INVENTION PROTOTYPE OF INDUSTRIAL SARDINE CUTTING MACHINE

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***Abstract* –** This paper gives the reader an insight in to the work we went through to invent the concept for an automated Industrial Sardine cutting machine. The challenge given to us by the Industry was to prototype a machine that can cut and gut the head of sardines automatically on a large scale. Variation of Fish size is not too much of a concern as the raw material is graded fish. We set out to invent a simple but strong concept resulting in a machine with minimal complexity which will reduce the cost of production and also improve the ease of maintenance. This paper is testament to how we achieved a supposedly complex automation using simple mechanical automation. To support our concept we also set out to build a prototype of the proposed machine to prove this concept will work.

I. INTRODUCTION

Canning is a method of preserving food in which the food contents are processed and sealed in an airtight container. Seahath is one such fish canning company. Right now Seahath is one of the largest manufacturers of canned seafood’s in India. The products of Seahath being sardines, mackerel & Tuna in different varieties like brine, tomato sauce, oil, etc.

At present Seahath cannot cater to it’s requirements using manual cutting of fish since it is time consuming and labour intensive. So they are forced to import pre cut fish from Karnataka. There are Sardine cutting machines existing abroad but the cost of importing them is high and does not figure well in to the company’s profit. This entire situation can be resolved if we can design an Industrial Large-scale Fish cutting machine. The machine can be built at a lower cost and since it is our own design it can be patented. Also we have strived to keep the design as simple as possible with the best possible functionality that will lead to ease in manufacturing and also ease in further maintenance which will result in overall cost efficiency in the cutting department. Because of budget and time limitations as we are students we have fabricated a prototype to prove our concept works and which will be used by the company to make a full-scale working industrial machine.

II. FISH SPECIFICATIONS

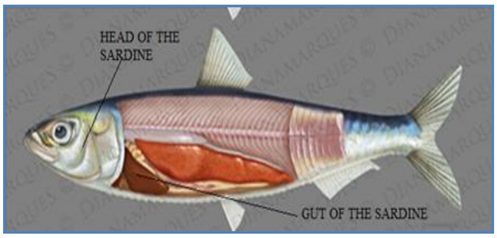

Fig.1 : Head and the gut of the fish

In this fig as shown above the head and the gut of the fish are marked. This are the two things which are supposed to be removed and the rest of the body is further processed and then canned.

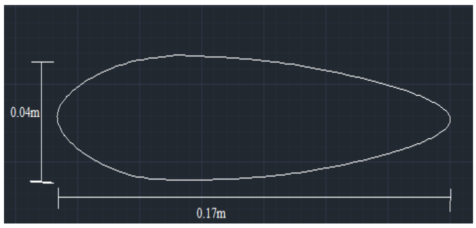

Fig. 2 : Top view of the Sardine

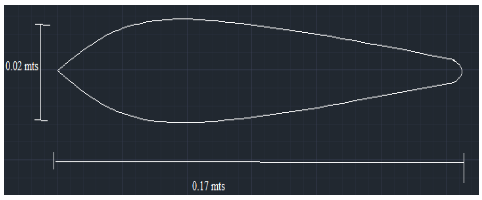

Fig.3 : Side view of the sardine

These dimensions which are mentioned here were provided to us by the industry. Since canning is the done, fishes are passed through quality control or in general graded to a certain size to fit the can.

Length of the fish (sardine) = 0.17 m

Width of the fish (sardine) = 0.04 m

Thickness of the fish (sardine)= 0.03 m

III. IDEOLOGY

A. *Inspiration*

The main inspiration for designing this machine was obtained by observing the manual cutting of fish. So it was observed that we need a mechanism that will hold the fish during the cutting and a forward motion against the blade to cut it. But the cut has to be partial leaving the gut portion of the fish untouched for further cutting. Then the head can be separated along with the gut buy moving the fish forward while blocking the head with a fixed object.

Now the next obstacle was to ensure that all fish have their head pointing forward while they enter the machine. This is achieved by dropping the fish on to a vibrating platform. By nature the center of mass of the fish is very near to its head. Due to this the fish will always move in the direction which its head is pointing. Hence using this property and a vibrating platform we can get the fish sorted.

