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## A REVIEW OF COCONUT HUSKING MACHINES

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### ABSTRACT

Husking of coconut is among the most-difficult post-harvest operations relevant to coconut. Traditionally the entire husking is done manually using either a machete or a crowbar, and it involves much human drudgery, skill, training, and endurance. There are lots of machines invented all over the world to mechanize this operation, but only a few of them are available in market, sadly some of them have vanished from the market and the rest have not reached the market yet due to many reasons. So a study was conducted about the various coconut husking machines which were made so far stating what are advantages and disadvantages of them, the study included both the manually and mechanized versions of husking mechanisms.

**Keywords:** Agriculture, Coconut, De-husker Husking machine, Keramithra.

### 1. INTRODUCTION

Farm mechanization increases the effective utilization of machines to increase the productivity of land and labor. Besides it helps in reducing the drudgery, time and cost of cultivation in farm operations. In farm mechanization, the operations are divided into three i) Pre-harvesting operation ii) Harvesting operation iii) Post-harvesting operation. Pre-harvesting operation is the operation that done before harvesting which includes seed selection, land preparation, sowing, irrigation etc. Harvesting is the operation that harvests the fruit or the output from the particular plant. Post-harvesting operation is done for mainly for consumption, storage or preservation and transportations, which generally includes husking, breaking, shelling, drying. Among these the husking of coconut is the most-difficult operation relevant to coconut.

The coconut palm (*cocos nucifera*) is found all over the globe, where it has mingled into the lives of the local people. It provides almost all the requirements of humans such as food, drink, fire woods, medicines, domestic utensils etc. Because of these reasons, it has been called the “tree of heaven” and “tree of life” [15]. Coconut is native to coastal areas of Southeast Asian countries such as Malaysia, Indonesia, Philippines and westward towards the coastal India, Sri Lanka, East Africa, and tropical islands such as Seychelles, Andaman and Mauritius. In these regions, the palms were able to establish themselves on sandy and coralline coasts. Coconut palm can either be an introduction or even possibly a native to the Pacific coast of Central America [10].

As mentioned, coconut is a popular drupe among various others all over the world. Many machines are fabricated and used in various part of the world to mechanize the post processing operation. The present study is focused on the various machines which are available for the husking operation of coconut and points out the advantages and disadvantages of each.

## 2. CLASSIFICATIONS

Based on the type of actuation, coconut husking machines are divided into two categories (i) Manually operated coconut husking machine (ii) Power operated coconut husking machine. In the case of manual husking machines, all operations are carried out manually. Since a very large force is to be applied as the effort, and due to the small mechanical advantage, husking is tough and hence involves considerable exertion. In the case of house hold husking, manually operated husking machines generally suits best. But for industrial uses, motorized machine can be opted.

- I. Manually Operated Husking Machine
  - a) Coconut Husk Removing Tool
  - b) Coconut Husking Machine
  - c) Coconut Spanner
  - d) Coconut Husk Removing Tool
  - e) Mini Coconut De-husker
  - f) KAU Coconut Husking Machine
  - g) Keramithra- Coconut Husking Tool
  - h) Ce Co Co Coconut De-husker
  - i) Coconut De-husking Machine
  - j) Apparatus For Removing Fiber From Cocoanut
  - k) CPCRI Husking Tool
- II. Power operated Husking Tool
  - a) Twin Blade Coconut Husking Machine
  - b) Rotary Coconut De-husker
  - c) Hydraulic Coconut De-husking Machine
  - d) Mechanical Coconut Husking Machine
  - e) Power-operated Coconut Husking Machine
  - f) Continuous Power Operated Coconut Husking Machine

## 3. MANUALLY OPERATED COCONUT HUSKING MACHINE

### 3.1 Coconut Husk Removing Tool

A modified version of the smithy tongs was basically the earliest known twin-blade husking tool developed by Waters [5]. It had two lips sharpened like thin wedges, in the juxtaposed or closed position; it was swung and impaled on the coconut, and then separated to loosen the husk. The operations were repeated for three or four times to finally take out the kernel. It is evident from figure1 that it is not that much convenient to use and the coconut should be held somewhere while husking operation is done and that could be one of the reasons why it was not popular at all.

