Automatic Indexing and Drilling Machine

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Abstract— The ultimatum of this project is to achieve feeding, indexing and drilling from a single input while overcoming the drawbacks of the previously defined machine. This is achieved by using a single input shaft regulating the motion of the drilling machine as well as the indexing mechanism. The foundations of the machine lay in the cam and follower linkage and double ratchet mechanism, which monitor the major operation of drilling and indexing respectively. The machine has a provision to deploy as many numbers of spindles demanded by the operation in a required sequential manner to obtain the most efficient dimensioning at the end of the cycle delivering and abiding to the quality aspect at the same time. With the change in the requirements the respective spindle can be replaced and the feed and indexing can also be altered accordingly, hence giving a fully interchangeable machine. With the introduction of this project, the manual intervention is limited only to the loading and unloading of the work piece.

Keywords: Indexing Mechanism, Double Ratchet Mechanism, Cam and Follower, Toggle Clamp, Drill Machine

I. INTRODUCTION

In present scenario, manufacturing is approaching to become more flexible, agile and efficient under the changing environment of global competition, increased product variety, high renewal rate of product and shorter product life cycle in technology. In such an era, usage of conventional impact drilling machine is a manual, labor intensive and cumbersome manufacturing process. Newer manufacturing methods are evolving to overcome such drawbacks. This project is about a unique approach towards developing a robust machine capable of indexing and manufacturing precise holes overcoming the drawbacks of the previous methods. Having a capability to deliver near to perfect results, the following project poses great improvement and application of assemblage of 100% mechanical sub-systems. The process of conventional drilling machine is more time consuming and requires more human efforts. So, we have proposed an alternative method which is fully automatic and indexing machine. This system requires less human efforts and it is less time consuming.

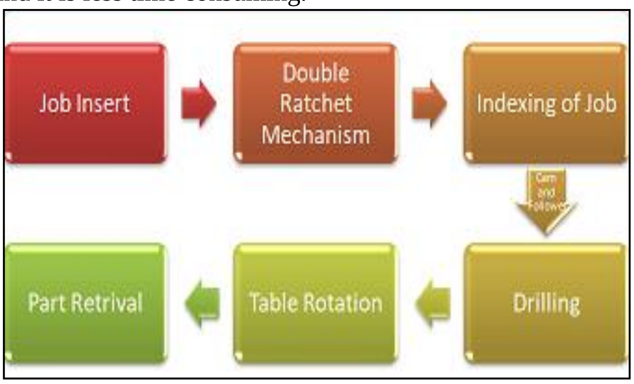

Fig. 1: Path of processing

II. OBJECTIVES OF THE PROJECT

1) One of our most important primary objectives is to have a machine which can perform automatic indexing, feeding, and drilling.
2) This is achieved by using a single input shaft regulating the motion of the drilling machine as well as the indexing mechanism.
3) The foundations of the machine lay in the cam and follower linkage and double ratchet mechanism, which monitor the major operation of drilling and indexing respectively.
4) This project focuses upon automation of three main aspects: feeding, indexing and drilling.
5) Following are some objectives of this project
   1) To reduce human efforts
   2) Automation
   3) To increase productivity
   4) Time consumption
   5) Less initial investment

III. METHODOLOGY

In the conventional impact drilling machine, only a single drill could be performed at a time. Even while using the gang or multi-spindle drill machine there is no provision for automatic part loading and most importantly indexing of the job. The process was not just time consuming but is labor intensive as well. Many attempts towards pre-marking the centers also lacked the proper accuracy in indexing.

A. Advantages at a Glance:

– Precise serial production of part families and demanding work pieces
– Longer -life and reliability
– High Productivity
– High accuracy and repeatability
– Fast changeover between parts of a family

This project focuses upon automation of three main aspects of the conventional impact drilling machine, namely automation in feeding, indexing and drilling.

B. Automation in Feeding:

Manual placement and retrieval of individual jobs from under the spindle for every individual drilling cycle has been the age-old procedure to load and unload jobs in the traditional drilling machine. The procedure also involves placement of the job in respective fixtures consuming precious time. What this machine brings to table is the only manual intervention required is to place and remove the job from collects (housing).

