DESIGN AND EXPERIMENTAL INVESTIGATION ON VIBRATORY FEEDER FOR BOLT THREADING MACHINE

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Abstract—This research paper is all about the vibratory bolt feeder machine, by using of vibratory system. It describes the assets of vibratory bolt feeder, in short VBF, over the conventional bolt feeder system. Old machine commonly uses in bolt feeding industry. Old system has consisted of several type of trouble. Some of them are, it consist moderate feed rate of bolt as well as drain more energy to operate as compare to vibratory bolt feeder machine. This paper consists of design and development of vibratory bolt feeder machine.it is an integrated model of several parts which first design and later it would be developed. Whole structure of VBF built on round circular plate. On which magnetic coli was mounted and connected with the bowl. Leaf spring connects with bowl to base for provide external support for bowl as well as compensate the force also. Trap is laid inside the bowl through which bolts were feed. It whole machine works on vibration which regulated by controller.

Keywords—Vibratory; Bolt Feeder; Trapdesign;Bolt threading Machine

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1. INTRODUCTION

This paper is all about the vibratory bolt feeder machine. It describes feature as well as design and development of whole vibratory blot feeder machine with regards to industrial uses. It also describes how the designs and development of machine have been done and how the dimensions are selecting.in sort, whole descriptive methodology is covers in this paper.

In current era of industrial market, phenomenal competition is going on. Every industry wants to extrude there machinery as well as upgrade according with repetitive period of time. More often in traditional industry like bolt manufacturing company should upgrade with latest technology.so, this vibratory bolt feeder is conduct with it but how? Bolt manufacturing process is takes on several machining process. There are bolt heading, bolt threading respectively. In bolt heading process long constant wire first brakes into the small pieces according with bolt size required. Than in next process, bolt feed into the bolt threading process for that conventional bolt feeder were use.in spite of that VBF should be use. Conventional bolt feeders should have more ideal time which lad it to more energy drain with low or moderate production rate. To overcome that trouble, vibrator bolt feeder machine should be use.it works on the vibration system to feed the bolt in proper orientation to the bolt threading machine.

This machine is develops by using mechanical as well as electrical knowledge because it works on basis of mechanical principal but controlled through controller. Controller varies the feed rate of bolt as per our requirement.

Vibratory bolt feeder machine is call as VBF in short.it develop by using several integrated parts which are first design according with requirement and then it develops. It mainly contains five parts and they are:

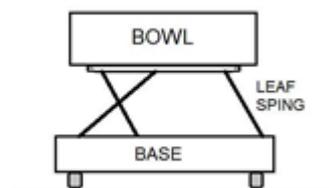1. Base
2. Leaf spring
3. Bowl
4. Trap
5. Magnetic coil

Fig.1 Schematic Diagram of VBF

In initial stage of design, each part has been made and then in second phase each part has been developed and in third or last phase of project, they were examine or critical analysis has been done over it. The physical structure of VBF is shown in Fig.1 how it looks alike after it developed. The base has been made from cast iron and much heavier in weight. The magnetic coil placed on base it provides vibration to bowl which exactly mounted above it. Bowl is getting alternate support from three leaf springs which held inclined and connect bowl with base. There is an inclined trap design into inner circumference of the bowl

2. PROBLEM DEFINATION

In bolt manufacturing industry, there are needs of feeder machine to feed parts or bolts in proper orientation. There are several Traditional method are available like rotary and reciprocating feeder. Mainly rotary feeder is more preferable for bolt manufacturing. The rotary feeder

machine is shown in Fig.2. It is traditional way to feed the bolt to the bolt threading machine. In which each bolts are feed respectively one after another.

If we say it as probabilistic system so it is not wrong, because its working method proves it. It has one rotary bowl which rotates in vertical direction about horizontal axis. One traps which placed between canter of bowl to the threading machine. The bowl is rotate through motor, and bolts are put in it and while it rotates the bolts are bubbling in it and out of them, some bolts probably less number but properly placed in trap and feed. So that number of bolt are in way to place in trap but unfortunately some of them were placed which laid to enhance the ideal time for bolt threading machine as well as consume more time and energy to complete the task. There were many other troubles also their like while bolt bubbling in the bowl they might had clash among them and between bolt and trap which led to damage the bolts and trap. This machine required large space area, too.

In short, this traditional way of feeding system consist of lots of bother and they have low production rate, more energy consumption and part defect.

Fig.2 Conventional Bolt Feeder Machine or Rotary Feeder Machine

Fig.3 & 4 Bowl of Conventional Feeder

3. DESIGN OF PRINCIPLE COMPONENETS

Before Design is the process of making virtual structure of part or machine as per actual dimension or scale dimension via different software like AutoCAD. Design is most important thing to accomplish of any project or work.it gives prototype image or virtual structure which we will want to make in future.

