A SYSTEM FOR THE MECHANISATION OF CANE HARVESTING

By ANGUS MACLEAN.

Introduction.

Mechanisation in any sphere of production necessitates that a measure of continuity be obtained, and where large quantities are to be handled bulk should receive special attention. The production engineer or planner, in considering the design of any system, endeavours to keep bulk down to a minimum, as this naturally reduces the size and consequently the cost of the mechanical units.

As a result of mechanisation many radical changes have taken place in previously established hand methods, and it should be appreciated that to devise a machine to do the self-same job as is done by hand is not always possible; but where it is, economics may forbid it. This is a point to which due consideration is not always given. A broad vision is necessary in approaching such problems and the engineer must allow scope to his imagination, embracing the problem as a whole and not isolating the various stages into separate departments for individual solution.

System in use.

Machines for the harvesting of cane have been designed and tried in some cane-producing countries, with varied measures of success; none giving real efficiency. Some of these machines trash, others top, and again some do both, but rather unsatisfactorily. All these machines handle the cane in its original length, resulting in large heavy machines, with a long wheel base and high centre of gravity, being most unsuitable for land which is not flat. Again, such machines are restricted to handling cane which is more or less upright, reducing their sphere of usefulness. Cane which is not standing erect but fallen and interlaced presents a problem as yet unsolved.

Machines for loading which may be developed or are at present in use must also be large and weighty to handle the cane in uncut lengths, making the machines costly and difficult to manoeuvre.

Handling of cane in its whole length would appear therefore to be full of difficulties, but there is no definite reason for the canes remaining uncut, although some of the present methods would not allow the cane being otherwise. It should be remembered that the first operation on the cane at the mill is the reduction of its length.

In this country, and in many others, burning of the trash in the field before cutting was practised for some time, but it is now appreciated that the trash has something to contribute to the conservation of the soil.

System proposed.

The machine to harvest cane must be designed to trash and top cane, all of which is not upright, must be easily manoeuvrable and have a low centre of gravity. It would seem, from a consideration of all the foregoing, that it is not practical to continue the development of methods when the cane is handled in its uncut length. Fig. 1 illustrates a representative example of a sugarcane with the usual distribution of leaves and tops, some dead leaves also being shown. By cutting this cane at the dotted lines the trash and tops are severed from the main stalk. Thus the cane would be cut from the ground, and trashing and topping accomplished with the same operation. It is not suggested that separation of the cane and trash would be completely effective, but results of 80 per cent. may be expected, a considerable improvement on the condition of cane at present being received at the mills. The cane thus cut into 6-inch to 18-inch lengths would be easily handled and loading machines simplified.

Mechanical Harvester.

For cutting of the cane into short lengths as suggested above, the required number of cutters or knives would be mounted on a vertical shaft and the cane would be swept into the machine by fingers fitted between the cutters—the top cutters being adjustable to suit the general undulations of the cane height. The top of the cane receiver may be linked to these adjustable cutters, so that the upper leaves and part of the top need not pass through the machine.

For cane that is not upright, but interlaced and lying down, a cutter or cutters should be included to sever these canes that resist a simple attempt at parting them. Fig. 2 shows this cutter and the general approach of the machine to the cane face.

The cane would not be cut close to the ground, but about 12 inches above at the dotted line (*a*) of Fig. 1. Thus there is no necessity for this part of the machine to have a guide wheel to enable the main cutter to follow the contour of the ridges (in Natal). This stubbled cane would be cut as shown in fig. 3 by a manually operated adjustable cutter, the gatherer sweeping these canes against the rotating blade or saw, and up into the boot of elevator, which would discharge into the main elevator of fig. 6. The actuating of the adjustable cutter may conceivably be done by a guide wheel as the main body of the cane would have been removed, allowing the guide wheel a fairly clear passage.

