MATERIAL DETAILS

1. Drill chuck

- Are made from special alloy steel with precision bored and reamed taper jaw holes. Its sleeve, jaws and gear-rings are hardened and ground for long life. Components exposed to wear viz. set of jaws and nuts and keys made of quality alloy steel are hardened to maintain accuracy and extend chuck life.
- Is made by first forming an elongated metal body with a toothed back face and a front face, then machining a longitudinally extending groove having sides and a floor in the front face, and forming inwardly projecting and longitudinally spaced retaining bumps on the groove sides. A hard-metal insert is fitted into the groove between the retaining bumps and then bonded to the body in the groove. The body is heat-treated, that is annealed, before machining the groove in it to reduce internal stresses. Then the body is cleaned and oiled to prepare it for machining and to eliminate any oxidation created by the heat treatment. After machining the body and before fitting the insert the body is deburred and cleaned again. Normally the insert is bonded to the body by soldering or brazing In order to allow the insert to seat directly on the jaw and not be held off it by the solder a channel is formed between the insert and the body in the groove. The insert is bonded to the body by filling the channel with the solder. The channel can be formed in the insert or in the body. Sometimes injection moulding is also used.

2. Woodruff key

- Made up of stainless steel mixed with slight steel coated with zinc.
- Used to secure the individual gears in the main shaft.
- They are heat treated to Rockwell's "C" 40-50 and are machined surfaced. The seats for woodruff keys are made using woodruff cutters.

3. Spindle

- Is preferably made up of silicon nitride ceramic.
- Alloy carbon steel can also be used for spindles.

- They are made by rotational moulding or sometimes injection moulding is used also.

4. Bearing Retainer

- Made of a porous material.
- Heat treatment process is used.
- Made by mixing decreased bran with a thermosetting resin before kneading, purveying the kneaded mixture after fired into carbonized powders sieved. Then mixing carbonized powder and applying heat treatment.

5. Ball Bearing

- There are 4 major parts of manufacturing ball bearing -

i) Races

- 1 Both races are made in almost the same way. Since they are both rings of steel, the process starts with steel tubing of an appropriate size. Automatic machines similar to lathes use cutting tools to cut the basic shape of the race, leaving all of the dimensions slightly too large. The reason for leaving them too large is that the races must be heat treated before being finished, and the steel usually warps during this process. They can be machined back to their finished size after heat treating.
- 2 The rough cut races are put into a heat treating furnace at about 1,550 degrees Fahrenheit (843 degrees Celsius) for up to several hours (depending on the size of the parts), then dipped into an oil bath to cool them and make them very hard. This hardening also makes them brittle, so the next step is to temper them. This is done by heating them in a second oven to about 300 degrees Fahrenheit (148.8 degrees Celsius), and then letting them cool in air. This whole heat treatment process makes parts which are both hard and tough.
- 3 After the heat treatment process, the races are ready for finishing. However, the races are now too hard to cut with cutting tools, so the rest of the work must be done with **grinding wheels.** These are a lot like what you would find in any shop for sharpening drill bits and tools, except that several different kinds and shapes are needed to finish the races. Almost every place on the race is finished by grinding, which leaves a very smooth, accurate surface. The surfaces where the bearing fits into the machine must be very round, and the sides must be flat. The surface that the balls roll on is ground first, and then lapped. This means that a very fine abrasive slurry is used to polish the races for several hours to get almost a mirror finish. At this point, the races are finished, and ready to be put together with the balls.

ii) Balls

- 4 The balls are a little more difficult to make, even though their shape is very simple. Surprisingly, the balls start out as thick wire. This wire is fed from a roll into a machine that cuts off a short piece, and then smashes both ends in toward the middle. This process is called cold heading. Its name comes from the fact that the wire is not heated before being smashed, and that the original use for the process was to put the heads on nails (which is still how that is done). At any rate, the balls now look like the planet Saturn, with a ring around the middle called "flash."

- 5 The first machining process removes this flash. The ball bearings are put between the faces of two cast iron disks, where they ride in grooves. The inside of the grooves are rough, which tears the flash off of the balls. One wheel rotates, while the other one stays still. The stationary wheel has holes through it so that the balls can be fed into and taken out of the grooves. A special conveyor feeds balls into one hole, the balls rattle around the groove, and then come out the other hole. They are then fed back into the conveyor for many trips through the wheel grooves, until they have been cut down to being fairly round, almost to the proper size, and the flash is completely gone. Once again, the balls are left oversize so that they can be ground to their finished size after heat treatment. The amount of steel left for finishing is not much; only about 8/1000 of an inch (.02 centimeter), which is about as thick as two sheets of paper.
- 6 The heat treatment process for the balls is similar to that used for the races, since the kind of steel is the same, and it is best to have all the parts wear at about the same rate. Like the races, the balls become hard and tough after heat treating and tempering. After heat treatment, the balls are put back into a machine that works the same way as the flash remover, except that the wheels are grinding wheels instead of cutting wheels. These wheels grind the balls down so that they are round and within a few ten thousandths of an inch of their finished size.
- 7 After this, the balls are moved to a lapping machine, which has cast iron wheels and uses the same abrasive lapping compound as is used on the races. Here, they will be lapped for 8-10 hours, depending on how precise a bearing they are being made for. Once again, the result is steel that is extremely smooth.

