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Design and Modal Formulation of Power Operated Chaff Cutter

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ABSTRACT: The chaff cutter was simple but ingenious device for cutting straw or chaff or hay and oats into small pieces before being mixed together with other forage and fed to horses and cattle. Apart from being more economical than previous methods of feeding, this aided the animal's digestion and prevented animals from rejecting any part of their food. Since the chaff cutter was made largely of wood with only a small amount of iron work, it cost relatively little to make and, as a result, few farms, town or country stables were without one by the end of the eighteenth century. To overcome this, a Power Operated as well as manually operated chaff cutter will be used. This is also simple in construction, low cost. Energy and time will not require more than earlier chaff cutter.

Keywords: Chaff Cutter, electric Motor,

I. INTRODUCTION

The early chaff knives had a scimitar like shape with a carved blade broadening towards a cranked wooden handle. Most ended their days with undulating edges. Scythe blades were often modified and used. From the 1860's most factory produced replacement knives were made with straight cutting edges varying in length between 20-34 inches with cranked or cross head handles. At least 9 large edge tool manufacturers produced them in numbers including Isaac Nash and sons who continued to advertise their best crown chaff knives in the 1930's. The cutting position on some could be adjusted by moving the pivotal or hinge bolts into alternative holes drilled along the approximate end of the knife arm. When not in use the knife rested in an open ended bracket or stop situated half way down the position front leg. Knives were removed for thorough sharpening. Left handed boxes were uncommon.

Beneath the box a treadle, hinged to the knife arm or the adjustment leg, operated a wood block clamp situated inside the trough just behind the cutting edge. Its purpose was to compress the straw before cutting. The clamp was held by a narrow length of iron bar which extended vertical suits cut in both sides. In pre - 1800 form, this bar had looped ends from which ropes drew the clamp down on to the straw. But, in order to move the straw forward after each cut, the clamp had to be continually pulled up by hand using a piece of cord tied between the side and an iron staple located on top of the clamp. In the later development the clamp was perforated by a spindle and held between an inverted bracket joined to be treadle by a single hook or chain.

By 1815 this type of linkage had been sprung by a length of spring steel or wood bolted under the feed end which automatically returned the clamp to its upper pre-compression position whenever the treadle was released. Some boxes, however, were equipped with a less wide spread form of recoil springing, the principal of which probably originated in Europe. It comprised of two springy wooden poles fastened to the rear sides of the box, the overhanging ends of which were tied to the ends of the clamp bar. Another more durable method of springing was provided by a pair of side mounted steel rods attached directly to the clamp spindle. These rods, under tension, were slightly curved and fastened by brackets towards the feed end of the box.

Working with a sprung clamp the trough was filled with straw and with the operator's left hand holding the curved handle of the dwarf fork, the tines embedded in the bundle, the operator passed it forward under the raised clamp to an inch or so past the cutting edge. Then with his left foot on the treadle, his right hand holding the knife, he pressed the treadle down compacting the straw, raised the knife to a high position and brought it down and across the face of the cutting edge slicing the protruding straw into half inch(13mm) long pieces. The foot was taken off the treadle, releasing the straw and the fork used to push the bundle forward again to repeat the process. The operator sometimes stood with his right foot on a small stool to apply more downward pressure on the treadle with his left foot. For two men working often a man and a boy, some boxes were equipped with a additional but smaller chaff fork with only three times situated and secured at the feed end.

The assistant loaded the straw and moved it along with his fork to the operator who continued as before. A stable riddle or biting sieve was usually placed below the cutting end to catch the cut chaff.

Types of Chaff Cutter

On the basis of cutting mechanism, the chaff cutter shall be of following types

a) Fly wheel type, and

b) Cylinder type.

On the basis of cut-chaff dropping position, the chaff cutter shall be of following types

a) Let-fall type,

b) Throw-away type, and

c) Blow-up type.

On the basis of feeding system, the chaff cutter shall be of following types

a) Chute-fed, and

b) Conveyor-fed.

