

Design and Fabrication of Lawn Mower

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ABSTRACT

This project is to fabricate a grass cutter with helix shaped blade. At present grass cutter is operated by fuel and electrical energy. The design objective is to come up with a mower that is portable, durable, easy to operate and maintain. In our project we fabricate the grass cutting machine for the use of agricultural field, to cut the crops in the field. This is a new innovative concept mainly used in agricultural field. It is simple in construction and its working is easy. The components that are used are wheel, gear arrangement, roller, bearing, and base frame. Below the gear arrangement cutting blade is revolved. As the gear arrangement rotates the reel mover tends to cut the plants or crops. The reel consists of several helix shaped blades mounted to a rotating shaft. The whole set up is placed on a movable base which has a wheel arrangement. It is used to maintain and upkeep lawns in gardens, schools, college's etc.

Keywords: Grass cutting machine, Components, Power supply, Sickle bar, Bevel gear and Cutting blade.

1. INTRODUCTION

The A lawn mower is an important equipment to maintain the beauty of the lawn. The mower is with revolving blades to cut a lawn at an even length to make it good-looking. For the domestic purpose and in villages, people cannot spend more money on heavy machineries. In villages there is more power cut problem and in these areas, this manual lawn mower used effectively. In market there are so many lawn mowers are available. It is not easy and also very difficult to maintain uniform size. Hence we design to make a lawn mower without any power source due to reduce the power consumption. The blade removes the extra growth of the lawn and roller gives light pressure to the top surface of Lawn. It gives fine look to the lawn and uniform look throughout the Lawn. The cutting mechanism is made of a flat blade rigidly fixed to the frame behind the spiral arrangement which is configured to contact at least one reel bar of the spiral blades during the rotation of the spiral mechanism.

A traditional lawn mower is the height of the grass cut cannot be adjusted spontaneously because the height adjustment of the rotor blade is done by lifting the whole deck with the help of wheel support and this mechanism takes time at least (4-5 minutes) to adjust the rotor. The components that are used are motor, gear arrangement, cam, chain and sprocket, lead screw, wheel, control unit. Below the gear arrangement cutting blade is fixed. When the motor starts running by the use of power supply, the shaft also rotates and that rotates the gear arrangement which is coupled with the motor. Power consumption becomes essential for future. Solar grass cutter is a very useful device which is very simple in construction. The most common types are fitted with wheels, but a newer innovation is the hover model in which the spinning blade also acts as a fan that provides a lift force, lifting the mower body clear of the ground on the same principle with a hover craft. Rotary mowers generally have opening by the side of the housing through which cut grasses are expelled. Some are

attached with a grass collector at the exit point. The blade is seldom sharp enough to give a neat cutting. The blade simply tears the grass resulting in brown tips. However, the horizontal blades are easy to remove and sharpen or replace. Existing engine trimmers suffer from high initial cost, high levels of engine noise, high fuel consumption rates and high operator's fatigue in long-run. For the installation of anchors technicians are more and more supported by manufacturers with descriptive technical manuals and in some cases with training courses.

