

A Semi Automation Based Cover Assembly in Flywheel Design

R.Vinoth¹, T.Santhosh², R.Niranjana², M.Gokulakrishnan², T.Karthikeyan².

¹ Assistant Professor, ^{2,2,2,2}UG scholars,

Department of Mechanical Engineering, Nandha Engineering College, Erode-52,
Tamil Nadu, India.

Abstract- A flywheel design has been characterized as disc type and arm type. Both type of flywheels is used to store rotational energy, but modes of operation varies according to the smaller and larger sized engines. In our group, has been detailed view on disc type flywheel, it becomes major part that used in engines/machines. A Semi automation is defined as the system of work to be performed as the part of manual and part of automation. Manufacturer attempted to automate everything and remove human element with industries, but people are found on many assembly lines. Because humans are still the most programmable, efficient "machines" for most assembly lines. So only, we are using semi automation system on cover assembly in flywheel. There is no fully automation, because multiple variations of a product are usually assembled on same line and requires a tremendous amount of flexibility is difficult to achieve on it. As a result, semi automation system is simpler way to assemble flywheel.

Key Words: Geneva Mechanism, Rotary actuator, Photo and Proximity Sensor, Hydraulic motor, Pneumatic Cylinder

I. INTRODUCTION

In recent years, many industries attempted to automate everything and remove human element. But people are still found on many assembly lines. So semi automated system is one of the familiar way to assemble flywheel. Error proofing refers to analyze the defects and prevent a material, this activity is also known as poka-yoke in Japanese. This process will be proceeding with the use of external Geneva mechanism. In this type of mechanism, the Geneva cross is connected with cam drive externally using driven wheel has four slot and rotation of drive wheel by one step of 90 degree. There are many mechanisms were to be used, with this external Geneva mechanism is selected due to simplest and least expensive compared to other intermittent motion mechanisms. When drive slot has a locking surface pin to rotate one revolution and driver slot has locking ring to rotate half revolution that brings correct position for screw place on fixture of a cover assembly in flywheel. Most of the automation system to be used sensors as a major part that performed more effectively. The Lm guide is used to move the pneumatic gun by the direction of upward and downward that operated by pneumatic cylinder. The proximity sensor is placed near to the pneumatic cylinder to monitor the Lm guide that moves upward and downward direction and photo sensor is placed

near to the pneumatic gun for detecting the screws are in the fixture of a flywheel cover. When the alarm has raised after getting false feedback of csk screw is not available in the fixture then process will be stopped automatically. The following steps are identified as a problem statement during manual operation in flywheel assembly.

- ✓ It may be possible for missing screws during fastening that cause manual error.
- ✓ This will lead to reassemble the part will affect the material quality.
- ✓ It affects quality of a material will be sometimes increase in manufacturing time and also in high cost.
- ✓ This will never fulfill the customer's expectation.

II. LITERATURE REVIEW

Actual Case Study and Experimental Setup for Automobile Flywheel was carried out by [1] Hardik R. Patel. Flywheel is a device to smoothen the cyclic fluctuation of speed change when delivering constant output power from the engine. Thus, a properly designed flywheel has to ensure the cyclic fluctuation of speed within prescribed limits preferably as small as possible. To counter the requirement of smoothing out the large oscillations in velocity during a cycle of a mechanism system, a flywheel is designed, optimized and analyzed. The main objective of our project is to reduce weight of automobile. If Engine Flywheel has more weight than its need, then it will decrease fuel efficiency. If engine flywheel has less weight than its need, it will consequently enhance speed fluctuation, Vibration and Noise. Researcher has taken up one case study of Tata truck (LPT2521BS IV) for weight optimization without changing energy storage capacity for future work.

[2] G.K. Gattani-In present investigation, to counter the requirement of smoothing out the large oscillations in velocity during a cycle of a I.C. Engine, a flywheel is designed, and analyzed. By using Finite Element Analysis are used to calculate the stresses inside the flywheel, we can compare the Design and analysis result with existing flywheel.

Virtual manufacturing of classic external Geneva mechanism was carried out by [3] Florin BLAGA. - Starting from the known relations, the paper presents the

design and implementation of digital manufacturing using an integrated virtual prototype CAD_CAE_CAM. After determining the numerical values for the dimensions of the elements which compose the Geneva mechanism, the data are used in the CAD application in order to make 3D models. So, the obtained model is transferred to the CAM module that performs the tool paths. After postprocessing the data, it is obtained the CNC program for the implementation on a machine tool with it NC 530 Heidenhain equipment.