Terminology

For the purpose of this standard following definitions shall apply

- **Fly wheel type:** A chaff cutter is having rotating fly wheel with blades.
- **Cylinder type:** A chaff cutter is the cutting mechanism in which it consists of rotating cutting cylinder.
- **Let fall type:** A chaff cutter is that in which the cut fodder is dropped down to the bottom of the chaff cutter.
- **Throw way type:** A chaff cutter is that in which the cut fodder is thrown away to the front ward of the chaff cutter.
- **Blow up type:** A chaff cutter is that in which the cut fodder is blow up through the blow-up pipe.
- **Chute fed chaff cutter:** A chaff cutter is that in which the feeding of the fodder crop is done through a chute.
- **Conveyor fed chaff cutter:** A chaff cutter is that in which the feeding of the fodder crop is done through a conveyor.

II. COMPONENTS OF CHAFF CUTTER

A. Technical specifications:

Sl.No.	Type	Manual/Power Operated
1	Type of Gear Box	Made by Cast Iron
2	No of Rollers	02
3	No of Blades	02
4	Width of Mouth	20CMS/8 inch
5	Drive Wheel	C.I. FLAT
6	Output	70-80kg/hr
7	Approx. Weight	120kg
8	Motor speed	1400 rpm

B. Materials of Construction.

Sl.No.	Components	Material
1	Handle	Mild Steel
2	Fly Wheel	Cast Iron
3	Main Shaft	Mild Steel
4	Worm &Worm Gear	Cast Iron
5	Feed Rolls	Cast Iron/Mild Steel
6	Cover plate	Cast Iron/Mild Steel
7	Feed Roll Shaft	Cast Iron/Mild Steel
8	Gears	Cast Iron
9	Pulley	Cast Iron
10	Blade	Mild Steel
11	Legs	Mild Steel
12	Leg Support	Mild Steel

Handle. Handle shall consist of handle support of mild steel rod and a wooden grip placed over the rod. The diameter of the handle support should be minimum of 15 mm. The total length of the handle shall be at least 500 mm and the length of wooden grip shall be 430mm to 450 mm. The diameter of the grip shall be 37 mm to 42 mm. The grip shall be properly attached with the support. The one end of the support shall be threaded. The handle shall be attached with fly wheel by a hexagonal nut with washers.

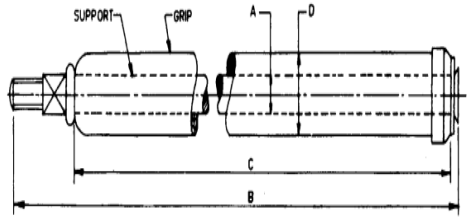

Fig. 1. Handle.

Fly Wheel. A flywheel of 900 mm to 1350 mm diameter shall be provided. The flywheel shall have two arms. Each arm shall be provided with one square hole for fixing the handle; three holes for fixing the blade and six tapped holes for fixing the bolts for blade setting adjustment. At the centre of the flywheel a circular hole shall be provided for connecting it to the main shaft. A hole of 10 mm diameter shall be made in the rim of the flywheel parallel to direction of the hub hole. The weight of the fly-wheel shall not be less than 24 kg.

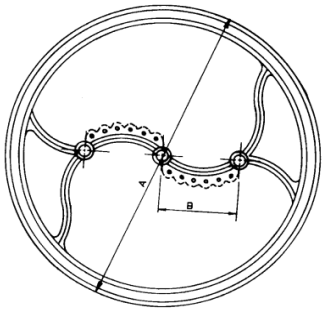

Fig. 2. Fly Wheel.

Main Shaft. The one end of the main shaft shall be rigidly attached at the centre hole of flywheel and other end may be supported on a plumber block. The length and diameter of the shaft shall be 400 mm and 30 mm respectively. Plumber block shall be provided with bush or ball bearing.

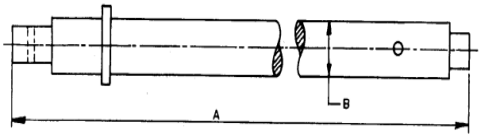

Fig. 3. Main Shaft.