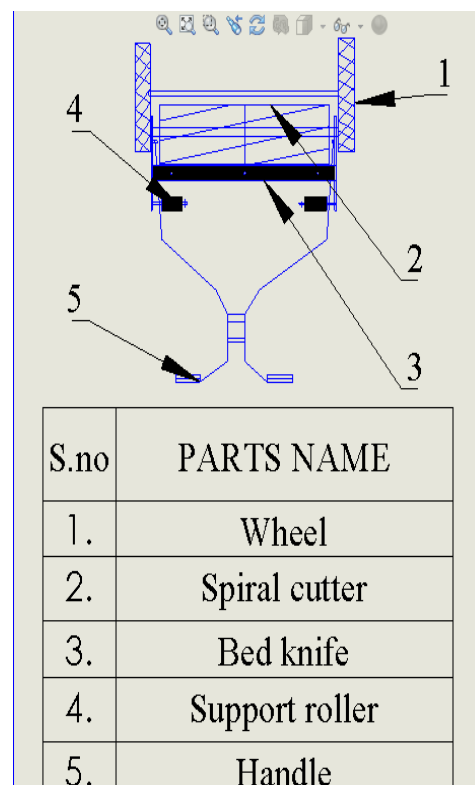


Fig. 1 Lawn mower-2D diagram

2. MECHANISM DESCRIPTION

Lawn mower is an essential tool for the maintenance of yards. They vary in size, mode of operation, and human power. The power source riding mowers for example are usually powered by a gasoline engine and are ridden and steered by the operator. It will walk behind mowers are designed to be pushed by the operator and while getting the power from the wheel rotation. Modern gas powered and electric powered lawn mowers cut grass with a single blade revolving at a high speed parallel to the ground. In these method there is five blades in cylinder is rotating and achieving the same power given by the operator. The blade is slightly raised along its rear edge to create draft that lifts the cutting blades before its cutting operation.

Terminology

The attitude refers to the angle of the bed knife. This reference is in degree differential from the surface of the turf, (or the line intersecting the bottom of the rollers). The shear point is the point that a reel blade contacts any given point on the bed knife at a specific point in time. The reel centerline, is the imaginary line drawn perpendicular to the grass dissecting the reel at its center.

This line is used to find the Behind Center Distance (BCD), this is the distance the shear point lies behind the centerline. There are two rollers. The rear roller trails the cutting unit, and is usually a solid roller.

Some cutting units have a fixed by screws, and the rear roller is used to set the height of cut. Others, such as the newer DPA design cutting units, have a fixed rear roller, and the front roller is used to set the height of cut.

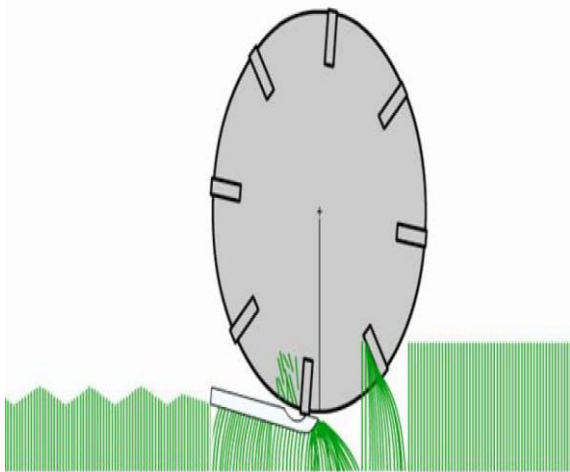


Fig.2. Grass cutting on bed knife

The performance of the machine was evaluated through a field test. A land predominantly covered with carpet grass was mapped out into plots of 4mx2m. Seven of these plots were selected by randomization process and mowed. The spiral lawn mower uses multiple cutting blades arranged in form of a cylinder which is turned by a gear connected to the wheels. The act of pushing the machine makes the cylinder revolve.

The blade is connected to the bevel gear. This gear train increases the speed of the cutting blade. Shafts of the gears are connected to the bearings. The bearings are used for the shaft stability and frictionless rotation. The lubricant is used for bearings is ester oil. Straight bevel gear is used in this lawn mower because of its simple design and low speed. The cutting blade is a low lift blade used for the low speed.

Wheel

Wheel is the mother part of all the components. Attached to the axle and used to move the entire system. The main wheels are the contact point with the ground. The ring gear having 63 teeth and it is covered by the frame need of protection. The circular diameter of wheel is 200 mm. Tire is covered outer side of the wheel which gives the grip on wheel rotation.