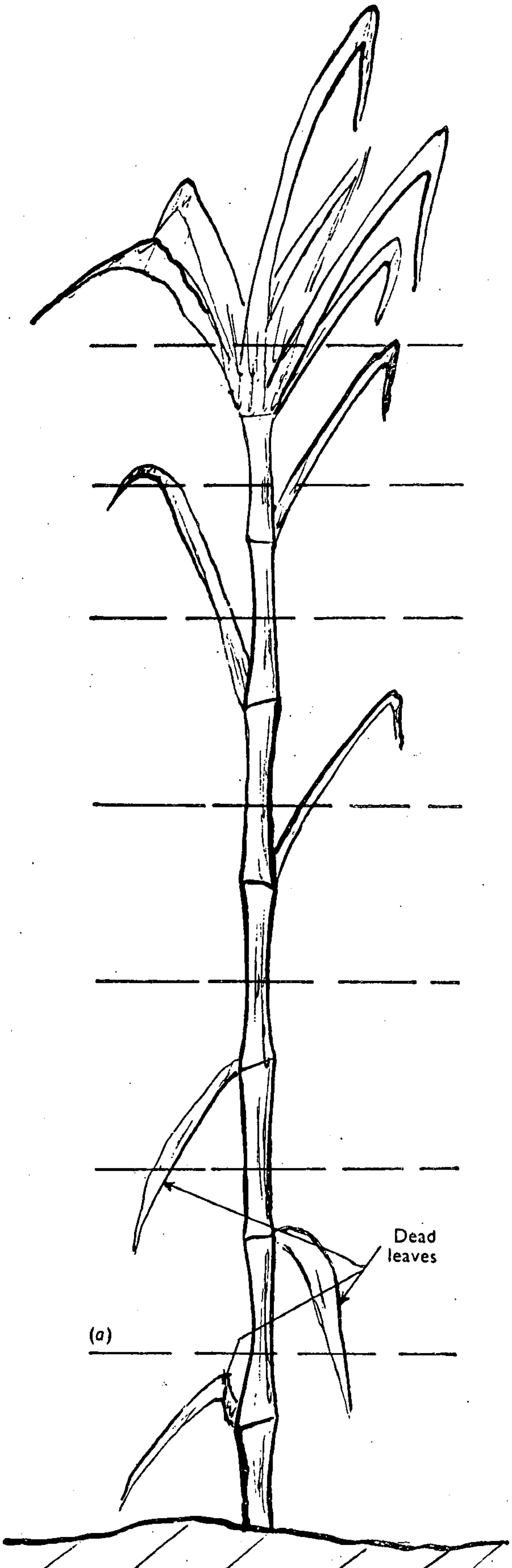


Fig. 1

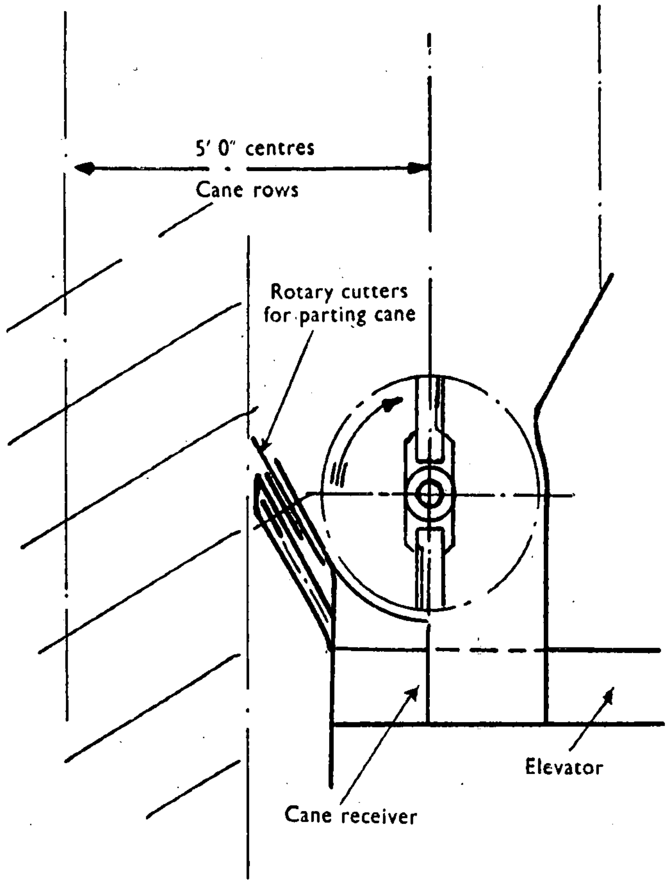


Fig. 2

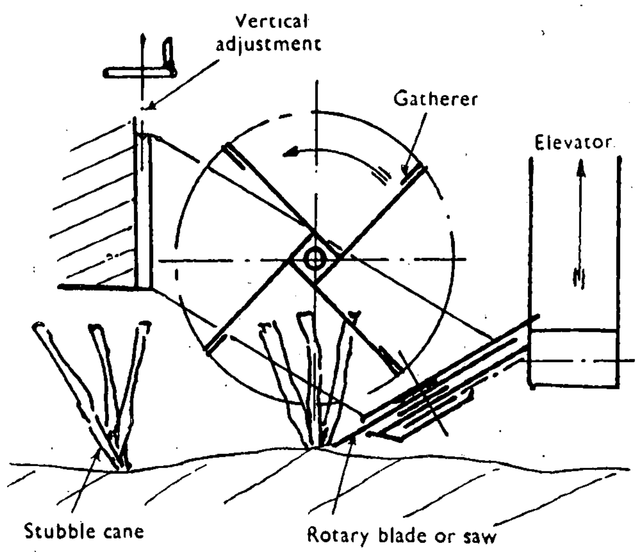


Fig. 3

The cut cane, trash and tops have to be separated, the latter two to be returned to the soil. Many methods may be evolved for this purpose, but two suggestions are as indicated in figs. 4 and 5. The specific gravity of the cane is about seven times that of the leaves, and approximately three and a half times that of tops, thus on projecting these parts separate trajectories will be followed by each. It should be a simple matter to collect the cane separately from the rest as in fig. 4, and a form of winnowing as in fig. 5 would also be very effective with such a difference in the specific gravity. A combination of both these methods may be still more efficient.

The trashed cane passing to the elevator would be raised and discharged into a trailer behind, or into a vehicle running parallel, depending upon the form of transport.

A line diagram of these operations is shown in fig. 6, and to give a rough indication of the probable dimensions of such a machine a D.4 caterpillar tractor is shown hatched as a background. The construction of this machine is simple and the sections would be light, the heaviest portion of the machine being the cutter with the driving gear. As will be seen, the centre of gravity is low, allowing the machine to work on hilly ground.

Three men only would be required to operate this machine, i.e. one skilled driver-operator, one semi-skilled stubble cutter operator, and one labourer at the loading. As experience was gained it may be