[4]. Parker-Hannifin-Pneumatic cylinder (sometimes known as air cylinders) are mechanical device which use the power of compressed gas to produce a force in a reciprocating linear motion. One major issue engineers come across working with pneumatic cylinders has to do with the compressibility of a gas. Many studies have been completed on how the precision of a pneumatic cylinder can be affected as the load acting on the cylinder tries to further compress the gas used. Under a vertical load, a case where the cylinder takes on the full load, the precision of the cylinder is affected the most. A study at the National Cheng Kung University in Taiwan, concluded that the accuracy is about ± 30 nm, which is still within a satisfactory range but shows that the compressibility of air has an effect on the system. Pneumatic systems are often found in settings where even rare and brief system failure is unacceptable. In such situations locks, can sometimes serve as a safety mechanism in case of loss of air supply (or its pressure falling) and, thus remedy or abate any damage arising in such a situation. Leakage of air from the input or output reduces the pressure and so the desired output. Upon job specification, the material may be chosen. Material range from nickel-plated brass to aluminum, and even steel and stainless steel. Depending on the level of loads, humidity, temperature, and stroke lengths specified, the appropriate material may be selected.

A survey and experimental evaluation of proximity sensor was carried out by [5] Richard Volpe. This paper provides an overview of our selection process for proximity sensors for manipulator collision avoidance. Five categories of sensors have been considered for this use in space operations: intensity of reaction, triangulation, time of flight, capacitive and inductive. From these categories the most promising commercial and mature laboratory prototype sensors have been selected and tested. After reviewing the selection process and the experimental results, conclusions are drawn about which sensors are best and why. While many companies make inductive and capacitive sensors, most are designed to be switches for very short range (<1cm) assembly line part presence detection. Amongst inductive sensors, slightly long range detection. However, because of its large size it has a range twice that of the nearest industrial model. Among capacitive sensors, the same long range sensor prevails, while primarily selling standard short range sensors.

[6] Robert H. Garwood published a hand book of photoelectric sensing. There is a detailed view on the past, present and, future photo detecting sensor. A photoelectric

sensor is an electrical device that responds to a change in the intensity of the light falling upon it. The first photoelectric devices used for industrial presence and absence sensing applications took the shape of small metal barrels, with a collimating lens on one end and a cable exiting the opposite end. The cable connected a photo resistive device to an external vacuum tube type amplifier. A small incandescent bulb, protected inside a matching metal barrel, was the opposing light source. These small, rugged incandescent sensors were the forerunners of today's industrial photoelectric sensors. A brief discussion on sensing theory, sensor selection, interfacing, troubleshooting, sensing logic.

[7] Tsai et al. - a rotary electromagnetic actuator where small electrical signals are converted into limited mechanical rotation normally less than $\pm 180^\circ$. Typical applications are optical scanning, thermal imaging, servo valves, scan mirror mechanism, direct laser mirrors, position missile guidance radar antennas, open shutters for heat seeking sensors and as direct drive in robotics. The main types of DC actuators are (a) Laws of relay type suitable for small angular movement in which coil is on the stator and salient soft iron in rotor. (b) Doubly wound type suitable for larger angular movement which has a configuration of concentrated windings on both stator and rotor. (c) Toroidal type in which there is a distributed winding on the stator with a permanent magnet rotor. When comparing the doubly wound and toroidal type, the latter type exhibits similar torque /angle characteristics as that of the former type in addition to the advantage of simple construction.

III. WORKING PROCESS

In mass production, all process depends on the operator. In mass production, all process depends on the operator may be chances to missing any screws during fastening in assembly. This will lead to reassemble the part will affect the material quality and increased in productivity time. Using semi-automation system will be enable effective work to prevent from above identified problem.