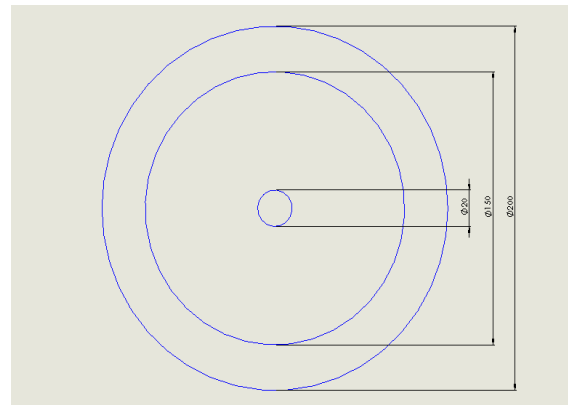


Fig.3 2D- Diagram for wheel

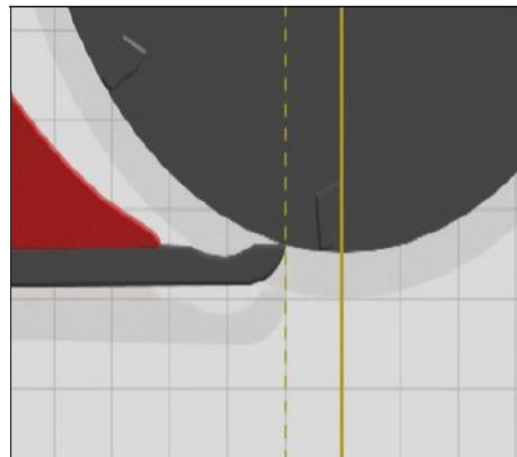


Fig.4 Spiral cutter

Spiral Cutter

The spinning blades of the mower do not actually cut the grass. It manipulates the grass to be cut by the cutter blade or bed knife. The cutting surface shears the grass as it is caught between the spinning drum and the cutter blade. A reel mower cuts grass with a scissors like shearing action, as the moving helix shaped blades pass over the stationary bed knife. The cutting action requires that the bed knife and reel blades matched, and in close relationship with each other. This wheel is then ground to be a perfect cylinder. The reel is supported by precision bearings held within the side plates. The side plates are held in place by a frame. This becomes the reel assembly, and is a precision cutting tool. The reel assembly is

supported by rollers, and pulled along the ground by a carrier frame. Everything comes together, to make a precision cutting tool.

The spinning blades of the mower do not actually cut the grass. It manipulates the grass to be cut by the cutter blade or bed knife. The reel consists of five or six helix shaped blades, welded to supports and mounted to a shaft. This weld is then ground to be a perfect cylinder. The reel is supported by precision bearings held within the side plates. The side plates are held in place by a frame.

This becomes the reel assembly, and is a precision cutting tool. The reel assembly is supported by rollers, and pulled along the ground by a carrier frame. Everything comes together, to make a precision cutting tool.

Bed Knife

The bed knife is held rigidly in position on the bed bar by screws. The bed knife is sharpened to be flat and square so the sharp edge contacts the reel blades across the entire length. If the bed knife is not flat, or the reel is not a perfect cylinder, it is impossible to get the bed knife to contact along the entire length of the reel. The contact between the blade reel and cutter blade provides a shearing force which cuts the grass. It consists of a horizontal knife screwed to bed knife bar.

Spur Gear

The lawn mower shall be driven from both wheels with suitable ratchet action provided on both sides between the drive wheels and cutting reel. Gears and pinions shall mesh fully and smoothly.



Fig.5 Spur Gear

Spur gears or straight-cut gears are the simplest type of gear. They consist of a cylinder or disk with the teeth projecting radially, and although they are not straight-sided in form of the edge of each tooth is straight and aligned parallel to the axis of rotation.

Geared devices can change the speed, torque, and direction of a power source. The term is used to describe similar devices even when the gear ratio is continuous rather than discrete, or when the device does not actually contain any gears, as in a continuously variable transmission.

Mechanism

A mechanism is a device designed to transform input forces and movement into a desired set of output forces and movement. The internal spur gear is transfers the torque to the cutter cylinder by gear engagement. The cutting mechanism is made of a flat blade rigidly fixed to the frame. Mechanisms generally consist of moving components such as gears and gear trains, belt and chain drives, cam and follower mechanisms, and linkages as well as friction devices such as brakes and clutches, and structural components such as the frame, fasteners, bearings, springs, lubricants and seals, as well as a variety of specialized machine elements such as splines, pins and keys.