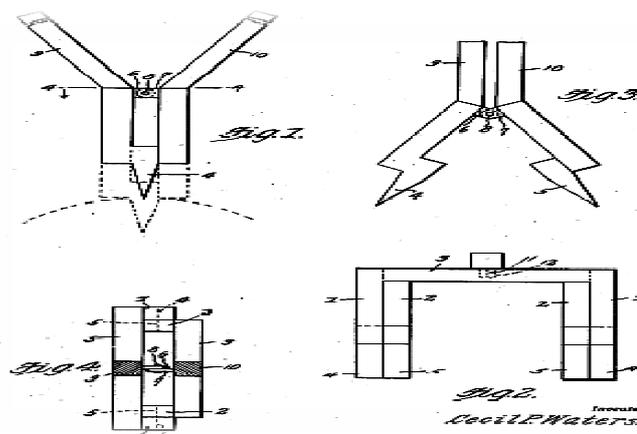


Fig.1 Coconut Husk Removing Tool

### 3.2 Coconut Husking Machine

Another twin-blade tool, which appeared to be better than that of Waters, was of the tool developed by Titmas and Hickish which is called the Coconut Husking Machine [17]. This was a tool mounted on a wooden platform, and stood upright when placed on the floor. Coconut was held by hand and impaled on the stationary tool. The downwards action of

its foot lever each time caused the separation of one sector of the husk. Repetition of these operations to three or four times caused complete removal of the husk. Re-setting of its movable blade on to the stationary blade, to keep them in the juxtaposed upright position, was achieved with the aid of a tension spring of high spring constant. Slipping of the foot from the pedal during downwards action would be causing a quick return of the pedal, and any part of the leg or body coming in the way of its path is bound to get an impact, which may sometimes be a reason for impending injury. Moreover, depressing of the pedal in the standing posture of the operator and with one foot, in coconut husking is not that advantageous, as this action destabilizes the operator. These disadvantages might have prevented the acceptance of this tool.

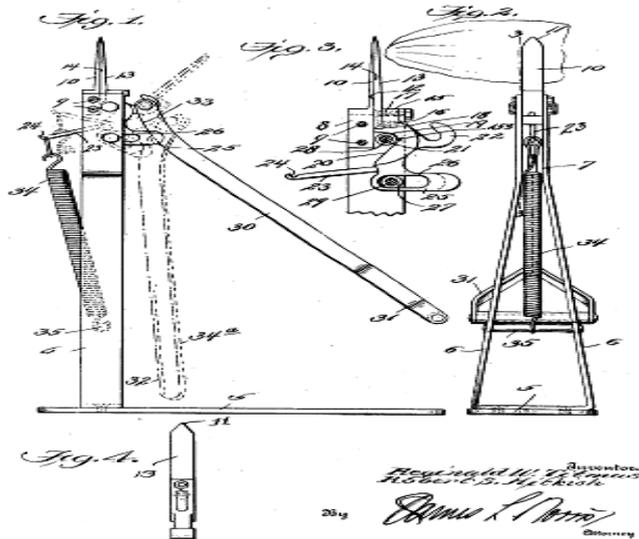


Fig.2 Coconut Husking Machine

### 3.3 Coconut Spanner

A husking tool called the *Coconut Spanner* [20] was developed in the rural areas of Kerala, India especially from the Malabar region, where its inventor was unknown. It was commercialized during 1990's in Kerala. It was a modified version of the smithy tongs with long handle and sharpened tongue. It is in juxtaposed or closed position and impaled on the coconut, and then separated to loosen the husk. The unit operation was repeated three or four times to finally take out the kernel. Each time, the operator had to bend for manipulating the coconut placed on the platform which could be at the ground level. Then, he has to rise and straighten up for lifting the tool and impaling it downwards against the coconut. This could be the reason for it not becoming popular.

