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Pedal powered Rice threshing machine

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Abstract: Threshing of rice is of great importance in Asia and especially in a country like India where rice is a staple diet for at least 70% of the population. Motorized threshing machines tend to be very large and hence maintenance and use are difficult. The compact-size manual threshing machine is very convenient to handle in small terrace fields in mountains areas where a large machine is not usable. Moreover the manual threshing machine does not rely on electricity to operate and as such it can be used in places with low or no electricity supply. Also due to low cost it can be used by average farmers who produce at least 80% of India's rice. In a way, development of manual rice threshing machines provides the scope of establishment of small scale cottage industries concerned with threshing and packaging of rice. This in turn would lead to the empowerment of the farmers which hence would be instrumental in the progress of agriculture. Keeping the aforementioned matters in mind, the paper presents a Pedal Powered Manual Rice Threshing Machine which is based on a simple gear transmission mechanism powered by a pedal.

Keywords: Machine, Manual, Pedal, Threshing, Rice

1. Introduction

Development of manually operated rice thrashing machines creates a good scope for establishment of small scale cottage industries which in turn would empower farmers and thereby provide a path of progress in the field of agriculture.

This report deals with the construction of a Pedal Powered Rice Thrashing Machine which is based on a gear transmission mechanism powered by a pedal. The major components of this machine include:

- Pedal
- Connecting Rod
- Gear Mechanism
- Cylinder Shaft
- Threshing Cylinder
- Feed Table

2. Construction and Components

In this chapter an attempt has been made to appropriately elaborate the construction and components of the proposed system.[1][2][3]

2.1 Construction

The construction of the system is simple. Components are arranged or assembled in such a manner that the power consumed and force required by the system is very low. To start the operation the threshing drum or cylinder is rotated by hand. Once the angular momentum or rotational inertia takes over, the operator is required to put very less effort on the pedal and thereby maintain the rotation of the threshing cylinder. Moreover the gear-pinion assembly is designed in a way that is of the increasing gear mechanism type. As a result the drum or cylinder rotates at a high speed on application of little force on the pedal.

The construction can be seen as an assembly of six major components.

They are:

- Pedal
- Connecting Rod
- Gear Mechanism
- Cylinder Shaft
- Threshing Cylinder
- Feed Table
- Cylinder Hood

2.1.1 Pedal

In the proposed system, the pedal is a component which aids the operation of the mechanism. It is a wooden bar with metal grip and one of its ends attached to a connecting rod. This connecting rod connects the pedal with the gear mechanism. The operator has to just apply a small amount of force on the pedal in the downward direction after the angular momentum takes over. Due to the angular momentum the pedal retrieves in the upward direction to its original position on its own. Hence the operator can continue the process over and over again just by pushing the pedal after regular intervals in the downward direction with the application of small amount of force.

2.1.2. Connecting rod

The Connecting Rod is a MS rod which connects the pedal with the gear mechanism. The rod converts the reciprocating motion of the pedal to the rotary motion of the gear. The Connecting Rod itself also operates in a reciprocating motion. The connecting rod should be strong enough to resist the stresses that develop during the operation which may cause bending of the rod or may also lead to failure.

2.1.3. Gear Mechanism

The gear mechanism consists of an assembly of a gear and a pinion. The main purpose of this assembly is to assist the connecting rod in converting the reciprocating motion of the pedal to the required rotary motion of the threshing cylinder.

2.1.3.1. Gear

It is the larger wheel to which the connecting rod is attached (pin-joint via ball-bearing). When the angular momentum takes over, the threshing cylinder and hence the gear rotates in one direction(i.e. clockwise or anticlockwise). Taking advantage of this angular momentum, the reciprocating motion of the pedal is transmitted as a rotary motion to the gear mechanism which finally rotates the threshing cylinder amplifying its rev speed manifolds. Hence the gear rotates in clockwise or anticlockwise direction whichever is desired.