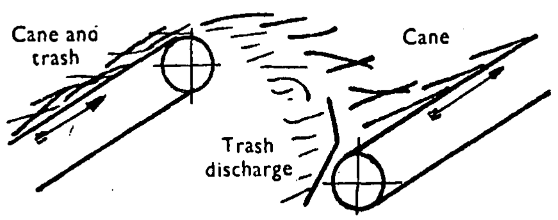


Fig. 4

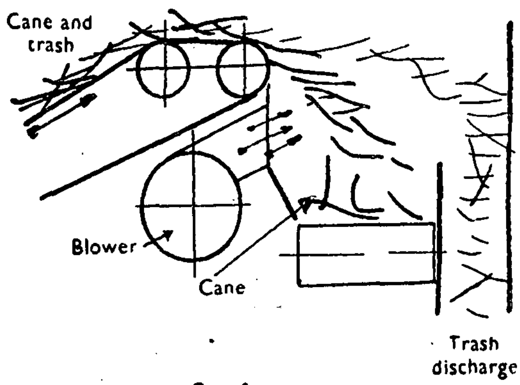


Fig. 5

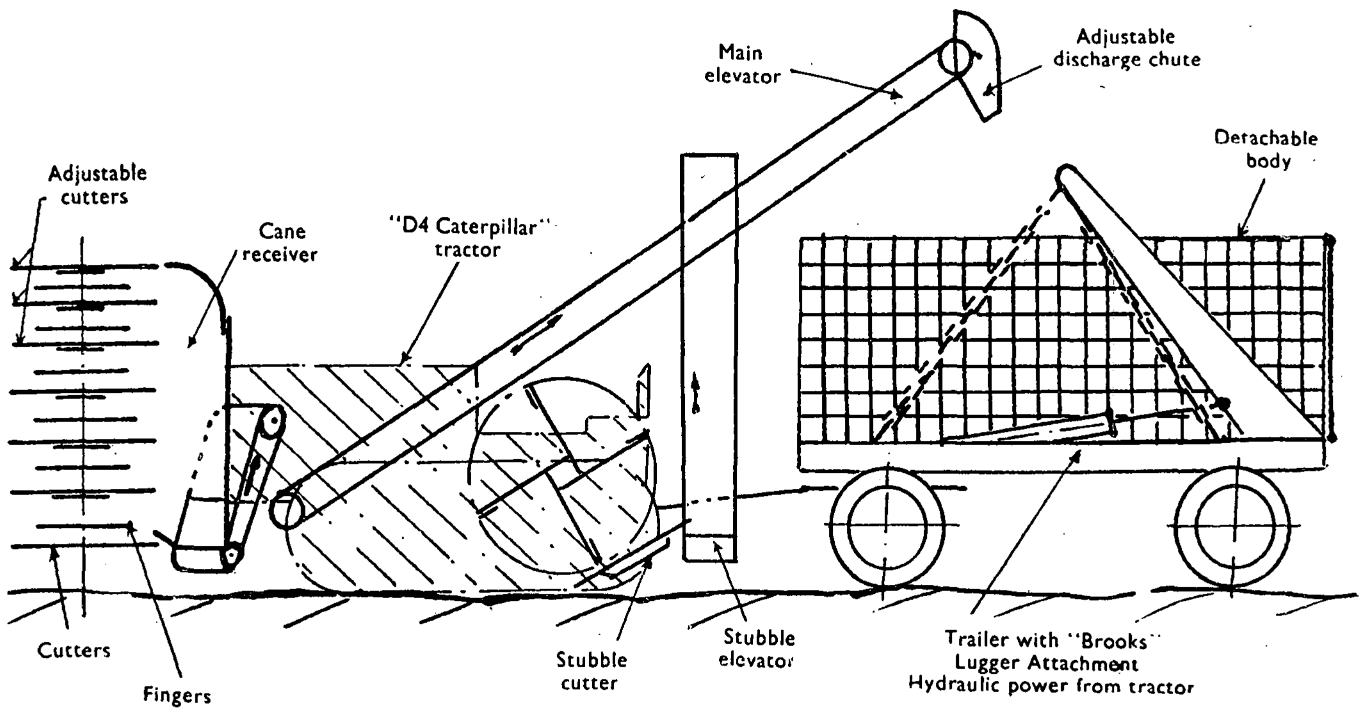


Fig. 6

possible to dispense with the semi-skilled man and have a mechanically-actuated stubble cutter as suggested above.

Working in fields where the rows are 5 feet centres this machine might conceivably travel at $2\frac{1}{2}$ m.p.h.,

$$\text{i.e. } \frac{2.5 \times 5280}{43,560} \times 5 = 1\tfrac{1}{2} \text{ acres/hour}$$

for an eight-hour day = 12 acres.

At 30 tons per acre the machine may handle 360 tons per day (of eight hours).

