Shaper :-

Shaper is a reciprocating type of machine tool intended to produce flat surfaces. These surfaces may be — Horizontal
— Vertical
— Inclined.

- Acc to type of mechanism
  - Crank type
  - Geared type
  - Hydraulic Type.
- Acc to position & travel of ram
  - Horizontal type
  - Vertical type
  - Travelling head type

Two types of movements
1. Horizontal
2. Vertical.

- Shaper size is determined by maximum length of stroke / cut it can make. (175 to 900 mm)
- Quick return mechanism is employed because :-
  1. Torque provision.
  2. Range of cutting — stroke length adjustment
  3. Rotary form → Reciprocating form change.
- Operations of shaper :-
  - (i) Machining Horizontal surface
  - (ii) " vertical "
  - (iii) " Angular "
  - (iv) cutting slots, grooves & keyways
  - (v) " Irregular "
  - (vi) " splines / cutting gears
- Vertical shapes are used for machining internal surfaces, keyways, slots / grooves.
- Shaper follows quick return mechanism. ie in the front stroke of shaping it has a constant speed and while returning ie in backstroke it returns very quickly.
  - It is done so as to save time
  - In backstroke, angle is very less so that cutting may not take place.
- Cutting speed depends upon the type of material & machining condition.

- Difference b/w Shaper & slotter
  1. The work table in slotter has radial movement. If this movement is vanished then slotter becomes vertical shaper.
  2. In slotter, the ram holding the tool reciprocates in ~~horizontal~~ vertical axis. whereas
     In shaper, the ram holding the tool reciprocates in horizontal axis

Slotter

- Slotter machine falls under the category of reciprocating type of machine tool similar to shaper or a planer.
- It is used to cut grooves, keyways and slots of various shapes for making regular and irregular surfaces both internal & external gears.
- Ram holding tool may also reciprocate at an angle to horizontal table in addition to vertical stroke. → Shaper
- Size of slotter → Max^{m} length of stroke of ram.
- Slotter removes metal during downward cutting stroke.
- Quick Return Mechanism.
- 3 movements — Longitudinal, Cross, Circular
- Slotter operations:-

(i) Machining flat surface.
(ii) " cylindrical "
(iii) " irregular " & cam machining
(iv) " slots, keyways & grooves.

- cutting speed = Rate with which the metal is removed during downward cutting stroke (m/min)
- feed = movement of work per double stroke expressed in mm.
- Depth of Cut = Iar distance measured b/w the machined surface & unmachined surface.

⇒ **Grinding**:- is a metal cutting operation performed by means of a rotating abrasive wheel that acts as a cutting tool.

- To show high surface quality, accuracy of shape & dimension.

Two types — Rough / Non-precision, Precision Grinding

- **Abrasives**: It is a substance that is used for grinding & polishing operations. It should be pure & have uniform physical properties of hardness, toughness & resistance to fracture to be useful in manufacturing grinding wheels.

(1) Natural – Sandstone, solid quartz, emery (Al_2O_3), corundum (Al_2O_3), diamond.
(2) Artificial – SiC, Al_2O_3.

Fitting

- The term "bench work" denotes production of an article by hand on bench.
- Fitting is the assembling together of parts and removing metals to secure the necessary fit, and may or may not be carried out at bench.
- The operations performed in fitting include:-

(a) chipping
(b) filing
(c) scraping
(d) Grinding
(e) Sawing
(f) Marking
(g) Drilling
(h) Reaming
(i) Tapping
(j) Dieing

- Material of Bench vice → Cast iron body
  → fixed jaw & movable jaw → cast steel.
  → Handle, square threaded screw & nut — mild steel.
- Size of vice by width of its jaws (80 to 140 mm)

- Files — (High grade steel)
  Hardened piece of high grade steel with slanting rows of teeth.
  Used to cut, smooth or fit metal parts
  Except hardened steel. it cuts all the metals.
- Two types on basis of cuts of teeth

① Single cut flat file
→ (Used on a very hard metal)
→ Teeth are cut parallel to other across the file at an angle about 60° to the centre line of file.

② Double cut flat file
→ Over cut teeth being cut at about 60° and upcut at 75° to 80° to centre line
- The larger the file, the coarser it is.

- Shapes of files

(a) Flat file — Double cut on faces, single cut on edges.
(b) Handfile — Double cut
(c) Square file —
(d) Pillar file
(e) Round file — (Flat tailed)
(f) Triangular file
(g) Half round file
(h) Knife Edge file

- Filing:- It serves to remove the burr from the cuts & clean the face of the cuts and to finish the final shape of a workpiece.

• Tap: is a screw like tool which has threads like a bolt & 3 or flutes cut across the thread.
used to cut threads on inside of a hole.
→ High C.S or HSS.
→ cutting inside threads is called Tapping.

Welding

welding is a process of joining 2 similar metals by the application of heat with or without application of pressure & addition of filler material.
→ weldability is the ~~property~~ capacity of being welded into ~~the~~ inseparable joints having specified properties.
It depends on:-
① M.P ② thermal conductivity ③ thermal expansion
④ surface condition ⑤ change in microstructure.

Welding
- Pressure welding (Plastic) — Gas welding, spot welding, forge welding, Resistance welding, "thermit" welding.
- Non-pressure welding (Fusion) — Electric arc, Laser, Thermit welding

• In plastic welding / pressure welding, the pieces of metal to be joined are heated to a plastic state and then forced together by external pressure.
• In fusion welding (non-pressure welding, the material at the joint is heated to a molten state and allowed to solidify.
• In cold welding, joints are produced without the application of heat but by applying pressure which results in intersurface molecular fusion of parts to be joined.
→ Mainly used to weld non-ferrous sheet metal [Al and its alloys]

• Arc welding:- ① Carbon arc ② Metal arc ③ Plasma arc
④ Submerged arc ⑤ Electro-slag ⑥ Flux-cored. ⑦ MIG (Gas Metal Arc)
⑧ Gas Tungsten Arc (TIG) ⑨ Atomic Hydrogen arc

⑧ Gas Tungsten Arc (TIG)
Source → Electric Arc.
Anode → positive pole of DC
Cathode → −ve " " "

When anode & cathode are brought together and are sep. by a very small distance such that the current continues to flow through a path of ionized particles called plasma an electric arc is formed. This ionized gas column acts as a high Resistance conductor that enables more ions to flow from anode to

Heat is generated as the ions strike the cathode.