2.1.3.2. Pinion

It is the smaller wheel of the gear mechanism which remains in mesh with the Gear. The Pinion being smaller in size increases the speed and hence the power as it is transmitted to the threshing cylinder shaft. This gear mechanism is of the increasing type. Since power is transmitted from larger wheel (i.e. gear) to the smaller wheel(i.e. pinion) hence the output torque increases to a great extent. Thereby a small amount of effort is required to rotate the cylinder.

2.1.4. Cylinder shaft

The cylinder shaft is basically a MS rod coupled with the pinion which is meshed with the gear that comprises the gear drive mechanism. This shaft drives the threshing cylinder and thereby fulfills the purpose of the proposed machine. The rod (cylinder shaft) should be strong enough to resist the twisting stress, hence it has been made of strong materials like mild steel, high carbon steel etc.

2.1.5. Threshing cylinder

The threshing cylinder consists of an iron frame with wooden bars attached across the frame. The iron framed cylinder is so designed that its length is greater than its diameter. Wooden bars are used to decrease the overall mass of the machine. On each of these bars are attached a number of nail like threshing spikes. The nails should be attached in such way so that can maximum grains from the panicles. Moreover the wooden bar provides the advantage for easy attachment of the nails, as nails can be easily pierced into the wooden bar with much less effort.

2.1.6. Feed Table

The feed table is a metal sheet attached to the bottom of the threshing machine that is responsible to collect the grains and separate the residue. The sheet is bent at parts in a way so as to give the feed table the desired shape that is required for the machine to work efficiently.

2.1.7. Threshing cylinder hood

The threshing cylinder hood is a rectangular hood structure welded on a main frame above the threshing cylinder. The main function of the hood is to prevent the flow of the grains back towards the operator which may cause eye injuries. The structure of the hood is made of a metal sheet and the panicles (muthas) are fed into the gap in between the hood and the lower frame. Even after including this safety feature, there still remains future scope of future safety developments.

3. Design Analysis

Determination of Torque Required to Comb Off Grains from Stalk

Torque, T= Fr

Assuming that force acts per unit length of tong, taking force per 10 mm segment of length.

= FN ⇒ FN/10 mm

= 0.1 FN/mm

Considering Fig. 1,

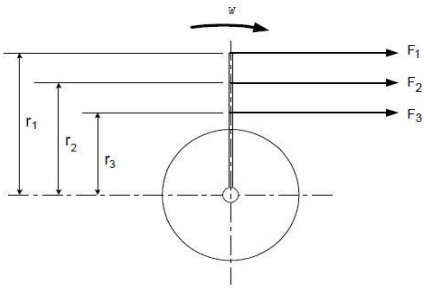

Fig. 1. Cross section of tongs on rotating drum

The torque resulting from individual force is given by,

Where, F_i and r_i are i^{th} force and i^{th} radius respectively.

Resultant Torque,

$T = F_1r_1 + F_2 r_2 + - - - + F_ir_i$

$\sum F_ir_i$

Where n = number of length segments given by,

But, $F_1 = F_2 = F_t$

$\therefore T_{resultant} = F \sum$

Fig. 2 shows the analysis of force acting on each tong.

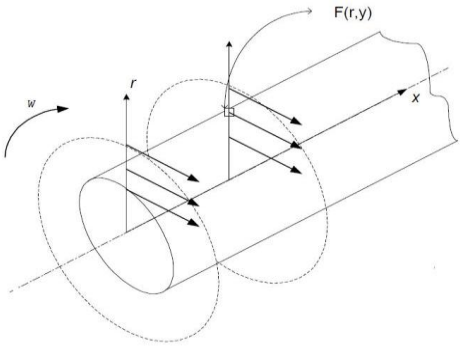

Fig. 2. Analysis of force acting on each tong.

