MECHANICAL PRINCIPLES FOR HARVESTING PRICKLY PEARS

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Abstract

Three devices to facilitate harvesting of prickly pears are presented in this paper. Two of such devices are intended for fresh market while the other for industrial processing. It was found that a torque around the longitudinal axis of the fruit detaches it from the pad with very reduced damage. One hand tool for harvesting prickly pears for fresh market and one device for non-selective harvesting are based on this principle. A third device based on detaching the fruit by cutting a piece of the pad of the pad close to the pears is also presented. The three devices are compared regarding field capacity, fruit damage and convenience for the operator.

Introduction

According to a report of the Center for Prickly Pear of the State of Mexico, prickly pears grow in 30 million hectares in the center and north of Mexico. Most of the crop is not cultivated averaging 200 plants per hectare with a height of 2.8 m or more. In contrast, cultivated plantations have 625 plants per hectare and the height is controlled by pruning to maintain the fruit low for hand harvesting. Plant production varies from 20 to 30 kg/plant. However, exploitation of prickly pear fruit is limited due to the tremendous labor requirement during harvesting. A worker picks approximately 160 kg/day as an average. In addition, harvesting may be harmful to the worker due to spines on pads and fruit. Harvesting is done normally during morning hours when moisture prevents the small spines (glochids) from spreading with the wind.

In this paper, discussion will be centered on the description and performance of three devices developed to facilitate harvesting of prickly pears, regarding the speed of harvesting, fruit damage, and convenience.

Principles for Fresh Market

During the initial steps of the research some locally developed tools were found. These tools detach the fruit by bending it several times with reversing motion. Only well ripe fruit were harvested without damage with such a tool.

As a result of a preliminary experiment it was found that a torque of 1 N.m around the longitudinal axis of the fruit was needed to detach the fruit with very reduced or no apparent damage. Based on this principle a hand tool was developed. Fig. 1 shows a complete view of the tool configuration and Fig. 2 the cutting modulus assembly. The cutting modulus works as follows: Flexible fingers 2 are normally opened. When

the cable is pulled, the screw 5 turns causing the nut 4 to move to the left, thus closing the flexible fingers until they grasp the fruit 1. In this position the nut stops and begins to transfer torque to the clutch assembly 7 causing the slippage between the friction disks and twisting the fruit until it is detached. A simulation of the mechanical performance of this tool is presented in Ref. (2).

Experience shows that harvesting prickly pears by cutting a piece of the pad causes less damage to the fruit, suggesting the development of a tool based on such a principle. Fig. 3. shows a prototype of the tool. This tool is considerably simpler than the twisting one and works as follows: the operator grasps the handle causing a tension in the wire that rotates the lever of the cutting modulus. The sharp end of the lever presses on the pad cutting a piece of it together with the fruit.

The following table shows a comparison of the two principles. Although the speed of harvesting in a short period of time is higher for the twisting tool, in a longer period the cutting tool is more convenient due to the lower weight of it.

	Twisting Tool	**Cutting Tool**
Speed of harvesting Kg/h	74.0	68.0
Damage %	6.6	0.0
Weight kg	1.725	0.925
Length of the tool mm	860	1350
Working reliability	S	S+
Simplicity of construction	S	S+
Convenience for the operator	S	S+

S: Satisfactory

Principle for Processing

Prickly pear varieties used for production of food-coloring normally ripe uniformly allowing non-selective harvesting. In addition, pears are mainly located in the circular end of pads. Taking advantage of these considerations a device to apply torque to all fruits on the pad were developed as shown in Fig. 4. Rubbered disks may be approached by the action of a hydraulic cylinder. One the pad is being pressed by the two disks, these rotate in opposite directions applying torque to fruit around the longitudinal axle. The speed of rotation is slightly higher in one disk allowing the fruit to come off the disk. Disk rotation is due to an hydraulic motor that works independently of the closing cylinder.

Performance of the device is presented in Fig 5. Average picking time per pad of 2.55s seems promising although there is a time spent in positioning the device at the pad location. Damage of 12% seems acceptable because fruit will go directly to the

processing plant. Losses of 5.99% correspond to pears left on the pad. Thus far, this device has only been tested in the laboratory.