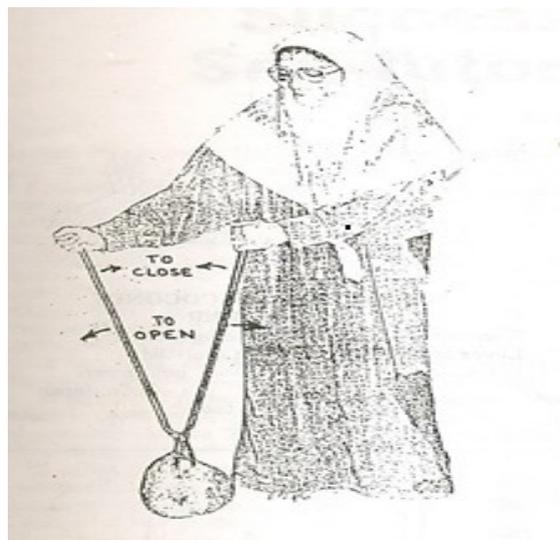


Fig.3 Coconut Spanner

### 3.4 Coconut Husk Removing Tool

Edward D. Hill developed a husking tool called *Coconut Husk Removing Tool* [11], which worked on the same principle of a twin wedge blade. Tool consisted of a stationary blade and a movable blade, which was attached to the central portion of a cross bar, the ends of which slide on a spaced rod forming part of a frame. One blade was stationary and the other was a movable blade. It had a handle and a blade which can be separated from each other. The frame was mounted on a support for increased stability. Coconut was placed in a bowl in the upright position and the blade attached cross bar can moved in a vertical manner that helped to impale the blade on the coconut husk and separated the stationary and movable blade causing husking. The unit operation can be repeated three or four times for complete husking. The main problem associated with this tool was the difficulty to impale the coconut. Also it was strenuous to keep the coconut on the bowl.

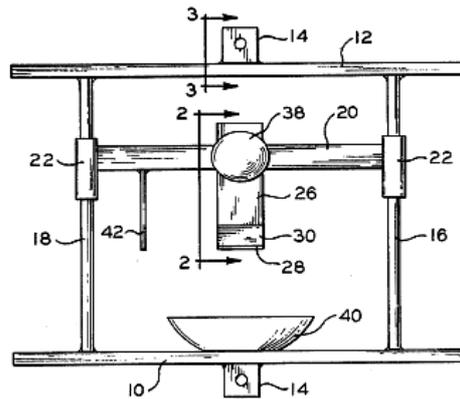


Fig.4 Coconut Husk Removing Tool

### 3.5 Mini Coconut De-husker

Ganesan and Gothandapani invented a mini coconut de-husker [12], consisting of a tong-like tool mounted on a pillar. The coconut was kept on a platform and was impaled from the top with the sharp jaws of the tool swinging downwards about the pillar. After penetration, the handles of the tool were pulled outwardly to separate the jaws. This ripped of the husk into one sector. The coconut was then turned and the tool was made to impale on another portion of the remaining husk and the process of ripping open the husk was repeated. The operations were then repeated till complete de-husking. It is obvious that de-husking using this tool involved more cumbersome unit operations. Each time, the operator had to bend for manipulating the coconut placed on the platform which could be at the ground level. Then, he has to rise and straighten up for lifting the tool and swinging it downwards against the coconut. This could be the reason for it not becoming popular.

