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Retrofitting For Gear Lapping On Lathe Machine

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Abstract: Retrofitting is the addition of components, features or accessories on an older system that did not have when it manufactured. It is used to carry out various operations on the same machine. Retrofitting is considerable change in current machine to make it flexible for doing various operations. Here is retrofitting for gear lapping on a lathe machine. It reduces high investment cost to buying separate gear lapping machine. It is economical for all small scale industries and medium scale industries.

Gears are key to power transmission in our day to day life. Mechanical power transmissions use belt, chain, and gears for power transmission. This paper includes how to use the gear lapping process & innovative way of gear lapping machine. We can use conventional lathe machine which is present in most of the machine shop. The attachment is designed on simple design and is easy to use. It may include different types of gears. Whichever cutting process is used, tooth surface errors appear, in part because of tooling wear and machine distortion, in part because the gears are heat treated after cutting which releases internal strain and causes tooth flank distortion. Therefore, a finishing operation is necessary. As a result, excellent smoothness and quietness of operation can be obtained

Keywords: Retrofitting, Lathe Machine, Lapping, Superfinishing, Cost Saving.

1. INTRODUCTION

This paper is case study explaining about successful implementation of gear lapping machine by varying economical way gear manufacturing involve conventional gear manufacturing and recent gear manufacturing processes. After Manufacturing of gears, there is need to super finish the gears to reduce noise level and for the effective operation of gear. This retrofitting converts the lathe machine to gear lapping machine and this tends to reduce the investment cost on new special gear lapping machine

DEFINITION OF GEARS

Gears are toothed members which transmit power/motion between two shafts by meshing without any slip. Hence, gear drives are also called positive drives. In any pair of gears, the smaller one is called pinion and the larger one is called gear immaterial of which is driving the other.

When pinion is the driver, it results in step down drive in which the output speed decreases and the torque increases. On the other hand, when the gear is the driver, it results in a step up drive in which the output speed increases and the torque decreases.

GEAR MANUFACTURING

Gear manufacturing can be divided into two categories namely forming and machining as shown in flow chart in Fig.1.2 Forming consists of direct casting, molding, drawing, or extrusion of tooth forms in molten, powdered, or heat softened materials and machining involve roughing and finishing operations.

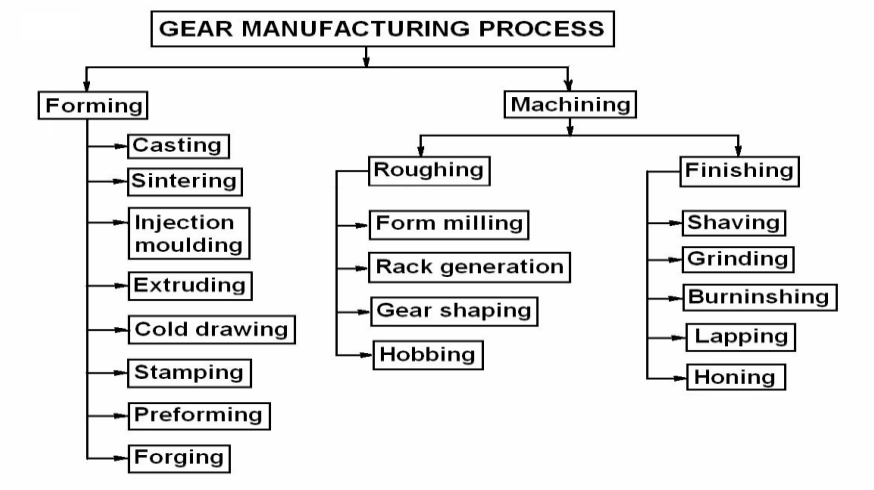


Fig. Categories of gear manufacturing process

2. PROBLEM IDENTIFICATION (NEED FOR PROJECT)

PROJECT IDEAS AND SOLUTION

As it is observed why gears need to be lapped, and lapping is the last stage of gear production hence after machining a gear on shop floor, burrs are located on gear teeth, so for removing this burr at present worker use blower to remove burr from gear, but it is very dangerous because that burr can damage the hand or fingers of hand. If gears are not deburred then gears used in gear box are early damage and its life also reduced so as to increase the life of the gear and to reduce the maintenance of gear hence for increasing life of gear, selected to manufacture a gear deburring machine.

