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(Empowering Students with 21st Century Skills)

DEPARTMENT OF MECHANICAL ENGINEERING

LAB MANUAL

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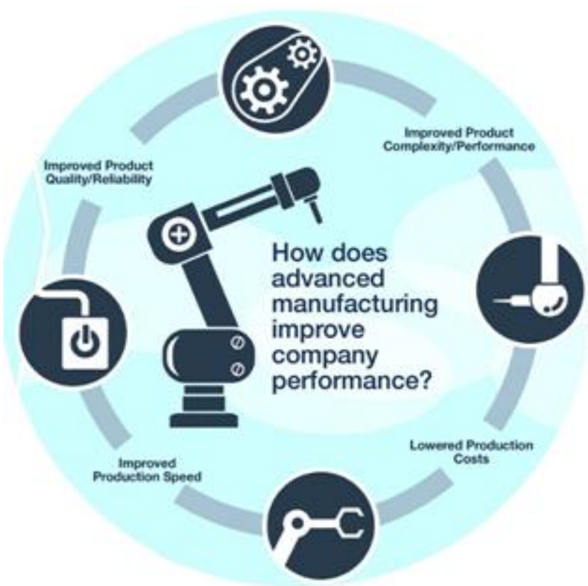
FOR

MANUFACTURING TECHNOLOGY LAB (MEC-264)



Vision of the Department

The Mechanical Engineering Department aims to be recognized as an outstanding educational centre to develop innovative engineers who are proficient in advanced fields of engineering and technology and can contribute effectively to the industry as well as for socio-economic upliftment of the society.

Mission of the Department

M1: To impart outcome-based education with a research orientation to the students to develop them as globally competitive engineers.

M2: To imbibe the students with academic, leadership and entrepreneurship skills needed by the industry in particular and society in general.

M3: To adopt flexibility and dynamism in designing the programme structures to cope up with emerging market needs.

M4: Establishment of liaison with top R & D organizations/Industries and leading educational institutions for practical exposure of the students and faculty as well as to the state of the art.

Programme Educational Outcomes (PEOs)

After the successful completion of undergraduate course, Mechanical Engineering, Graduates will be able to:

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PEO1: Plan, design, construct, maintain and improve mechanical engineering systems that are technically sound, economically feasible and socially acceptable.

PEO2: Apply analytical, computational and experimental techniques to address the challenges faced in mechanical and allied engineering streams.

PEO3: Communicate effectively using conventional platforms as well as innovative / online tools and demonstrate collaboration, networking & entrepreneurial skills.

PEO4: Exhibit professionalism, ethical attitude, team spirit and pursue lifelong learning to achieve career, organizational and societal goals.

Program Outcomes (POs) - B. Tech. Mechanical Engineering

PO1: **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues, and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

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PO9: Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

PO12: Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSO) - B. Tech. Mechanical Engineering

PSO1: Apply mechanical and interdisciplinary knowledge to analyze, design and manufacture products to address the needs of the society.

PSO2: Apply state of the art tools and techniques to conceptualize, design and introduce new products, processes, systems and services.

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Department of Mechanical Engineering

L	T	P	Credits
0	0	2	1

<table>
<tr><td>Course Code</td><td colspan="9">MEC264</td></tr>
<tr><td>Course Title</td><td colspan="9">Manufacturing Technology Lab</td></tr>
<tr><td>Course Outcomes</td><td colspan="9">On the completion of the course the student will be able to:
CO1: Understand and use different machines in machine shop.
CO2: Understand the concept of welding and use of different welding machines.
CO3: Understand the concept of casting and foundry.
CO4: Understand the use of furnaces in casting.</td></tr>
<tr><td>Examination Mode</td><td colspan="9">Practical</td></tr>
<tr><td rowspan="2">Assessment Tools</td><td colspan="4">Continuous Assessment (CA)</td><td rowspan="2">MSE</td><td rowspan="2">MSP</td><td rowspan="2">ESE</td><td rowspan="2">ESP</td><td rowspan="2">Total</td></tr>
<tr><td>Quiz</td><td>Assignment/ Project Work</td><td>Attendance</td><td>Lab Performance</td></tr>
<tr><td>Weightage</td><td>-</td><td>-</td><td>-</td><td>20%</td><td>-</td><td>-</td><td>-</td><td>80%</td><td>100</td></tr>
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S. No.	LIST OF EXPERIEMENTS	CO Mapping
1.	To study the characteristic features of lathe and prepare a job practicing different operations on mild steel rod.	CO1
2.	To study the characteristic features of milling machine and machine the hexagonal head and the slot on the specimen.	CO1
3.	To study the characteristic features of shaper and machine a V-block.	CO1
4.	To study the characteristic features of drilling machine.	CO2
5.	To join two given metal plates by a square butt joint, Lap joint, Tee joint using arc welding.	CO2
6.	To study the characteristic features of TIG/MIG welding and join two given metal plates making different welded joints.	CO2
7.	To study the characteristic features of different resistance welding processes and join two given metal sheet by resistance welding processes	CO2
8.	To study the characteristic features of SAW welding and join two given metal plates.	CO3
9.	To make the mould of different types of pattern.	CO3
10.	To make cores of different shapes and test the core.	CO4
11.	To make pattern for given casting with all necessary allowances, parting line running system details.	
12.	Investigate the casting defects and suggest remedial measures.	

(MACHINE SHOP)

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EXPERIMENT NO: 1

Experiment 1: To study the characteristic features of lathe and prepare a job practicing different operations on mild steel rod.

Apparatus:

Single point tool, MS rod, Brush,

Theory:

Lathe is one of the most versatile and widely used machine tools all over the world. It is commonly known as the mother of all other machine tool. The main function of a lathe is to remove metal from a job to give it the required shape and size. The job is securely and rigidly held in the chuck or in between centers on the lathe machine and then turn it against a single point cutting tool which will remove metal from the job in the form of chips. Fig. 1 shows the working principle of lathe. An engine lathe is the most basic and simplest form of the lathe. It derives its name from the early lathes, which obtained their power from engines. Besides the simple turning operation as described above, lathe can be used to carry out other operations also, such as drilling, reaming, boring, taper turning, knurling, screw thread cutting, grinding etc.

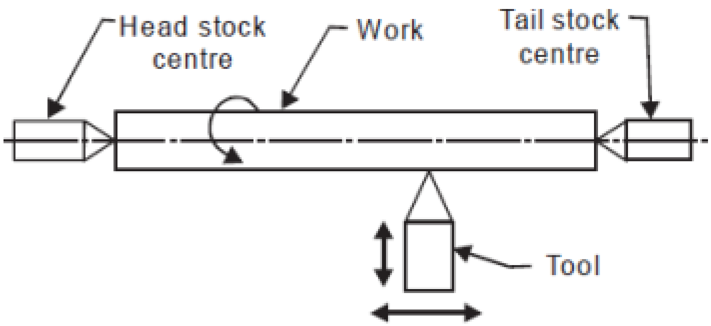

Fig.1. Working principal of lathe machine

Construction of Lathe Machine:

A simple lathe comprises of a bed made of grey cast iron on which headstock, tailstock, carriage and other components of lathe are mounted. Fig. 2 shows the different parts of engine lathe or central lathe.

The major parts of lathe machine are given as under:

1. Bed
2. Head stock
3. Tailstock
4. Carriage
5. Feed mechanism
6. Thread cutting mechanism

Bed:

The bed of a lathe machine is the base on which all other parts of lathe are mounted. It is massive and rigid single piece casting made to support other active parts of lathe. On left end of the bed, headstock of lathe machine is located while on right side tailstock is located. The carriage of the machine rests over the bed and slides on it. On the top of the bed there are two sets of guideways-innerways and outer ways. The inner ways provide sliding surfaces for the tailstock and the outer ways for the carriage. The guideways of the lathe bed may be flat and inverted V shape. Generally, cast iron alloyed with nickel and chromium material is used for manufacturing of the lathe bed.

Head Stock:

The main function of headstock is to transmit power to the different parts of a lathe. It comprises of the headstock casting to accommodate all the parts within it including gear train arrangement. The main spindle is adjusted in it, which possesses live centre to which the work can be attached. It supports the work and revolves with the work, fitted into the main spindle of the headstock. The cone pulley is also attached with this arrangement, which is used to get various spindle speed through electric motor. The back-gear arrangement is used for obtaining a wide range of slower speeds. Some gears called change wheels are used to produce different velocity ratio required for thread cutting.