iii) Cage

- 8 Steel cages are stamped out of fairly thin sheet metal, much like a cookie cutter, and then bent to their final shape in a die. A die is made up of two pieces of steel that fit together, with a hole the shape of the finished part carved inside. When the cage is put in between and the die is closed, the cage is bent to the shape of the hole inside. The die is then opened, and the finished part is taken out, ready to be assembled.
- 9 Plastic cages are usually made by a process called injection molding. In this process, a hollow metal mold is filled by squirting melted plastic into it, and letting it harden. The mold is opened up, and the finished cage is taken out, ready for assembly.

iv) Assembly

- Now that all of the parts are made, the bearing needs to be put together. First, the inner race is put inside the outer race, only off to one side as far as possible. This makes a space between them on the opposite side large enough to insert balls between them. The required number of balls is put in, then the races are moved so that they are both centred, and the balls distributed evenly around the bearing. At this point, the cage is installed to hold the balls apart from each other. Plastic cages are usually just snapped in, while steel cages usually have to be put in and riveted together. Now that the bearing is assembled, it is coated with a rust preventative and packaged for shipping.

6. Gear Housing

- Made up of alloy containing carbon steel and small percentage of aluminium.

- Gear housings are normally die-casted to obtain the particular shape required.

7. **Ball Bearing**
   - Refer to number 5 (same as 5)

8. **Gear Complete**

- Made up of cast iron.
- Cast iron gears are made by heating a blanket of cast iron and having a tooth forming part to such a temperature that it is compatible to the blanket. The teeth forming part is then pressed by projecting teeth of the rolling machine. The teeth forming part becomes hot. The blanket is then cooled and a teeth part is generated in the teeth forming part of the blanket. Hot rolling with low plastic deformation resistance prevents lowering of strength and improves gear accuracy.

9. **Flat Washer**

- Made up of aluminium then coated with steel.
- Aluminium sheet is placed on a surface, and then this sheet is punched with a hammer with the required size, thickness and radius. After this the aluminium washer is coated with steel.

10. **Pan Head Screw**

- Made up of aluminium alloy metal to avoid cracking. Steel can be coated to give more protection.
- Alternative material can be nickel alloy screws

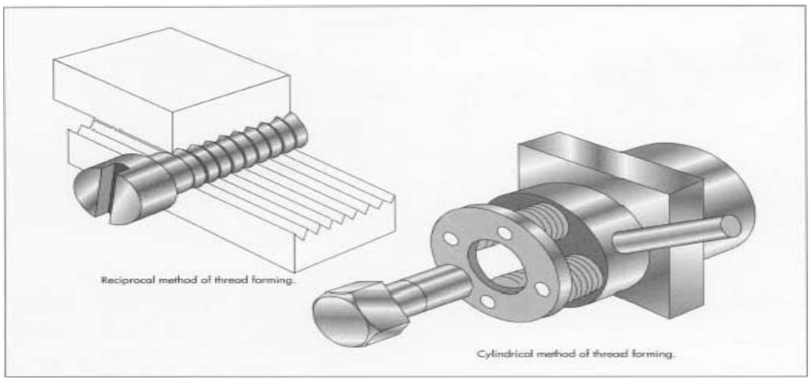
Machining is only used on unique designs or with screws too small to be made any other way. The machining process is exact, but too time consuming, wasteful, and expensive. The bulk of all screws are mass manufactured using the thread rolling method, and that is the procedure described in further detail.

Cold heading

- Wire is fed from a mechanical coil through a prestraightening machine. The straightened wire flows directly into a machine that automatically cuts the wire at a designated length and die cuts the head of the screw blank into a preprogrammed shape. The heading machine utilizes either an open or closed die that either requires one punch or two punches to create the screw head. The closed (or solid) die creates a more accurate screw blank. On average, the cold heading machine produces 100 to 550 screw blanks per minute.