For field test of this principles it is necessary to have a manipulator and a special vehicle to carry the picking device for harvesting the fruit. Both machines are under development at the present time.

Discussions and Conclusions

Regarding the speed of harvesting, both principles for fresh market have similar performance but the one with the twisting principle is slightly faster. However, regarding fruit damage and convenience for the operator, the cutting edge principle is preferred. In addition, this tool is simpler and easier to produce.

In relation to the non-selective harvesting the counter rotation disks principle seems promising. However the completion of the development is depending on a clearly defined demand for prickly pears for processing.

References

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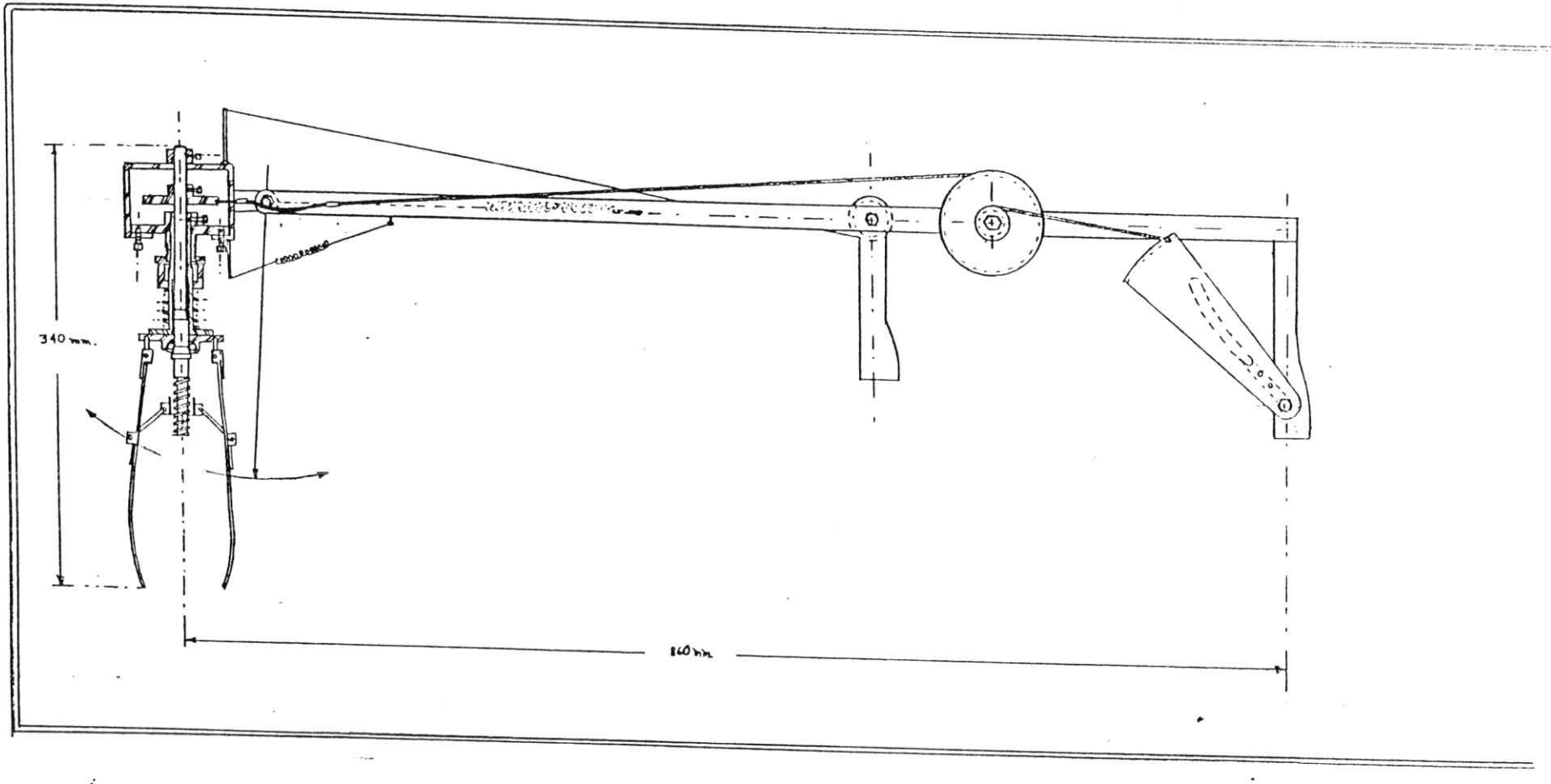
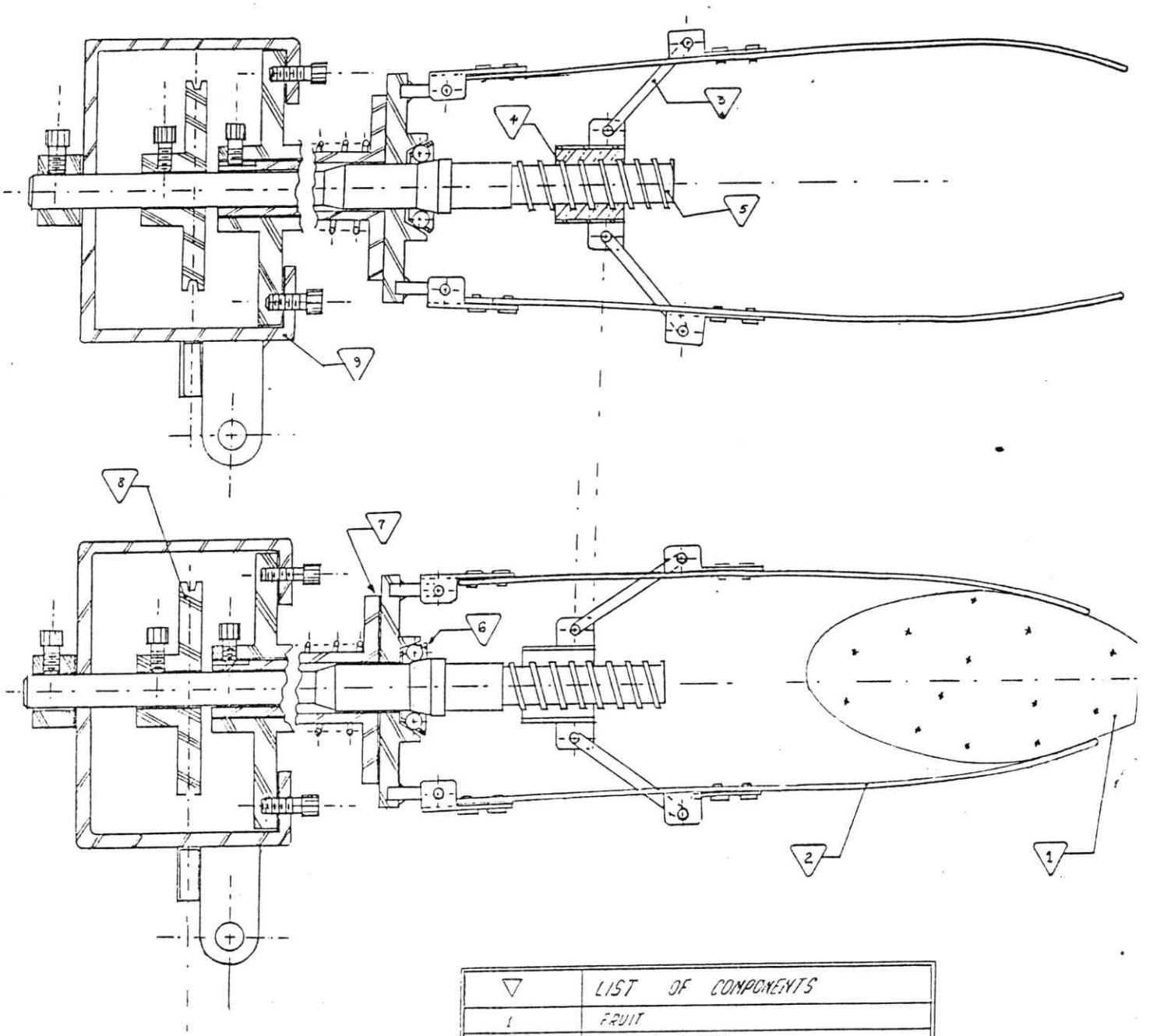


Fig. 1.- Tool configuration based on the Twisting principle.