Tail Stock:

Fig. 3 shows the tail stock of central lathe, which is commonly used for the objective of primarily giving an outer bearing and support the circular job being turned on centers. Tail stock can be easily set or adjusted for alignment or non-alignment with respect to the spindle centre and carries a centre called dead centre for supporting one end of the work. Both live and dead centers have 60° conical points to fit centre holes in the circular job, the other end tapering to allow for good fitting into the spindles. The dead centre can be mounted in ball bearing so that it rotates with the job avoiding friction of the job with dead centre as it important to hold heavy jobs.

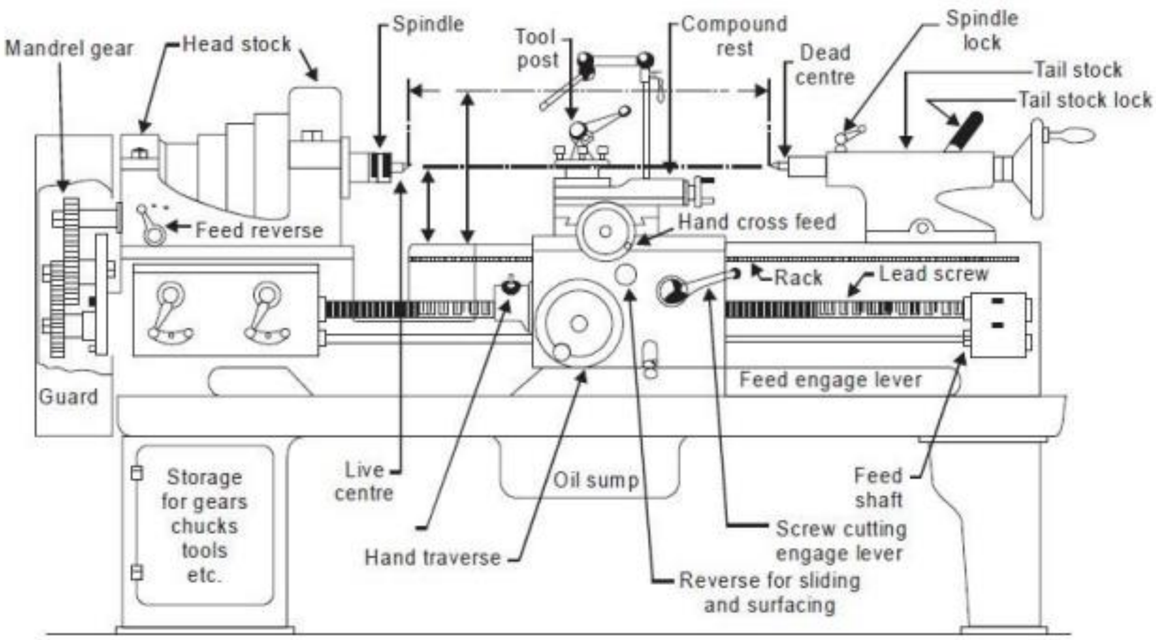

Fig.2 Different parts of engine lathe or central lathe

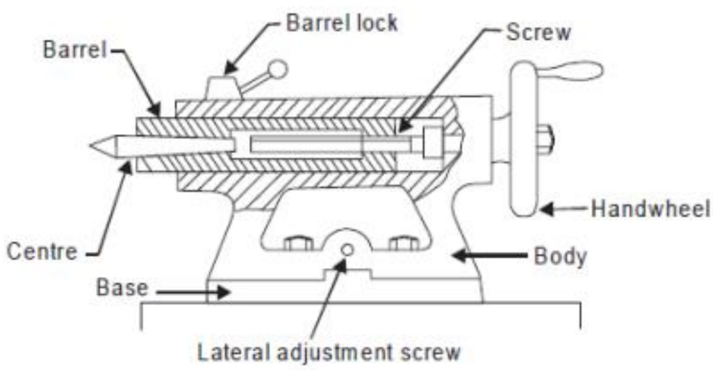

Fig.3 Tail stock of central lathe

Carriage:

Carriage is mounted on the outer guide ways of lathe bed and it can move in a direction parallel to the spindle axis. It comprises of important parts such as apron, cross-slide, saddle, compound rest, and tool post. The lower part of the carriage is termed the apron in which there are gears to constitute apron mechanism for adjusting the direction of the feed using clutch mechanism and the split half nut for automatic feed. The cross-slide is basically mounted on the carriage, which generally travels at right angles to the spindle axis. On the cross-slide, a saddle is mounted in which the compound rest is adjusted which can rotate and fix to any desired angle. The compound rest slide is actuated by a screw, which rotates in a nut fixed to the saddle. The tool post is an important part of carriage, which fits in a tee-slot in the compound rest and holds the tool holder in place by the tool post screw. Fig. 4 shows the tool post of centre lathe.

Feed Mechanism:

Feed mechanism is the combination of different units through which motion of headstock spindle is transmitted to the carriage of lathe machine. Following units play role in feed mechanism of a lathe machine

1. End of bed gearing
2. Feed gear box
3. Lead screw and feed rod
4. Apron mechanism

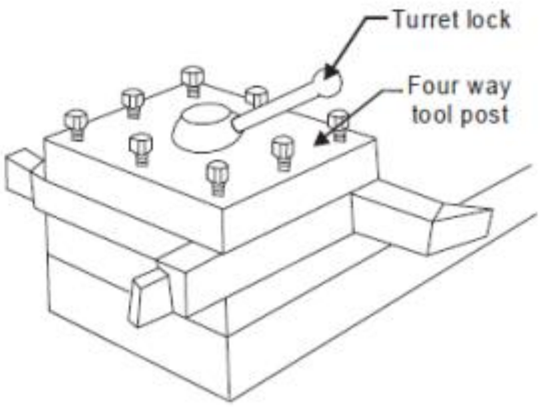

Fig.4 Tool post of centre lathe

The gearing at the end of bed transmits the rotary motion of headstock spindle to the feed gear box. Through the feed gear box, the motion is further transmitted either to the feed shaft or lead screw, depending on whether the lathe machine is being used for plain turning or screw cutting. The feed gear box contains a number of different sizes of gears. The feed gear box provides a means to alter the rate of feed, and the ration between revolutions of the headstock spindle and the movement of carriage for thread cutting by changing the speed of rotation of the feed rod or lead screw. The apron is fitted to the saddle. It contains gears and clutches to transmit motion from the feed rod to the carriage, and the half nut which engages with the lead screw during cutting threads. Thread Cutting Mechanism The half nut or split nut is used for thread cutting in a lathe. It engages or disengages the carriage with the lead screw so that the rotation of the leadscrew is used to traverse the tool along the workpiece to cut screw threads. The direction in which the carriage moves depends upon the position of the feed reverse lever on the headstock.

Specification of Lathe:

The size of a lathe is generally specified by the following means:

(a) Swing or maximum diameter that can be rotated over the bed ways

(b) Maximum length of the job that can be held between head stock and tail stock centres

(c) Bed length, which may include head stock length also

(d) Maximum diameter of the bar that can pass through spindle or collect chuck of capstan lathe.

Fig. 5 illustrates the elements involved in specifications of a lathe. The following data also contributes to specify a common lathe machine.

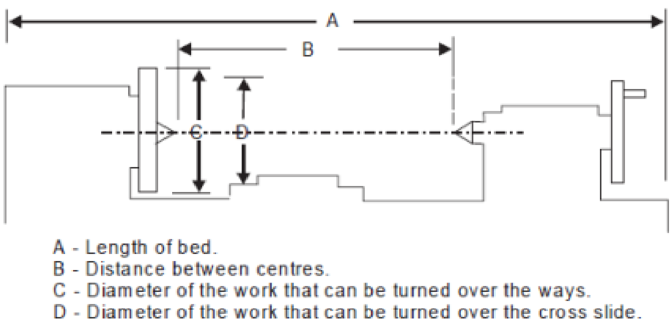

Fig 5: Specifications of lathe machine

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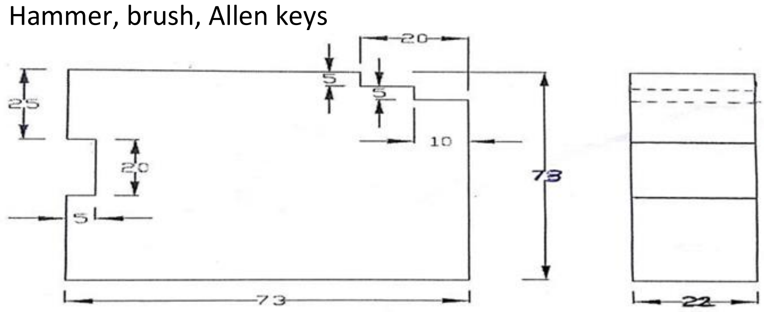
EXPERIMENT NO: 2