...rical energy is converted into heat energy.
- 1 KWh electricity = 250 Cal (1000 J)
- Temperature of arc = 6000 to 7000°C (depends on type of electrodes b/w which it is struck)
- Heat of arc raises the temperature of parent metal which is melted forming a pool of molten metal.
- $\frac{2}{3}$rd heat → near positive pole
- $\frac{1}{3}$rd " → near -ve pole.
- Electrode connected to +ve pole will burn away 50% faster than when connected to -ve pole.
- Arc-Welding Equipment:

(1) AC-DC machine
(2) Electrode
(3) Electrode Holder
(4) Cables, Cable Connectors
(5) Cable lug
(6) Chipping hammer
(7) Earthing clamps
(8) wire Brush
(9) Helmet
(10) Safety goggles
(11) Hand gloves
(12) Aprons, sleeves etc.

- DC from generators by electric motor:
- AC " transformers (step down (200-400V) to (50-90V) (60Hz) (300-400A)
- Automatic welding requires 800 and 3000A
- Ex: Indian Oxygen's INDARC 400(S)
- Advantage of DC welding → Higher arc stability and the degree to which work is heated.
- with DC, greater heat is generated at +ve pole of arc.
- In metal arc welding, connect work to positive pole & filler rod to -ve pole in order to melt the greater mass of metal in base material.
- 3 to 4 KWh → AC
- 6 to 10 KWH → DC
- Efficiency of AC → 0.3 to 0.6
- Power factor in AC → 0.3 to 0.4
- " " " DC → 0.6 to 0.7
- free-Drop Transfer.
- DC → (30-35V)
- AC → (50 to 55V)
- Non-Consumable Electrodes → C; Graphite; Tungsten.
- Consumable " →

-: Coated Electrodes :-

(1) To facilitate the establishment & maintainance of the arc.
(2) To protect the molten metal from the oxygen and nitrogen of a by producing a sheild of gas around the arc and weld pool.
(3) To provide the formation of slag so as to to protect the welding seam from rapid cooling.
(4) To provide a means of introducing alloying elements not cont. in core wire.

- Current depends on thickness of material.
  Electrode depends on " " " taken.
  size

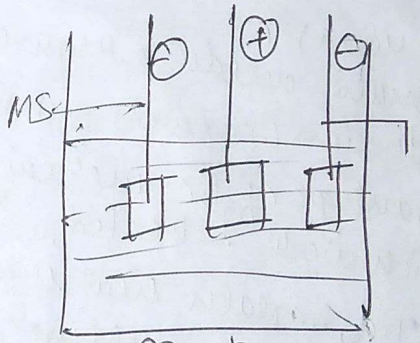
→ Electroplating :-

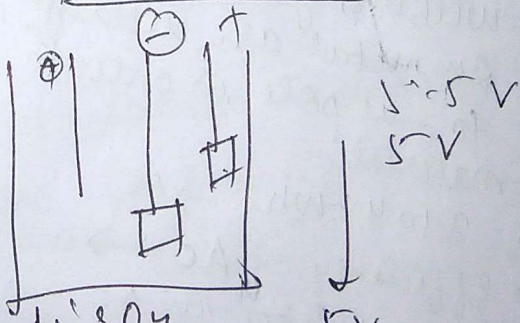
Electroplating is a process of covering a surface or object usualy metallic with a thin adherent coating of same or other metal by electrolysis.

- DC current at low voltage
- article → cathode, metalplate → anode.
  electolyte → metallic sol^n.

file
- Buffing set
→ HCl (wash ~~2 typ 2 ti~~
→ watn → 2 times (1min)
→ Anodic cleaning (watn + caustic) NaOH + Heat (40-50°C)
⊕
→ HCl wash
→ watn 2 times (2min)

$H = I^2RT$





100%

60-90°C.

Milling :- ('form Relieved cutter')

- A milling machine is a machine tool that removes metal as the work is fed against a rotating multipoint cutter.
- Because of multiple cutting edges it removes metal at a very fast rate.
- Size of column and knee type milling machine is designated by the dimensions of the working surface of table & its maximum length of longitudinal, cross & vertical travel of the table.
- Tools Used :-
  12 D.P. Gear cutter, Mendrel, Vernier calliper, chuck key, Double ended D-Spanner, Screwdriver, spur gear.
- Operations performed :-
  Teeth cutting, Method of simple indexing $\left(\frac{40}{N}\right)$.
  ① Calculating diameter
  ② Teeth cutting
  ③ Crank Ratio.
  ④ Gear cutting.

Spindle Drive mechanism of Table feed mech

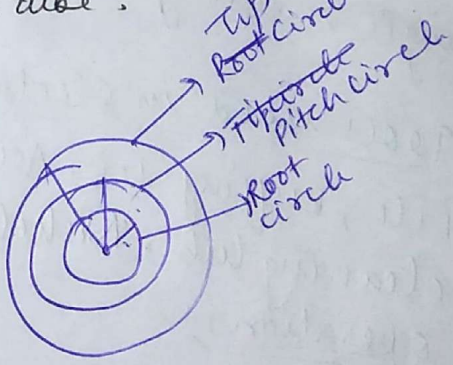
Clearance - Radial distance from top of tooth to bottom of tooth

Module (m) = Pitch dia in mm / No of teeth

Addendum → Radial height from pitch circle to tip circle

Dedendum → Radial depth from pitch circle to bottom of tooth space in mating gear

- Tools used in shaper :-
  Hammer, Number Punch, Try square, Machine vice, V-shaped single point cutting tool (HSS), cast iron cube.
- operations performed in shaper :-
  (1) Adjustment of block over the table.
  (2) Facing of side of iron cube.
  (3) changing face of iron cube.
  (4) Number punching.



- Tools used in Slotter :- (CSK ring)
  Try square, Double ended spanner, Hammer, steel scale, spring divider, Number punch, Cast Iron Block, Slot cutting tool (HSS)
- Operations performed in slotter
  (1) Placing and fixing of iron block (2) Grinding the surface
  (3) Marking of Ext. Radius & slot (4) Slot cutting.