Worm and Worm Gear. The worm shall be fitted on the main shaft. The hole size of the worm shall be such that it should push fit on the main shaft. the outer diameter and length of the worm shall be 75 mm or 80 mm and 155 mm respectively. The pitch of the worm shall be 25 mm. It shall be provided with two holes for proper fixing to the shaft. The distance of centre of hole from the end of the worm shall be 50 mm or 13mm.

OTE —The pitch of the worm at both ends shall be 25 mm but teeth a tone end may be double start to enable to have two chopping length by reversing the worm.

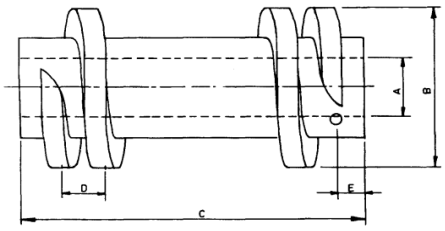

Fig. 4. Worm and worm gear.

Warming Roller. A warning roller which is a sort of idler roller with spring shall be fitted just before the feeding rollers as an alternate to cover chute.

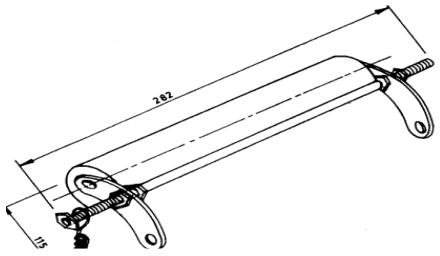

Fig. 5. Warming Roller.

Feed Rolls. There shall be two feed rolls. The length and outer diameter of the rolls shall be 207 mm and 75 mm or 85 mm respectively. Each roll shall have eight projections on circumferential periphery. The lower roll shall have 11 fill teeth and upper roll 10 full and two half teeth on lengthwise fixing the axles.

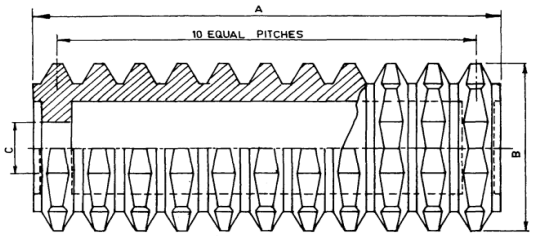

Fig. 6. A Lower Feed Roller.

Back Plate. There shall be one back plate fitted in between two side plates at the rear. The length of the back plate shall be 207 mm and width including teeth shall be 145 mm. There shall be 12 teeth in the back plate.

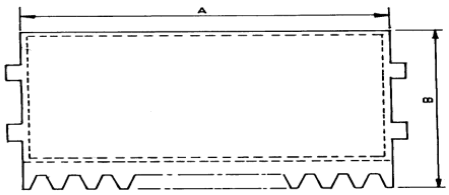

Fig. 7. Back Plate.

Shear Plate. A rectangular plate with top open shall be attached at the front of the feed rolls. The width and height of the plate when measured internally shall be minimum 207 mm and 105 mm respectively. The shear plate shall have 12 fill teeth.

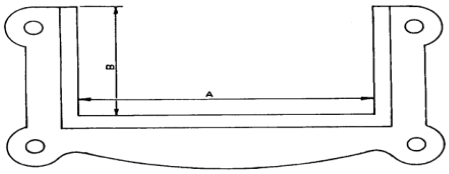

Fig. 8. Shear Plate.

Stand. Stand shall consist of four legs, leg supports and one finger in each leg. The leg shall be made of angle section of minimum 50 mm x 50 mm x 2 mm size. The leg support may be detachable or riveted with the leg. The fingers may be a separate component attached to the leg or maybe made by taking out at the bottom of each leg. The total height, length and width of the stand shall be minimum of 750 mm, 600 mm and 550 mm respectively. In one of the legs a hole of 10 mm shall be provided at a point coinciding with the hole made in the rim of the fly wheel.

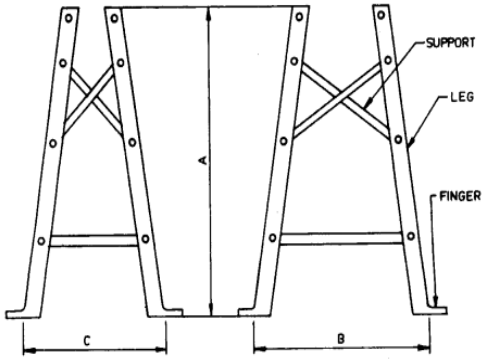

Fig. 9. Stand.

