Advantages of Rotorvane Manufacture

The advantages of Rotorvane manufacture found on Aislaby are listed below :

(1) Greater rolling capacity for a given capital outlay

(2) Quicker fermentation and easier control

(3) Better and larger initial dhool percentages

(4) Saving in handling, labour and power

(5) Improvement in factory lay-out due to less rolling room machinery requirements, and easier erection of conveyor systems

(6) Saving in machinery maintenance and repairs to rollers and tables

(7) Improved percentages of main grade teas

(8) Improved liquors and better sale prices of all grades.

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To attain these advantages, about eighteen months of extensive experimental work has been carried out. Several modifications to the Rotorvanes have been found necessary ; new end plates have been designed ; temperature and pressure has had to be controlled ; Reverse Pitch Vanes have been introduced while oxygen injection is presently being installed.

This experimental work has gradually led to improved results and to assist those planters who are interested, I outline our present rolling and manufacturing procedure, and will deal later with Rotorvane modifications.

Aislaby Rolling Procedure—A/1 For daily crops 28,000—50,000 lb green leaf (Using three 8" Rotorvanes).

Stage 1 *Leaf :* A high standard of green leaf is of primary importance.

Wither : 46% to 48% made tea to withered leaf. This leaf is sifted and cleaned over an inspection belt to remove and coarse leaf and coir rope *etc.*

Charges : 3,200 lb withered leaf is charged every hour into 4 × 47" rollers in sequence, each roller charged 15 minutes after the previous charge.

Conditioning Roll : 30 minutes with full pressure 7 on and 3 off. Leaf is then discharged into trolleys and conveyed direct to a "B" series handed pair of Rotorvanes which are conveyor fed at 1,600 lb per hour per Rotorvane (or 3,200 lb output per hour).

First Rotorvane Pass : Leaf entering the Rotorvane is passed into the chamber by the large worm wheel and is propelled through the vanes and resistors at 34 rpm Three Reverse Pitch Vanes are fitted as follows : FFRFRFRFF and the two machines are individually drived by 2 × 15 HP motors.

First Roll Breaking : Leaf discharged from the Rotorvane is held in trolleys for a period of fifteen minutes at 18" thickness to allow the extracted juices to be re-absorbed into the leaf particles prior to Roll-Breaking. Normal roll-breaking follows over a C C C Rotary Roll-Breaker using No 5 and 6 meshes. First dhool is extracted averaging 50%.

Note : It can be seen at this stage that 50% or 1,600 lb of dhool has already been dealt with by one initial roll and only one Rotorvane pass, leaving a balance of 1,600 lb first bulk.

Stage 2 *Second Rotorvane Pass :* The 1,600 lb of first bulk is then automatically conveyed direct from the roll-breaker discharge to an "A" series Rotorvane for a second pass at 34 rpm using forward pitch vanes only.

Second Roll Break : Once again the second Rotorvaned discharged leaf is automatically conveyed (without any waiting period) to the second roll-breaker using similar No 5 and 6 meshes, where second dhool extraction averages 32%.

Note : At this stage leaf has had one initial roll and two Rotorvane passes and the total dhool extraction is 50% + 32% = 82% leaving a balance 18% bulk (or 575 lb of rolled bulk) which is then orthodox rolled.

Stage 3 *Final Roll :* The balance 575 lb second bulk is then finally rolled on a 44" orthodox machine for 25 minutes using full pressure 5 on and 2 off.

Final Roll Breaking : The final rolled leaf is then passed over a third CCC Rotary Roll-Breaker with numbers 5 and 6 meshes and the third dhool extraction averages 12%, leaving a big bulk of 6%.

Fermentation : Average 1 hour 45 minutes from commencement of initial roll.

Firing : Order of firing *always* 1, 2, 3 and big bulk. For this programme it must be clearly appreciated that adequate drier capacity must be available for 1,450 lb made tea per hour at normal firing temperatures.

Sifting : Normal procedure.

Aislaby Rolling Procedure—A/2 For daily crops 28,000—50,000 lb green leaf (using two Rotorvanes as a handed pair and thereafter orthodox rolling).

Stage 1 As in the Programme A/1 (Stage 1).

Stage 2 The 1,600 lb first bulk, instead of being given a second Rotorvane pass, is orthodox rolled in 2×47″ Rollers, using full pressure 5 on and 2 off for a period of 25 minutes. Leaf is then rolled breaked and again 32% second dhool can be extracted.