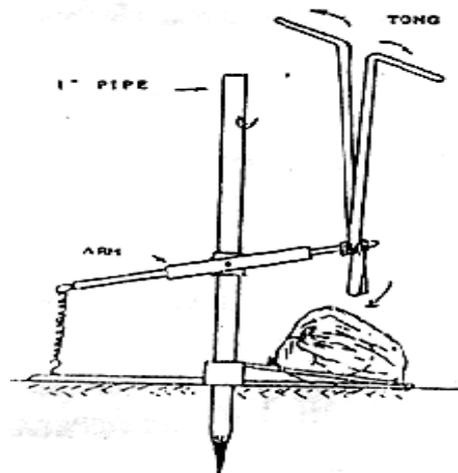


Fig. 5 Mini Coconut De-husker

### 3.6 KAU Coconut Husking Machine

Aboobekkar and Narayanan developed a foot operated husking tools [21] from Kerala Agricultural University, India. Upon depressing the foot pedal downwards by one foot, the movable blade gets separated from the stationary blade, thus, ripping apart a sector of the husk of the coconut remaining impaled on the juxtaposed blades. Operations had to be repeated for completely removing the husk in three or four sectors. In this cases also, the blade/blades were powered manually. On a comparison with the *Keramithra*, it was seen to be offering only lesser advantage. Hence, this too was not accepted by the people.

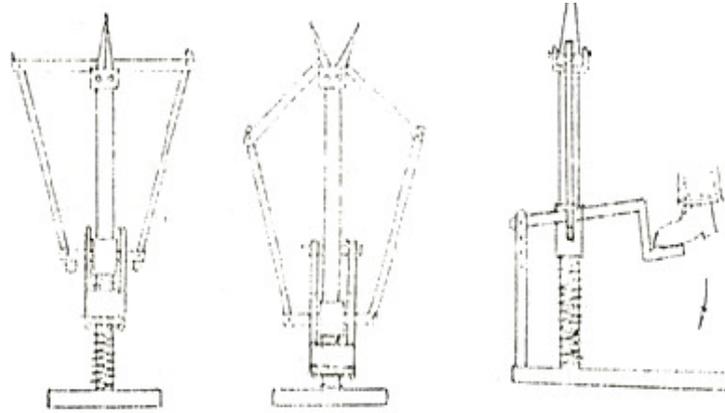


Fig.6 KAU Coconut Husking Tool

### 3.7 Keramithra- Coconut Husking Machine

The KAU Coconut Husking Tool (*Keramithra*) [13] developed in the Kerala Agricultural University, India was invented by Jippu and Joby, was simple not only in construction but also in use. It consisted of mainly a stationary wedge, a movable wedge, a hinge pin, a wedge seat, a lever and a pedestal with a base. The coconut was impaled with both the hands on to the two juxtaposed wedge-like blades oriented upwards. On pulling the lever upwards by one hand, the movable blade or wedge placed on the load arm of the lever swings away from the stationary blade loosening a sector of the husk from the nut. By repeating twice or thrice the husk can be separated completely from the coconut. It took only about 8 to 20 seconds for husking a nut depending upon the variety, maturity of nut and the skill of the operator [1]. It was light in weight (2.5 kg), and was simple to use and handle and required no maintenance at all. Though this tool was quite acceptable at the domestic level, it is not so good in large-scale husking [14].

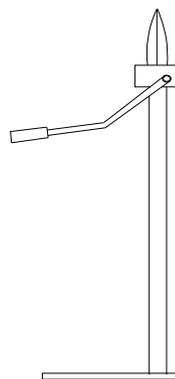


Fig. 7 KAU Coconut Husking Tool (*Keramithra*)

### 3.8 Ce Co Co Coconut De-husker

Another pedal operated husking tool, which appeared in Japan which was called *Ce Co Co Coconut Cracker (De-husker)* [6] developed by CeCoCo Japan. This was a tool mounted on a platform, and standing upright when placed on the floor. Coconut was fed by hand and impaled on the stationary tool. The depressing of its foot lever each time caused the separation of one sector of the husk. Repetition of these operations three or four times caused complete removal of the husk. Re-setting of its movable blade on to the stationary blade, to keep them in the juxtaposed upright position, was achieved with the aid of a torsional spring of high spring constant. Slipping of the foot from the pedal when

depressing would be causing quick return of the pedal, and any part of the leg or body coming in the way of its path was bound to get an impact, which may sometimes be inflicting injury. Moreover, depressing of the pedal in the standing posture of the operator and with one foot, in coconut husking was not that advantageous, as this action destabilized the operator as well as the tool. These disadvantages might have prevented the acceptance of this tool.

