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A LABORATORY TEST-TUBE RICE MILLER

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SUMMARY

The milling of small samples of brown rice for examination of grain characteristics and for chemical analysis, is a problem faced by rice scientists, particularly plant breeders. Hitherto available methods are based on shaking the samples with an abrasive in test tubes. The machines used are bulky and take upwards of an hour to mill a single batch of samples. A small, compact machine has been designed, on the basis of short-stroke and high frequency. This machine mills a batch of samples in five to ten minutes.

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Rice scientists, particularly plant breeders, require small samples of milled rice for visual examination of overall grain appearance (size, shape, chalkiness, and translucence) or for specific physical or chemical tests adapted to small samples. Various devices have been used to accomplish the milling of small samples of brown rice, most of them based on the vigorous shaking of the sample with an abrasive in a test tube. In 1956, Beachell (1) built an electrically powered machine to shake a bank of 20 test tubes containing brown rice samples mixed with quartz. This machine was in use at the Regional Rice Quality Laboratory, Beaumont, Texas, until 1964. A similar machine was constructed for use at the Rice Experiment Station, Crowley, Louisiana, by C. N. Bollich (1). Scott, Webb and Beachell (1 & 2) built an improved machine, based on the same principle in 1964, and this machine is in use at several laboratories.

The improved test-tube miller of Scott et al replaced quartz as abrasive with fused aluminum oxide of two grit sizes (46 and 60) in equal parts, the abrasive being one-third by weight of the sample. This machine reciprocates two banks of test tubes containing samples, at 390 strokes per minute with a 5½-inch stroke. Satisfactory milling is obtained after 90 to 110 minutes of shaking. The machine accommodates 80 small test tubes (3-gm samples) or 48 large test tubes (12-gm samples) per loading. The power required is 1½ to 2 horsepower, and the machine is bulky, occupying 15 square feet of laboratory space. In 1970 Boonit and Devakul (3) devised a similar machine, using an old single-cylinder horizontal-piston engine. A wooden block, with eight test tubes fixed in it, was attached to the piston and an electric motor of 1 hp was used to reciprocate the piston at 1000 strokes per minute. This machine was claimed to accomplish milling in a shorter time than that of Scott et al, and occupies only 6 square feet of laboratory space. The use of a commercial engine probably overcame to some extent, problems connected with dynamic balancing as well.

The machines described above have some shortcomings for use as laboratory equipment. It was felt that a test tube miller should be compact in size. It should not need frequent lubrication and should have minimum vibration. Milling should be accomplished in as short a time as possible and power requirement be low. High frequency vibration with short stroke length offers better design possibilities. An experimental machine was designed for 1000-1500 frequency and a 1" stroke length.

The Experimental Test-Tube Miller

The experimental machine consisted of two boxes (each holding 12 test tube samples) mounted on three fibreglass strips: two vertical strips to support the boxes on the frame, and one horizontal strip to connect the box to an eccentric with 1 inch stroke. The two eccentrics for the two boxes were opposed 180° on the central drive shaft so that the boxes moved in opposite direction and this provided improved dynamic balancing. The fibreglass strips were rigidly bolted at each end. During operation the fibreglass flexed sufficiently and this eliminated the need for hinges and consequent lubrication. For test purposes, a variable speed pulley drive was used to evaluate the optimum speed of operation.

Initial observations on the performance of the machine indicated that a critical factor may be the length of vacant space between the sample in the test tube and the neoprene cork. Tests were conducted with standard 3-gram samples in tubes of varying length, so that the empty space in the tube was 0.25, 0.5, 0.75, 0.86, 1.0, 1.12 and 1.25 inches. Two types of rice were used, one with dark testa and one with white testa, and the tests were conducted at different speeds. For a 3-gram sample, a plastic test tube of ½-inch diameter, 2½ inches long, was found to be the best size for the 1" stroke.

The time required for polishing decreased with increasing speed. At each speed, there was an optimum empty space in the test tube. At 1500 rpm and 1750 rpm, this empty space was equal to the stroke length of 1". At 1500 rpm the difference between 0.86", 1.00" and 1.12" empty space length was not too great and therefore the 1" empty space was selected for use in the final design. The time taken for milling was 5 minutes at 1500 rpm and 12 minutes at 1000 rpm.

Tests were also conducted with commercial abrasives of different grit sizes. Both emery (hardness 3.6) and silicon carbide (hardness 9.6) of four different grit sizes were used in the hope that a harder grit would enable the speed of the machine to be reduced. In all these cases, the milled rice acquired a black or gray color due to disintegration of the abrasive. Fused aluminum oxide, which is white, had no such effect and was found to be the most satisfactory.