C. Automation in Indexing:

Having a fixed position of spindle(s), every time a new hole is supposed to be drilled in the job, the machine immobile, the job is required to be properly placed under the spindle in order to obtain the required hole. Possessing a proven Ratchet Mechanism as well as notches in rotation supporting linkages, a precise positioning of the work piece under the spindle is guaranteed.

D. Automation in Drilling:

As mentioned previously, the conventional drilling machine depends upon the manual actuation and is carried out one job at a time. A cam and follower linkage is responsible for the sequential engagement of the drill as well as returning of the drill to the absolute position.

IV. DESIGN REPORT

After selecting the material from standard available parts, it is essential to verify their sustainability to the working conditions. Following is the design report of the respective components according to their sequence of motion.

A. Frame: Box pipe

Material: MS
Vertical dimension = 1.4m
Horizontal dimension =0.9m

B. Input Shaft:

Dimensions of the proposed component: -
Internal diameter (d_i) = 14mm
Outer Diameter (d_o) = 18mm
Length = 900mm

1) Available data:

Number of revolutions per minute = 4
K_B = 1.5
K_T = 1.5
Yield Tensile Strength = 247MPa = 247 $\frac{N}{mm^2}$

2) Calculation of Power (P):

$P = \frac{2\pi nT}{60}$ Watt
$3.6 = 2\frac{\pi 4T}{60}$
T =8.5925×10^3
Calculation of Shear Stress (ζ):
$\zeta = \frac{16}{\pi d_o^3(1-K^4)}\sqrt{(K_b M)^2 + (K_t T)^2}$
Also ∵ $\zeta = 0.3$ Syt
$\zeta = 7.41\ \frac{N}{mm^2}$
$7.41 = \frac{16}{\pi \times 18^3(1-0.77^4)}\sqrt{(1.5M)^2 + (1.5 \times 8592.5)^2}$m = 35.58× 10^3 Nmm

C. Bearing

1) Available Data:

Radial Force (F_r) = 30N
Axial Force (F_a) = 12N
Number of revolutions per minute (N) = 4
Rating life in hours in million revolution (L_{h10}) = 4000 hrs.
Calculation for Equivalent Dynamic Load: -

$$P_e = (XVF_r + F_a)K_a$$

… Where X = Radial Factor
V = Rotation Factor
K_a= Load Factor
Thus, we have

$$X = \frac{F_a}{VF_r} \quad Y = \frac{F_a}{C_o}$$

∴X = 0.4 ∴Y = 1.6
…where Y = Thrust Factor
C_o = Basic Static Capacity
∴ P_e = 31.2N
Calculation for Rating life in million revolutions (L_{10}): -

$$L_{10} = \frac{(L_{h10}) \times N \times 60}{10^6}$$

∴ L_{10} = 0.96
$L_{10} = (\frac{C}{P_e})^a$; a=3, for roller bearing
C = 30.67kN
Hence, from manufacturers catalogue,
∴Selected bearing is 6404.

D. Cam

Follower movement is Return-Rise-Dwell
Stroke of Follower(S) = 50mm
Angle of Return (θ_r) = 168°
Angle of Rise (θ_R) = 72°
Angle of Dwell (θ_d) = 120°
Diameter of Roller (d_r) = 25.4
Minimum Radius of Cam (r_b) = 100mm

E. Table turning mechanism (Double-Ratchet)

Angle between two teeth = 36°
Base radius of ratchet = 150mm
Maximum radius of ratchet = 50mm

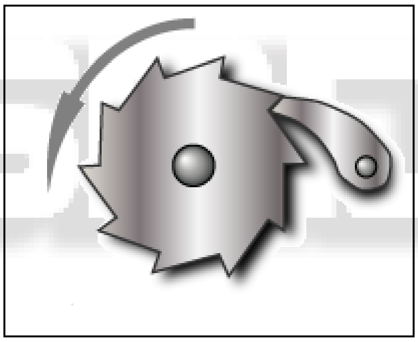

Fig. 2: Ratchet

F. Spring

D = Mean coil diameter (2" =50mm)
d = Wire diameter (4mm)
δ = deflection (30mm)
W = load (15kg)
K_s= shear stress factor (1.04)
L_f = free length (66.5mm)
L_s = solid length (32mm)
P = pitch (4.57mm)
Design Sustainability is proven from Standard component data and Catalogues of standard components.