C. Electric Motor

An electric motor is an electrical machine that converts electrical energy into mechanical energy. The reverse of this would be the conversion of mechanical energy into electrical energy and is done by an electrical generator. In normal motoring mode, most electric motors operate through the interaction between an electric motor magnetic field and winding currents to generate force within the motor. In certain applications, such as in the transportation industry motors with traction motors, electric motors can operate in both motoring and generating or braking modes to also produce electrical energy from mechanical energy.

Fig. 10. Electric Motor.

In this chaff cutter 2HP, single/three phase electric motor is used. To this electric motor pulley is fixed at one end, which is connected to fly wheel with the help of flat belt.

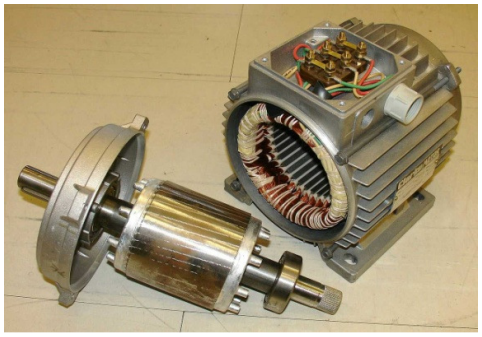

Fig.11. Rotor of Electric Motor.

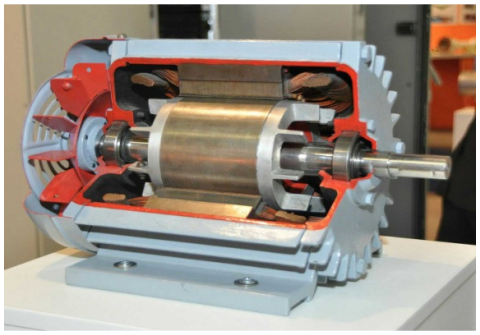

Fig. 12. Cut view of Electric Motor.

D. Other requirements for Chaff Cutter

- The worm gears should as far as possible, be enclosed and should preferably be run on an oil trough.
- The bearings shall be completely enclosed and shall have provision for lubrication.
- Provision shall be provided to change the inclination of the plane of the cutting.
- Knives to the plane of rotation of fly wheel to avoid feed interference.
- Provision to change the direction of rotation of feed rolls should be provided.
- Hooks at suitable places maybe provided for lifting the chaff cutter for easy movement.
- The maximum height of cranking from ground level shall be within 800 to 900 mm. The cranking radius shall be 250 to 350 mm
- All the three sides of shear plate shall be in one plane.
- Operational manual giving operational, maintenance, assembly instructions and adjustments shall be supplied by the manufacturer with each chaff cutter. Instructions for safe operation of chaff cutter shall also be provided.

III. WORKING OF CHAFF CUTTER

A. Working Operation of Manual Chaff Cutter

Operate the fly wheel of the chaff cutter at 50 rev/min and feed the fodder manually. Ensure that the feeding is done continuously and covers full width and height of the throat. The feeding should be done from root side of the fodder.

A handle is provided to the fly wheel, by which e can rotate the fly wheel. Blades are attached to the fly wheel through which the chaff or straw or hay can cut. Chaff is feed through tin sheet metal into a feed roller, where worm gear is available. When fly wheel rotates by means of handle, the fly wheel shaft is connected to the feed roller, by which the roller will rotate and it will moves the chaff towards Blades. Then chaff will cut into small pieces. Then this will provide to cattle.

Designed and developed using technological advancements, hand operated chaff cutter or manual chaff cutter machine is highly precise machine and are smooth to operate. Impeccably designed, these chaff cutters are useful for chopping up hay and oat-straw to feed livestock and prepare fine raw material for food processing industries.