The Prototype Test-Tube Miller

A prototype machine was designed and built on the basis of the findings reported above. This machine is provided with two boxes each holding twenty-four samples. Sealed ball bearings were used to eliminate periodic lubrication. The eccentric was designed to facilitate easy fabrication and assembly. A ¼-hp electric motor was used to power the unit. Figures 1 and 2 illustrate the prototype machine. A wooden block with holes drilled to accommodate test tubes, serves to keep sample tubes in position in the aluminum boxes. The block is held between flexible urethane or rubber pads in the boxes to eliminate any relative movement between box and sample tubes. The machine is designed to work at 1500 rpm, requiring 5 minutes for milling a set of 48 samples.

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(1) Scott, J. E., B. D. Webb and H. M. Beachell. A Small-Scale Rice Test-Tube Miller. Crop Science, Vol. 4, No. 2, pp. 231-232. 1964.

(2) Scott, J. E., B. D. Webb and H. M. Beachell. Specifications for Constructing the Rice Test-Tube Miller. Crops Research, USDA ARS 34-63. August, 1964.

(3) Boonit, A. and D. Devakul. A Note On a Simple Test-Tube Milling Machine. International Rice Commission Newsletter, Vol. XIX No. 1. March, 1970.

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ADDENDUM TO PAPER NO. 71-08, "A LABORATORY TEST-TUBE RICE MILLER"

The milling technique described in the paper uses fused aluminum oxide as the abrasive. The high cost of the abrasive, and the fact that it is not readily available, prompted trials of cheaper and more readily available materials as abrasive. Paddy grains (1 gm paddy per 3 gm sample) were found to be satisfactory, but required 10 minutes of shaking to mill the sample satisfactorily.

Satisfactory milling was also obtained without any abrasive, if the samples were shaken for 30 minutes. However, the high temperature resulting from the longer duration of shaking caused the bran to adhere to the milled rice in a caked form, and it was necessary to rub the sample between two pieces of linen to remove the bran. This drawback was eliminated when the sample was treated with "Carbotex" dust (a finely pulverized form of calcium carbonate).

A small quantity of dust is lightly mixed with the sample and excess dust is screened off, leaving only a surface coating of dust on the grains. The sample can now be shaken for 20 to 25 minutes, after which no further treatment is necessary.

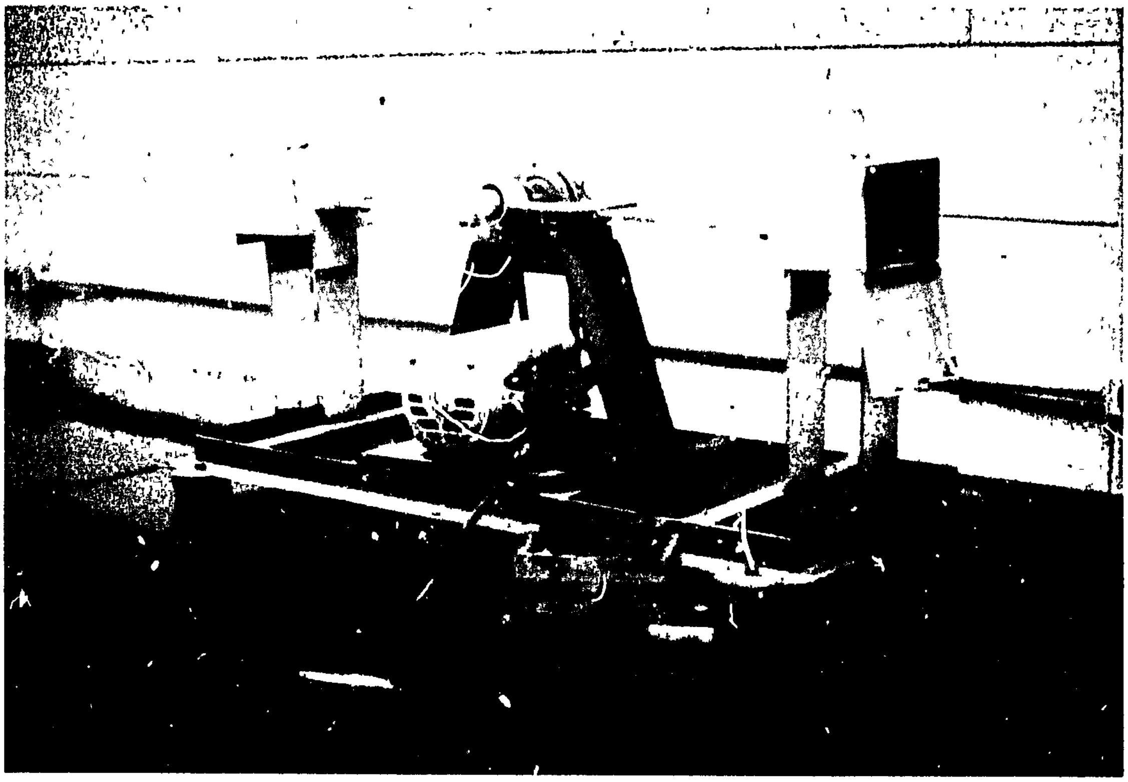

Fig. 1. The prototype laboratory test-tube rice miller.