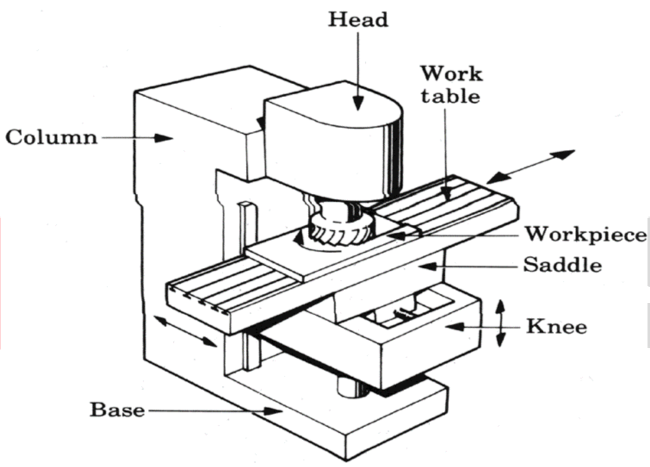
Experiment 2 To study the characteristic features of milling machine and machine the hexagonal head and the slot on the specimen.

Apparatus:

Materials Required: Mild Steel Work Piece.
Machine Required: Milling Machine
Measuring Instruments: Vernier Calipers
Cutting Tools: Plane (Face) Milling Cutter.
Marking Tools: Steel Rule, Scriber

a. Work holding fixtures: work piece supporting fixtures
b. Miscellaneous tools: Hammer, brush, Allen keys





OBSERVATION: Record the following in a tabular form:

Machine Tool Specifications (Table A)

Machine	**Type & Make**	**Size**	**Speed given to**		**Feed given to**		**Type of Surface Produced**
			Tool	**Work**	**Tool**	**Work**	
Milling m/c							

Speed and Feed Data (Table B)

No.	**Milling m/c.**	
	Speed	**Feed**
1.		
2.		
3.		
4.		

PROCEDURE:

1. The dimensions of the given rod are checked with the steel rule.
2. The given rod is fixed in the vice provided on the machine table such a, one end of it is projected outside the jaws of the vice.

3. A face milling cutter is mounted on the horizontal milling machine spindle and one end of the rod is face milled, by raising the table so that the end of the rod faces the cutter.
4. The rod is removed from the vice and fitted in the reverse position.
5. The other end of rod is face milled such that, the length of the job is exactly 100 mm.
6. The table is lowered and the rod is removed from the vice and refitted in it such that, the top face of the rod is projected from the vice jaws.
7. The face milling cutter is removed from the spindle and the arbor is mounted in the spindle; followed by fixing the plain milling cutter.
8. The top surface of the job is slab milled; first giving rough cuts followed by a finish cut.
9. The job is removed from the vice and refitted in it such that, the face opposite to the above, comes to the top and projects above the vice jaws.
10. The top surface of the job is milled in stages; giving finish cuts towards the end such that, the height of the job is exactly 40 mm.
11. The burrs if any along the edges are removed with the help of the flat file.
12. Learn the names of the major units and the components of each machine. Record these details (Table A). Please ensure that the main isolator switch is off and check that the machine cannot be inadvertently started. Do not remove guards). Use the manufacture's handbook for details that cannot be inspected.
13. Record the obtainable speed and feed values (Table B).
14. Note down the special features of the speed and feed control on each machine

PRECAUTIONS:

1. The milling machine must be stopped before setting up or removing a work piece, cutter or other accessory.
2. Never stop the feeding of job when the cutting operation is going on, otherwise the tool will cut deeper at the point where feed is stopped.
3. All the chips should be removed from the cutter. A wiping cloth should be placed on the cutter to protect the hands. The cutter should be rotated in the clockwise direction only for right handed tools.
4. The work piece and cutter should be kept as cool as possible (i.e. coolant should be used where necessary to minimize heat absorption).
5. The table surface should be protected with a wiping cloth.
6. Tool must be mounted as close to the machine spindle as possible.

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RESULT:

ADVANTAGE:

1. Both flat and formed surface can be produced.

DISADVANTAGES:

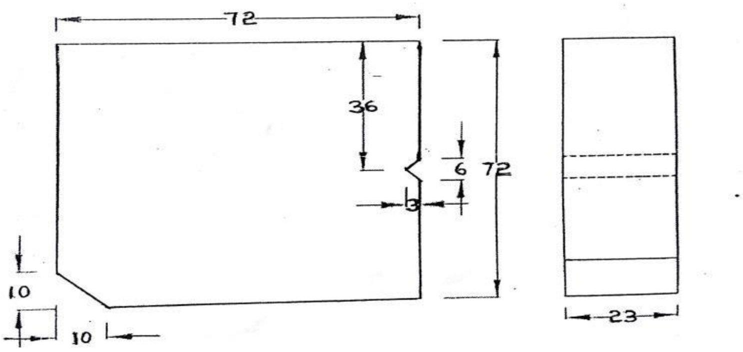
(i) Quality of surface generated will be slightly wavy
(ii) Lubrication is difficult.
(iii) Needs heavy fixture since the cutting force results in lifting the work piece.
(iv) Results in vibration.
(v) Cutting force is not uniform.

APPLICATIONS:

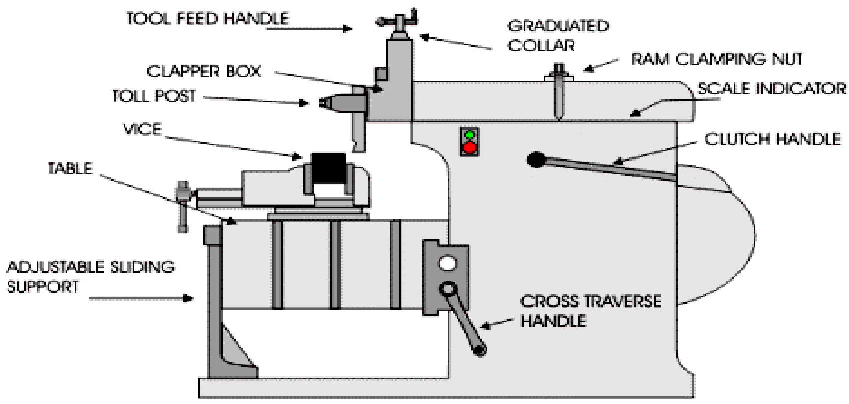
Milling machines are widely used in the tool and die making industry and are commonly used in the manufacturing industry for the production of a wide range of components. Typical examples are the milling of flat surface, indexing, gear cutting, as well as the cutting of slots and key-ways.

EXPERIMENT NO: 3

Experiment 3 : **To study the characteristic features of shaper and machine a V-block.**
MATERIALS REQUIRED: Mild steel / Cast iron / Cast Aluminum.
MACHINE REQUIRED: Shaping machine
MEASURING INSTRUMENTS:
Vernier calipers, Vernier height gauge, Dial indicator, required steel ball.
CUTTING TOOLS
H.S.S tool bit, V-tool, Plain tool, Grooving tool.



ALL Dimension are in mm



OBSERVATION Record the following in a tabular form:

Machine Tool Specifications (Table A)

Machine	Type & Make	Size	Speed given to		Feed given to		Type of Surface Produced
			Tool	Work	Tool	Work	

Speed and Feed Data (Table 2)

No.	Shaper M/c.	
	Speed	Feed
1.		
2.		

PROCEDURE:

1. Run the machine at low speed and observe the motions, which control the shapes of the surfaces produced. Note particularly the features, which control the geometrical form of the surface.
2. Learn the names of the major units and the components of each machine. Record these details (Table A). (Please ensure that the main isolator switch is off and check that the machine cannot be inadvertently started. Do not remove guards). Use the manufacture's handbook for details that cannot be inspected.
3. Record the obtainable speed and feed values (Table B).

4. Note down the special features of the speed and feed control on each machine.
5. Measuring of specimen.
6. Fixing of specimen in the machine vice of the shaping machine
7. Giving the correct depth and automatic feed for the slot is to be made.
8. Check the slot with the Vernier calipers & precision measurement by slip gauges at the end.

PRECAUTIONS:

1. The shaping machine must be stopped before setting up or removing the work piece
2. All the chips should be removed from the cutter.