Stage 3 As in Programme A/1 (Stage 3).

Aislaby Rolling Procedure—A/3 For daily crops 28,000 lb green leaf and under (using one Rotorvane for first pass and thereafter orthodox rolling).

Leaf and Wither : Leaf standard and degree of wither should be similar to Programme A/1.

Charges : 1,600 lb withered leaf is charged every hour into 2×47″ rollers, in sequence, each roller charged 30 minutes after the previous charge.

Conditioning Roll : 30 minutes with full pressure 7 on and 3 off. Leaf is then discharged and fed into one 8″ Rotorvane at 1,600 lb per hour.

First Rotorvane Pass : As in Programme A/1 (Stage 1) but only one Rotorvane is in operation.

First Roll-Breaking : As in Programme A/1 (Stage 1) 50% dhool is extracted of 800 lb leaving a first bulk of 800 lbs.

Rolling : The 800 lb first bulk is now orthodox rolled on 1×47″ (or two small rollers) using full pressure, 5 on and 2 off, for a 25 minute period. Leaf is then roll-breaked and again 32% second dhool is extracted.

3rd bulk is now reduced to 280 lb which can be re-rolled once again on a small roller for 25 minutes extracting the last 12% dhool and leaving a big bulk of 6%.

It can be seen from these rolling programmes that in all cases the Rotorvanes have been used in the early stages of rolling. From experience we found that leaf passed through the Rotorvane in the early stages allowed *all* the leaf to be processed thoroughly, juices were extracted fully and re-absorbed into the leaf particles prior to fermentation. This treatment of the leaf increased the strength and liquoring properties of the tea, as each particle of leaf received identical treatment, something that no orthodox roller can achieve.

Temperature of leaf after the initial roll was generally in the mid 80s. With full pressure in the Rotorvane the temperature rose rather alarmingly to nearly 100°F, but with lighter pressure and modifications to the end plate, leaf came out of the Rotorvane at 92° to 95° which was not found in any way excessive. Dhools were even throughout and a quicker and more even fermentation was possible.

With a 50% first dhool extraction in comparison with a normal 15% from an orthodox roller, the whole rolling procedure was speeded up. The first two dhools alone totalled 82%. I cannot therefore agree or advocate that Rotorvanes are best used for later rolls.

It is interesting to note the actual machinery requirements on the three rolling programmes, which will substantiate the advantages mentioned earlier.

PROGRAMME A/1 (Crops 28,000—50,000 lbs green leaf)	—4×47″ rollers, 3×8″ Rotorvane, 1×44″ roller and three roll-breakers.
PROGRAMME A/2 (Crops 28,000–50,000 lbs green leaf)	—4×47″ rollers, handed pair Rotorvanes. 2×47″ rollers, 1×44″ roller and 3 roll-breakers.
PROGRAMME A/3 (Crops not exceeding 28,000 lbs green leaf)	—2×47″ rollers, 1× 8″ Rotorvane 1×47″ roller and 1×35″ roller and 2 roll-breakers.

With Programme A/1 in full operation, only 12 rolling room labourers are needed to handle 48,000 lb of green leaf during 8 hours rolling, and only 5 large rollers, 3 Rotorvanes and 3 roll-breakers are required. On an orthodox programme to handle similar crops within 8 hours, 31 labourers would be needed and 12 rollers and 4 roll-breakers would be the minimum machinery requirements. Power consumption similarly is reduced by 50%.

The layout of Aislaby factory rolling room is given in Plan form (Figure 4) to show its simplicity, and the conveyor belt system which minimizes handling and labour.

It can also be seen how rolling programmes A/1, A/2 and A/3 can be made adaptable to fit varying daily leaf intakes. The conveyors are all mobile, and so can be moved out of their marked positions in the event of Rotorvane breakdowns when orthodox rolling procedure can be reverted to immediately.

It should be made clear at this stage that estates who have installed or are installing Rotorvanes with their tremendous output do not necessarily require large rollers to keep them adequately fed ; a number of small orthodox rollers could similarly be used to maintain the Rotorvane feed, but naturally more labour, power and maintenance expenditure would be required if a number of small machines were used in preference to the larger type. The primary essential, however, for best results is to maintain an even feed throughout the working day and never allow the Rotorvane to run empty or undercharged, for leaf pressure must be built up and retained within the cylinder, thus ensuring that all leaf particles are treated identically in the process.