Company's design department showed a simple model of gear deburring machine for manufacturing. Industry already have one gear deburring machine but that machine cannot work properly because that machine can't deburr gear fast and take much time for deburring and production also more hence company required one gear deburring machine

Then company's supervisor discussed different types of burrs occurred while manufacturing the gear and differentiates that burr into different classes and also discussed brush which used for gear deburring machine.

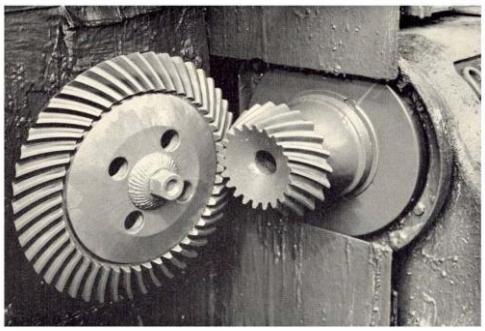
As it observes M/s Top Gear Transmission Pvt. Ltd. manufacture small gears around 500 gears per day and need to be deburred.

At present in Top Gear Transmission's workers deburr the small gears manually and using blowers to clean the gears which are very costly and having a gear deburring machine but this machine is time-consuming, less effective and noisy.

Therefore it was proposed to manufacture gear deburring machine which deburrs around 500 gears per day and same machine useful to deburr for a variety of gears being manufacture.

3. METHODOLOGY

3.1 Lapping



Gear lapping is the process of imparting a very fine finish and a high degree of accuracy to gear teeth, by using a lapping tool and applying a fine-grained abrasive between a work material and a closely fitting surface, called a lapping plate. By running mating pairs together in a gear lapping machine and feeding a liquid abrasive compound under pressure into the gear pair, small amounts of metal are removed as the gears rotate, thus refining the tooth surface and achieving the desired contact pattern.

Whichever cutting process is used, tooth surface errors appear, in part because of tooling wear and machine distortion, in part because the gears are heat treated after cutting which releases internal strain and causes tooth flank distortion. Therefore, a finishing operation is necessary.

Finishing can be done by grinding the gear teeth, but it is expensive in terms of tooling and time and is therefore usually limited to small productions such as aerospace gears. Finishing can also be done by lapping, whereby the gear set is operated for a short time, under limited speed and torque, at varying positions such that the abrasive lapping compound improves the contact surfaces. Lapping is normally applied to hybrid gear finishing because it is economical for large production volumes. As a result, excellent smoothness and quietness of operation can be obtained

Lapping typically improves the wear properties of gear teeth and corrects the minute errors in involute profile, helix angle, tooth spacing and concentricity created in the forming, cutting or in the heat treatment of the gears. Therefore, gear lapping is most often applied to sets of hardened gears that must run silently in service. It is important to bear in mind that gear lapping is a mating process; two gears that have been matched by lapping should be operated as a set, and also replaced as a set, rather than singly.

Lapping is the super-finishing surface machining operation for obtaining surface roughness at a sub-micron level. Lapping is accomplished by running the gears together, usually in the presence of an abrasive lapping compound, until an acceptable noise level for the gear pair is achieved. The configuration of these gears results in high sliding speed over the flanks of the gear teeth, thereby making these gears particularly well suited to the lapping process. A drawback associated with this method of gear production is that once the gear pair is lapped, the gears must be stocked, mounted, or replaced in matched sets.