RESULT

ADVANTAGES:

1. Single point cutting tools used in shaper are expensive these tools can be easily grounded to any desirable shape.

2. Shaper set-up is very quick and easy and can be readily changed from one job to another.

DIS ADVANTAGES:

1. The shaper is unsuitable for generating the flat surfaces on very large parts because of limitations on the stroke and overhang the ram.

2. The primary motion is accomplished by rack and pinion drive using a variable speed motor.

APPLICATIONS:

A shaper machine is a cutting machine that cuts a linear tool path using a linear relative motion between a single-point cutting tool and the piece of work. This type of machine is usually used to machine flat, straight surfaces, although it is also able to perform more complex tasks including the machining of dovetail slides, gear teeth and internal spline, keyways in the boss of either gears or pulleys and many other forms of work that take advantage of the machines linear relative motion.

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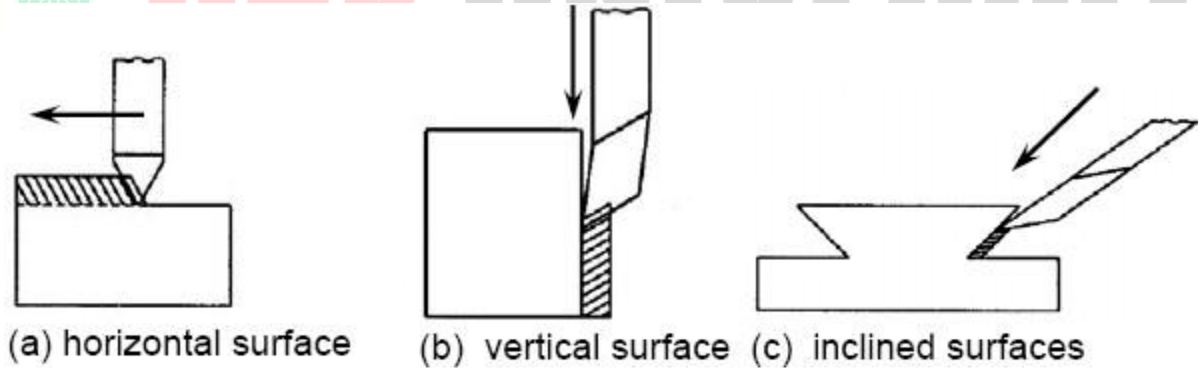
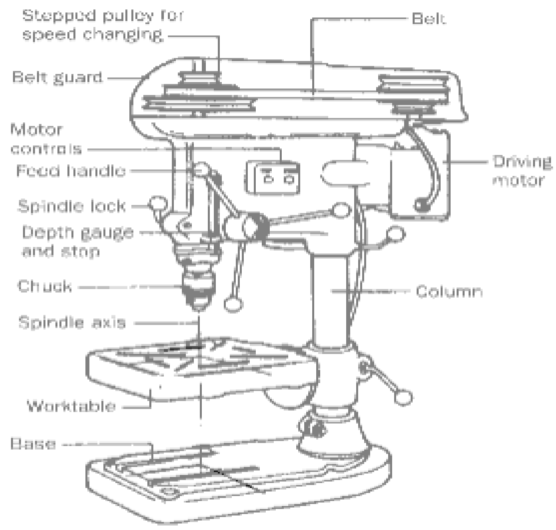
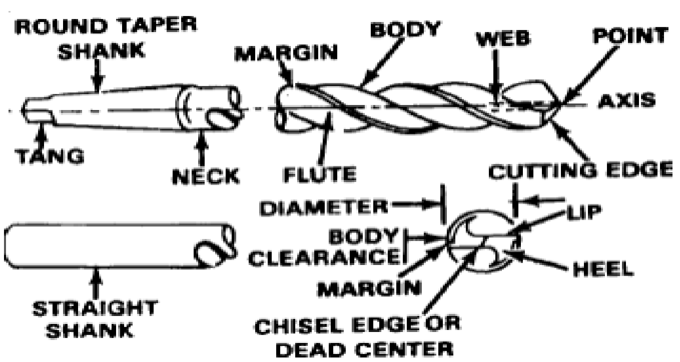


EXPERIMENT NO: 4

Experiment 4 To study the characteristic features of drilling machine.
Apparatus:
Drilling machine, drill tool, coolant, metal piece, brush.
Theory:
When drilling a hole using a hand or power drill, it can be tricky to drill the hole at a right angle to the work. Drills often have a level incorporated into the drill housing, but usually this requires good vision to read. There are, however, several techniques that persons with low vision or no vision use which can make drilling quite accurate. These techniques include: Drill guides in a range of diameters are available from hardware stores or building supply centers. Placing the guide on the surface of the work to be drilled and inserting the bit through the guide makes it possible to drill a hole straight into the work. If you have access to a drill press, you can make a set of drill guides yourself by drilling holes of different diameters into small blocks of wood. These works just like the drill guides described above. If you don't have access to a drill press, you might ask a sighted friend to make drill guides using a portable drill with a built-in level.



Tip:
Over time, the guide hole in the wooden guide may become slightly enlarged, which may make it a bit more difficult to position the drill at exactly a 90-degree angle. Remove a square or rectangle of wood from a board, creating a right angle; then place the bit into the corner to help align the bit. Place a large-headed nail with the head down on the surface of the board, and align the bit with the nail by touch. Use an empty spool of thread or sewing machine bobbin (pictured below). Mark the spot by making a "start hole" with an awl, nail, or ice pick. Place the drill bit through the spool or bobbin and align the point of the bit with the start hole you have created. With the drill in the "off" position, place the flat end of the spool or bobbin firmly against the surface and hold it in place with pliers. Please note: Do not use your hands to hold the spool in place. With the drill and spool in this position, start the drill – and your hole will be straight/perpendicular with the surface.
Twist Drill:
Twist drills are rotary cutting tools normally having two cutting edges and two flutes which are grooves formed in the body to provide cutting lips, to permit the removal of chips and to allow coolant or cutting fluid to reach the cutting action. They are identified by the shank style, straight or taper, then by length, screw machine, jobber or taper length, by the material they are made from and finally by the helix or spiral of the flutes.



(WELDING SHOP)

EXPERIMENT NO: 5

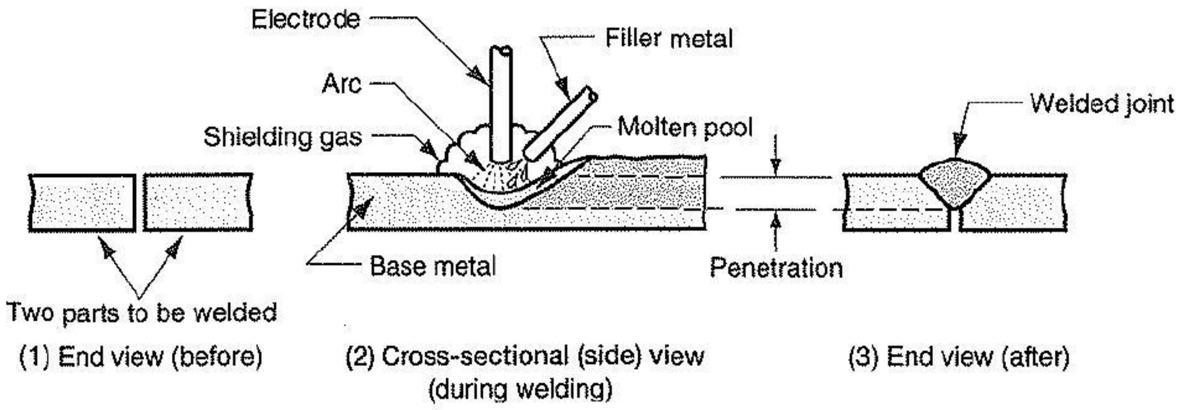
Experiment 5: To join two given metal plates by a square butt joint, Lap joint, Tee joint using arc welding.

Equipment and Material Required:

D.C Welding machine, Bench vice, Tensile testing machine, M.S. Plates of 100x50x5(2), Metallurgical microscope.

Tools Required:

Hack saw, chipping hammer, wire brush, safety goggles, Hand gloves, Face shield, Files.