3. MATERIAL USED

Mild steel



Fig.6. Mild steel

Wear of material

Wear is commonly defined as the undesirable deterioration of a component by the removal of material from its surface. It occurs by displacement and detachment of particles from surface. The mechanical properties of steel are sharply reduced due to wear. The wear of material may be due to the friction of metals against each other, eroding effect of liquid and gaseous media, scratching of solid particles from the surface and other surface phenomena. There are following principle types of wear as described below.

Abrasive wear

It results when nonmetallic particles penetrate the metal surface and Cause removal of metallic debris.

Adhesive wear or metal to metal wear

This wear caused due to relatives sliding or rolling movement of two mating metallic surfaces.

Erosive wear

Erosive wear occur as a result of relative movement between metal and liquid or gas.

Corrosive wear

The destruction of materials by the action of surrounding medium is called corrosion.

4. DESIGN CALCULATION

1. Gear calculation

No. of teeth on ring gear (Z_1) = 63

No. of teeth on pinion (Z_2) = 12

Module (m) = 3 mm

Diameter of gear (d_2) = $m \times Z_2$

$$= 3 \times 63$$

$$= 189 \text{ mm}$$

Diameter of pinion (d_1) = $m \times Z_1$

$$= 3 \times 12$$

$$= 36 \text{ mm}$$

Average forward speed (V) = 0.8 m/s

(It was chosen as the design standards for operational convenience (Kerner et al.,

1980)).

$$\text{Velocity (V)} = \frac{\pi D_2 N_2}{60}$$

Wheel diameter (D_2) = 200 mm

$$0.8 \times 10^3 = \pi \times 200 \times N_2$$

Speed of wheel $N_2 = 77$ rpm

$$\frac{N_1}{N_2} = \frac{Z_2}{Z_1}$$

Speed of cutter $N_1 = \frac{63}{12} \times 77$

$$N_1 = 402 \text{ rpm}$$

Weight of mower = 13.5 kg

$$= 132.435 \text{ N}$$

Average forward speed = 0.8 m/s

Power on machine wheel (P_w) = Weight \times velocity of machine

$$= 132.435 \times 0.8$$

$$P_w = 105.95 \text{ watts}$$

$$T_2 = \frac{P \times 60}{2\pi N_1}$$

$$= \frac{105.95 \times 60}{2\pi \times 402}$$

$$T_2 = 2.517 \text{ Nm.}$$

Shear stress on cutter blade (τ) = 1.602 $\frac{\text{N}}{\text{mm}^2}$

$$T_2 = \frac{\pi}{16} \times \tau \times d^3$$

$$2.517 \times 10^3 = \frac{\pi}{16} \times 1.602 \times d^3$$

$$d = 20 \text{ mm.}$$

3. Cutting force(F_c)

$$\text{Power on cutter cylinder } (P_c) = (m_c \times g) \times \frac{\pi D_c N_c}{60}$$

m_c - mass of the cutter = 6 kg

$$= (6 \times 9.81) \times \frac{\pi \times 0.14 \times 402}{60}$$

$$P_c = 173.449 \text{ watts}$$

$$\text{Torque } (T_1) = \frac{P \times 60}{2\pi N_c}$$

$$= \frac{173.449 \times 60}{2\pi \times 402}$$

$$T_1 = 4.12 \text{ Nm.}$$

$$= \frac{2.517}{4.12}$$

$$R = 1.637$$

$$= \frac{4.12 \times 6 \times 9.81}{1.637}$$

$$F = 148.14 \text{ N.}$$

4. Handle

Axial stress handle

$$(\delta_h) = \frac{F_h}{A_h}$$

Input force of drive

$$(F_h) = 50 \text{ N}$$

Area of the handle

$$(A_h) = \pi \times d \times l$$

$$= \frac{50}{\pi \times 20 \times 1050}$$

$$= 7.51 \times 10^{-4} \frac{\text{N}}{\text{mm}^2}$$

$$\text{Axial allowable stress of mild steel} = 50 \frac{\text{N}}{\text{mm}^2}$$

So, the design is safe.