• Tools used in fitting:

5" Parallel jaw Bench vice, Double cut flat file 12", Mild steel flat, 4" try square, 6" outside odd leg spring caliper divider, Centre Punch, Ball pein hammer, 8mm twist drill and 9mm tap with handle.

• Operations:

(i) Filing
(ii) Marking
(iii) Punching
(iv) Drilling
(v) Tapping

• Tools used in ~~welding & electroplating~~,
Mild steel and mild steel electrode (flux coated) (10 gauge) ~~Single V-Butt joint~~, welding machine, ~~Electrode Holder~~,

• ~~Operations~~ :-

• Tools used in welding:-
Mild steel and mild steel electrode (flux coated-10 gauge).
Electrode holder, AC arc welding set, welding glass, chipping Hammer, Tong, steel wire brush, 12" ~~flat~~ double cut flat file, 5" parallel jaw bench vice, Mill try square,

• Operations:-
Single V-Butt joint by electric arc welding, Filing, Brushing

• Tools used in Electroplating:- Mild steel (welded piece) file, Buffing set, Acid cleaning, water cleaning tub, Anodic cleaning tub, Nickel electroplating Tub, 5V DC Power Supply.

• Operations:-

Electroplating:

Anode:
$Ni \longrightarrow Ni^{2+} + 2e^-$

Cathode:
$Ni^{2+} + 2e^- \longrightarrow Ni$.

Carpentry:

- Grain in wood → Appearance or pattern of the wood on any cut surfaces.
  open grained wood → oak
  close " " → fir / pine

- **Seasoning of wood** :-
  It makes timber lighter in weight, more resilient and less liable to twist, warp and split.
  Its strength, hardness and stiffness increases as it dries.
  Two methods of drying / seasoning :-

① **Natural seasoning**
This is also known as Air drying. A lot of time is consumed in this type of seasoning.

② **Artificial seasoning**
In this seasoning, the time period is very much reduced.

⇒ Seasoned Timber contains a proportion of moisture, which varies from 16-22%. (outdoors)
or interior work or Heated atmosphere (8-12%)

- **Moisture content** :- is the ratio of amount of water in a sample and the dry weight of the wood sample itself exp. as % age.

⇒ **Common Defects** :-

1) **Seasoning defects**
2) **Natural defects**
3) Defects due to destructive agents
4) Defects " " Manufacturing / cutting
5) Pitch → (Resinous materials accumulate in the timber)

Types of woods

- Soft wood (light) (Mango)
  (Conifers) (Mahogany)
  (long narrow leaves)
  (Deodar, Pine, Fir)
  (Non-refractory)
  [Readily catch fire]
  (resist axial stress)

- Hard woods. [equal & strong, heavy]
  (Broad-leaved trees)
  [Sal, Pyingadas, Ash, Teak]
  Refractory
  (Do not readily catch fire)
  (Resist axial as well as transverse strain)

Common types of Timber :-

Babul, Mahogany, Mango, Sal, Sissu,

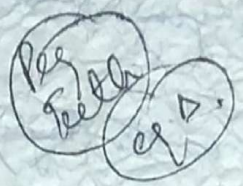
- Marking & Measuring Tools.

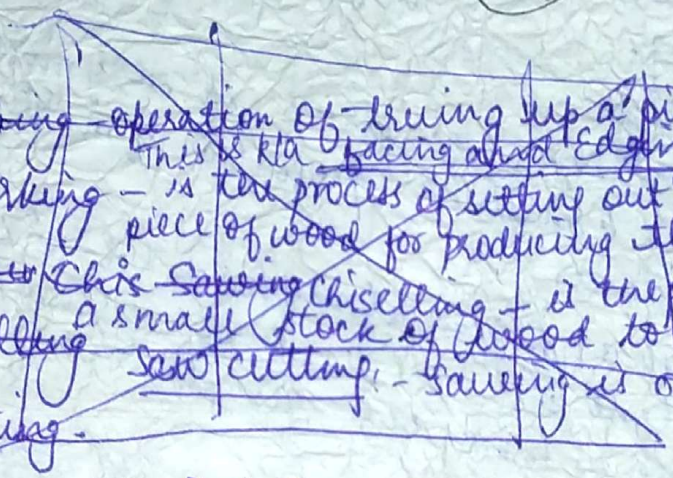
Rules, Try Square, Gauge — Marking Gauge, Mortise gauge,

- Cutting Tools :-

Saws :- Tenon or back saw, Dovetail saw, Chisel (Firmer, Mortise) (3-16mm)

- Planes — Iron Jack Planes.
- ~~Boring Tools~~ :-
- Holding Tools: Bench vice,
- Processes :-





~~(1) Marking~~ (1) Planing - operation of truing up a piece of wood by planer
This is kta facing and Edging.

(2) Marking - is the process of setting out dimensions on a piece of wood for producing the required shape.

(3) ~~Sawing~~ This Sawing Chiselling - is the process of cutting a small stock of wood to produce the desired shape.

(4) ~~Chiselling~~ Saw cutting :- Sawing is one of

(5) Fitting.

Babul.

Soft wood → Mango, Mahogany, Deodar, Pine, fir,

Hard wood → Teak, Sal, Sheesham, Ash, Pyingads)

Sissu.

Tools used in Carpentry :-

(used) (1 thumb screw)

Iron Jack Plane, Iron scale, Marking Gauge, (2 thumb screw)

(blade set at an angle of 45°) Bench vice, Mortise chisel (3-16mm), Firmer chisel, Tenon Saw,

Try square, Mortise Gauge (2 thumbscrew), Mallet

Types of Saws :

(Blades are 250 to 400mm)
13 teeth per 25mm

Rip saw, Cross cut handsaw, Tenon or back saw

Panel Saw, Coping Saw, (Teeth are equilateral in shape)

Compass Saw, Tenon

Processes.

1. Planing
2. Marking
3. Chiselling
4. Saw cutting
5. Fitting

- Planing → "facing and Edging"

Chiselling → cutting a small stock of wood to produce the desired shape.

Carpentry Joints.

1. Halving Joints. (Half-lap)
2. Mortise and Tenon Joints
3. Bridle Joints (open mortise and tenon joint)

(1) Aim of this joint is to secure the corners and the intersections of the framing, and keep all the face flush. (ie in same plane).