Welding Terminology:

1) Backing: It is the material support provided at the root side of the weld to aid in the control of the penetration.
2) Base Metal: The metal to be joined or cut.
3) Bead or Weld bead: It is the metal added during a single pass of welding. The bead appears as strikers.
4) Crater: In arc welding, a crater is the depression in the weld metal pool at the where the arc strikers.
5) Deposition Rate: Rate at which weld metal is deposited per unit time and expressed in kg/hr.
6) Fillet Weld: The metal fused into the corner of a joint made of two pieces placed at approximately 90 degrees to each other.
7) Penetration: Depth up to which the weld metal combines with the base metal as measured from the top surface.
8) Puddle: Portion that is melted by the heat of welding.
9) Root: The point at which the 2 pieces to joined are nearest.
10) Tach weld: A small weld used to temporarily hold the two pieces together during actual welding.
11) Weld face: Exposed surface of the weld.
12) Weld pass: A single movement of the welding torch or electrode along the length of the joint, which results in beats, is weld pass.

Description:

Principle of Arc welding:

An arc is generated below 2 conductor cathode and anode. When they are touched to establish flow of current. An arc is sustained electric discharge through ionized gas column called plasma b/w 2 electrodes. Electrons liberated from cathode move towards anode at high-speed large amount of heat is generated. To produce are potential diff b/w 2 electrodes should be sufficient.

Straight and Reverse Polarity:

The positive terminal of DC supply is connected to work piece and the negative terminal to electrode and known as DCSP.

The positive terminal of DC supply is connected to electrode and negative to work piece and is known as DCRP.

Heat Affected Zone (HAZ):

A HAZ of a weld is the part of welded joint, which has been heated to temperature up to solidify temperature resulting in various degree of microstructure as

Tensile Test: This test is carried out to determine the ultimate tensile strength under static loading of the base metal weld metal on welded joint.

Procedure:

1. Given 2 M.S. plates are filled at an angle of 450 at 2 surfaces to be joined (V groove is formed) 2. Electrode is fixed to electrode holder.
3. Connections to be given such that electrode- negative and work piece positive.
4. Welding is to be done carefully for the half-length of the plates.
5. The work piece is to be cut into two halves by power hacksaw.

6. The beads are polished, etched with two percent natal solution and studied under the microscope whose magnification factors 10X for the heat effected zone.
7. By gripping the beads b/w the jaws pf Tensile testing machine and load is applied until the work piece breaks and the readings is to be noted.
8. The same procedure is repeated for the remaining half which is welded by reverse polarity and the results are to be compared

Precautions:

1. Edge preparation should be done very carefully.
2. Before welding ensure that the surfaces are extremely clean.
3. While welding always use face shields or goggles.

Result:

The effect of polarity on weld strength and heat effected zone in arc welding was studied.

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EXPERIMENT NO: 6

Experiment 6: To study the characteristic features of TIG/MIG welding and join two given metal Plates making different welded joints.

Material Required:

Inert gas (helium, argon) welding outfit, MS Sheets 150x50x5mm (2No)

Apparatus Required:

Wire brush, hand gloves, and chipping hammer, spark lighter, TIG and MIG equipment.

Theory:

MIG welding MIG (Metal Inert Gas) welding, also known as MAG (Metal Active Gas) and in the USA as GMAW (Gas Metal Arc Welding), is a welding process that is now widely used for welding a variety of materials, 28 | P a g e ferrous and nonferrous. The essential feature of the process is the small diameter electrode wire, which is fed continuously into the arc from a coil. As a result this process can produce quick and neat welds over a wide range of joints. MIG welding is carried out on DC electrode (welding wire) positive polarity (DCEP). However DCEN is used (for higher burn off rate) with certain self-shielding and gas shield cored wires.

MIG Torch: This provides the method of delivery from the wire feed unit to the point at which welding is required. The MIG torch can be air cooled or water cooled and most modern air cooled torches have a single cable in which the welding wire slides through a Liner.

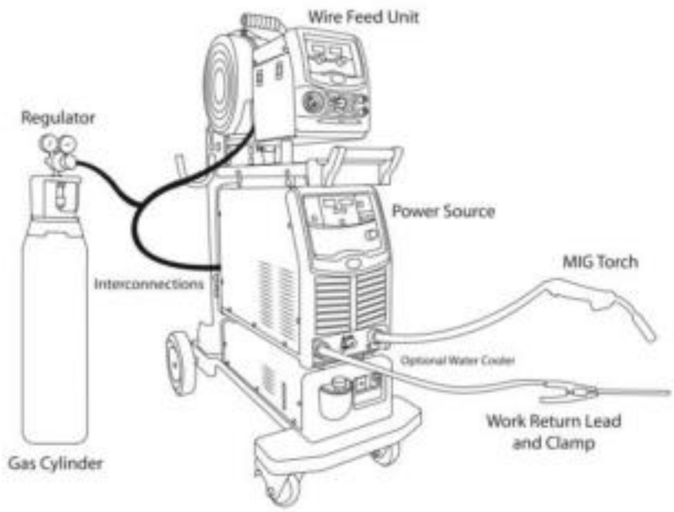

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Fig: A Typical MIG welding setup

Power Source: MIG welding is carried out on DC electrode (welding wire) positive polarity (DCEP). However DCEN is used (for higher burn off rate) with certain selfshielding and gas shield cored wires. DC output power sources are of a transformer-rectifier design, with a flat characteristic (constant voltage power source). The most common type of power source used for this process is the switched primary transformer rectifier with constant voltage characteristics from both 3-phase 415V and 1- phase 240V input supplies.

Shielding Gas: This is a complicated area with many various mixtures available, but the primary purpose of the shielding gas in the MIG process is to protect the molten weld metal and heat affected zone from oxidation and other contamination by the atmosphere. Different gases used for shielding are Argon, Helium, CO2, Ar-CO2 Mixture etc.

TIG Welding Process: TIG (Tungsten Inert Gas) welding also known as GTA (Gas Tungsten Arc) in the USA and WIG (Wolfram Inert Gas) in Germany, is a welding process used for high quality welding of a variety of materials, especially, Stainless Steel, Titanium and Aluminium.

Power Source: TIG welding can be carried out using DC for Stainless Steel, Mild Steel, Copper, Titanium, Nickel Alloys etc and AC for Aluminium and its Alloys and Magnesium. Further information on the TIG Welding Process follows information on equipment used in this document. The Power Source is of a transformer design with or without a rectifier, with a drooping characteristic (constant current power source).

TIG Welding Process: TIG (Tungsten Inert Gas) welding also known as GTA (Gas Tungsten Arc) in the USA and WIG (Wolfram Inert Gas) in Germany, is a welding process used for high quality welding of a variety of 29 | P a g e materials, especially, Stainless Steel, Titanium and Aluminium.

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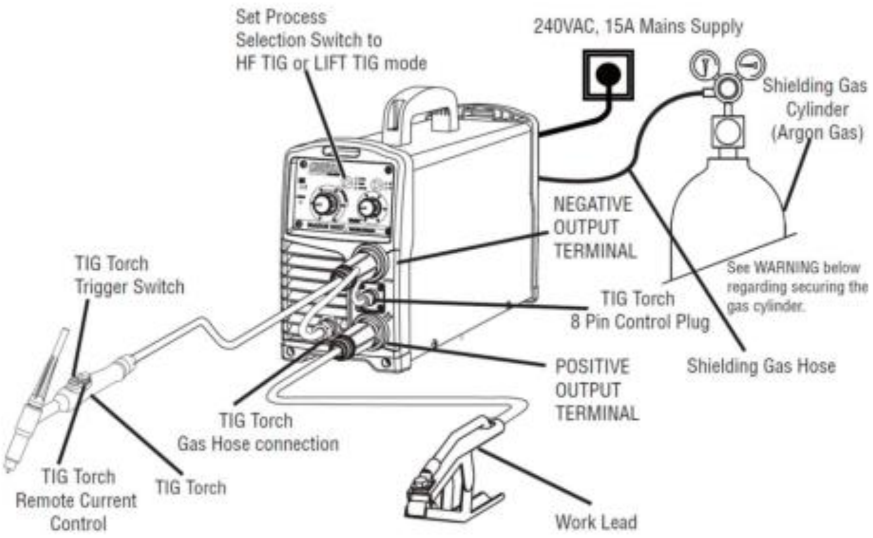
Process follows information on equipment used in this document. The Power Source is of a transformer design with or without a rectifier, with a drooping characteristic (constant current power source).



TIG welding setup

Procedure:

1. Inert gas valve on the torch is opened slightly and lightened with the help of a spark lighter.
2. The torch tip is to be positioned above the plates so that white cone is at a distance of 1.5mm to 3mm from the plates.
3. Torch is to be held at an angle of 300 to 450 to the horizontal plane.
4. Now filler rod is to be held at a distance of 10mm from the flame and 1.5 mm to 3 mm from the surface of the weld pool.
5. As the backward welding allows better penetration, back ward welding is to be used.
6. After the completion of welding, slag is to be removed by means of chipping hammer, wire brush.