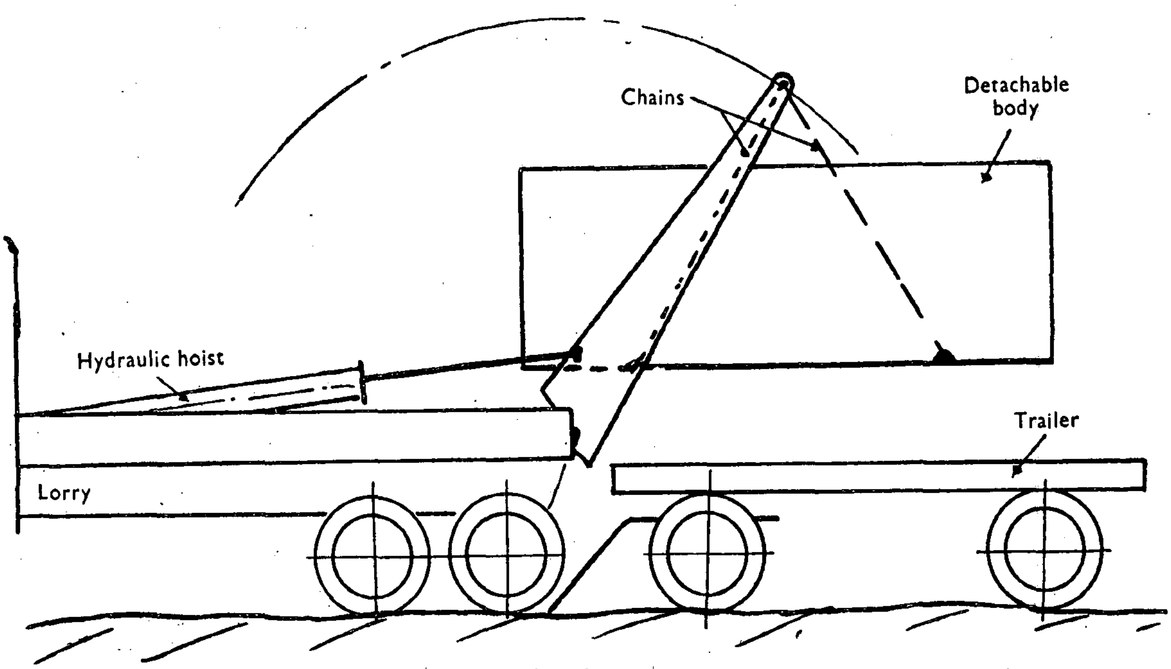
Now, from figures published by the "South African Sugar Journal" in February, 1949, in a survey by Mr. A. A. Lloyd, Secretary of the Mechanisation Committee of the South African Sugar Association, there are no growers (excluding millers cum-planters) whose daily delivery rate approaches this figure, making it uneconomic to operate large machines individually. Some form of zoning or regional harvesting is therefore required to operate large machines such as are already in operation in other countries or may be developed here. Harvesting and contracting companies may be formed and some modifications to present agreements may also be required.

The above figures are taken on the same basis as for machines operating with cane in its uncut length. By the method proposed, however, smaller and lighter machines could be developed to handle 75 to 100 tons of cane per day, bringing the machines nearer the requirements of the average grower.

Transport.

To keep down the number of units required for the transport of the cane to the siding or mill, some quick means of loading and unloading the vehicles and trailers is necessary, and each lorry should have at least one trailer so that the number of power units is kept at a minimum.

The Brooks cane lugger, manufactured by the Brooks Equipment & Manufacturing Co. of U.S.A., and advertised in the journal "Sugar" (see December issue, 1948, p. 53) is shown in fig. 7, and from the position indicated it will be seen that a trailer could be loaded by reversing the truck against the trailer. The mechanical harvester suggested above can discharge into a trailer, which for use with the lugger system may be fitted with this form of hydraulic hoist. By using several detachable bodies the harvester could dump a full body and lift an empty and thus be in continuous operation. The lugger could then load up both lorry and trailer with full detachable bodies, dumping the two empties brought back from the tram or truck siding or from the mill. The detachable bodies could be so made as to be self-discharging as illustrated in fig. 8.



"Brooks" Cane Lugger

Fig. 7

Assuming a speed of 25 m.p.h., a 3-ton lorry with a 3-ton trailer could haul 24 tons per hour a distance of about five miles, which distance is greater than the average haul.

Where tractor-drawn trailers are in use the same system could be employed, with the trailer next the tractor having the lugger attachment and the hydraulic power obtained from the tractor.

The existing tram trucks are suitable only for handling uncut cane, but to make these trucks suitable for handling the short canes a wire basket of 4-inch to 6-inch mesh could be fitted. To enable the trucks thus modified to be unloaded, the sides would be hinged at the top and a standard mechanical tipper could be employed. Fig. 9 illustrates both the basket and the unloading.

For the loading of the tram truck, it is suggested that the truck could be loaded on to a lugger type trailer in the same manner as the detachable bodies. This would mean that when loading or unloading to and from the tramline that the trailer would straddle the tramline. An alternative method would be a trailer like the Askew tram truck trailer as exhibited by Mr. G. H. Askew of Umhlali at the Mechanisation Committee's "field day" held at Natal Estates on 26th October, 1948, and described and illustrated in the Committee's Report No. 2, issued as a supplement to the "South African Sugar Journal," January 1949. In both these methods the tram truck is loaded direct from the harvester.