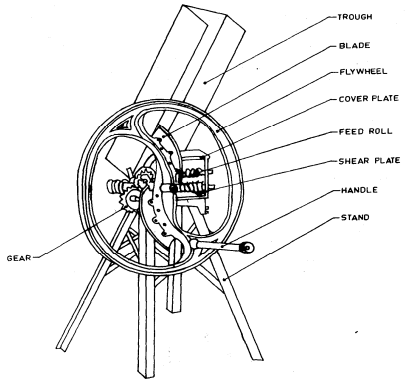

Fig. 13. A Typical Drawing of Manually Operated Chaff Cutter.

B. Working Operation Of Power Chaff Cutter

Chaff cutter machine for feed is powered by electric motors, drive main shaft, Main shaft gear through the gear box, universal joints, etc. pass speed regulation power to compression roller. When the material enter the compression roller Tsao kun clamping pressure and cut into cutting institutions at a certain speed enter the cutting part, approved by high speed rotating cutter cut up after the through the material outside.

Power Operated chaff cutter consist a electric motor which is 2HP, three phase and Starter is required. A flat belt (leather) is connected to fly wheel and motor pulley through which the fly wheel will rotate. When power supplied, the motor will starts, then the fly wheel rotates through a flat belt. At the same time the chaff feeds through a tin sheet metal. The feed roller connected by fly wheel main shaft through which the feed roller will rotate n then it will carry the chaff towards the Blades with the help of worm gear mechanism system. Then the chaff will cut into small piece, it will helpful for cattle.

Motors are the mating powers. The powers are transmitted to the main shaft. The gears on the other side of the main shaft transmits the speed governed power to the grass roller though the gear box, cardan joint, chains and others. When the materials under processing enter into the upper and lower grass rollers and after being fed into the cutting room by the grass rollers and cut in the cutting room, the materials get out from the outlet hole through high speed cutter.

Fig. 14. Power Operated Chaff Cutter.

IV. TEST ON CHAFF CUTTER

A. Idle Run Test

Fix the chaff cutter on level and preferably on hard surface. Operate it for 30 minutes. During the operation observation shall not show the following:
a) Presence of any marked oscillation.
b) Presence of knocking or rattling sound.
c) Obstructions in running of shafts in bearings, and
d) Any marked unusual wear or slackness in any component.

B. Tests for Variation in Cut Length

Installation

Fix the chaff cutter firmly on the level and preferably hard surface. Set the clearance between blades and shear plate and make other adjustments in accordance with the manufacturer's recommendations for cutting a particular length of the chaff.

Fodder. Take sufficient quantity of fodder to be cut. The fodder should be of same variety and free from roots. The length of the fodder should, as far as possible, be the same.

Theoretical length. The theoretical length of the fodder to be cut shall be obtained by the following formula:

$$x = \frac{n}{N} \times \frac{22 \times D}{7 \times R}$$

where, x = Length of cut in mm,
n = rev/min of feed roll,
N = rev/min of fly wheel,
D = Diameter of the feed roll,
R = Number of blades.

V. ADVANTAGES AND DISADVANTAGES

A. Advantages

- Chaff Cutter has steel structure.
- Equipped with safety device. Reliable and safety.
- Compact structure simple operation and installation.
- Chaff cutter has long service life.
- Skilled persons are not required.
- For operating manually more energy is not required.

B. Disadvantages

- Chaff cutter is not easily portable.
- High power consumption.

C. Applications

Dairy farms: In dairy farms it is used to cut the chaff, dry grass, green grass at a very large scale.

Farm fields: Farmer uses the chaff cutter for cutting the chaffs and other things which are to be feed to the domestic elements.

Animal food processing industries: Now a day, there are industries which manufacture food for animals through this chaff, there also this chaff cutter is used.

VI. CONCLUSION

Implementation of technology in the field of agriculture has brought a very wide changes in manual procedures are replaced by advanced technical procedures.

Here before we used to cut the chaff, grass manually to be feed the animals. When it was in a very large scale it is difficult to cut and time consumes more. Due to in the chaff cutter, chaff can be easily cut in a very least time and helps avoiding injuries because through manual chaff cutter, we can get injuries. So technology has brought a wide change in the field of agriculture.

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