Thread rolling

- Once cold headed, the screw blanks are automatically fed to the thread-cutting dies from a vibrating hopper. The hopper guides the screw blanks down a chute to the dies, while making sure they are in the correct feed position.
- The blank is then cut using one of three techniques. In the reciprocating die, two flat dies are used to cut the screw thread. One die is stationary, while the other moves in a reciprocating manner, and the screw blank is rolled between the two. When a centerless cylindrical die is used, the screw blank is rolled between two to three round dies in order to create the finished thread. The final method of thread rolling is the planetary rotary die process. It holds the screw blank stationary, while several die-cutting machines roll around the blank.



Threads can be cut into the blank by several methods. In the reciprocal method, the screw blank is rolled between two dies. In the cylindrical method, it is turned in the center of several rollers.

- All three methods create higher quality screws than the machine-cut variety. This is because the thread is not literally cut into the blank during the thread-rolling process, rather it is impressed into the blank. Thus, no metal material is lost, and weakness in the metal is avoided. The threads are also more precisely positioned. The more productive of the thread-rolling techniques is by far the planetary rotary die, which creates screws at a speed of 60 to 2,000 parts per minute.

11. Pin

- Made of aluminium alloy metal sometimes coated with zinc.
- The pins are made by hot rolling process. The material is rolled by hot rollers making it thinner to a designed diameter and also extruded at the same time. Then it is cut into expected length and sometimes coated with zinc.

12. Ring

- Made up of cast iron.
- They are casted with iron liquid poured into the design then let it be cooled. Sometimes when making small rings, they are normally punched by a hammer giving it a ring shape.

13. Helical Gear

- Are made of alloy steel.
- A cold extrusion process for forming internal ring gears comprising the formation of an annular ring gear blank having precise inside and outside diameters, placing the work piece over a circular mandrel having external gear forming die teeth and a pilot portion adapted to receive the blank, placing a die ring around the mandrel and the assembled work piece, a circular punch arranged coaxially with respect to the mandrel and the work piece, moving the punch into the annular space occupied by the work piece between the die ring and the mandrel, advancing the punch by means of a press whereby the work piece is cold formed through the external teeth of the mandrel, moving the die ring in synchronism with the downward motion of the work piece through the die teeth thereby eliminating any frictional forces in the direction of motion of the die during the extrusion process, and retracting the die ring following the extrusion of the work piece thereby permitting automated ejection of the work piece.

14. Retaining Rings

- Made up of Carbon Spring Steel: This steel is known for its high strength, and reliability in retaining ring applications. Can sometimes be coated with zinc o non-metallic finish over the steel to make it corrosion resistant.
- It is normally casted or sometimes injection moulded.

15. Ball Bearings

- Refer to number 5

16. Gaskets

- Gaskets are made up of graphite, cellulose fibre, synthetic rubber and starch mixed together that is used in sealing joints exposed to high working temperatures
- They are prepared by pressing the material to a designed width and then cutting into appropriate shape and size required.

17. Gear Housing Cover

- Made up of aluminium alloy.
- They are made by a process of die casting or pressure die-casting where the aluminium alloy is poured into the chamber then the air is removed where the molten aluminium alloy solidifies under pressure.

18. Ball Bearing

- Refer to number 5.

19. Fan

- Made up of aluminium metal with a little percentage of sell to give hardness.
- Made by injection moulding where the alloy on poured into the chamber and then left to cool.

20. Armature Assy

- Made up of stainless steel
- The process involved is die casting where the design is made in the machine for greater precision of the tooth and then the product is normally machined finished.

21. Ball Bearing

- Refer to number 5(same process involved).

22. Pan Head Screw

- Refer to number 10(same process involved)

23. Baffle Plate

- Baffle plate is made of stainless steel or mild steel and can also be used.

- Formed by a process of pressing where the material is placed on a surface and the material is pressed by a machine that has a required design of the baffle plate.

24. **Field**

- Made up of steel comprising of copper wires turned around to give a magnetic field to work.
- The metal part is sand casted with machine finished and then the copper wire is rolled around to give it a field.

25. **Support**

- Made up of steel. Sometimes coated with stainless steel.
- Process involved is injection moulding then cooled down to obtain the support

26. **Makita Label**

- Normally labels are made up of tin then plated so that it doesn't rust.
- The label is obtained by pressing. The readings on the label are stamped using hammers to whatever design required.

27. **Name Plate**

- Same process involved as number 26.

28. **Motor Housing**

- Made up of iron.
- The process involved to make motor housing is sand casting then it is machine finished to give it a proper dimension and shape.

29. **Pan Head Screw**

- Refer to number 10 (same process involved)

30. **Handle Base**

- Made of iron
- Injection moulding process involved then machine finished.

31. **Pan Head Screw**

- Refer to number 10 (same process involved)

32. Pan Head Screw

- Refer to number 10 (same process involved)

33. Handle Set

- Made up of iron and aluminium.
- Injection moulding process involved because pins visible

34. Handle Set

- Refer to number 33 (same process involved)

35. Brush Holder Cap

- Made up of carbon.
- The process involved is sand casting then machined surfaced. The Brush Holders can be supplied with surface treatment against corrosion, to enhance their performance and life span.