(2) Mortise → Rectangular Hole
Tenon → fitting into hole.

(3) Reverse of mortise and Tenon Joint
(No mortise) (2 grooves)
[a tenon → slot]

Used Joints.

1. Butt or Rubbed Joints.
2. Dowel Joints
3. Tongue and Groove Joints.
4. screw and Slot
5. Dovetail Joints
6. Corner Joints.

Foundry / Moulding

- Job → Conical wheel
- Pattern → Selfcore pattern
- Properties of sand :- Green Moulding sand.
  [68% → Silica, 6-10% Moisture, Clay 18-22%]
- Green sand is called "Green" because of presence of moisture in it.
- Furnace in which Al metal is melted is k/a Pit furnace.
- M.Pt of Aluminium is 660°C
- Coal type used - Hard coke [usually temp range is 1000-1600°C]
- But in melting Al temp range is [1200°C - 1400°C]
- It contains a less carbon content, therefore energy produced is much more.

Tools used: Riddle, Butt Rammer, Peen Rammer, Slick (used to repair and finish small surfaces of mould, and oval spoon slick is usually used), Lifter (used to clean & finish the bottom & sides of deep, narrow openings in moulds), Strike off bar, Sprue pin, Raiser pin, Swab, Gate cutter, Mallet, Vent (To avoid blow holes). Moulding Box.

(Tin)

(Green Strength)

Types of Sands :-

- Zircon → Cores of Brass & Bronze castings.
- Olivine → Non-ferrous castings.
- Chamotte → Heavy steel castings.
- Casomite (chrome - magnesite) — chilling tendency is to be increased to control solidification. Suitable materials in moulds for steels & castings.

- Properties of Green Sand moulding :-

(1) Porosity / Permeability -
(2) Flowability -
(3) Collapsibility
(4) Adhesiveness
(5) Cohesiveness / Strength -
(6) Refractoriness - (Capable of withstanding high temp of metals in molten state without fusing) (measured by sinter pt)

ocesses of Moulding:-

1) Ramming → using (peen, and butt rammer)
2) Planing → using strike off bar
3) Venting → vent wire
4) Gate cutting → Gate cutter.
5) Pouring → Metal pouring

⇒ Advantages of ~~using~~ green sand Mould.

1) least expensive method.
2) less distortion than in dry sand moulds bcoz no baking is required.
3) Flasks ready to use in minimum time.
4) Dimensional Accuracy is good across parting line.
5) Less danger of hot teraing of casting than in other types

• Disadvantages :-

(1) Sand control is more critical than in dry sand moulds.
(2) Erosion of moulds is more common in production of large castings.
(3) Surface finish. decreases as weight of casting increases
(4) Dim. accuracy ↓ as weight of casting ↑.

• Methods of G.S. Moulding:

(1) Open sand method
   (1) Bedded in
(3) Turn over method. (one use)

Tin Smithy

- GI sheet of 30 Gauge is used.
- Galvanised iron → coating of zinc.
- Gauge $\propto \frac{1}{\text{thickness}}$.
- Soldering is the process of joining two metals with a 3rd soft metal which is applied in molten state.
- Solder is an alloy of lead + Tin (50% + 50%)
- HCl → removes all dust particles.
- NH_4Cl → removes carbon & other particles from soldering iron.
- Metals used in sheet metal work are Black Iron, Aluminium, GI, stainless steel, copper, Brass, Zinc, tin plate, lead etc.
- Stainless steel → Nickel, chromium, C, etc.
- Tools used:

① Scriber ② spring dividr ~~Callipers~~ ③ Mallet.

④ Shears/Snips/scissors. ⑤ Stakes — Grooving Stake
- Hatchet stake.

⑥ Anvils ⑦ Mandrel.

⑧ Soldering Iron [forged piece of Cu joined to an iron rod with a wooden handle]. ⑨ Try square.

- Operations performed :-

① Laying out ④ Shaping ⑦ Assembling.

② Cutting ⑤ ~~Folding~~ Jointing.

③ Bending (Force is applied to local areas). ⑥ folding

⇒ Shearing :- A cut in a st. line across a strip, sheet or bar.

- Joints :- [Hems and Seams]
- Hem is an edge or border made by folding : Stiffens sheet of metal
- Seam is a joint made by fastening two edges together.

Hems are of 3 types:-

① Single Hem - Folding edges of sheet metal over.

② Double Hem - Edges folded over twice.

③ Wired Edge -

sinta

Smithy / Forging

- Open hearth portable furnace is used.
- Steam coke is used [C content is more, Energy is less]
  [500 - 700°C] or [700°C - 1000°C] C.f = (1400 to 1500 Cal]
- Mild-steel's recrystallisation temperature is 723°C.
- After forging some mechanical prop. change: like -
  (1) U.T.S. [ultimate Tensile Strength].
  (2) fatigue
  (3) Endurance
  (4) Rusting
  (5) wear & Tear
- Applications:-
  Crank shaft, Scissors, / Snips / Shear, Hand tools like [wrenches pipe Spanners, Adjustable wrench, Nut & Bolt, Hammers, Tongs. Connecting Rods
- Nut & Bolts are manufactured by 2 processes -
  (1) Crude / Locally
  (2) machinery.
- Colors verification ⟶ Red hot, Yellow hot

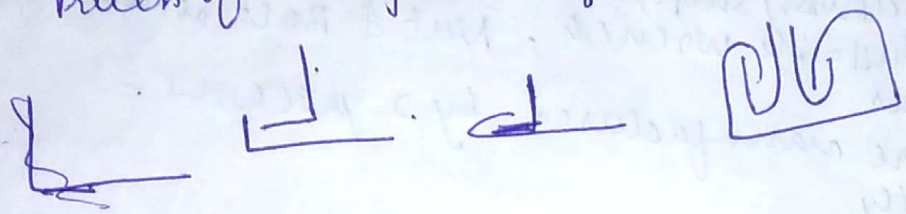
- Forging refers to the process of plastically deforming metals / alloys to a specific shape by a compressive force exerted by some external agency like Hammer, press, rolls etc.
- All ductile metals can be forged, forgeability of a metal at the forging temperature depends upon the crystallographic structure, M.P, yield strength, strain rate, dry friction.
- forgeability ↑ with temperature.
- forgeability is the relative ability of a material to deform without rupture.
- colour verification :-
  Red hot: [500 - 850°C]
  Yellow - 1050°C.