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Observation Table(MIG/TIG):

S No	Current (A)	Voltage (V)	Intial weight (gm)		Final weight (gm)		Time (second)	Metal Deposition Rate (gm/sec)
			Tool	Work	Tool	Work		

Precautions:

1. Proper pressure should be applied on the electrodes.
2. Correct electrode diameter needs to be chosen depending on the material thickness to be joined.
3. Proper weld time should be selected for welding.
4. Use Gloves while doing operation.

EXPERIMENT NO: 7

Experiment 7: To study the characteristic features of different resistance welding processes and join two given metal sheet by resistance welding processes.

Material Required:

GI Sheet of 50 x 50 mm--- 1 No's

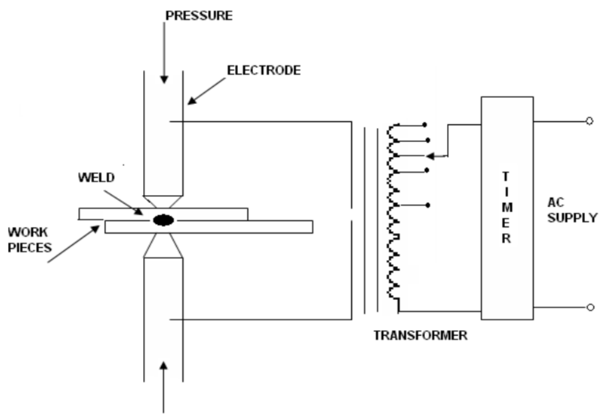
GI Sheet of 50 x 50 mm---- 1 No.

Apparatus Required:

Spot Welding Equipment, Snips and Gloves

Theory:

Spot welding is a resistance welding process in which overlapping sheets are joined by local fusion at one or more spots by the heat generated by resistance to the flow of electric current through work pieces that are held together under force by two electrodes, one above and the other below the two overlapping sheets as shown in Fig.



PRINCIPLE OF RESISTANCE SPOT WELDING

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In resistance welding (RW) a low voltage (typically IV) and very high current (typically 15,000 A) is passed through the joint for a very short time (typically 0.25 s). This high amperage heats the joint, due to the contact resistance of the joint and melts it. The pressure on the joint is continuously maintained and the metal fuses together under this pressure. The heat generated in resistance welding can be expressed as

$$H = k\, I^2\, R\, t$$

Where H = the total heat generated in the work, J

I = electric current, A

t = time for which the electric current is passing through the joint, s

r = the resistance of the joint, ohms

and k = a constant to account for the heat losses from the welded joint.

The resistance of the joint, R is a complex factor to know because it is composed of

1. The resistance of the electrodes,
2. The contact resistance between the electrode and the work piece,
3. The contact resistance between the two work piece plates,
4. The resistance of the work piece plates.

The amount of heat released is directly proportional to the resistance. It is likely to be released at all the above-mentioned points, but the only place where a large amount of heat is to be generated to have an effective fusion is at the interface between the two work piece plates. Therefore, the rest of the component resistances should be made as small as possible, since the heat released at those places would not aid in the welding. Because of the squaring in the above, equation, the current, i needs to be precisely controlled for any proper joint. The main requirement of the process is the low voltage and high current power supply. This is obtained by means of a step-down transformer with a provision to have different tappings on the primary side, as required for different materials. The secondary windings are connected to the electrodes which are made of copper to reduce their electrical resistance. The time of the electric supply needs to be closely controlled so that the heat released is just enough to melt the joint and the subsequent fusion takes place due to the force (forge welding) on the joint. The force required can be provided either mechanically, hydraulically, or pneumatically. To precisely control the time, sophisticated electronic timers are available. The critical variable in a resistance welding process is the contact resistance between the two work piece plates and their resistances themselves. The contact resistance is affected by the surface finish on the plates, since the rougher surfaces have higher contact resistance. The contact resistance also will be affected by the cleanliness of the surface. Oxides or other contaminants if present should be removed before attempting resistance welding.

Steps Involved In Spot Welding:

The job is clean, i.e. free from grease, dirt, scale, oxide etc. Electrode tip surface is clean, since it has to conduct the current into the work with as little loss as possible. Very fine emery cloth may be used for routine cleaning.

Proper welding current has been set on the current selector switch.

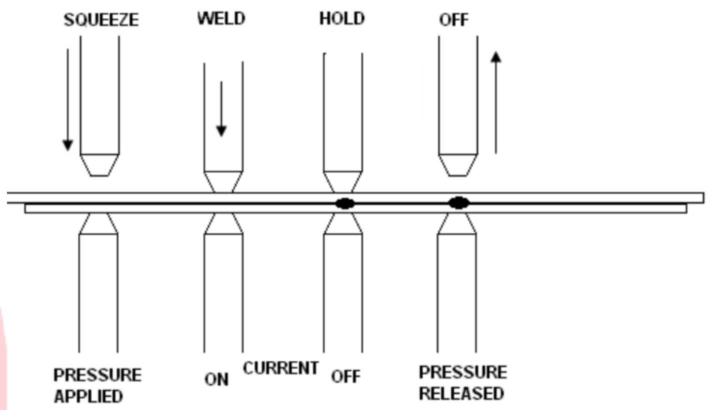
Proper time has been set on the weld-timer.

Step I: Electrodes are brought together against the overlapping work pieces and pressure applied so that the surfaces of the two work pieces under the electrodes come in physical contact after breaking any unwanted film existing on the work pieces.

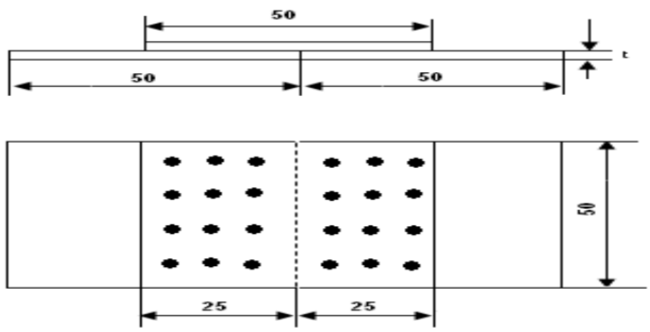
Step II: welding current is switched on for a definite period of time. The current may be of the order of 3000 to 100.000 A for a fraction of seconds depending upon the nature of material and its thickness. As the current passes through one electrode and the work pieces to the other electrode, a small area where the work pieces are in contact is heated. The temperature of this weld zone is approximately 8150C to 9300C. To achieve a satisfactory spot weld the nugget of coalesced metal should form with no meeting of the material between the faying surfaces.

Step III: at this stage, the welding current is cut off. Extra electrode force is then applied or the original force is prolonged. This electrode force forges the weld and holds it together while the metal cools down and gains strength.

Step IV: The electrode force is released to remove the spot-welded work pieces.



STAGES IN MAKING SPOT WELD



Single Strap Butt Joint

Procedure:

1. The two pieces to be joined by spot welding are placed between the two electrodes in the required position.
2. Set the timer for which the current flows through the electrodes with reference to the thickness of the plates
3. Press the foot lever, so that the movable electrode moves towards the fixed electrode.
4. This causes to develop a pressure of about 200-1000 Kg / cm2 on the sheets.
5. A low voltage and very high current is passed through the joint for a very short time. The duration of the current flow is for about 2 sec (This high amperage heats the joint, due to contact resistance at the joint and melts it).
6. Then the metal under electrodes pressure is squeezed and welded
7. The pressure is then released and the process is repeated until the job is completed.

Precautions:

1. Proper pressure should be applied on the electrodes.
2. Correct electrode diameter needs to be chosen depending on the material thickness to be joined.
3. Proper weld time should be selected for welding.
4. Use Gloves while doing operation.

EXPERIMENT NO: 8

Experiment 7: To study the characteristic features of SAW welding and join two given metal plates.