Assuming that initial rollers are being regularly fed to allow a constant feed of 1,600 lb of withered leaf into each 8" Rotorvane, the question of regularizing a standard pressure with some form of control is left to the performance of the end plate at the discharge point of the machine and this important factor requires very careful thought and attention to obtain correct results.

The original "A" series Rotorvanes were fitted with a brass saucer-shaped end plate which fitted neatly into the discharge end of the Rotorvane cylinder ; (Figure 1A). This end plate was designed to add pressure to leaf within the cylinder as two movable arms with adjustable counter weights pressed the end plate towards the cylinder, but was made adequately flexible to retract against excessive pressure by the counter arm balances, the leaf falling from the cutter rims of the end plate. This system of pressuring the leaf was a standard fixture on the "A" series machine, and was found most satisfactory.

The estate during the later half of 1963 had met with such success with the "A" series Rotorvane that a further two machines were ordered and full Rotorvane policy was decided for the future, based on the Programme A/1. In order to economise where possible, rolling room machinery was re-sited as indicated in the plan.

In May 1964, the handed pair Rotorvanes were sited on a three foot raised plinth to allow adequate space for conveying the discharged leaf to the Rotary roll-breakers. A conveyor was designed to run from a geared motor at variable speeds from 1/3 rpm to 8 rpm, and by this slow moving conveyor with a simple speed adjustment, the waiting period in trolleys required for juice re-absorption into the leaf was eliminated as this took place while the leaf was in the process of being automatically conveyed to the roll-breaker. Leaf, at a spread on the belt of 9"/12" took 8 to 15 minutes.

The two new Rotorvanes were found to be of the new "B" series type and differed considerably from the "A" series, having no control pressure arms. The saucer shaped end plate (Figure 1A) had been replaced by an adjustable Iris end plate (Figure 1B and C).

First trials using these new machines with the Iris end plates in varying positions were found most unsatisfactory. The discharged leaf was very flaky and fibrous and the end plates in the fully open positions (Figure 1B) did little to improve the appearance of the leaf. Drier blow-out increased to 5% in comparison with 2½% on the "A" series machine, and made tea appearance deteriorated. Top grade percentages were similarly adversely affected and a drop of 5% was found. Matters became even worse when experimenting with Reverse Pitch Vanes, where drier blow out rose as high as 11% and top grade percentages dropped by a further 5%.

It was interesting at this stage to receive brokers reports from London and Colombo stating that liquors had in fact improved but bad appearance had substantially outweighed this improvement in the liquors.

It was thus obvious, that the Iris end plate as supplied, was unsuitable for Ceylon manufacture with hard withers as the leaf was being excessively damaged in the Rotorvane process. Numerous experiments were carried out by adjustments and modifications to internal vanes and resistors as well as smoothing the corrugated surface of the Iris end plate, reducing the size of the plate blades etc. No noticeable improvement resulted. These modifications led to the rejection of the Iris end plate as supplied, since this was evidently the cause of leaf damage.

The estate then experimented with a new floral type end plate (Figure 2A) which gave immediate and improved results. Reverse Pitch Vanes were then reintroduced into the cylinder as follows: FFRFRFRFF, and liquors improved without affecting appearance (See Figure 2B and C of Reverse and Forward Pitch Vanes).

At the time of writing, further experiments are being carried out in an effort to procure the same high percentages of top grade teas that the "A" series model produced, while at the same time maintaining the stronger liquors given by the "B" series Rotorvane. To achieve this a pressure control pre-set by hand has been successfully fitted to an extended rotor shaft (Figure 3A). The saucer end plate has been re-introduced with certain modifications. Slots have been cut to allow processed leaf to pass through the end plate (Figure 3B) in addition to discharging around its circumference, which situation still can occur when pressure for any reason rises above that chosen.

These modifications (Figure 3A) allow movement of the end plate and simulate the operation of the "A" series Rotorvane. The pressure adjustment is now more compact and can be pre-set, while the spring supplies the safety factor formerly given by the swinging weighted arms.

These new ideas are proving most successful and, with the introduction of oxygen injection into the cylinder *via* a resistor, are expected to speed fermentation and give redder infusions. When the additional experiments have been completed, further findings will be made available.