Note: Equation 7 is sum of arithmetic series. This is much applicable in the case being considered
Where, n = no of terms = no of segments
a = first term
d = common difference
Total torque,
$T_t = T_r \times k$ ……8
Where, k = number of tongs.
Determination of Power Required to Thresh Off Grains from Stalk
This is given by,
$P = T_t \omega$ …….. 9
Where ω = angular velocity in rad s^{-1}

4. Working Mechanism

The mechanism proposed in a nutshell is very similar to the conventional treadle mechanism. Much like the treadle mechanism the power here is transmitted from the foot of the operator via a peddle through a geared mechanism to a rotating shaft which in turn rotates a cylinder thereby fulfilling the threshing operation.

Initially the drum or the cylinder has to be rotated externally towards the output side so as to impart a momentum to it. Once the cylinder gets the required momentum, further rotational motion can be induced by the application of periodic nominal forces on the paddle. The high gear ratio used in the mechanism minimizes to a great extent the effort required by the operator. Further the use of ball bearings instead of simple pin joints at various points leads to a much smoother running of the mechanism. In addition to that the wire projections on the threshing cylinder have been shaped in the form of the letter 'V' so as to obtain optimum threshing output. The 'V' shaped wires ensures that no hay remains stuck on the drum during the operation. Also the addition of a rectangular hood above the cylinder adds to the safety of the operator.

Coming to the motion transmission involved in the proposed mechanism, the reciprocating motion of the pedal is transmitted to the gear via the oscillating motion of the connecting rod. The oscillating motion of the connecting rod causes rotational motion of the gear(larger). The smaller gear which is meshed with the larger gear rotates at a higher speed. A shaft coupled with the small gear (pinion) thereby rotates, rotating along with it the threshing cylinder or drum. The gear ratio involved in the aforementioned mechanism is as high as 1:4 which largely steps up the rotational speeds. [3][4]

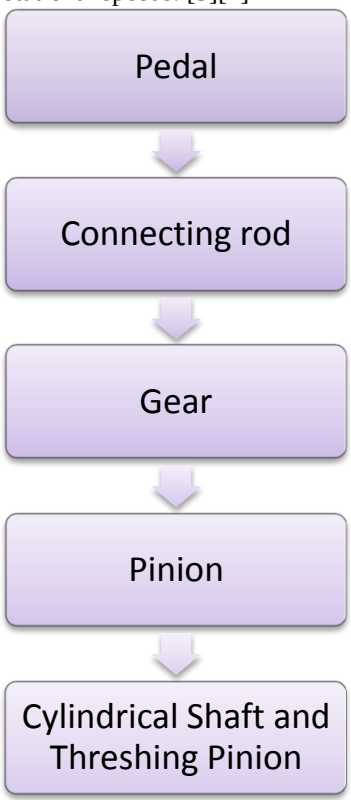

Fig 3- Power transmission Flow Chart

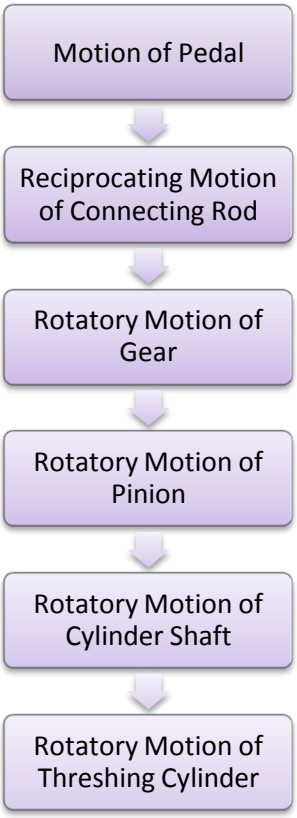

Fig 4- Motion transmission flow chart

5. Conclusion

The design and fabrication of a rice threshing machine has been successfully carried out by this work. The machine is capable of threshing, separation of stalk from grains and reduction in number of broken grains, thereby, giving a better method of threshing than the traditional methods. In addition to it the safety of the operator has also been enhanced .All the materials used were locally sourced.

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