Beginning temp. for forging = 1200°C - 1300°C
finishing Temp = 910 - 723°C.

Seams:

(a) Lap seam (b) Grooved seam (c) Dovetail seam (d) Double seam
(e) Single seam (f) Burred Bottom seam (flanged seam);

(a) Lap seam – Lap joint by means of soldering.
(b) Grooved seam – Locking two single hems together by means of groover.
(c) Single seam – Join bottom to vertical bodies of various shapes.
(d) Double seam – Similar to single seam, its formed edge is bent upward against the body.
(e) Dovetail seam – Join flat plate to a cylindrical piece.
(f) Flanged seam – Join bottom of a container to its body.
Process of making narrow flange is k/a Beeding.



Edge

...gether by means of

④ Double ...ls used.

Anvil

② Hand hammers :-

- Ballpeen Hammer
- Straight Peen hammer
- Cross peen hammers.

③ Tongs — Ring Tong
- Gad Tong
- Straight lip fluted tong
- flat tong

④ Sledge Hammer

⑤ Swage.

- operations performed

① Heating.
② Hammering
③ swaging
④ upsetting (Heading)
⑤ Quenching.

- upsetting is the process of increasing the thickness of a bar at the expense of its length and is brought about by end pressure
- swaging is the process of increasing the length of the bar at the expense of its width / thickness or both.

Hammer Heads ⇒ Caste Steel.

Cutting Tools. ——— · Single edged cutting (Turning, shaping, Boring etc.)

Double edged cutting (Drilling)

① Single point tool — lathes, Shapers, Slotters

② Multipoint tools — Milling cutter, Broaching tool.

Cast iron → Iron + 2-4% C.

Steel → 1.5% C (upto)

Mild Steel → 0.05 - 0.30% C

HCS → 0.6 - 1.5% C

HSS - 0.75% C.

Slotting Machine

Intro-

Diff in shaper & slotter

(1) Ram holding the tool reciprocates in vertical axis whereas in shaper it reciprocates in Horizontal axis

~~(2)~~ → vertical shaper & slotter similiar.

(2) In vertical shaper the ram holding the tool can also reciprocates at an angle to the horizontal table in addⁿ to vertical stroke.

→ Uses of slotter :- Making regular & irregular surfaces, cutting grooves, keyways, slots for various shapes, handling large & awkward workpiece etc.

→ Developed by Brunel 1800

(3) In shaper pressure ~~along~~ to the ~~to the~~ length of the tool in slotter acts along the tool length.

Types of slotter:

2 Types - Puncher slotter & Precision slotter.

Puncher slotter - heavy, rigid used to remove large amt of metal from forgings or casting

→ length of stroke 1000 - 2000 mm

→ feed controlled by electric gears.

Precision slotter - lighter & operated at high speed.

→ give light cuts & accurate finish

→ whitworth quick return mech.

Slotter Size

→ specified by the max length of the stroke of the ram

→ Size 80-700 mm

Slotting Machine Parts-

Base, column, saddle, Crosslide, Rotating table, Ram & toolhead assembly, Ram drive mech, Feed mech:

→ the movement of the shole may be controlled by hand/ power to supply crossfeed.
→ T slots are for holding the job by dyf clamping device.
→ A slotter removes metal in downward stroke & no metal in upward stroke.

Ram drive mech are -
1) whitworth quick return mech.
2) Variable spud reversible motor drive mech.
3) hydraulic drive mech.
→ length of stroke = 2 of eccentricity = 2×3B
→ The angle of cutting stroke > Angle of return stoke
→ greater eccentricity ~~greater~~ longer length of stroke.
→ hydraulic & electrical drive - vibration are minimized better surface finish.

Feed mech -
- Feed given by the table.
→ 3 types of feed movement
1) Longitudinal 2) cross 3) circular.
Longitudinal → fed ⊥ to the column toward or away from its face.
cross - fed parallel to the face of the column
circular - table rotated on vertical axis.

Work holding Devices -
→ work hold by T-bolts, & clamps or special fixtures

other operat^{n} –
operat^{n} performed are – ① Machiing flat surface
② " cylindrical "
" Irregular surface & cam machiing
③ Machiing slots, keyways & grooves.

①–
– clearance of 20-25 mm is left before the beginning of cutting stroke.
– Table clamped to prevent any longitudinal / rotary travel & cut start from one end of work.

②
The feeding is done by the rotary table feed screw which rotates the table through small arc at the beginig of each cutting stroke.
– slotter specially Intended for cutting internal grooves.

Slotter tools
– Tool remove metal in vertical cutting stroke.
– pressures Acts Along the lengths of the tool.
– keyway cutting tools are thinner at cutting edge
– Round nose tools used — Machiing circular or contoured surface.
– Sq. nosed tool — Machiing flat surface.

Feed – movement of the work per double stroke expressed in mm.

Fitting

Intro

→ Bench work - product^{n} of an article by hand on bench.

→ Fitting - Assembling together of parts & removing metals to secure the necessary fit & may or may not be carried out at the bench.

→ operation used in fitting work

1) filing 2) Marking 3) Drilling 4) Tapping.

Vice

→ Vice - Bench vice, leg V, pipe V, hand V, pin vice etc.