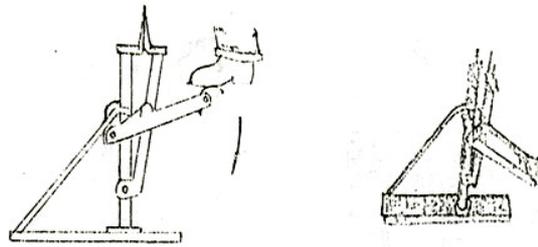


Fig.8 Ce Co Co Coconut Dehusker

### 3.9 Coconut De-husking Machine

Apart from the wedge assembly, husking tool called Coconut De-husking Machine was developed by Dinanath [9]. A machine specially designed to remove the husks from the coconut included a plurality of rollers rotating in opposite directions effectively toward one another, wherein each roller included a plurality of penetrating spikes sharpened to penetrate and effectively engage the husk portion of the coconut. The interaction of the rollers in combination with the gripping action of the spike serves to tear away the husk from the nut leaving the nut intact. The major hindrance with this device was due to its large size having a one meter roller length. Hence it very difficult to operate and large force is required due to small mechanical advantage [4].

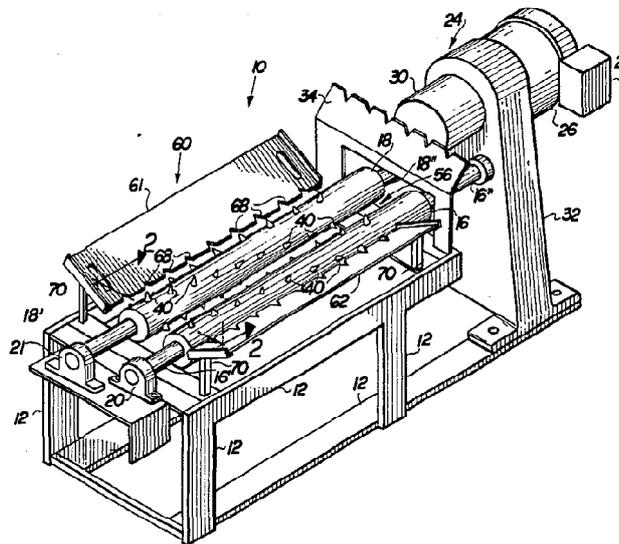


Fig.9 Coconut De-husking Machine

### 3.10 Apparatus For Removing Fiber From Coconut

In 1911 Rene Marot from the Republic of France developed a machine called Apparatus for Removing Fiber from Coconut [18]. The machine consisted of knives arranged in vertical planes, arranged in the center and movable in guides so that they can be all brought toward each other or moved away from each other simultaneously. These knives were fixed at the end of a rod whereby they can be raised and lowered, the rod being also adapted to be moved on its axis through a certain angle. Coconut which was placed on a support consisted of lower knife having a cutting edge and these knives were brought together by a lever helping it to hold the coconut in correct position. By moving the upper lever helped to penetrate the eye of the coconut and these knives were given a rotational movement through about 90 degree. The traction thus exerted on the upper half of the fibrous layer detached the latter throughout its height. The major hitch with this machine was that it required huge force to operate and as a manually operated it would be more useful for house hold activities, but because of its huge size it wouldn't be acceptable.