In VBF, there are mainly four parts to design and they are following:

1. Base Plate
2. Leaf spring
3. Bowl
4. Trap

1. Base Plate:

Base is most essential part for any kind of machine because it provides support for all machine parts on it. In VBF, all integrated are placed on round plate which shown in Fig.5. It is made up from the cast iron because it must be come into compression and cast iron best martial to sustain compressive force. Their dimensions are ϕ 260 mm* 40 mm.
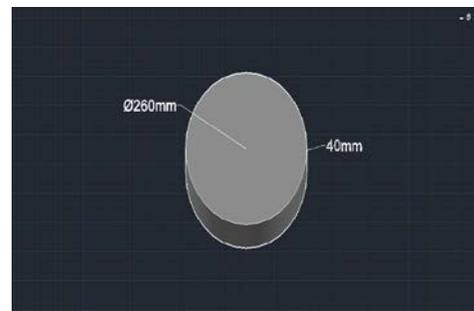

Fig.5 Base Plate

2. Leaf spring

As per the structure of VBF leaf spring is parts which connect the bowl with base. It also provides external support to bowl. It poisoned in inclined way rather than straight one. The reason behind is that the resultant force acting on bowl is in inclined way so after it resolute in horizontal and vertical component we need place leaf spring in such way that it compensate both resulted force that's why it placed in inclined way.in that potion spring comes in both tension and bending so, for that select such material which have higher sustainability against tension as well as bending also. Temper (55si2mm90) is the best material for spring which higher capability against both tension and bending. Their dimensions are deriving from using given equation that is 15mm*3mm. it structure as shown in Fig.7.

The dimension of leaf spring are finding with using following equation.

Load to be sustain

Weight = mass base plate of bowl + mass vertical circumference wall

$$= \delta * v + \delta * \pi * D * t_1$$

Width & thickness

Allowable bending stress is = 600 MPa

$$\sigma\_b = (6 * W * L)/(n * b * t^2) \qquad (1)$$

Deflection of spring (δ) = 1.5mm to 2mm
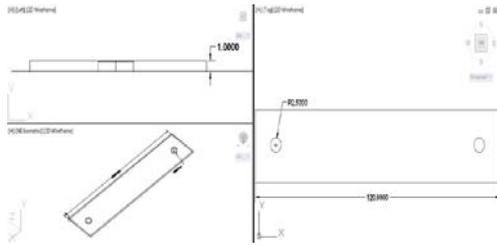
$$\delta = (6 * W * L^3)/(n * b * t^3)$$
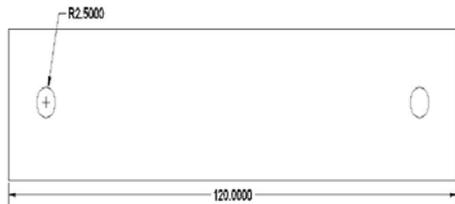

Fig.6 Orthogonal View of Leaf spring

Fig.7 Dimensional Parameters of leaf spring

3. Bowl

It is an essential and most critical part for VBF, in which all the bolts are storage.it is connected with leaf spring for external support and connect with magnetic coil from which it gets the vibration.so, it is made from metal sheet.

4. Trap Design

It is most critical part to design. It placed in inner peripheral surface of bowl in spiral way. For design the trap following process is proceeding:
a. Bowl inner peripheral surface divide into ten equal parts Fig.9.
b. Cut the peripheral of bowl form one point and then it convert in rectangular plane and draw the straight line between any two diagonal of rectangular plane Fig.10.
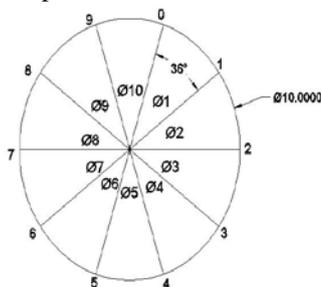c. By using trigonometric equation solve the equation and get the angel of trap.