IV. VISUALIZATION OF IMPORTANT COMPONENTS

A. *Drum*

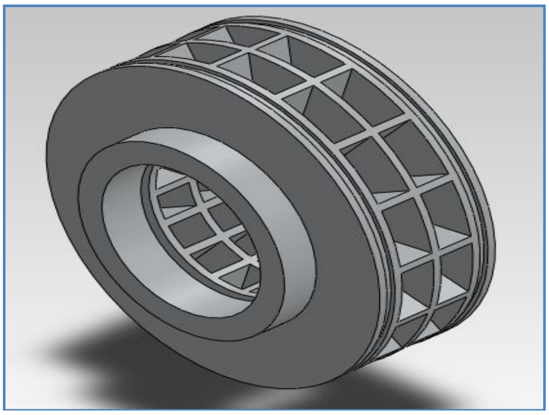

Fig.4 : Drum

As discussed earlier we need a method of holding down the fish during the cutting operation. So this function is performed by the drum. The drum has slots in it with a narrowing cross section. The cross section at the inner radius of the drum is closely equal to the width of the fish at its neck. Also the rotation of the drum is what gives the fish its forward motion allowing for the cutting operation to take place.

B. *Cutting block*

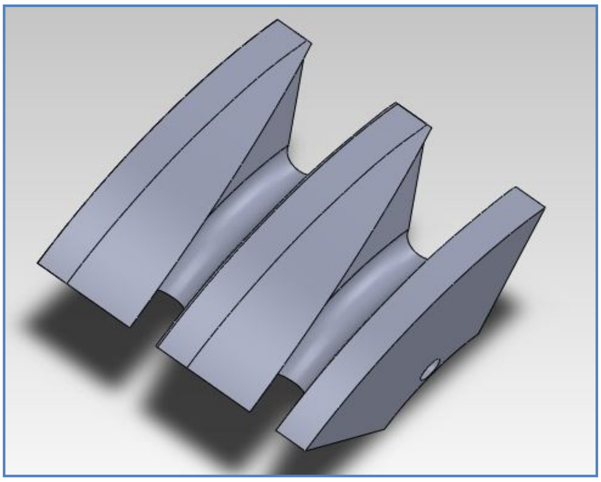

Fig.5 : Cutting Block

The cutting mechanism is a solid block with a slot in it as shown above. Now this slot very nearly mimics the profile of the fish at its neck. This provides additional support for the fish apart from the drum. Also if any fish were to slip through the drum it will be held by the block. And a curved blade with a gradually reducing surface area is fitted to this block as shown below. The blade is placed such that it initially allows the fish to adjust in the slot and then gradually gives a deep cut at its neck. Also the entire slot is not covered by the blade. This is to ensure that the gut of the fish is not taken away.