Table I shows comparative grade percentages of tea manufactured by the two types of Rotorvanes with modified end plates, and Reverse Pitch Vanes.

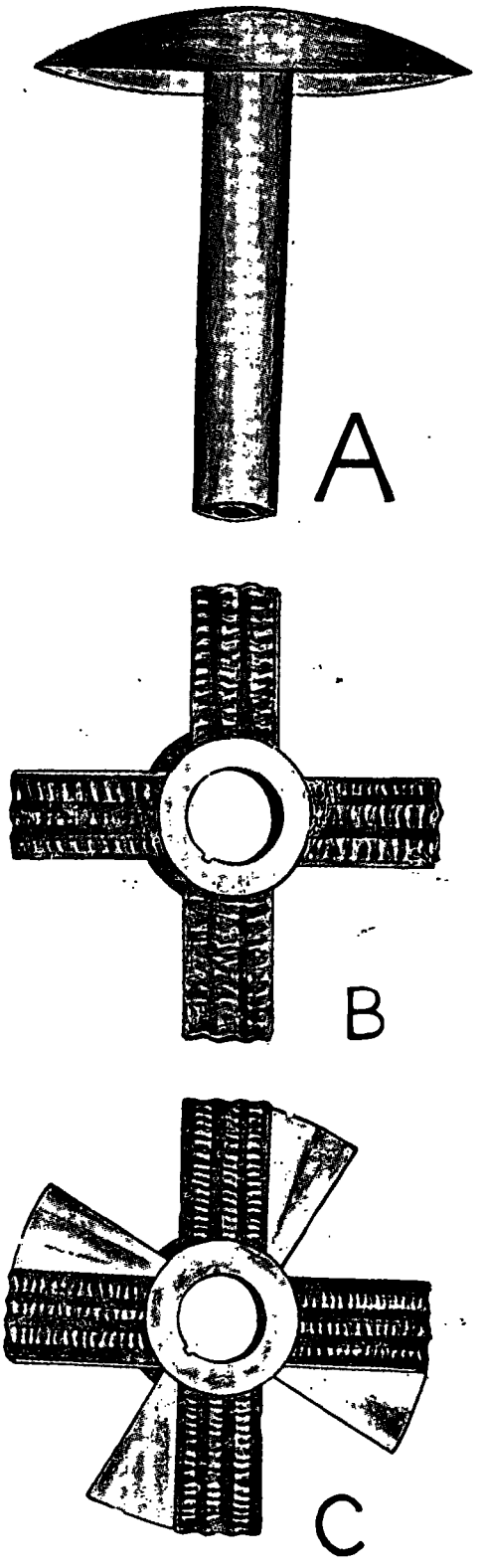
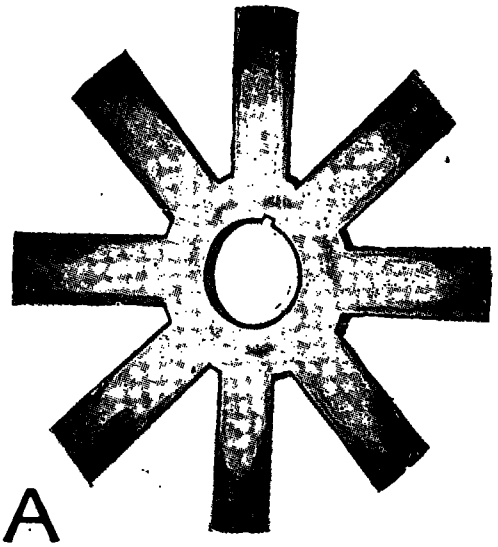
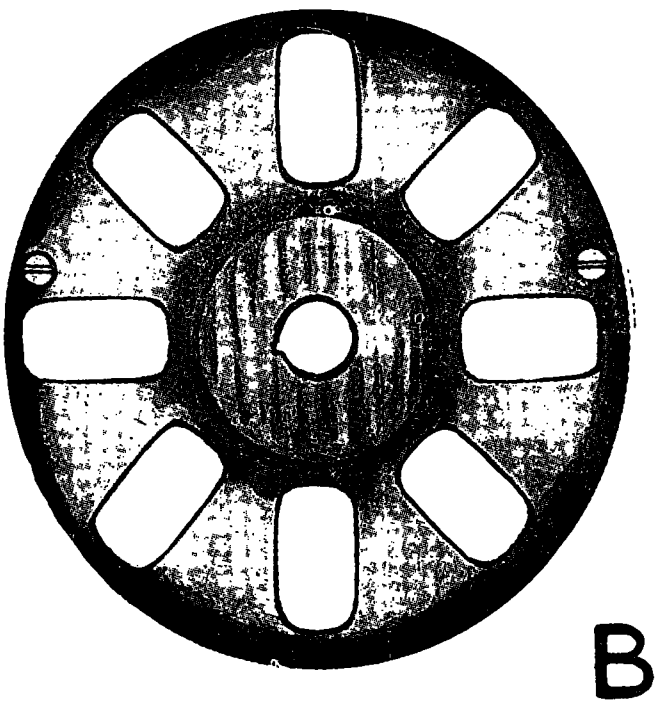