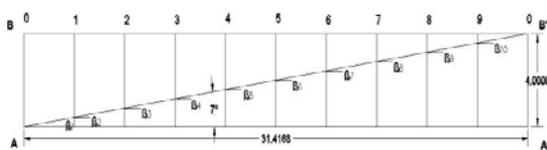Fig.8 Division of Bowl into equal part

Fig.9 Bowl Peripheral converts into Rectangular Plane

Conical trap linearly increase in all parts

Angel made in all parts = $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8, \beta_9, \beta_{10}$

All angels are same

$B = \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = \beta_8 = \beta_9 = \beta_{10}$

$$\tan \alpha = \frac{A'B'}{AA'}$$

$$\beta = \tan^{-1} \frac{A'B'}{AA'}$$

$$\beta = \tan^{-1} \frac{4}{31.4}$$
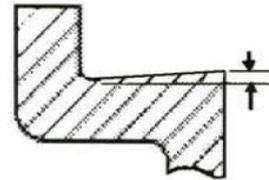
$$\beta = 7.26°$$

Fig.10 Positive Trap angle
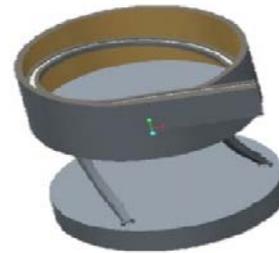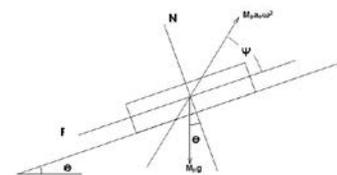

Fig.11 Solid Model of VBF

FORCE ANALYSIS

Fig.12 Force Analysis

Angel of inclination of the feeder track - θ
Vibration angle - φ
Track amplitude - A_o
Track amplitude parallel to the track - A_p
Track amplitude normal to the track - A
Mass of bolt or feed part - M_b
The coefficient of static friction between the track and bolts- μ_s
Gravity - g
Friction force – F

$$M_b A_o \omega^2 \cos \varphi > M_p g \sin \varphi + F$$

4. CONTROLLER CIRCUIT

A VBF is fully operated through controller. Input of magnetic coil is directly connected with output of controller. There are several part use to make controller and they are fuse, switch, indicator, timer, regulator. It all connect in such manner it shows in given Fig.13
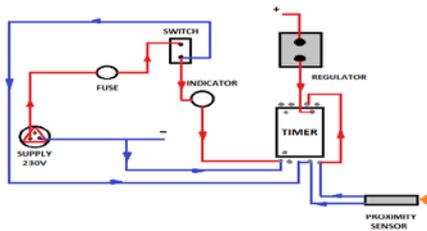
Fig.13 Circuit Diagram

5. RESULT AND DESCRIPTION

The objective behind of this project is to design and development of the vibratory bolt feeder machine which can be able to perform work easily. This process began with finding limitation of conventional bolt feeder system later it complete with developing of VBF.

In conventional bolt feeder machine has several types of trouble regarding to its uses. Like, it had moderate feeding rate, now day where every minutes for the production is important. Feed rate of conventional blot feeder is near about 20 to 30 bolts per minutes. Other drawbacks of this machine are also there which all are overcome by introducing vibrator bolt feeder machine in place of conventional bolt feeder. There many other advantages of VBF which describe below

1) Increase feed rate:

VBF has continually and constant federate of bolts for whatever times it's in working condition. Federate of conventional and vibratory bolt feeder is comparing in given Table.1.

Table.1 INCREASE FEED RATE

Conventional bolt feeder (bolts/minute)	Vibratory bolt feeder (bolts/minute)
20 to30	90 to100

2) Continuity

In conventional machine feeding of bolts is depending on probability of bolt get place in trap in correct manner otherwise it will clash with trap and drop into the bowl and again and again this process is proceed. In VBF bolts are feeding in correct orientation with continues flow by magnetic coil. Magnetic coil produce continues vibration to cause the motion of bolts in correct orientation

3) *Noiseless operation*

In conventional bolt feeder bowl rotate about horizontal axis and drop the bolts from top most part of the bowl and bolts clash with tram which makes noise and additional noise add by motor and rubbing of bolts while it's moving in bowl.
While in VBF steeper motor makes less noise and vibration of bowl also makes less noise and rubbing between bolts is also less. So, operation of VBF is near about noise less operation.

4) *No hazer dies of bolts*

In conventional machine bolts feeds from top most part of bowl which may defect the bolts and trap as well. While in VBF there are no any kinds of clash so there are no defect produce in bolts

5) *Low Power Consumption*

In conventional machine there are two motor are used to rotate drum which consume more electricity. While in VBF only one steeping motor is used so it should consume less electricity
In VBF, bolts are feed by vibration and moves on spiral path.so for that, inertia force must be high. This force mainly depends upon various parameters. If parameters are change inertial force must change. Those parameters are trap angel, vibration angel, frictional force between trap and bolt, mass of each bolt. By using the equation of force analysis we conclude that one angel of trap which have highest federate for VBF. It shows in below Table.2

Table.2 MAXIMIZING CONDITION OF VBF

Angel of trap (in degree)	Feed rate of vibratory bolt feeder (cm/sec)
5.5	10.77

6. ACKNOWLEDGMENT

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