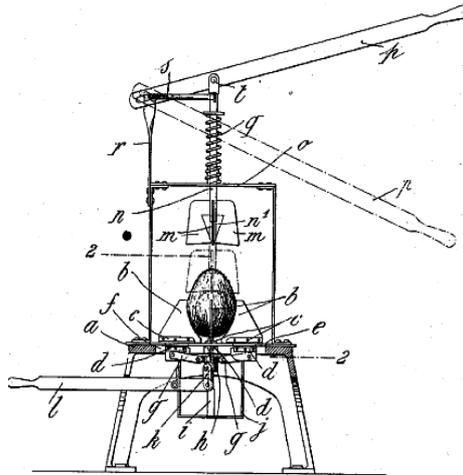


Fig.10 Apparatus for removing fiber from coconut

### 3.11 CPCRI Coconut De-husking Tool

In Central Plantation Crop Research Institute (CPCRI), Kerala, India, a manually-operated de-husker [7] was developed and improvised. It consisted of three sharp separable blades, which initially faced upwards and in a juxtaposed position. In operation, the blades would go up and outwardly by swinging about their pivots at the bottom. In the process, the husk of the coconut gets impaled upon the blades and the nut is ejected. The impaling of coconut and actuation of the blades were carried out using a hand-lever and a foot-lever. This was however a cumbersome process and hence was not been accepted widely. Moreover, not only that the feeding was manual but also its movable blade actuation was again manual. The major impediment with this device was its large size.

## 4. POWER OPERATED COCONUT HUSKING MACHINE

### 4.1 Twin- Blade Husking Machine

A twin-blade was been developed in such a way that the husking of the coconut was done by inserting coconut onto one of its twin-blade and the other flat blade would help in the process of peeling. A 1.5 hp motor coupled through a belt to a long, cylindrical metal rod with two sharp blades fixed at the tip of the rod of the machine. The blades were 19 cm long and placed two inches apart. The rotating motion of the blade aided to husk the coconut easily. A switch was used to operate the machine by the operator with his leg in each hushing. This rotation of the machine blades facilitated the husking process. A better grip on the coconut was provided by the flat blade, which acted as the stopper that prevented the nut to slip away vertically. But the disadvantage in using it was concerned with safety and this can be done only by a skilled person, otherwise; hands may get cut as the worker has to hold the coconut in his hand during husking process.



Fig. 11 Two Blade Husking Machine

#### 4.2 Hydraulic Coconut De-husking Machine

A robust hydraulically-operated machine called the Coconut de-husking machine [8] which is developed by an Australian company, Fletchers Engineering Ltd., Australia. It consisted of electric motor, hydraulic system, arm like structure, holding mechanism. The de-husking machine was powered by an electric motor which was attached to hydraulic system. Hydraulic power was used for operating the arm like structure which was used for opening coconut husks. Holding mechanism was used to hold the coconut in a standing position in which the eye was on the top position. It also consisted of some lifting mechanism (hydraulic powered) for lifting the holding mechanism. Husking was due to the combined action of lifting the holder and the arm. The major problem related to this machine was that it was bulky and had high power consumption. It also required skilled labor to lift the coconut according the husk opening



Fig.12 Hydraulic Coconut De-husking Machine

#### 4.3 Rotary Coconut De-husker

A rotary coconut de-husker [16] was developed in Kelappaji College of Agricultural Engineering and Technology, India. It was intended for a large-scale application. This machine consisted of a stationary concave, enveloping a rotating drum. The clearance space between the drum and the concave formed a converging volute to accept the whole coconut at the inlet and accommodate the husked smaller nut at the outlet. Numerous small blades were fixed on the outer surface of the drum and the inner surface of the concave. The coconut was fed at the inlet and into the clearance between the inlet and the drum which gets compressed slightly by the system and forces to roll or revolve. In the process, the blade penetrated the husk and punctures it along different planes. The shear force exerted upon the coconut by the blades of the rotating drum and the concave cause to rip open the husk along different planes. In some cases, the coconuts were completely husked and the nut emerged out at the outlet. In some cases, full coconuts with punctured and softened husk emerged out. Such coconuts required secondary operations to completely remove the husk. In short the machine, as the first prototype, functioned satisfactorily.