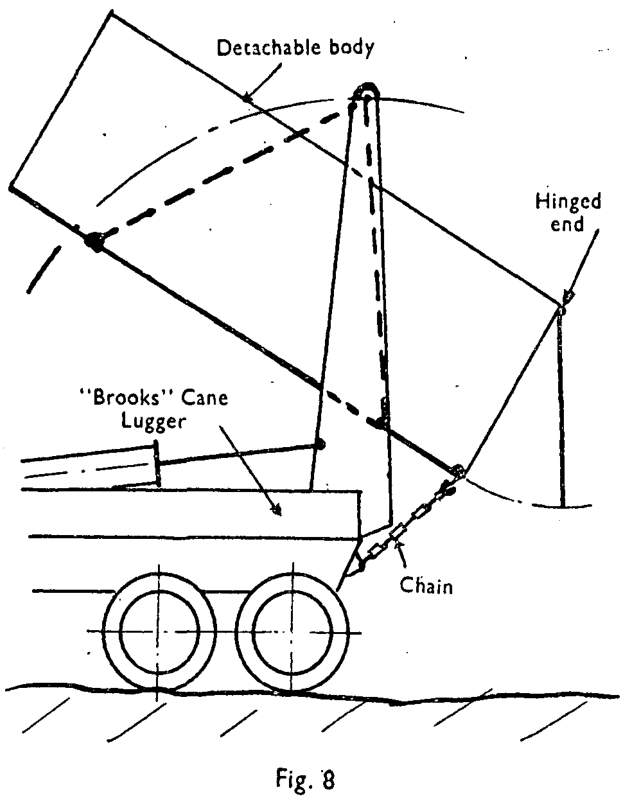


Fig. 8

Loading at Siding.

With the cane in short lengths as now proposed, a simple elevator, illustrated in fig. 10, would handle and load into S.A.R. trucks all the cane at any siding. The discharge chute being adjustable would enable the cane to be directed evenly over the whole truck.

Trashed cane volume is approximately 90 cubic feet per ton. With elevator 2 feet wide travelling at 150 feet per minute and cane 3 inches deep, cane handled per minute

$$= 2 \times 150 \times .25 = 75 \text{ cubic feet,}$$

i.e. a 3-ton lorry or trailer would be discharged in three and a half minutes.

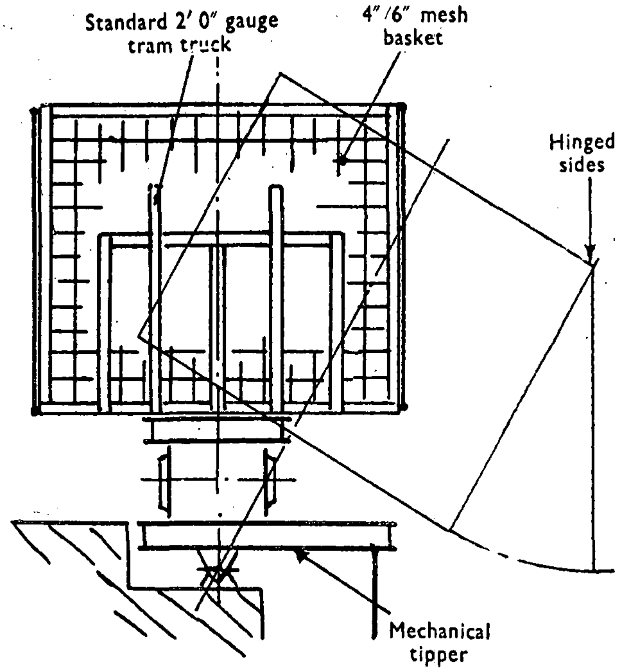


Fig. 9

The elevator, of course, could be designed to handle more or less as required, by modification to the speed or width. Construction would be light, requiring 2/3 h.p. to drive it.

For this loading operation three men are necessary, one skilled operator and two labourers. The discharging of the load would be handled by the transport driver and labourer.

Unloading at Mill.

Methods of unloading the railway trucks at the mill have been evolved to suit long canes, the usual practice being by crane grab. This grab, however, could easily be modified by introducing extra bars between the existing fingers.