Material Required:

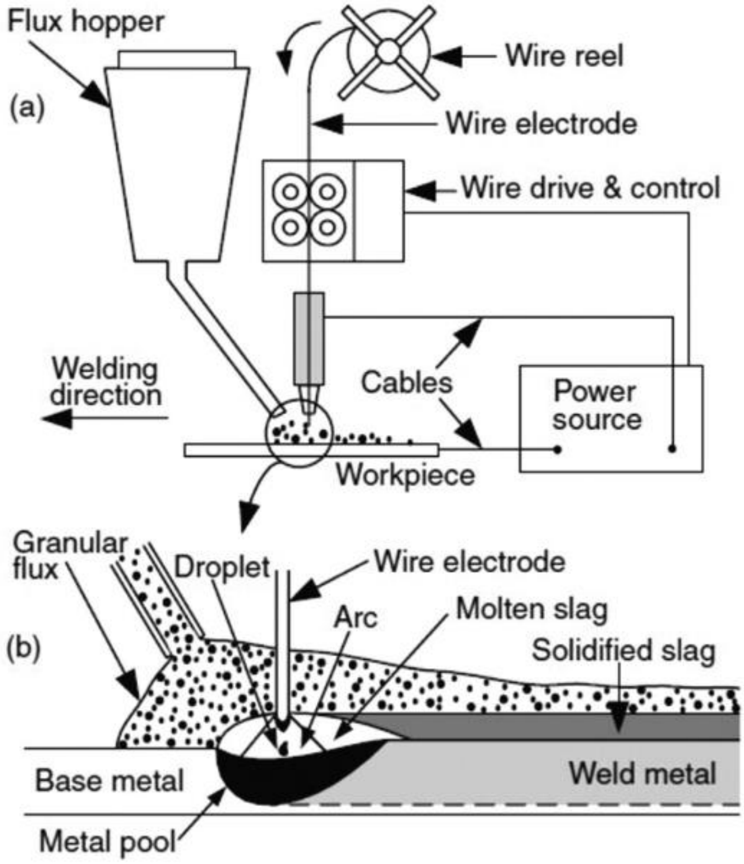
welding outfit, MS Sheets 150x50x5mm (2No)

Apparatus Required:

Wire brush, hand gloves, and chipping hammer, spark lighter, SAW equipment.

Theory:

Submerged Arc Welding (SAW) is a fully automated high productive process. A bare electrode is continuously fed through contact tube connected to the power source. Wire feeding is done by a motor connected with the controller. Roller guide draws wire from a reel. The wire where it meets the work piece and surrounding area always remain covered with granular flux continuously fed from the flux hopper. The arc is generated when the electrode comes closer to the job piece. For this welding process DCEP i.e., electrode connected to positive terminal of the power source and job piece connected to negative is most preferred. Due to flux covering the arc is not visible. Hence the name submerged arc applies. The heat generated, melts portion of the flux above the arc. This molten flux acts as a protective covering as well as thermal insulation during and after the welding process. The molten flux solidifies to form slag as the arc propagates along the weld line. After the welding is done, unused/unsolidified granular fluxes can be collected for reuse. The slag is removed by chipping. The flux also acts as a thermal insulator by promoting deep penetration of heat into the work piece. The unused flux can be recovered (using a recovery tube), treated, and reused. The consumable electrode is a coil of bare round wire 1.5 to 10 mm in diameter; it is fed automatically through a tube (welding gun). Electric currents typically range from 300 to 2000 A. The power supplies usually are connected to standard single- or three-phase power lines with a primary rating up to 440 V. Because the flux is gravity fed, the SAW process is limited largely to welds in a flat or horizontal position having a backup piece. Circular welds can be made on pipes and cylinders—provided that they are rotated during welding



Procedure:

1. First check the power connections and polarity.
2. Fill the flux hoper with granular flux and check continuity of flux flow by opening the stopper.
3. Fit the electrode wire through the drive and guide roller.
4. Turn on the power and check travel and wire feed as well as mark the welding line.
5. Clamp the two pieces to be welded along the weld line.
6. Now set operating parameters on the control panel.
7. Release the flux stopper to cover the plates and electrode with fluxes.
8. Engage the auto travel lever and start the process.

9. Check for the sound of welding as a signal that welding is going on.
10. After completion of travel turn off the process from the controller and close the flux stopper.
11. Collect the unused flux and then remove the solidified slag by chipping.
12. Unclamp the job after cooling and extract test pieces by cutting it for mechanical and metallurgical testing.

Precautions:

1. Ensure that the joint line exactly matches with the electrode travel path.
2. Appropriate clamping must be there to prevent distortion during welding.
3. Granular flux should be free of moisture.
4. Bare electrode must be free from rust and irregularities.

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EXPERIMENT NO: 9

Experiment 9: To make the mould of different types of patterns.

Apparatus:

Single piece pattern, green sand, dry sand, moulding box, strike off bar, riser & sprue pin, vent rod, trowels, rammer and riddle

Theory:

- Single piece pattern is also called solid pattern. It is the simplest type made in one piece without any joints, parting or loose pieces.
- It is suitable for simple shape and large size casting. The pattern can be located either in cope or drag box. The moulding process is quite inconvenient and time consuming. So such patterns are used for producing a few large castings.

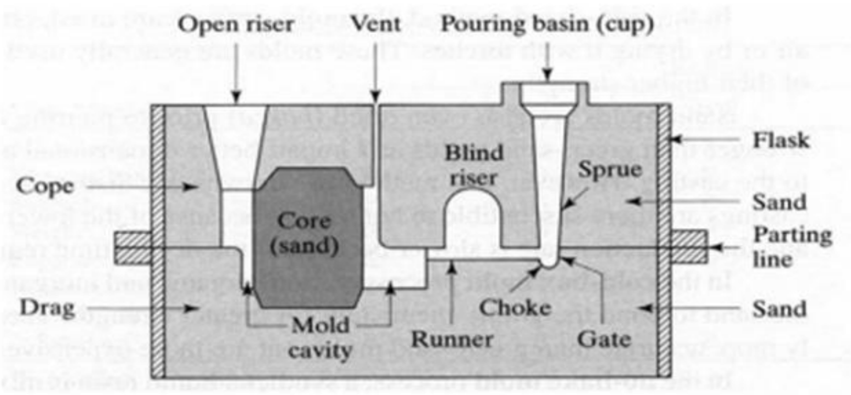

Figure 1: Gating System

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Procedure:

Single piece pattern-

1. First of all place the wooden or steel board on the table or floor
2. The pattern is placed in the drag box and Sprinkle some amount of dry sand in the flask and over the pattern to produce smooth surface finish. It also acts as a parting agent
3. Now, fill the drag-half of the flask with molding sand keeping the pattern in position
4. Ram the molding sand in the flask with the help of a rammer
5. Continue adding and ramming the sand until it is densely packed in the flask.
6. When the flask is properly rammed, then use a metal strip to remove excess sand from the upper surface.
7. Drag box is inverted so that pattern will face upwards. Now the cope box is placed above it
8. Place two rods vertically on either sides of the pattern, at a suitable distance, to produce sprue and **Rising system:**
9. Fill the cope-half with molding sand keeping the pattern and rods in position.
10. Ram the molding sand in the flask with the help of a rammer.
11. Continue adding and ramming the sand until it is densely packed in the cope.
12. When the flask is properly rammed, then use a metal strip to remove excess sand.
13. Now, remove the rods from the cope-half and as a result holes for spruce and riser will be produced.
14. Separate cope and drag portions of the flasks from each other, use draw spikes to remove the pattern from the mold.
15. Cut the in-gates in the mold and again sprinkle some amount or dry sand over the surface of mold to finally finish it.
16. The two boxes are then closed & kept ready for receiving molten metal.

Split Pattern

1. First of all place the wooden or steel board on the table or floor.
2. Place the drag-half of the flask on the bottom board and position drag-half of the pattern in it.
3. Sprinkle some amount of dry sand in the flask and over the pattern to produce smooth surface finish. It also acts as a parting agent.
4. Now, fill the drag-half of the flask with molding sand keeping the pattern in position.
5. Ram the molding sand in the flask with the help of a rammer.
6. Continue adding and ramming the sand until it is densely packed in the flask.

7. When the flask is properly rammed, then use a metal strip to remove excess sand from the upper surface.
8. Drag box is inverted so that pattern will face upwards.
9. Now, position the cope-half of the flask over drag and also the cope-half of the pattern.
10. Place two rods vertically on either sides of the pattern, at a suitable distance, to produce sprue and risering system.
11. Fill the cope-half with molding sand keeping the pattern and rods in position.
12. Ram the molding sand in the flask with the help of a rammer.
13. Continue adding and ramming the sand until it is densely packed in the cope.
14. When the flask is properly rammed, then use a metal strip to remove excess sand.
15. Now, remove the rods from the cope-half and as a result holes for spruce and riser will be produced.
16. Separate cope and drag portions of the flasks from each other, use draw spikes to remove the pattern from the mold.
17. Cut the in-gates in the mold and again sprinkle some amount or dry sand over the surface of mold to finally finish it.
18. The two boxes are then closed & kept ready for receiving molten metal.