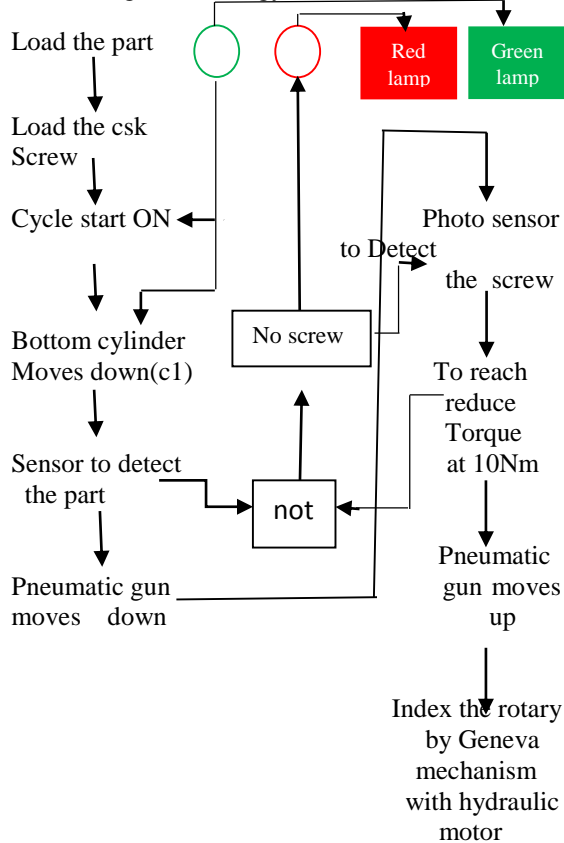
A. semi-automation:

part of machine -when the cycle starts, the Lm guide is used to move upward and downward direction that works with help of pneumatic cylinder. The pneumatic gun is fixed with Lm guide have been monitored by proximity sensor. When the photo sensor has to identify the screw in the fixture and give notification during the pneumatic gun that act to meet in the torque 10Nm. The Geneva mechanism has to rotate with the help of hydraulic motor and Geneva cross is connected with cam drive externally using driven wheel has four slot and rotation of drive wheel by one step of 90 degree have to rotate flywheel during the cover assembly takes some time for fastening the screw. The rotary actuator is to rotate 90 degree for pick and place the screw automatically.

part of manual-most of the industries were like to automate everything and skip the human elements. But humans were still found on many industries, because humans are still programmable, efficient, hardworking and leadership. The

part of manual work is to place the flywheel on the fixture in the assembly line. when the cycle start their operations with the operator press the start button. After completing their operations, the material will be removed from the fixture by operator and check quality.

B. Working methodology:



when the operator manually place the flywheel on the fixture. The rotary actuator will automatically pick and drop the screw by rotating 90 degree. When the cycle starts, pneumatic cylinder operates LM guide connected with pneumatic gun that moves up down direction were monitored by proximity sensor. the photo sensor is used to detect the screw at moving level torque 10 Nm and allow to fastening the screw is available. There is no screw, it will automatically stop the process.

- ✓ The green lamp indicates the cycle start.
- ✓ The red lamp indicates the cycle stop.

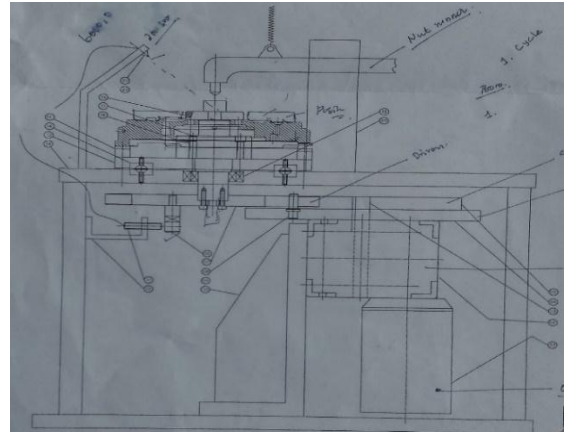


Fig-1: Working Layout

IV. MATERIALS FOR WORKING PROCESS

A. Geneva mechanism: The External Geneva mechanism is defined as the mechanism that converts constant rotational motion into intermittent rotary motion, is also known as Geneva wheel. The rotating drive wheel has a pin that reaches into a slot of the driven wheel.