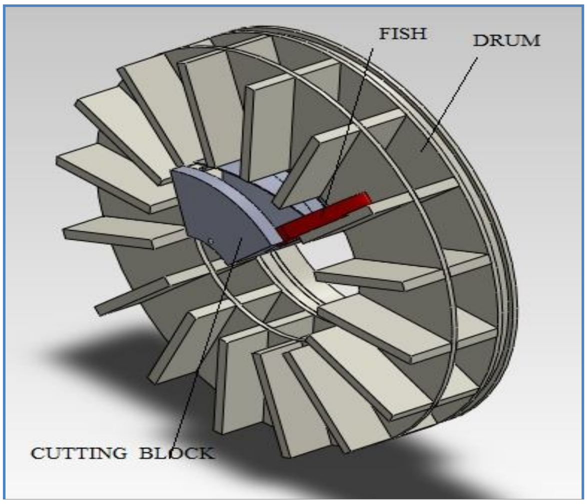

Fig.6 : Cross section of the drum with the fish being cut

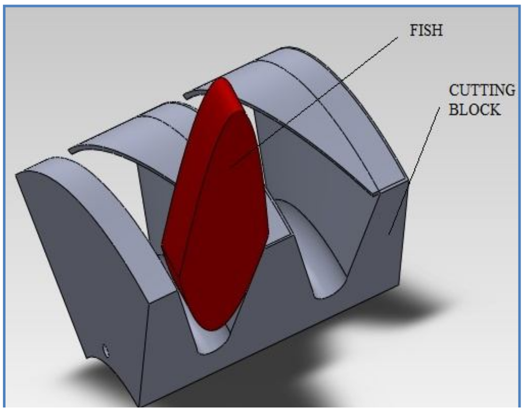

Fig.7 : Cutting Block with the fish

V. WORKING

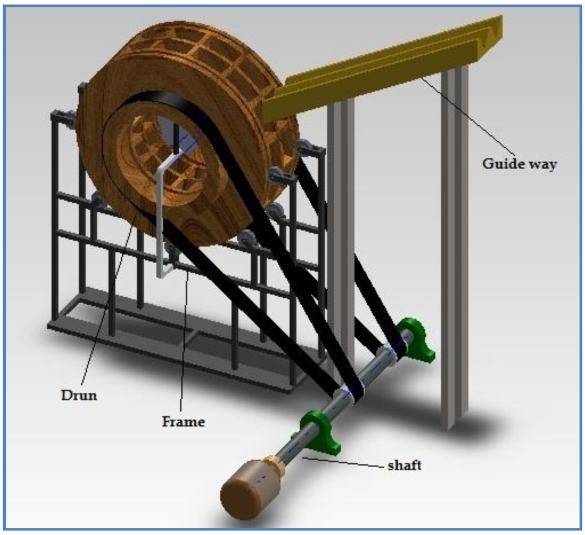

Fig.8 Assembly

The fish will initially fall on the Guide lanes. Then the forward facing fish will slide down into the slot. From the guide lane the fish will fall in to individual slots given in the drum. Now the head of the fish is resting in the cutting mechanism while the body of the fish is held by the drum.

The drum is resting on rollers on the support frame. The frame is fixed to the ground. The drum has pulleys that are attached by belt to corresponding pulleys on a metal shaft. The shaft is coupled to a motor. So any drive given by the motor will result in rotation of the drum. The motor speed reduction and the pulley ratios are adjusted in such a way that we get desired speed/RPM on the drum.

Now the fish is at its initial position in the drum as discussed above. By giving power to the motor the drum is rotated. As the drum rotates the fishes head is dragged through the cutting block. The cutting blade will cut the fish up to its gut. The fishes head will hit a fixed platform as it comes out of the cutting block which will cause the head to shear off along with the gut. So the fishes passing through the machine end up cut and gutted. These cut fish are then carried away for further processing.

VI. DESIGN

Design involves basic components the drum the cutting block and the frame.

A. Drum

Drum is made of plywood for prototype it will be made of AISI 304 steel standard for food processing.

1. Size of the slot

Based on width and thickness of fish at its neck.

Length of slot(Ls)- 0.04 m

Breadth of slot(Bs)- 0.03 m

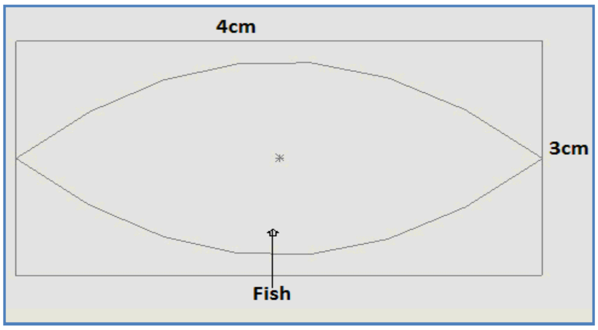

Fig.9 : Fish cross section at the bottom of the slot

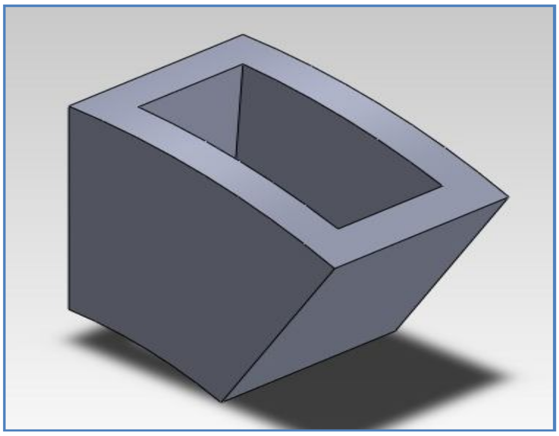

Fig.10 Slot

Assume Number of slots (N) = 16

Plate thickness (Tp) = 0.0045 m

Inner circumference = N(Tp+Ls)

= 2Π(Ri) = 0.628 m

Inner radius (Ri) = 0.1 m

Outer radius (Ro) = Ri + Length of fish above neck

= 0.210 m

Width of roller grove= 0.010 m

Depth of roller grove = 0.005 m

2. Speed of the drum

The speed/RPM of the drums rotation depends on how fast the fish has to move on the blade for it to get cut smoothly. So an experiment was devised to decide this.