Fabrication and Working

The conceptual design report highlights the design process used for this project. This report contains useful information with regards to the thought process and techniques used in analysing alternative solutions. The background and context for this project are discussed in detail in this report. The requirements that have been defined were established by doing market research and examining the problems that arise while using a manual mower. Basic and technical requirements have been defined for the project.

Basic requirements include physical characteristics such as weight and dimensions. These are fundamental to the safe and efficient operation of the mower. Technical requirements have been defined after initial calculations. A battery powered reel mower would separate the rotation of the blade reel from the rotation of the wheels, allowing the drum to spin faster and making it less susceptible to jamming. Reel mowers also cut lawns more evenly and much closer.

Working

Working of the lawnmower is depending on the wheel rotation. Wheel is the main component of this machine. The rotation is transferred from wheel to the spider by gear engagement. Also the rotation of the spider is controlled in one direction by the ratchet mechanism. It is placed on the pinion inside.

Rotating spider is strike the bed knife and the grass is sheared to applied level of cutting height. Maintenance of the height of cut is done using support rollers.

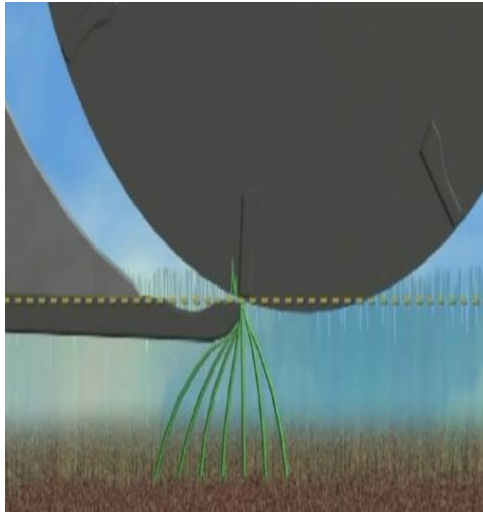


Fig.7 Grass cutting

Reel mowers also cut lawns more evenly and much closer. The cylindrical drum on a reel mower cuts every individual blade of grass like a pair of scissors. This produces a clean cut, which will protect the grass from disease and increases the health of the grass. Optimum clip rate is achieved when the bed knife and reel blades create small, even gatherings that are then cut. The result is a small, unnoticeable clip and an even after cut appearance.

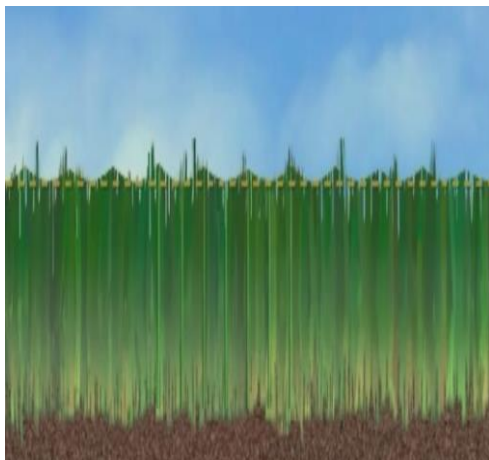


Fig.8 Clip rate-High speed condition

If the reel speed is too slow in relation to the groundspeed, there is too much space between cuts, resulting in visible clip marks and uncut grass. Visible clip marks in the turf are the result of an incorrect clip rate.

If the reel speed is too fast, in relation to groundspeed, the leaves of the grass plants impacted multiple times before being cut.

5. CONCLUSION

The progress in science & technology is a non-stop process. New things and new technology are being invented. As the technology grows day by day, we can imagine about the future in which thing we may occupy every place. The proposed system is found to be more compact, user friendly and less complex, which can readily be used in order to perform several tedious and repetitive tasks. The spiral blade lawn mower was designed, fabricated and tested. This does not have engine and is powered by the operator. Test revealed that, higher grass cutting efficiency is obtained when the lawn is dry before mowing. The machine is simply powered by manual pushing. Therefore, it can be used by both rural as well as urban dwellers. It is also affordable since the cost of production is low. High moisture content and undulated nature of the field surface affected the efficiency of the machine. The principle of the development of science is that "nothing is impossible". So we shall look forward to a bright & sophisticated world.

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