- Bench Vice
- Parallel jaw Bench V. — Fitter's V.
- fixed to the bench with coach screws, or with nuts & bolts.
- V have - cast Iron body, [fixed jaw, movable jaw] - both of ~~M.S~~ cast steel, [handle, square threaded screw, nut] - M.S.
- Protective grips or clamps - made up of lead, fibre, tin-plate etc used to protect the finish work.
- size of vice is t/a by the width of its Jaw.
- common width - 80-140 mm
- openings max^{n} - 95-180 mm.
- leg vice use by blacksmith
- Toolmaker's vice for filing & drilling.
- M.S made of

Hammers -

- made up of forged steel
- used to strike a job or a tool.
- 0.33 - 0.45 kg

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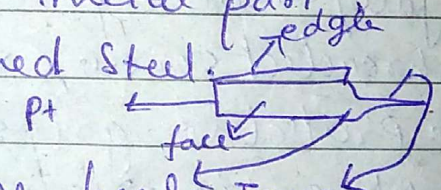
→ 4 parts – Peen, head, eye & face.
→ eye – oval or elliptical accomodate handle / shaft.
→ handle – elastic wood / bamboo
→ Av. handle – 250 – 325 mm long.
→ classification of hammer acc. to the shape of the Peen
→ Ball peen, Cross peen, Straight peen, soft.
→ Ball peen – k/a – engineer's hammer / chipping hammer.
→ Soft hammer – k/a – mallet
→ Chipping – process of removing thick layer of metal by means of cold chisels

Files

→ hardened piece of high grade steel with slanting rows of teeth.
→ use to cut, smooth or fit metal part
→ cut all metal except hardened steel.
→ Parts of file



Point, Safe edge, or edge, face, heel, Tang
Size – Distance from pt to heel without Tang
cut of teeth – 2 type → 1) Single-cut 2) Double cuts.
→ Double cut files have 2 sets of teeth
over cut – 60°
up cut – 75 to 80° to the centre line.
further classification of Single-cut & double-cut files
1) Rough 2) Bastard 3) Second cut
4) Smooth 5) Dead Smooth 6 Super Smooth.

- Rough cuts - used for soft metals
  - " for triming edges of castings
- Bastard - standard cut - for general shaping w.
- Second cut - gives good finish for many pieces of fitting w.

Shape - Flat file, Hand f, Square f, Pillar f, Round f. Triangular f.
- Flat file used.
- Flat file Double cut on face & Sugle cut on faces.
- Specification → length say 100mm single/Double cut
  Shape say flat Roughness

Filing

→ It serves to remove the burr from the cuts & clean the face of the cuts & to finish the final shape of workpiece.
→ Accuracy upto 0.05mm.
→ left foot in dirn of file stroke, & right foot at an angle of 70° in relatn to L.F.
→ grip the file from Right Hand.
→ file cuts on forward stroke & idled in Back stroke or return stroke.
→ as Rule in return stroke file is on work But pressure from L.H released.

- Method of filing
  cross filling, straight filling, Draw-filing

→ Draw filing doesn't remove metal but a smoother cutting is achieved.
→ when nt in use they are coated with machine oil to protect them frm rust.
→ Before using file oil removed by CCl4 or NaOH
→ worn files can be reused by dipping them in HCl.

Marking Tools

Tools used for marking
1) Surface plate 2) scriber 3) Punch 4) V-Block
5) Angle Plate 6) Try-square.

- Surface for testing flatness of work.
- Punch used for marking out work, locating centre.
- 2 types of punches
1) Prick P 2) Centre Punch.
- Angle of pt of centre punch - 60°
- Body portion punch - Steel rod - 90-150 mm long & 8-13mm in Diameter
- Try-square is made in one piece - Blade & Beam.
- Try-square is used to get a right angled surface to the trued surface or surface.

Marking out

→ consistes of marking on the job a series of definite lines or posit^n
→ These line act as guide to fitter who will work on the job.

→ The surface to be marked out generally treated with chalk or $CuSO_4$

Drill

→ tool to make holes in metal piece.
→ 3 types of Drill – flat D, straight fluted D, twist D
→ Best cutting angle – 118°
→ 2 types of twist Drill – parallel shank & Tapered shank.
→ Parallel shank D used in hand & electric Drill
→ Drill are taken out of the Spindle hole by taper cotter called Drift.
→ Taper used in Drill – Morse standard Tapper.

Drilling

→ operat^n of producing circular hole in metal piece
→ Pillar drilling machine is used.
→ oil or soap water in the form of coolant is used to prevent the cutting edges of the drill from being spoiled.

Taps

→ Screw-like Tool which has threads like bolt & 3 or 4 flutes cut across the thread.
→ used to cut threads inside of a hole as in nut

$4s^2$ 4p

$1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^3$

$1s^2$ $2s^2.2p^6.3s^2.3p^6$ $4s^2 3d^{10} 4p^3$

→ lower part of the tap is somewht tappered so that it can well attack the walls of the drill hole.
→ upper part consist of a shank ending in a sq. for holding the tap by tap wrench.
→ Taps made from carbon steel or H.S.S.
→ Hand taps made in sets of three

1) Taper tap — Roughter — end has 6 thread tapered
2) Second tap or plug tap — Intermediate — tapered back from edge abt 3/4 threads
3) bottoming tap — Finisher — used to finish the work

Tap drill size

→ Drill hole must be smaller than the tap by twice the depth of the thread.

$D = T - 2d$ → Depth.
↓ ↳ Diameter of tap
Diameter of the Tap drill size

Tapping

→ cutting inside threads is called tapping
→ Roughter first used.
→ oil should be used during the tapping so as to ensure smooth cutting & to prevent teeth from damaging — Lard oil used.

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Welding

Intro

→ process of joining similar metals by applicat^{n} of heat with / without applicat^{n} of pressure & addit^{n} of filler material.

Weldability

→ capacity of being welded into inseparable joints having specified properties such as definite weld, strength, proper structure etc.
→ Criteria — weld quality & the ease with which it can be obtained
→ Depends on — 1) M.P
2) Thermal conductivity
3) Thermal expansion
4) Surface condit^{n}
5) change in microstructure,

Types of welding

→ 2 headings — Plastic welding or Pressure W
— fusion welding or non-pressure W.
→ Plastic welding — pieces to metal to be joined heated to plastic state & then forced together by external pressure.
→ used in Forge We, Resistance We, thermit We, Gas We.
→ fusion We — metal heated to molten state & then ~~modify~~ solidify
→ Gas We, Arc We, thermit We.

Arc Welding processes - Carbon arc, Metal arc, Plasma arc, electroslag, Gas metal arc, Gas Tungsten arc etc.