3. Experiment

A straight cutting blade was taken and placed on a plane surface.

Two points at a known distance was marked on the blade clearly with marker.

Then the fish was cut on the bade.

Depending on the feel a suitable stroke speed was determined.

A video of the cutting operation was taken and the time taken for fish to move between the two marked points was noted.

Now convert the linear velocity to angular velocity to obtain the drum speed.

Dist between two points- 0.13 m

Time taken- 2sec

Linear velocity = 14/2 = 0.07m/sec

Linear velocity= Radius* Angular velocity

Radius- 0.1m

Angular velocity= 7/10 = .7rad/sec

⇨ RPM of drum- 7RPM

After further experimentation we have concluded that the machine will work in a range of RPM between 1RPM to 17RPM.

The optimum speed will be decided on the output required.

B. Cutting block

Cutting block is made out of mild steel for prototype will be made out of AISI 304 SS used in food processing in industry

Depth of slot(Ds) = Length of head = 0.05 m

Width of slot= Width at neck (Wf) = 0.04 m

Dist between groves=Tp= 0.0045mm

Outer radius of block (ro) = Ri – Clearance(0.002m)= 0.098m

Inner radius (ri)= ro-(Ds+5) = 0.043 m

Radius of bottom grove= 0.0075 m

The blade is right triangular

Base= 0.037 m

Height= 0.104 m

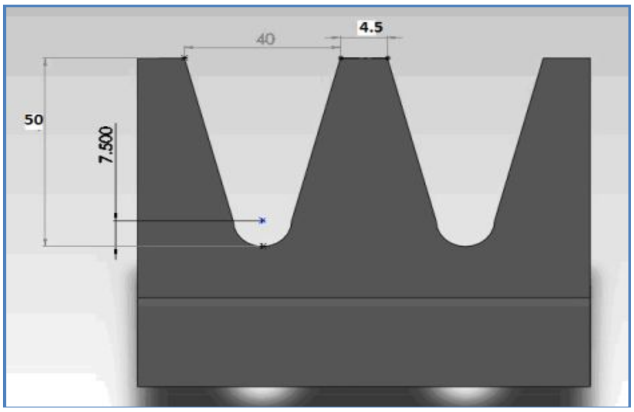

Fig.11 Cutting block dimensions

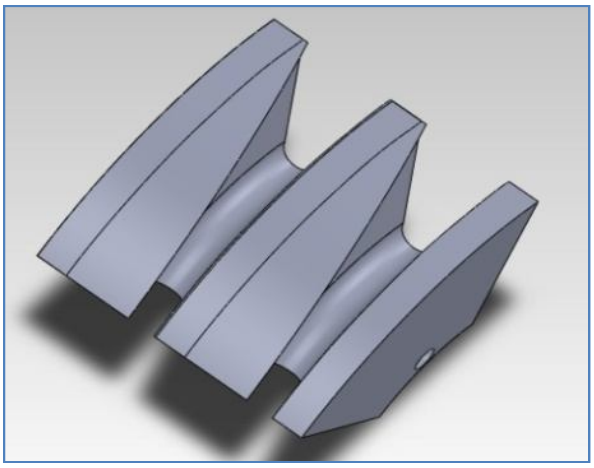

Fig.12 : Cutting block

C. Cutting capacity of the drum and cutting block

For every rotation of the drum there will be 32 slots passing the cutting blade. So the number of fish cut per minute for various speeds will be 32*RPM of the drum. Cutting capacity for following speeds is given below.

RPM	CUTTING CAPACITY/MINUTE
1	32
2	64
3	96
4	128
5	160
6	192
7	224
8	256
9	288
10	320
11	352
12	384
13	416
14	448
15	480
16	512
17	544
18	576
19	608
20	640