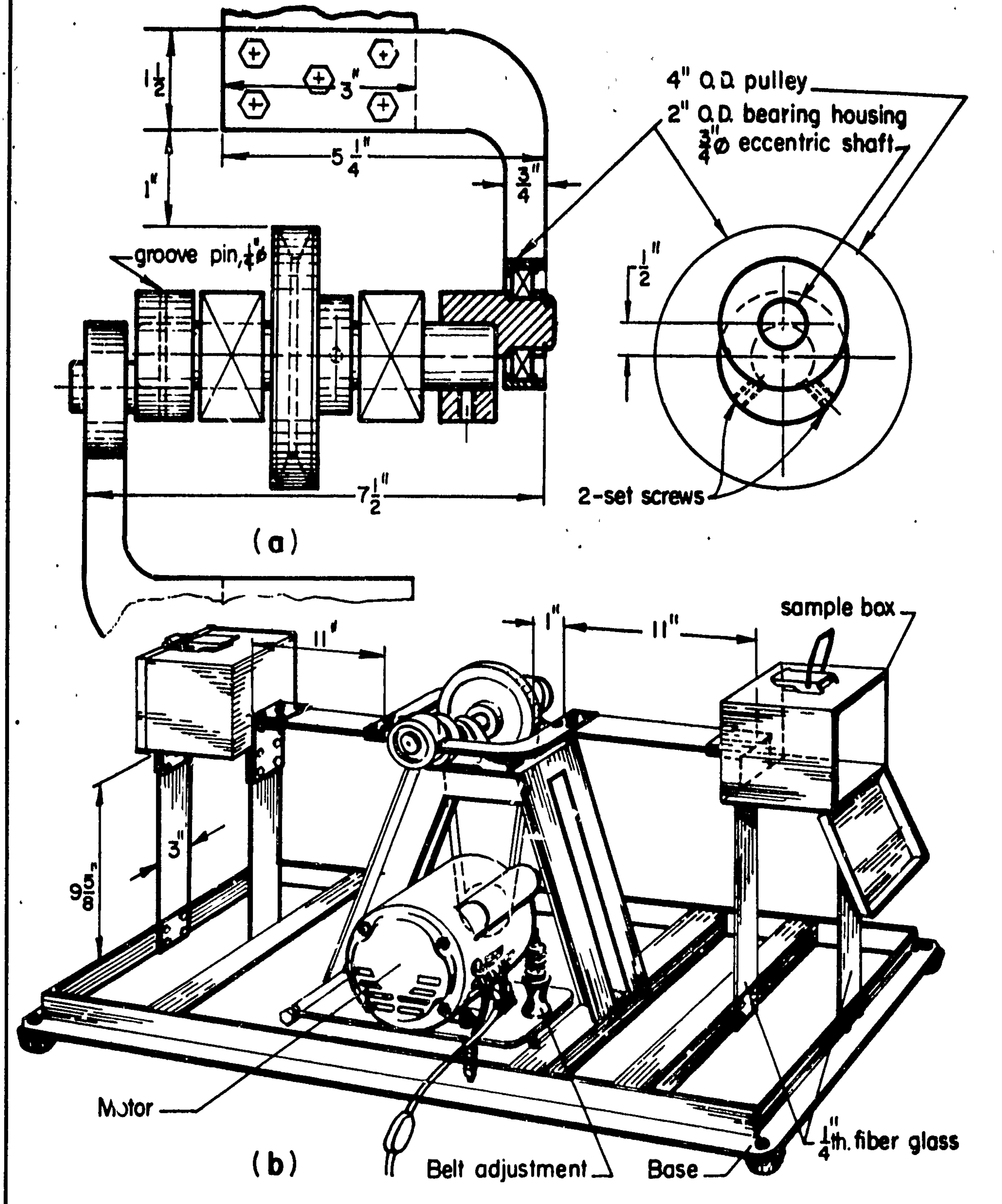

Fig. 2. The laboratory test-tube rice miller. (a) Detail of main shaft assembly. (b) General assembly.

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