The quickest and most effective method of discharging the railway trucks would be to tip them as with coal at a coaling station. The difficulty, as far as cane is concerned, seems to be the designing of a machine that will take care of the wattle poles introduced to give extra capacity to the low sided truck. It is possible to have hydraulically-operated clamps, which would hold these poles endwise, i.e. clamped along their length (or height) against the truck bottom, and which would come into action automatically as soon as the cycle of turn-over of the truck commenced. Similarly, the clamps would be automatically released when the cycle was complete. This could also be made easier by using more vertical poles of lighter section, making it unnecessary to have any horizontal poles.

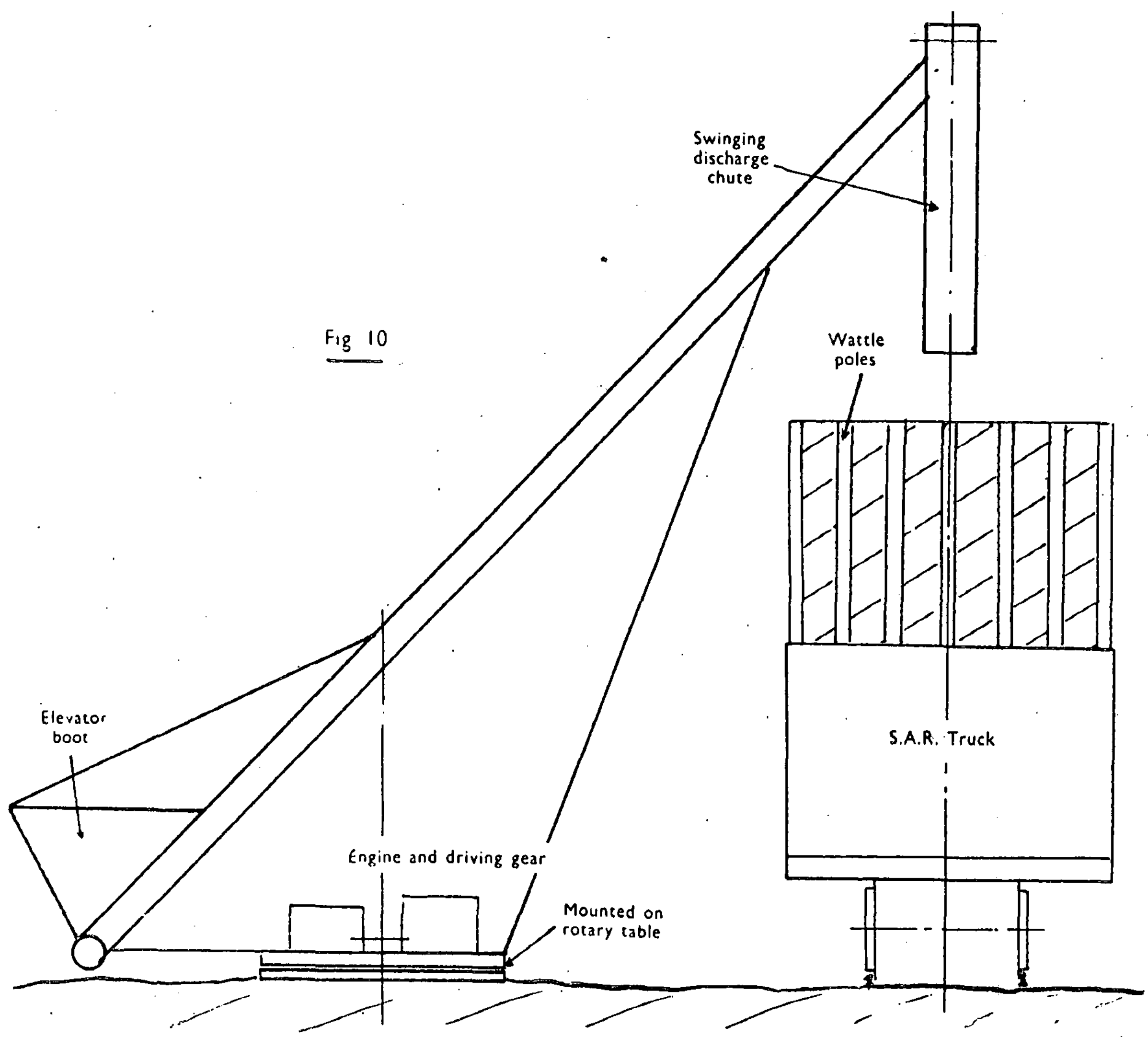
The unloading of the tram truck would be by tipping as described under "Transport" and shown in fig. 9.