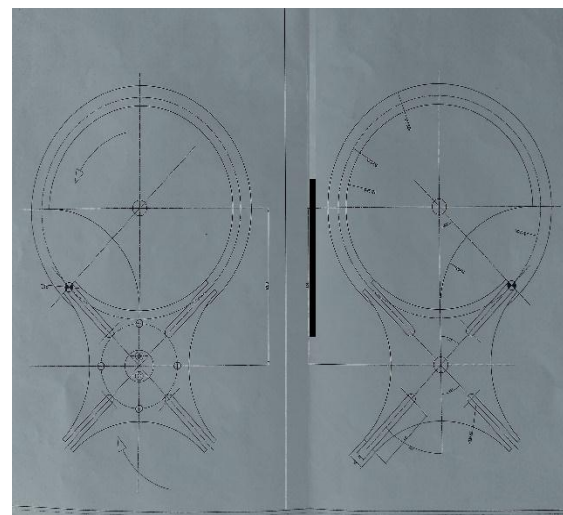


Fig-2: Geneva Mechanism

It is used as a mechanism for transfer constant rotational motion into intermittent rotary motion that moves with acceleration jumps at the starting and the last of the active phases (one) and it gives a precise location movement and its blockage, which makes it usable in many areas (two). Synthesis of mechanism involved to analyze the number of channels and its size to constructive establishment by various coefficients and also in functions of acting time (three).

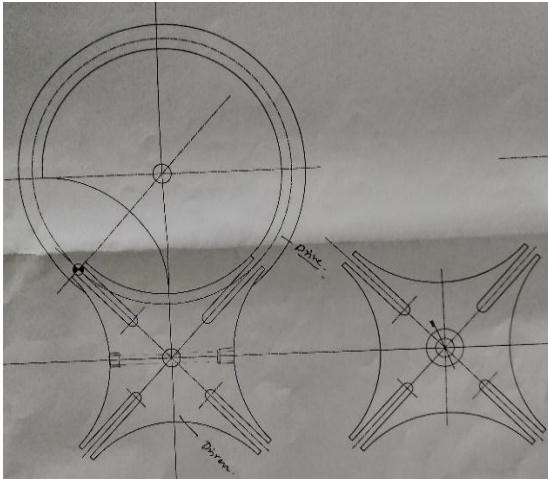


Fig-3: Drive & Driven Slot

In this mechanism, every turn of the driver wheel A and the driven wheel B that makes the more than half turn. The pin, attached to driver wheel A, moves in the slot causing the motion of wheel B. The contact between the lower parts of driver A with the corresponding hollow part of wheel B retains in its position when the pin is out of slot. Wheel A is cut away near the pin as shown in order to provide clearance for wheel B as it moves. If one of the slots is closed, A can make less than one revolution in either direction before the pin strikes the closed slot and stopping the motion.

B. Rotary actuator: A rotary actuator is defined as the actuator that contains rotary motion. The simplest actuator is purely mechanical, where linear motion in one direction gives rise to rotation. The most common actuators through are electrically powered.



Fig-4: Rotary Actuator

It is a simple concept made with pick and place robotic. The working principle of rotary actuator will be given by following steps.

- When the cycle starts ON and C1 cylinder is placed in it.
- Arm will move downward and pick the screw.
- Then moves upward and rotates 90 degrees.

- Arm will move downward and demagnetize to drop the screw in the fixture of cover assembly flywheel.
- Then again moves upward and rotates the same direction (90 degrees).
- C2 cylinder moves the screws one by one to the forward for arm pick up easily to magnetize.
- Sensor to be placed for notify end stop.

Features:

- ✓ Key slot type Sizes - Ø10, 12, 15, 18, 20, 25, 28, 32, 40, 50, 63 mm.
- ✓ rotating 90° or 180° depends on operation.
- ✓ Adjustable the rotation of angle at 45°.
- ✓ Magnetic sensing as standard Compact design.

C. Flywheel: Flywheel is defined as the rotating mechanical device that increases the machine's momentum; it also provides a greater stability of available power. Flywheels are made with carbon fiber materials and have an inertia called moment of inertia that contains bearings to revolve at speeds up to 60,000 RPM (1 kHz).