Metallurgy of weld

→ Stresses responsible for weld metal cracking.
→ Alloys of non-ferrous metals are softened in the heat affected zone due to annealing

Arc Welding

→ Src of heat - electric arc.
→ arc column generated b/w the anode - +ve end of pole of D.C power supply & cathode - -ve
→ when 2 conductors are brought together & separated for a small distance (2-4 mm) such that the current flows through the path of ionized particles called plasma, an electric arc is formed.
→ ionized gas column act as high - R conductor that enable ions to flow from A → C
→ electrical — heat energy.
→ electrode metal is melted & transferred to metal in the form of globules of molten metal.
→ 2/3 heat developed at +ve pole & 1/3 at -ve hole.
→ Arc crater - small depression in parent metal around which molten metal is piled up.
→ Arc length - Distance from centre of the arc from the tip of electrode to the bottom of the Arc crater.
→ 3-4 mm → Arc length.
→ Oxidation — adverse effect on mechanical Prop. of weld metal.

→ Shorter Arc — time of contact shorter

Metal transfer in Arc Welding

→ 3 ways

1) Dip transfer 2) free drop (large Drop) I

3) By spray (small Drop) I

→ Dip transfer — gobule of ~~oil~~ metal formed at the tip of the electrode during arcing. then it enlarges, elongates & touches the metal

→ free drop — Drop of molten metal small in diameter than Air gap

→ Small drop — tiny droplets.

Arc welding equipment

PAT — AC/DC machine
Electrode
electrode holder
cables & cable connectors
Cable lug
Chipping hammer
earthing clamps
wire brush
helmet
Safety goggles
Hand gloves
Aprons.

Arc welding machine —

→ Both DC & AC

→ DC — by motor or internal combustion engine

→ Normal welding V — 50-90V

→ Advantage of DC — higher Arc stability

→ ~~work to~~

→ connect work to +ve pole of DC generato

& filler rod to -ve pole in order to melt greater mass of metal in the base material.
→ open ckt voltage i.e voltage needed to strike the arc is higher than the arc voltage in order to have easy starting of the Arc.
- Arc blow - the space and the arc & in the adjacent metal is always threaded by M.F which tend to deflect the Arc.
→ Flow of current split in 2 parts
66% at +ve pole 33% at -ve pole.
→ electrode connected — +ve lead = electrode +ve or reversed polarity
→ electrode connected — -ve lead - electrode -ve or straight polarity
→ Non consumable electrodes - not consume during welding eg graphite, carbon
→ Advantages of coated electrode -
1) establishment & maintance of Arc
2) Protect molten metal from oxygen & Nitrogen
3) formation of slag to protect welding seam from rapid cooling
4) means of introducing alloying elements not contained in the core wire.
→ rods of electrode - 12 mm in Dia
450 mm L
→ electrode held at 20° from vertical & 3mm above.

Arc welding methods

1. Carbon Arc
2. Metal Arc
3. Metal-inert-gas A
4. Gas-tungsten A
5. Atomic H A
6. Plasma A
7. Submerged A
8. Flux-cored A
9. electro-slag welding

~~→ to~~ ①

→ an ① rod of carbon –ve electrod & work +ve.
→ use of C – bcz less heat generated ~~at~~ electrode tip.
→ D.C used.

②

metal rode as 1 electrod & other electrode W.
Temp – 2400°C – 2600°C
~~is~~ & DC AC & DC

D. Welding shows bead characterstics

Welding I too low – excessive pilling of M
★ " " " high. – excessive splatter
★ V too high – bead too small
★ welding speed too slow – excessive pilling of weld
★ proper I & timing – smooth, regular, well formed bead.

→ soldering is a method of uniting 2 or more pieces of metal by means of a fusible alloy or metal called solder applied in molten state

→ 5 basic types of Joints
Butt, lap, T-corner, edge

- Strickle box is often used when core with an Irregular shape is req.

FOUNDRY

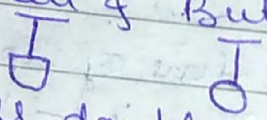
- Foundry or casting of forming metallic prods by melting the metal & pouring it into the mould & allow it to solidify.

MOULDING TOOLS AND EQUIPMENT

- 3 gps

1) Hand tools 2) Flasks 3) Mechanical Tool

- hand rammer used for packing or ramming the sand into the mould.
- 2 types - Peen & Butt.



- Slicker - small double-ended tool having flat at one end & spoon on other.
- Lifters - made of thin sect^{n} of steel of various L & B with one end bent at Right ∠.
- use to clean & finish the bottom, sides of dup, narrow openings in moulds.
- Gate cutter - tri plate small piece.
  - used for cutting gates & runners in mould.
- Sand moulds are prepared in specially constructed boxes called flasks.
- purpose to impart necessary rigidity & strengths wanted,
- Top part cope & lower part drag.
- Box flask - for small & medium size moulding

- Mechanical tool - power riddles, sand mixers, sand conveyors

MOULDING SANDS

- Principle Ingredients of sand
  1) silica sand grains
  2) clay
  3) moisture
  4) miscellaneous materials.

→ silica sand - 80-90%. SO_2, high softening temp & thermal stability.
→ silica sand grains impart refractions, chemical restivity & permeability to sand.
→ True clay impart necessary bonding strength
→ Moisture furnishes bonding act^n
→ Miscellaneous material - oxide of Fe, limestone, magnesia, soda & potash.
→ Moulding sand in 3 types
1) natural moulding sand
2) Synthetic / high silica "
3) special "

- Natural M. sor green sand

Types of moulding sand
Green sand
→ mixture of silica sand with 18-30% clay & 6-8% water
→ It is fine, soft, light & porous.
→ Green sand after dried or baked - dry sand.
→ Rounded shape grain are the best moulding

Sand. SAND ADDITIVES

- for smooth surface on casting the facing material additives are coke, dust, lead etc.

→ non-silica parting compound made from powdered phosphate Rock is the widely used as parting Dust.

- Properties of moulding sand

1) Porosity 2) Flowability 3) collapsibility
4) Adhesiveness 5) Strength 6) Refractiness.

- Refractiness - capable of withstanding high temp of metals in molten state without fusing

→ process by which sufficient moisture is added to moulding sand - sand Tempering.

MOULDING PROCESSES BASED ON SAND

GREEN sand mould

- prepared with natural moulding sands or with mix of silica sand, binding clay & water.