Conclusion.

By altering the basic method of harvesting of cane in its uncut length to short lengths of 6 inches to 18 inches, the harvesting machine becomes simpler and transport and loading problems are reduced to manageable propositions. No attempt has been made to illustrate completed designs and the sketches are diagrammatic only, but it is with confidence that such machines can be satisfactorily designed that the suggestions have been made.

By the presentation of this different approach to the mechanisation of cane harvesting, it is hoped to stimulate new interest and to promote imaginative designing on a broader outlook along lines hitherto unexplored.

Fig 10



The PRESIDENT asked the author to explain the statement that "the specific gravity of the cane was about seven times that of the leaves," as he thought that weight per cubic foot was really meant.

Dr. DODDS said that the only type of cutting machine he had seen in successful operation employed the principle of cutting the cane into lengths and using a blower to separate tops and trash. The principal objections to cutting the cane into short lengths came from the factory which objected that the greater exposed surface of cane led to more inversion and fermentation. He had seen only one other harvester which attempted to top cane at the right place as well as to trash it. That was the Luce Harvester, which was developed in Cuba and came into very limited use there, but was too cumbersome for most conditions as it would only work on perfectly level ground. He thought it had very limited application at the present time. Most of the cane harvesters in use in Louisiana and Hawaii were adjustable, and could cut the tops at different heights. They were not selective, however, like the Luce and Falkiner Harvester.

Mr. PALAIRET thought this question of inversion should be investigated. He appealed for an actual test to be done, testing deterioration in cane cut into short lengths against that of whole sticks. The advantage of the system advocated was that not only did operations become purely mechanical, but that it could lead to further simplification. A hopper could be utilized to store harvested cane until the trucks arrived to take it to the factory. This would mean quicker loading, as compared with the present ramps that were now necessary, because gantries and cranes were not suited to the type of labour we had.

There was another angle of approach to the problem of topping and trashing. The designing of machines to cut cane off at ground level was relatively simple, and a stationary machine which could top and trash cane was, he believed, already available. The tops and trash could then be made into compost at a convenient central point, and it would then be economical to return this to the fields. The fields would be clean and cultivation easy with modern machinery.

Mr. MOBERLY was of the opinion that while the output from a mechanical harvester might well be more than that required by an average grower, it should be possible for growers to combine and thus keep a small harvester well occupied. Instead of the present procedure in which a grower cut a certain tonnage each day, he could have his cane cut on one day of each week throughout the season. That would still enable him to deliver cane all through the different sucrose levels.

Mr. MACLEAN said that, as pointed out, the term specific gravity was not correct and should be interpreted rather as weight in a certain bulk of material.

The paper was not an attempt at a design of a harvesting machine, but rather to indicate a possible line of approach to the problem.

Mr. H. ARMSTRONG, who was unable to be present, sent in the following contribution to the discussion: Everyone attending this Conference was fully aware that the harvesting of cane was difficult and becoming increasingly so, due to the lack of manual labour which, though plentiful at one time, may in a few years be a thing of the past. It behoves us, therefore, to consider ways and means of carrying out the harvesting of cane by mechanical methods as a means of solving at least some of our difficulties.

The problem should be considered as a whole and not in sections as at present. We have a school of thought which considers that cane-cutting cannot be carried out on the hilly lands of Natal and Zululand. The writer also considers that it cannot be done with the present cumbersome type of machine. A machine of a lighter type, cutting the cane into easily mechanically-handled lengths, should not be outside the bounds of possibility. Such a machine would at the same time help to solve the question of trash to a great extent by permitting it to remain in the field with the tops where it is required, and eliminating trash at the factory, where it creates difficulties in the equitable distribution of the sucrose. This state of affairs would also assist materially in creating conditions for the more efficient milling of cane and, furthermore permitting an increased crushing rate of clean cane which is most desirable, due to the increased production required from the milling equipment of all factories in the near future.