▽	LIST OF COMPONENTS
1	FRUIT
2	FLEXIBLE FINGERS
3	CLOSING BAR
4	SQUARE THREAD NUT (½"-2 sqr 2 fillets)
5	SQUARE THREAD (½"-2 sqr 2 fillets)
6	BALL BEARING
7	CLUTCH ASSEMBLE
8	DRIVER PULLEY
9	SUPPORTING FRAME

Fig. 2.- Cutting modulus for the twisting tool.

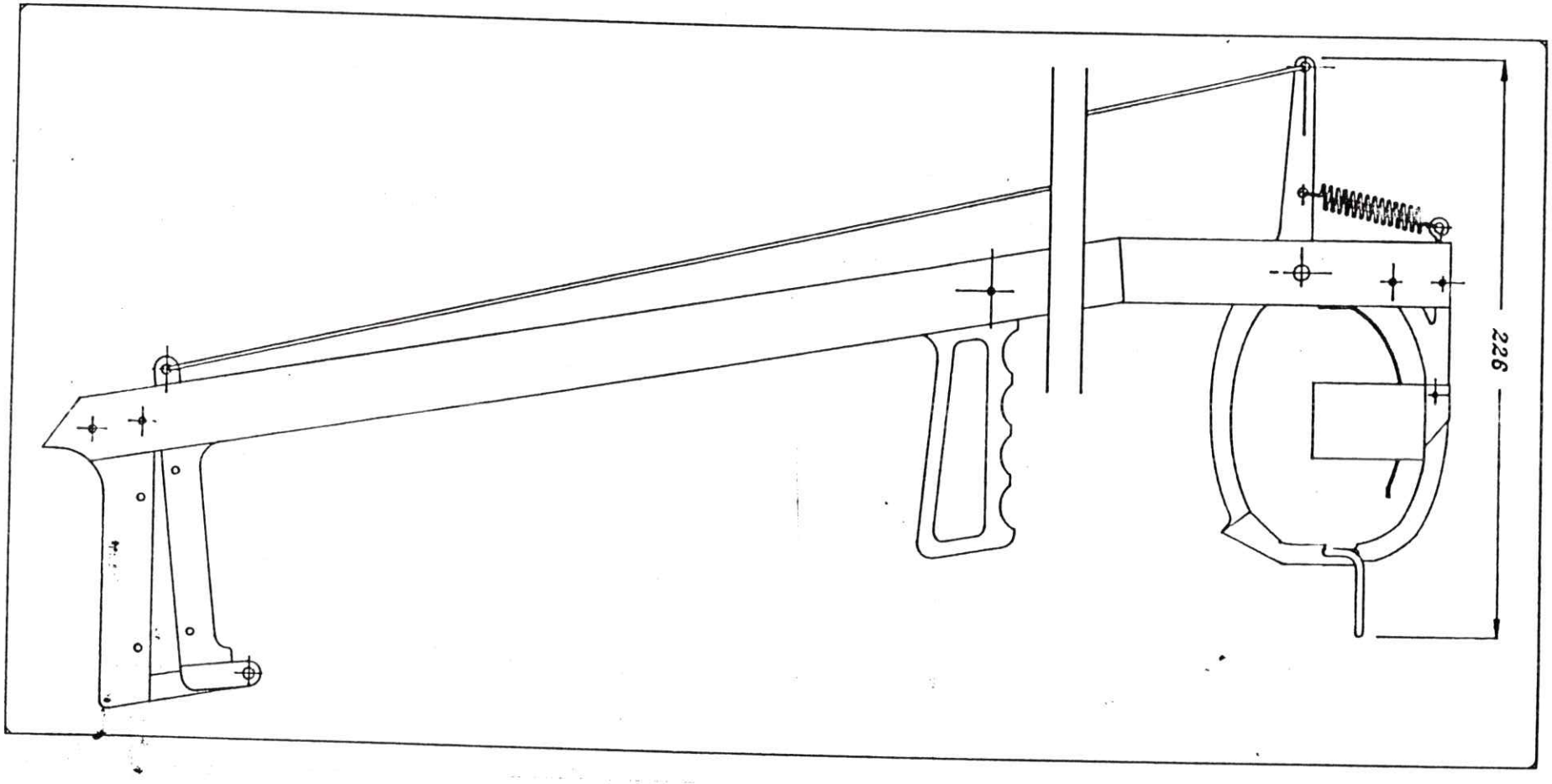


Fig 3. Tool configuration based on the principle of cutting a piece of the pad

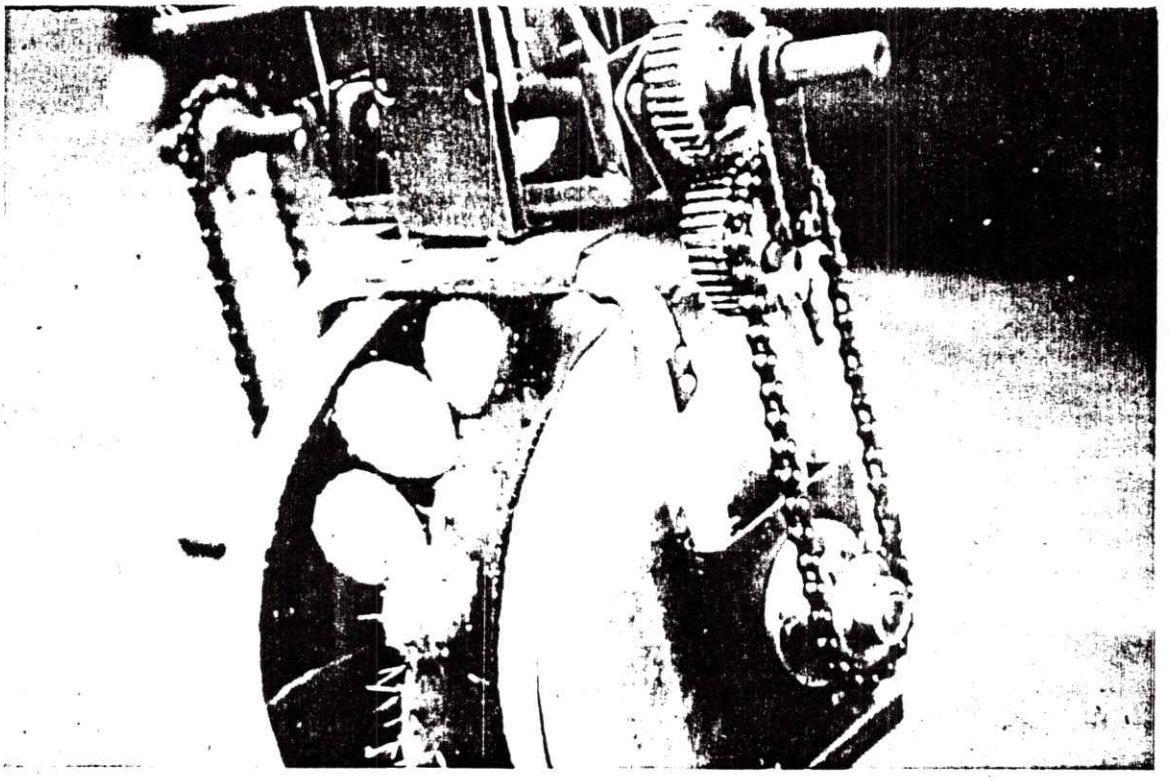