36. Carbon Brush

- Carbon brush consists of graphite powder mixed with metal powder and sintered. As increasing the metal content reduces the resistance loss of carbon brush, there are some problems such as inferior lubrication, anti-arc property, and increasing wear.
- Process start with raw materials such as graphite and carbon black. Measured amounts of these materials are ground, blended and mixed together according to the grade required. After pressing to shape in a die, the materials are kilned (heated in high temperature ovens). Furthermore processes such as impregnation and high temperature heat treatment are used to obtain special properties. Brushes are produced from these materials from a series of light machining and assembly operations.

37. Pan Head Screw

- Refer to number 10 (same process involved)

38. Switch

- Are made of thermosetting plastics. Chemically they are long chain molecules which are cross linked to other similar chains. Thermosetting plastic material on heating cannot be repeatedly melted-moulded. The reason for their resistance to repeat moulding is the cross links. These cross links prevent the displacement of polymer chains on heating. Due to it they don't become soft on heating. Bakelite is an important thermosetting plastic used for making switches.

- Injection moulding technique is used for the step of precompacting the fibre/resin mixture to express gases therefore prior to injecting sequential portions of the precompacted mixture into the mould cavity.

39. Strain Relief

- Is a semi-rigid epoxy. Because the epoxy stays somewhat flexible, it provides a nice transition between the rigid material and the flex material and reduces the chance for a tear to form in the flex material.
- A channel between the respective substrates is filled with a solvent soluble material which is applied in a manner such that a convex or concave shape is attained in the channel between the materials. A sensitizer may be mixed with the solvent soluble material prior to its placement in the channel between the substrates, and then a photo resist is applied to the composite, exposed and developed, yielding the desired circuit configuration. Next, copper leads are additively electrolessly plated to the desired thickness in the exposed circuit areas. After the leads have been formed, the solvent soluble material is removed leaving curved, strain relief leads suspended in air with the two ends interconnecting the substrates.

40. Pan Head Screw

- Refer to number 10 (same process involved)

41. Handle Set

- Refer to number 33 (same process involved)

42. Pan Head Screw

- Refer to number 10 (same process involved)

43. Pan Head Screw

- Refer to number 10 (same process involved)

44. Cord

- Made of Thermoplastic Elastomer (TPE). TPE has an extremely resistant coating so it can be used in environments where bacteria and other contaminants may exist. Incredibly strong and durable, TPE cords are also highly resistant to cuts, water, acid, heat, oxidation, chemicals, drugs, blood and other hazards that could present themselves in a medical setting.
- The process involved is as stated:

  A gripper device made of rigid material and having only two members. The two members are basically shaped alike, each having a single, longitudinal axis edge that faces and interlocks sliding with the other. One of the members has a number of cord or cable retaining cut-outs cut through an axis perpendicular to the sliding axis of the facing members. Provision is made for preventing the relative sliding of the members when cords or cables are being retained by the device, which can be secured by a single lock. The gripper device is small, easy to use and economic to produce.

45. Cord Guard

- Made up of Polypropylene. A cord guard made in accordance with this comprises a one-piece moulded, hollow plastic tubular member having a first, relatively fixed, end shaped to be connected to an appliance, a second, free end, and an intermediate, power cord-confining tube. The entire cord guard is hollow so that, when connected to an appliance, the appliance power cord extends there through. The plastic material used to produce the cord guard is relatively rigid but the power cord-confining tube is so formed as to provide adequate flexibility. Various thermoplastic materials could be used in moulding the cord guard, provided they are relatively rigid but capable of flexing.
- A cord guard has a power cord confining tube formed from a pair of wall members each of which has a series of stepwise and spirally extending wall panels. The panels of one of the wall members intertwine with the panels of the other of the wall members and both horizontal and vertical gaps are located between adjacent panels. In use, the tube readily flexes to a limited extent as needed by a spreading apart of the panel section margins that form the horizontal gaps.

46. Terminal Block

- Made of PE material with Brass insert and iron screw plate zinc. Each connector is made from a blank of conductive material and has an input terminal and multiple tubular output terminals for operatively connecting multiple wire conductors to a single wire conductor. The tubular output terminals are arranged in parallel and staggered relationship with respect to each other to minimize the size of the terminal block and the amount of material used for stamping the connectors.

- The process involved is normally injection moulding or sometimes pressing also.

47. <u>Handle Set</u>

- Refer to number 33 (same process involved)

48. <u>Dust Cover</u>

- Made of aluminum.
- The process used is pressing or sometimes injection moulded.