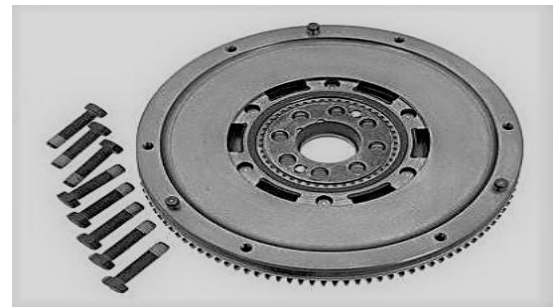
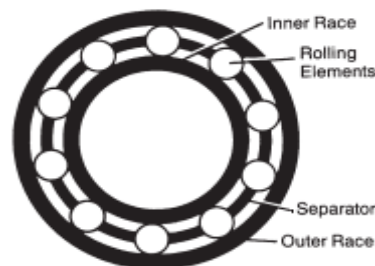


Fig-5: Flywheel

D. Bearings: A bearing is defined as the part that changes relative motion to desired motion and reduces friction among moving materials. It provides free rotation around a fixed axis. The smooth performance of bearings will contain inner race, outer race, separator, and rolling elements.



Bearing parts

Fig-6: Bearing

E. Photo Sensor: A photo sensor is an electronic device that used to detect a part on the flywheel. When the cycle starts, the sensor will be placed near to pneumatic gun that moves downward and sensor will give notification in the level of reach at torque 10Nm .it contains semiconductor called photoconductivity and it will vary according to the intensity radiation depends on the striking of the part.



Fig-7: Photo Sensor

F. Proximity Sensor: A proximity sensor is an electronic device that used to detect the nearby objects without physical contact. The proximity sensor has a principle of determinate sensing range, switching frequency and switching threshold.



Fig-8: Proximity Sensor

For example, an inductive proximity sensor requires a metal target, whereas a capacitive photoelectric sensor may be suitable for a plastic target. Proximity sensors have to detect the distances of a moving objects between the sensor and the target. A proximity sensor that is adjusted to a very short range can often be used as a touch switch. When anything comes in the range of Proximity sensor it flashes out infrared beam and monitors reflections. When sensor senses reflections it confirms that there's an object nearby.

G. Programmable Logic Controller (PLC): A control device, usually used in industrial control applications, that employs the hardware architecture of a computer and relay ladder diagram language. Inputs to PLCs can originate from many sources including sensors and the outputs of other logic devices. Banner sensors and logic devices are all designed for ease of interfacing to PLCs. Also, called "programmable controller".

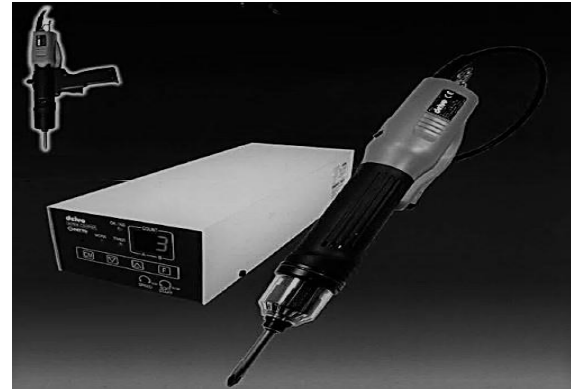


Fig-9: Pneumatic Gun Using Plc

V. MATERIALS SPECIFICATION

A. Flywheels- Flywheels are made from many different materials. In cars to smooth power-transmission may be made of cast or nodular iron, steel or aluminum depending on the performance application.