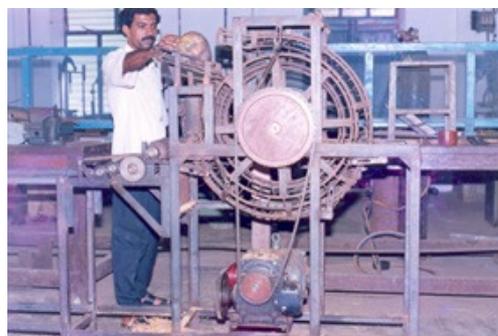


Fig.13 Rotary Coconut Dehusker

#### 4.4 Mechanical Coconut Husking Machine

The mechanical coconut husker [19] consisted of three main components- an inlet throat, a husking mechanism and an outlet. The husking mechanism of the machine consisted of two rollers powered by a 1.5 hp, 1440 rpm, and single phase AC electrical motor with integral reduction mounted almost vertically at the top of the machine and a gear box. Power was transmitted to the roller through helical gears. The powered rollers mounted in the right row rotate at a speed

of 50 rpm, the outermost one carrying a series of slightly curved sharp hook-like knives that engage with the husk when coconuts are fed from the mouth of the throat. The whole nut was fed through the feed chute holding it vertically by hand, towards the converging throat where it was caught between the two rollers. In the process, the sharp right roll consisting of slightly curved hook-like knives engage with the husk and left spring loaded rollers press the coconut towards the right spiked rollers. As the rollers rotated, the husk gets detached from the shell, effecting a complete de-husking of coconut. The de-husked coconuts falls outlet below the roller where the gap between the spiked rollers and spring loaded rollers and were collected.



Fig. 14 Mechanical Coconut Husking Machine

#### 4.5 Twin-blade Type Powered-Coconut Husking Machine

Again, the modification on the twin-blade tool with manual feeding of coconut was taken as a part of the project at KCAET, Tavanur, India [3]. It was mainly intended for small-scale application. The machine comprised of a cam and a follower which was connected to a hinged movable-blade for separating the movable blade from the stationary blade and then re-setting the former on the latter quickly. The cam and follower mechanism was intended to allow dwelling of the two blades in the juxtaposed position for  $280^{\circ}$  and separation of the blades for the remaining  $80^{\circ}$ , and then quickly re-setting the movable blade to the juxtaposed position. The cam is designed in such a way that the closing time of blade is 2 seconds, so that we can utilize that time for impaling the coconut into the juxtaposed blades and the opening time of blade was one second. The machine required 12-20 seconds for husking a nut depending on the skill of the operator. The major problem related to this machine was that it was bulky and costly not that much convenient for small-scale applications and in case of large scale, it would be time consuming and required skill.



Fig. 15 Twin-blade Type Powered-Coconut Husking Machine

#### 4.6 Continuous power operated coconut husking machine

Another machine called Continuous Power Operated Coconut Husking Machine [2] was developed in KCAET, which was a modification of rotary type coconut husking machine. Machines consisted of feeding chute, a husking unit, a husk separating unit and power transmission unit. The coconut fed at the feeding chute and in the clearance between the inlet and the drum was slightly compressed and forced to execute rolling or revolutions. In the process, the blade penetrated the husk and punctured it along different planes. The shear force was exerted upon the coconut by the blades of the rotating drum and the concave portion caused to rip open the husk along different planes. The full coconuts with punctured and softened husk fall into the husk separating unit which consists of two knurling rollers. There the softened and punctured husk is separated and the nut emerges at the outlet. The major problem related to this machine was that it was bulky and had high power consumption.



Fig.16 Continuous Power Operated Coconut Husking Machine

## 5. CONCLUSION

Many types of machinery were developed worldwide and a proper review of all the available machines was carried out looking into all aspects of cost, ease of use and viability. It was found that among the mechanisms one manual and one mechanized versions of de-husking machine was selected as the most appropriate for use. In the case of manually operated coconut husking machines, KAU coconut husking machine (Keramithra) is very popular mechanism among low cost de-husking tools available due to its simplicity, ease of operation when compared to a traditional tool. Even women and young children seem to use this for domestic-level husking of coconuts. In the case of power operated coconut husking machines, Mechanical coconut husking machine is very popular among the rest, as it is very easy to handle and skilled labor is not required. It also required only less time to husk the coconut.

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