Lapping is a Well-established process for finishing the tooth surfaces of gears. It is a process that provides an economical alternative to other hard finishing processes for gears and it has been used in all areas except for some aircraft applications. In the lapping process, a pinion and ring gear are mounted, via appropriate Work holding equipment, to respective spindles in a lapping machine that has the same basic design as a testing machine. In most instances of rolling of the gear set, the pinion is the driving member and the ring gear is braked. The gears are rolled in mesh and lapping compound, which can be a mixture of oil (or Water) and silicon carbide or similar abrasive, is poured into the meshing Zone.

Most lapping and testing machines have three degrees of freedom available for realizing relative motion between a ring gear and pinion.

To date, the structure of lapping machines usually has been similar to the construction principle as bevel gear cutting and grinding machines except that in most lapping machines, the shaft angle is permanently set to 90°. Thus, lapping machines have one less degree of freedom than cutting and/or grinding machines, so the gear lapping attachment is needed to recover these drawbacks of degrees of freedom, a variety of gears.

3.2 GEAR LAPPING

Lapping is a machining process, in which two surfaces are rubbed together with an abrasive between them, by hand movement or by the use of a machine. This can take two forms. The first type of lapping (traditionally Grinding) typically involves rubbing a brittle material such as glass against a surface like iron or glass itself with an abrasive material such as Aluminium oxide, silicon carbide, diamond, etc. in between them. This produces microscopic fractures as the abrasive rolls about between the two surfaces and removes material from the both.

The other form of lapping involves a softer material such as pitch or a ceramic for the lapping, which is charged with the abrasive. The lap is then used to cut a harder workpiece. The abrasive embeds within the softer material which hold it and permits it to score across and cut the harder material. On a finer limit, this will produce a polished surface.

Lapping is performed either manually or by machine. Hand lapping is done with abrasive powder as lapping medium, whereas machine lapping is done either with abrasive powder or with bonded abrasive wheel.

3.2.1. Hand lapping

Hand lapping of the flat surface is carried out by rubbing the component over the accurately finished flat surface of master lap usually made of a thick soft close-grained cast iron block. The abrading action is accomplished by very fine abrasive powder held in a vehicle. Manual lapping requires high personal skill because the lapping pressure and speed have to be controlled manually.

Laps in the form of a ring made of closed grain cast iron are used for manual lapping of the external cylindrical surface. The bore of the ring is very close to the size of the workpiece, however, precision adjustment in size is possible with the use of a set screw. To increase the range of working, a single holder with interchangeable ring laps can also be used. Ring lapping is recommended for finishing plug gauges and machine spindles requiring high precision. External threads can be also lapped following this technique. In this case, the lap is in the form of a bush having an internal thread.

Solid or adjustable laps, which are ground straight and round, are used for lapping holes. For manual lapping, the lap is made to rotate either in a lathe or honing machine, while the workpiece is reciprocated over it by hand. Large size laps are made of cast iron, while those of small size are made of steel or brass. This process finds extensive use in finishing ring gauges.

3.2.2 Lapping Machine

Machine lapping is meant for economic lapping of batch qualities. In machine lapping, where high accuracy is demanded, metal laps and abrasive powder held in suitable vehicles are used. Bonded abrasives in the forming wheel are chosen for commercial lapping. Machine lapping can also employ abrasive paper or abrasive cloth as the lapping medium. Production lapping of both flat and cylindrical surfaces. In this case cast iron plate with loose abrasive carried in a vehicle can be used. Alternatively, bonded abrasive plates may also be used. Centerless roll lapping uses two cast iron rolls, one of which serves as the lapping roller twice in

diameter than the other one known as the regulating roller. During lapping the abrasive compound is applied to the rolls rotating in the same direction while the workpiece is fed from the rolls.

Lapping a single piece at a time and mostly used for lapping plug gauges, measuring wires and similar straight or tapered cylindrical parts.