B. Gear box (worm)- transtech, model no: 63{TW63 80135/1314}.

C. Gear ratio, $I = \text{input/required rpm}$.

D. Hydraulic Motor- 0.5 HP motor {TM80A4}

VI. GRAPHS

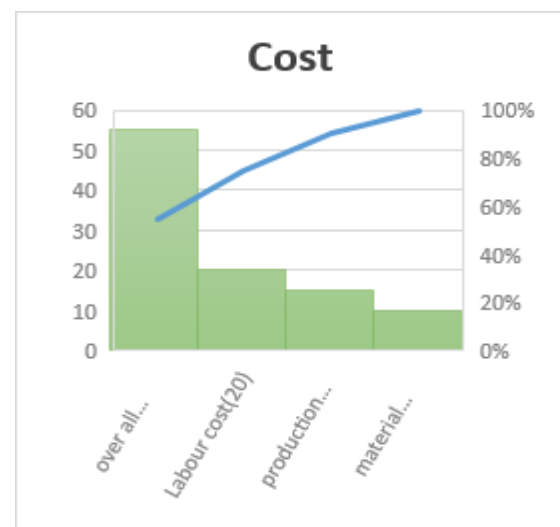


Fig 10: Cost Variation

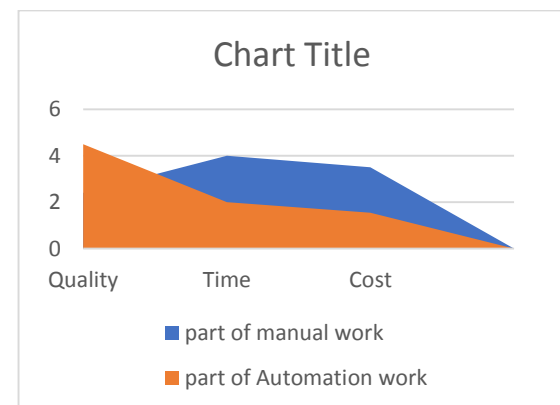


Fig-11: Time, Quality, Cost

VII.RESULT AND DISCUSSION

S.no	content	Part of Manual	Part of Automation
1.	Quality	Decrease	Increase
2.	Time	Increase	Decrease
3.	Cost	Increase	Decrease

By using semi-automation system, We can

- ✚ Increase the quality of a material.
- ✚ Decrease the defects in Assembly Line.
- ✚ Reduce the time in assembly.
- ✚ Increase the productivity.
- ✚ Decrease the cost of production.
- ✚ Improve customer satisfaction.

Error proofing concept implementation

- ✚ To detect the load of the screw
- ✚ To meet the act of csk screw at torque 10Nm
- ✚ To detect the part
- ✚ To reduce the double the times fastening.

VIII.CONCLUSION

In this paper, a semi-automated cover assembly process is proposed for the assembly line of flywheels in the industry. The external Geneva mechanism is chosen over the other intermittent motion mechanisms, because of its simplicity & the cost-effective solution will provides the existing problem. When drive slot has a locking surface pin to rotate one revolution and driver slot has locking ring to rotate half revolution that brings correct position for screw place on fixture of a cover assembly in flywheel. Rotary actuator is a simple concept made with pick and place the screws on the fixture by rotating 90 degrees.

IX. ACKNOWLEDGMENT

The project has been done and help of several individuals and organizations. we would like to extend our sincere thanks to all of them. We would like to express our sincere gratitude to industrial person Mr. murugaprakasam, senior design manager for his guidance and giving such attention & time in completing the project.

X.REFERENCES

- [1] A review of photodetectors for sensing light-emitting reporters in biological systems, Yotter, R.A.; Wilson, D.M. (June 2003). IEEE Sensors Journal. 3 (3): 288–303.
- [2] Bent Sørensen, Roskilde University Energy, Environment and Climate Group, Department of Environmental, Social and Spatial Change University 1, P. O. Box 260 DK-4000 Roskilde, Denmark. Available online 20 May 2008.
- [3] Cam, Geneva, and Ratchet Drives and Mechanisms", Mechanisms and Mechanical Devices Sourcebook (5th ed.), Sclater Neil (2011), New York: McGraw Hill, pp. 180–210, ISBN 978-0-07170442-7. Drawings and designs of various drives.
- [4] Development of a Proximity Sensor for Industrial Applications Sorin Fericean; Albert Dorneich; Reinhard Droxler; Daniel Krater IEEE Sensors Journal, Year: 2009, Volume: 9, Issue: 7 Pages: 870 - 876, DOI: 10.1109/JSEN.2009.2024058 Cited by: Papers (8) .
- [5] Design and Control for The Pneumatic Cylinder Precision Positioning Under Vertical Loading by Cheng, Chi-Neng. (2005).
- [6] Engineering Mechanics: Statics (11 ed.). Hibbeler, R.C. (2007). New Jersey: Pearson Prentice Hall. ISBN 0-13-221500-4.
- [7] Geneva mechanism and mechanical devices, Bickford, John.H. (1972). New York: Industrial Press inc. 128. ISBN 0-8311-1091-0.
- [8] Pneumatic Cylinders - North America. Parker Hannifin. Retrieved May 3, 2011.
- [9] Photodetectors, their performance and their limitations, Stockman, F. (May 1975). Applied Physics. 7 (1): 1–5.
- [10] Using Poka-Yoke techniques for early defect detection "by Robinson. June 18, 2012.