FIGURE 1—*A: Saucer shaped end plate*
B: Iris end plate in open position
C: Iris end plate half open





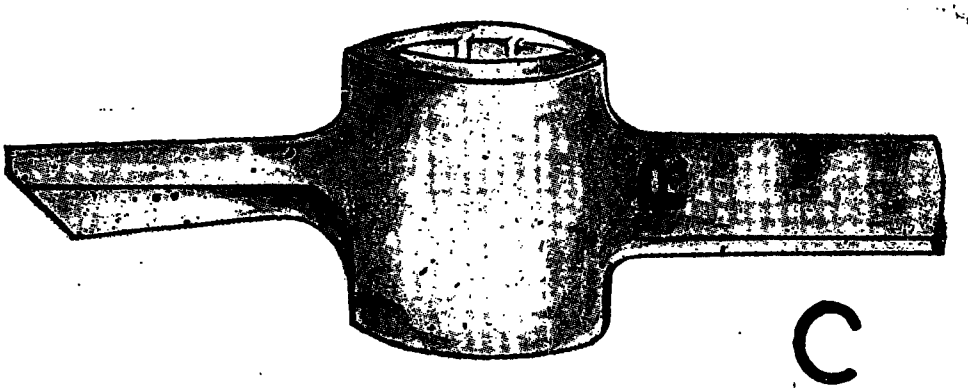


FIGURE 2—*A: Floral end plate*
B: Modified saucer shaped end plate
C: Reverse pitch vane