V. CONSTRUCTION AND WORKING

A. Construction:

– The machine assembly is rested over frame which is constructed from 1400*900*3 mm c/s square pipe of MS.
– The work table is rested upon a circular rail (a pipe) of dia. 21.65 inch.
– Toggle clamps at regular intervals are placed on work table.

- A circular disc made of wood (5 mm thick) having housing for jobs to be inserted by the employee.
- A double ratchet mechanism is fixed at the bottom of the work table, which is responsible for the indexing of the job.
- A MS pipe of 14mm internal diameter and length of 0.9 m is connected to the prime mover giving the input to the mechanism.
- The pinion of the bevel assemble, cam and follower mechanism is mounted on this shaft.

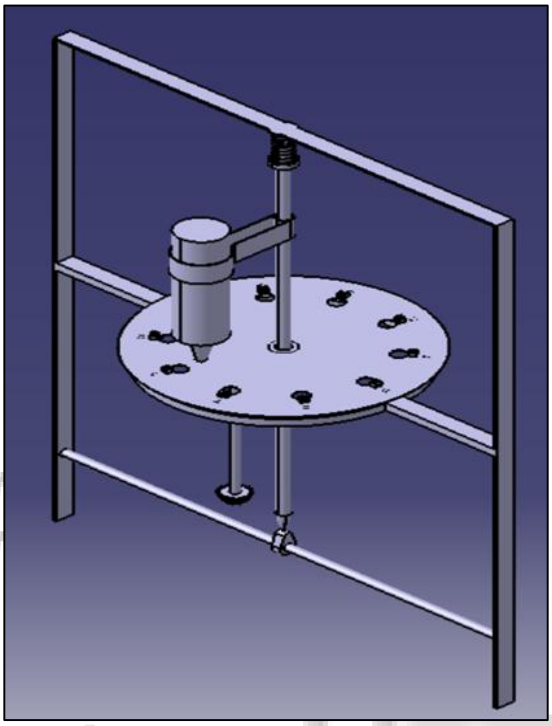

Fig. 3: Drilling Machine

Fig. 4: Assembly

B. Working:

The power is given to the input shaft by manually. The input shaft has two outputs where one output goes to the cam and follower and second goes to the bevel gears. Cam and follower uses the output power for to and fro motion of the drill machine. Second output from bevel gears utilizes the power to ratchet mechanism for rotating two ratchets. Both ratchets rotate in opposite direction which concludes to the indexing. As the worktable rotate in clockwise direction, the workstations under drill bit changes one by one. All ten workstations are in working condition except the one which is used for loading and unloading. In this working model we can increase the workstations and varies the type of operations which results in time as well as cost saving.

VI. APPLICATIONS

The Automatic indexing and drilling machine can be applicable for following:

- This machine in very useful in medium and small scale industries.
- For précised work with less human efforts this machine can perform in short time.
- Applicable where mass production is required.

VII. CONCLUSION

Many attempts towards the reduction of cycle time as well as simultaneous multiple drilling have had sizable number of drawbacks proving ineffective at certain decision-making instances. It is evident that the usage of electronic control as means of indexing has demonstrated the operation in a pattern and is an ineffective way of automation. As the ultimatum of this project is to achieve automatic feeding, indexing and drilling from a single input while overcoming drawbacks of conventional impact Drilling Machine. The machine has provision to deploy multiple numbers of spindles according to the job specifications in a sequential manner. The machine provides interchangeability between vast number and types of drilling operations. The automatic feeding and drilling mechanism sufficing the requirement of reduced time consumption while eliminating human intervention which results in higher accuracy.

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