Fig.13 Theoretical Cutting capacity table

D. Frame

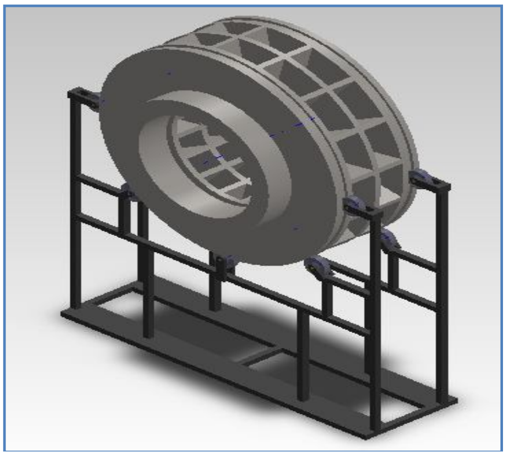

Fig.14 : Frame

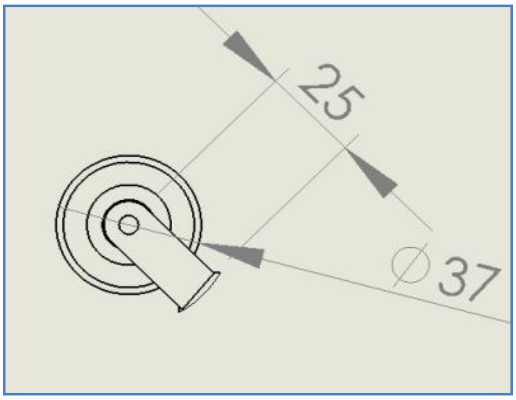

Fig.15 : Frame Wheel

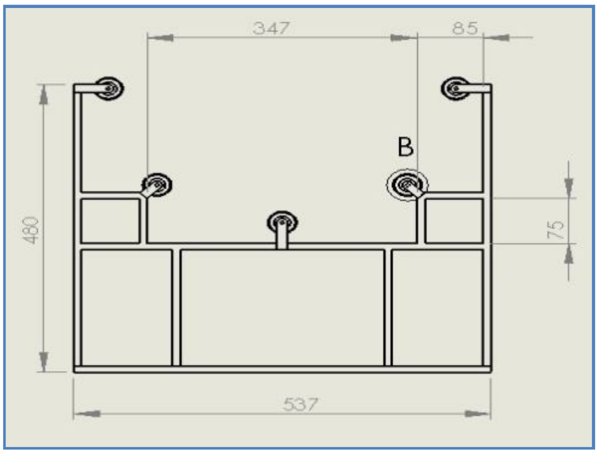

Fig.16 frame

The frame was designed in solid works. It is designed in such a way as to support the drum and allow it to roll on rollers and should not interfere with the belt drive. The dimensions are as shown above.

Frame was made out of Mild steel for the prototype for the actual machine it would be made of stainless steel

VII. DRIVE TRAIN

The basic components of Drive train are motor, coupling ,pulleys and the belt drive. Belt drive is made out of leather motor is a 108 W, 90 rpm motor, 12 N/m torque belt drive and the pulleys have a ratio of 6:1 to get 15 rpm on the drum. coupling used is spider coupling.

VIII. PROTOTYPE ACTUAL DESIGN

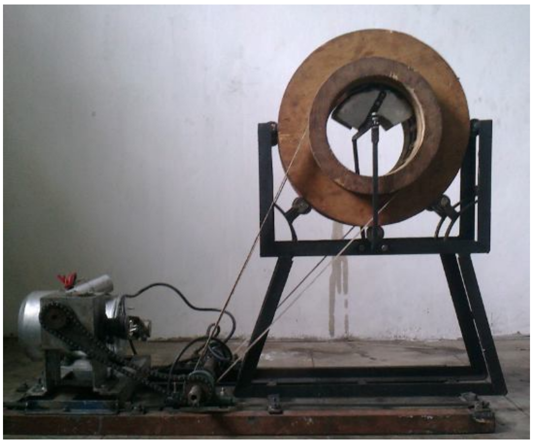

Fig.17 : Actual prototype

In the actual design of the prototype only the drive train is changed we have put motor which is single phase and 1440 rpm with v-belt attached to it. Then it is coupled with a gear box of gear ratio 1:150 and then further attached to the shaft by chain drive shaft has pulleys which are connected to the drum by a flat belt drive. All this reduction leaves the drum rotating at approx 2 rpm.

IX. FUTURE SCOPE

1) Seahath Canning Company is going to manufacture a full scale production model of the Fish Cutting Machine based on our prototype.
2) Our research can serve as a basis for future machines.
3) Further efficiency calculations can be carried out on prototype to maximize production.
4) Since it is our own design it can be applied for a patent.

X. ACKNOWLEDGMENT

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