Centreless lapping is carried out in the same principle as that of centreless grinding. The bonded abrasive lapping wheels, as well as the regulating wheel, are much wider than those used in centreless grinding. This technique is used to produce high roundness accuracy and fine finish, the workpiece requires multi-pass lapping each with progressively finer lapping wheel. This is a high production operation and suitable for small amount of rectification on the shape of the workpiece. Therefore, parts are to be pre-ground to obtain substantial straightness and roundness. The process finds use in lapping piston rings, shafts and bearing races.

3.2.3 Types of lapping

a) Surface lapping
b) Two piece lapping

Lapping is regarded as the oldest method of obtaining a fine finish. Lapping is basically an abrasive process in which loose abrasives function as cutting points finding momentary support from the laps. Material removal in lapping usually ranges from .003 to .03 mm but many reach 0.08 to 0.1mm in certain cases.

Characteristics of lapping process

- Use of loose abrasive between lap and the workpiece.
- Usually, lap and workpiece are not positively driven but are guided in contact with each other
- Relative motion between the lap and the work should change continuously so that path of the abrasive grains of the lap is not repeated on the workpiece.

Cast iron is the most used lap material. However, soft steel, copper, brass, hardwood as well as hardened steel and glass are also used.

3.3 LAPPING PASTE

Lapping paste is a mixture of hard abrasive particles in a suitable base like oil, grease or water based lubricant. The hard particles used are carborundum, aluminum oxide, silica, boron carbide, etc. The lapping pastes are graded from extra course to extra fine. The larger the grit rating of the lapping paste, the finer the paste.

Abrasives of lapping

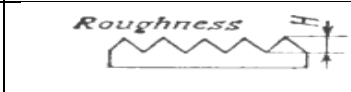
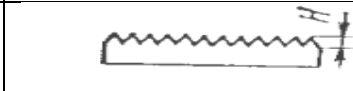
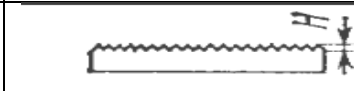
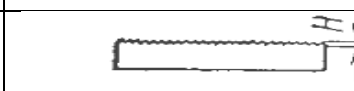
- Al_2O• Cr_2O_3, grain size 1~2 μm
- B_4C_3, grain size 5-60 μm
- Diamond, grain size 0.5~5 V

Vehicle materials and SiC, grain size 5~100μm for lapping

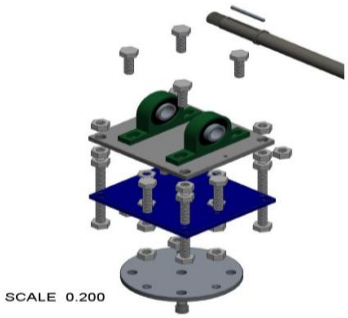
- Machine oil
- Rape oil
- Grease

Technical parameters affecting lapping processes are

- Unit pressure
- The grain size of abrasive
- Table: Gear finishing result

Process	Diagram of resulting surface	Height of micro-irregularity (μm)
Precision Turning		1.25-12.50
Grinding		0.90-5.00
Honing		0.13-1.25
Lapping		0.08-0.25

4. Exploded View



5. Assembly of Gear Lapping Attachment

RESULTS

- As the speed increase, the roughness minimizes that is speed is inversely proportional to surface roughness.
- The time required for the higher surface finish is high.
- The pinion surface roughness is less than wheel surface roughness.
- The silicon carbide is constantly removal from gears there for after internal of 10-15 min. The paste has to be applied again.
- On the sound meter, the mobile application it was observes that the noise is reduced from 47 to 38 dB.

CONCLUSIONS

- The manual deburring can be efficiently replaced by the use of this machine.
- Use of mechanization reduces errors.
- Due to machine the force applied on the gear surface is uniform thus maintaining the quality of the products.
- Though initial investment is more the machine can be used without stopping thus making it more profitable.

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