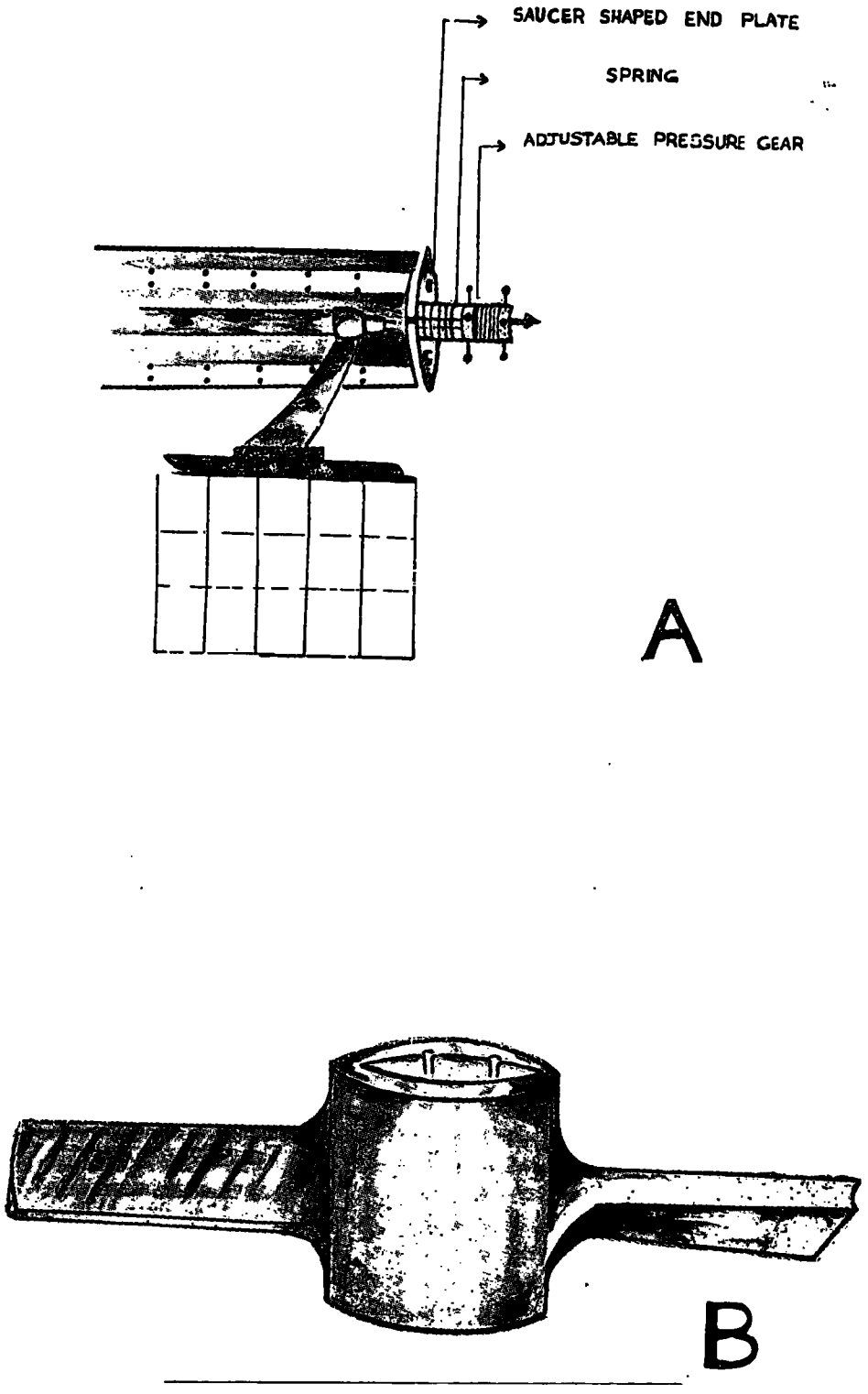


FIGURE 3—*A: Pressure control on extended rotor shaft*
B: Standard forward pitch vane