- Advantages

* least expensive method.
* less distortion than in dry sand moulds
* Flasks ready for reuse with min time
* Dimensional accuracy is good.
* less danger of hot tearing of casting

- Disadvantage

→ sand control more critical than in Dry sand M
→ erosion of mould in large casting
→ Surface finish deteriotes as the wt of casting ↑

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- * Dimensional accuracy ↓ as the wt of casting ↑
- - Principal method
- * open-sand method
- * Bedded-in "
- * Turn over "

MAKING GREEN SAND MOULD

TYPICAL MOULDING PROBLEM

- false cope

SHAPER

→ Shaper is a reciprocating type of machine tool intended primarily to produce flat surfaces.
→ Shaper can produce any surface composed of strgt lines elements
→ It can produce horizontal, vertical or Inclined surfaces.
→ Developed in 1836 by James Nasmyth.
→ classification of shaper –

According to type of mech used for giving reciprocating motion to the ram
1) Crank type 2) Geared type c) Hydraulic
- Acc. to position & travel of ram – Horizontal, Vertical, Travelling head
- Acc to the type of design of the table – Standard Shaper
Universal Shaper.
- Acc to the type of cutting stroke – Push, Draw

Crank Shaper – The shaper in which the cutting tool is given reciprocating motion Acc. to the length of the stroke desired while the work is placed on the Adjustable table.
– Large gear – bull gear.
– Bull gear power from motor.

Hydraulic shaper – Reciprocating movement of the ram by hydraulic power.
- cutting speed & force of ram drive remains constt to the end of cut.

Horizontal shaper – ram holding the tool reciprocates in horizontal axis.
- used flat surface.

Vertical shaper – ram holding the tool reciprocates in vertical axis.
- Adjustment of 10° can be done.
– useful in machining internal surface, keyways, slots or grooves.
– specially designed for internal keyways – keyseaters.

Travelling head – ram moves crosswise

Standard / plain shaper – when table have only 2 movements vertical & horizontal to give the feed.

Parts of shaper

Base → made up of cast Iron to resist vibration & take high loads.
→ Can take entire load of the machine.
→ It work on quick return mech.

Column – encloses the ram driving mech.
→ Rid on the left side can we open for Inspect^{n} & oiling
R.S – levers, handles etc.

Cross rail – Table may be moved which causes cross rail to move up & Down

Saddle

Table – can be moved crosswise or vertical by saddle & cross rail.
– Box like casting T-slots on the top & sides for clamping the work.

Ram – Reciprocating member.
- semi-cylindrical & heavily ribbed inside to make more rigid.
- houses screwed shaft for altering the position of the ram.

Toolhead - hold tool rigidly, provides vertical & angular feed movement of the tool.
- amt of feed or depth of cut adjust by micrometer dial.

Shaper size
→ size is determine by the max stroke or cut it can make.
→ usual size 175–900 mm
→ length of stroke – size of machine
→ for 250 mm – size of cube that can be planned & held
cross feed adjustment – 250 mm
extreme bottom position of crossrail 250 mm workpiece high.
→ length of stroke indicates
- belt drive, power input, floor space req., wt of the machine etc.

Shaper mechanism
→ Rotary movement to reciprocating movement by mech. contained in the column.
→ standard shaper – metal remove in forward stroke while no metal remove in return stroke.
→ To reduce total machining time – return stroke time min.
→ Design on the basis that in forward stroke it move slower speed depend on material while in return stroke faster speed. to reduce idle return time. → Quick return mech.
→ mech – ③ ① crank & slotted link mech
② whitworth quick return mech
③ hydraulic shaper mech.

→ crank & slotted mech – bull gear is power is transfer through pinion step
→ speed change by diff comb^n of gearing or shifting belt on cone pulley
→ slotted link – rocker arm.
→ Rotary mot^n of Bull gear converted to reciprocating movement of ram.
→ Angle of cutting stroke > Angle of return stroke.
→ cutting time : return time → 2:1 pratical limit – 3:2
→ Disadvantage – cutting & return speed are nt const.
→ min Rocker arm – 2 extremities max – Rocker Arm vertical
→ Bevel gear at centre of Bull gear.
→ closer the pin to centre of bull wheel – smaller stroke.
→ max stroke – crank pin – farthest end of slick.

whitworth

Feed mech – Driven & crossfeed movement in return stroke.
- crossfeed – to machine flat horizontal surface.
- amt of feed alter – shifting the posit^n of crank w.r.t centre.

* Holding Devices -
Methods — clamped in a vise
" on the table
" to the angle plate
" on V-block
Tool b/w shaper index centre.
- machine Vise — Plan vise — single screw & Double screw
Swivel " — Base at a Degree in vertical Plane
Universal " — swivel + tilted upto 90° from Horizontal Plane.
→ Double screw add gripping strength — deeper cuts/handling heavier Jobs.
→ Hold down tapered at an angle of 5°.

Shaper operations

Diff operatn are — 1) Machining horizontal surfaces
2) " Vertical "
3) " Angular "
4) cutting slots, grooves & keyways
5) " Irregular "
6) " spline or cutting gears.

① → table raised until there is a clearance of 25 - 30 mm b/w tool & workpiece.
→ Length of stroke — 20 mm longer than work.
→ Position adjusted that tool begin moves to move from a distance of 12-15 mm from workpiece & continues to move 5-8 mm after end of the cut.
→ short strokes — high speed long strokes — slow speed.
→ Depth of cut — 1.5 — 3 mm Roughing work
→ " " " — 0.075 - 0.2 mm finishing work.
→ Feed adjusted abt 1/2 the width of cutting edge of tool.

Shaper tool

→ Single point cutting tool having rake, clearance & other tool angles.
→ Rigid & heavier to withstand shock experienced by cutting tool.
→ Tool Angle change only by grinding.
→ Side clearance ∠ — 2° - 3°, front clearance ∠ - 4° for Fe & Steel.
→ High speed steel for tool of shaper
→ Cemented carbide tipped tool — harder material.

cutting speed - rate at which metal removed by cutting tool (— m/min)
→ cutting speed consider in forward stroke.
cutting speed — length of C. Stroke / time req by the C. Stroke.

$$V = \frac{nL(1+m)}{1000}$$

Feed - Relative movement of the tool or work in a dirn ⊥ to the axis of reciprocation of the ram per double stroke (mm)
Depth of cut - thickness of metal removed in one cut.