Fig 4. Counter–rotating rubbered disk principle for non selective harvesting

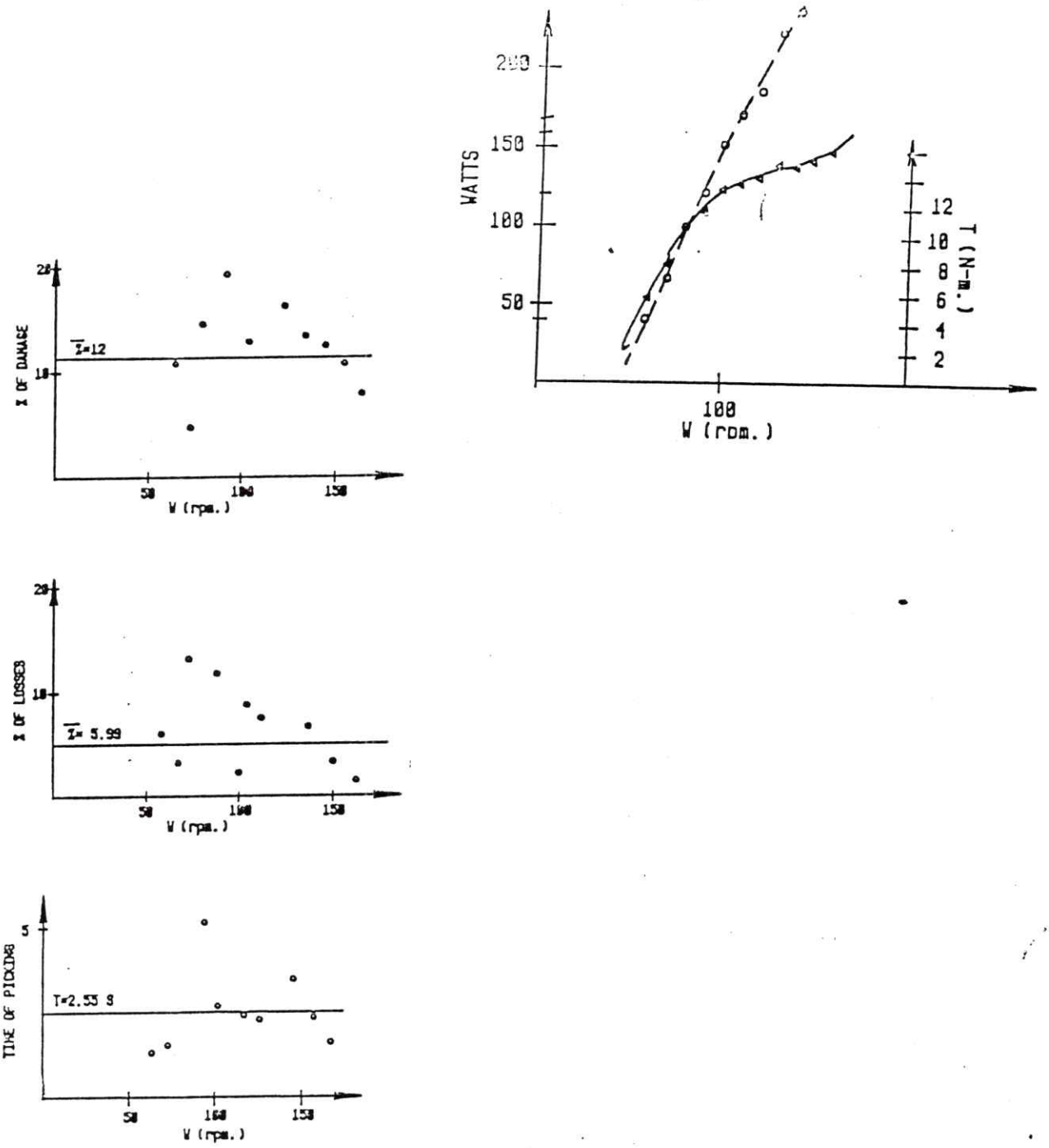


Fig. 5 - Performance of the counter-rotating rubbered disks prototype during laboratory testing for non selective harvesting.