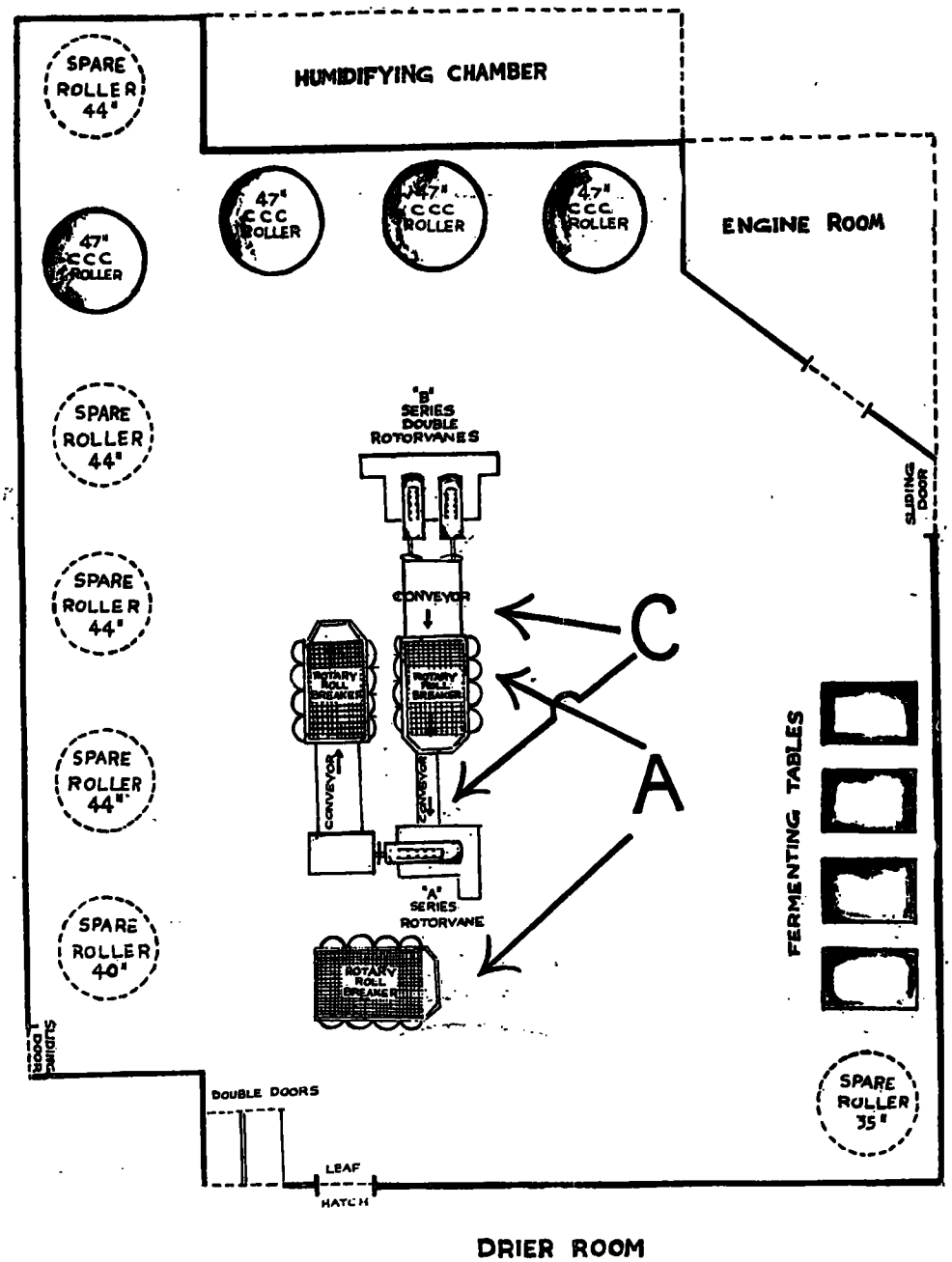


FIGURE 4—*Layout of the rolling room, Aislaby Estate*

A: Rotary roll breaker

C: Conveyor

TABLE I—*Grade percentages of tea made with the two types of Rotorvanes*

	Grade percentages										
	BOP	BOPF	Pekoe	Sub total	Dust No 1	BOP2 (BP)	BM	BPF	Dust No 2	Total	Drier throw out
B series with reverse pitch vanes and Iris end plate	46	31	2	79	3	5	7	5	1	100	11
B series with forward pitch vanes only and Iris end plate	48	31	3	82	5	4	4½	4	½	100	4
B series with reverse pitch vanes and floral end plate	50	33	4	87	3	3	4	2½	½	100	3½
A series with forward pitch vanes only and saucer end plate	51	35	4	90	2½	2½	3	1½	½	100	3½

Note : The OP grade is virtually eliminated.

The order of merit of these four types of Rotorvane manufacture is as follows : 3, 4, 2 and 1. Method 3, in spite of losing 3% of top grade teas by comparison with method 4 has produced stronger and brighter liquors which out-weigh such loss.

Sale Prices

The reader may naturally ask why prices should show an improvement and to what extent ? There is no doubt whatever that Rotorvane manufacture, done properly, improves a tea's liquoring properties ; teas are brighter and brisker with additional pungency. It is of particular interest that flavour is no way impaired by this more severe type of rolling. This is borne out by the fact that in 1963 and 1964 during the Uva flavoury season Aislaby prices were consistently among the top three estates in the district. Rotorvane manufacture was done throughout.

In 1964, after factory machinery re-arrangement to house the three Rotorvanes (Figure 4) had been completed, prices continued to rise and the nett gain can easily be seen from the figures extracted to date. These are given below :

	Nett Market Averages High	Medium	Estate Averages	Total crop made tea
1963	Rs. 1/91	Rs. 1/54	Rs. 2/04	1,772,651 lb (inclusive of 473,812 lb of bought leaf).
1964 To date 20/10/64	Rs. 1/93	Rs. 1/56	Rs. 2/24	1,711,858 lb (Inclusive of 530,949 lb of bought leaf).

Although Aislaby Estate is of medium elevation, the nett sale averages are considerably higher than the high grown average. Similarly, while the market averages have only increased by two cents to date in comparison with 1963, the estate's average has improved by twenty cents on a ten months' production of 1¾ million pounds of made tea. These figures are indicative of what can be achieved by a more modern approach to manufacture with the use of Rotorvanes.

In conclusion it must be clearly understood that conditions between districts and individual estates naturally vary considerably. Each estate must therefore be prepared to experiment in the early stages and to ascertain the best method to suit its individual conditions when attempting this new procedure. The standard of plucking and leaf intakes has a direct bearing on Rotorvane manufacture, for a bad standard can well ruin the final product.