Conclusion

1. The model is prepared as per the given Sand
2. Able to do all the operation to produce the model

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EXPERIMENT NO: 10

Experiment 10: To make cores of different shapes and test the core.

Apparatus:

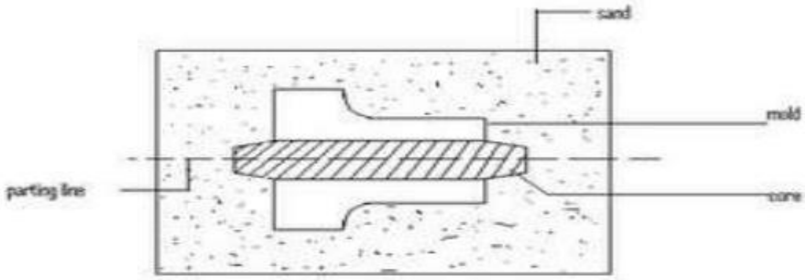
Single piece pattern, green sand, dry sand, moulding box, strike off bar, riser & sprue pin, vent rod, trowels, rammer and riddle

Theory:

CORE: These are the materials used for making cavities and hollow projections which cannot normally be produced by the pattern alone. Any complicated contour or cavity can be made by means of cores so that really intricate shapes can be easily obtained. These are generally made of sand and are even used in permanent moulds. In general, cores are surrounded on all sides by the molten metal and are therefore subjected to much more severe thermal and mechanical conditions and as a result, the core sand should be of higher strength than the moulding sand.

Types of Cores: Various types of cores of different designs and sizes are employed in different ways, in foundry work. A general way of classify them is to do so according to their shapes and positions in the prepared moulds. The main types of these are described below:

Horizontal Core. It is the most common and simple type of core. It is assembled in the mould with its axis horizontal. Depending upon the shape of the cross-section of the hole to be made in the casting, It may have any shape of its cross-section but the most commonly used, shape is cylindrical. This core is supported in the mould at its both ends. Unless it has a non-uniform cross-section, it is held in the mould on the parting line such that its one half remains in the cope and the remaining half in the drag.



Vertical core. It is quite similar to a horizontal core except that it is fitted in the mould with its axis vertical, as shown in Fig. It rests on the seat made at the bottom of the mould by the core print and is further supported by being located in a similar seat made in the cope. The top end of the core is provided with more taper in order to have a smooth fitting of the cope on the core. A major portion of the core usually remains in the drag part of the mould.

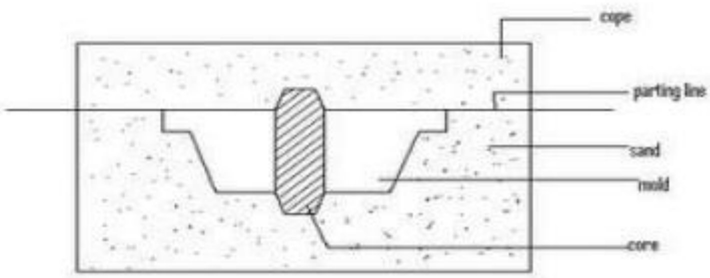


Fig 2 Vertical Core

Hanging or Cover Core. A core which hangs vertically in the mould and has no support at its bottom is known as a hanging core. In such a case it is obvious that the entire mould cavity will be contained in the drag only. A good many green sand cores formed in the cope by the pattern are of hanging type. Even otherwise, dry sand cores can also be suspended from copes by being suitably fastened to them by means of wires or rods etc., extending from within the core body to the top of the cope. Unlike this, a hanging core may be supported on a seat made on the parting surface in the drag, as shown in Fig below It is then known as a Cover Core.

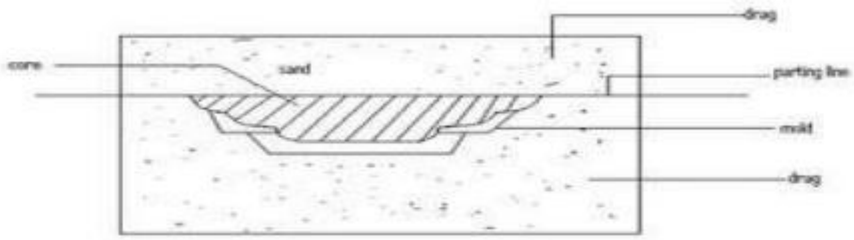


Fig. 3 Hanging or Cover Core

Wire core. It is also known as a Stop-off-Core. It is employed when the hole is desired to be produced in the casting at such a position that its axis falls either above or below the parting line. In such a core, its one side remains flush with the inner surface of the mould and the core, thus, acts as a stop-off. The back surface of this core is provided. With enough taper for its easy location. Many other names like Tail Core and Saddle Core etc. are also given to this type of core according to its shape and use. Apart from the above there are a few other types also, but they are not so commonly used.

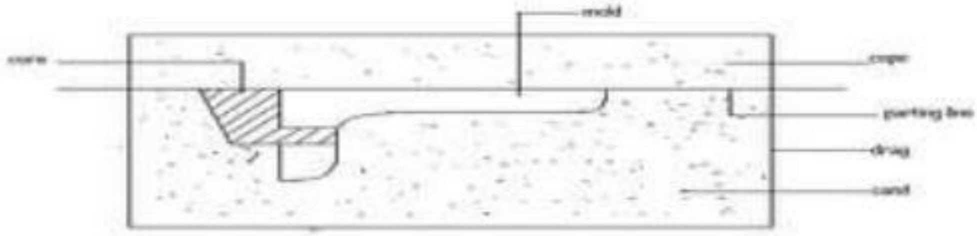


Fig. 4 Drop or Stopoff Core

Balanced core: It is used to produce a blind hole along a horizontal axis in a casting. As a matter of fact it is nothing but a horizontal core with the exception that it is supported only on one end. The other end remaining free in the mould cavity. It is, thus a sort of Cantilever- Since it has to support the weight of the overhanging portion. The core print provided on the pattern should be long enough so that sufficient length of the core may be embedded in the sand to balance the weight of the overhung. However, if the overhung is too much, such balancing will not be enough and the overhanging length of the core will have to be supported by means of Chaplets.

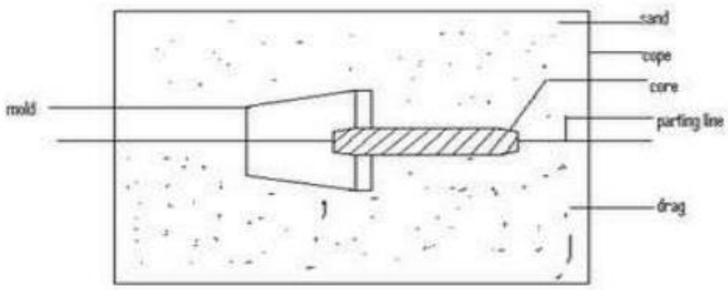


Fig. 5 Balanced Core

Ram-up Core, which is embedded in the mould. Such a need arises when placement of core is not possible after ramming. Similarly, when such a pattern is to be used which carries no core prints, the core is held between cope and drag simply due to the pressure put by the former. It is known as a **Kiss core.**

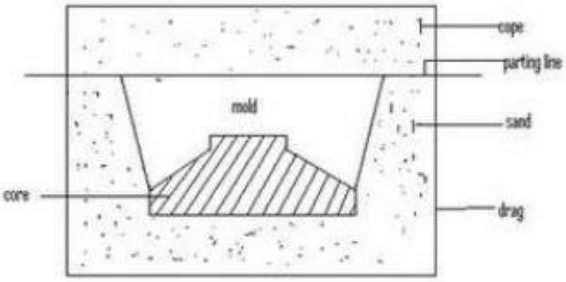


Fig.6 Ram up Core

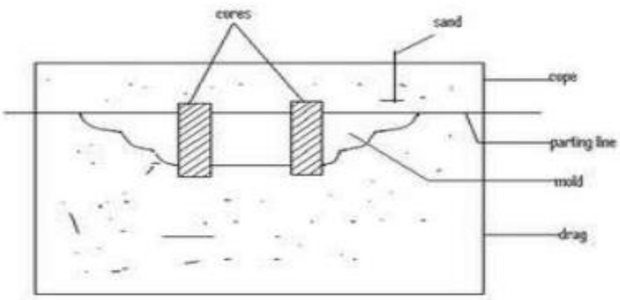


Fig. 7 Kiss Core

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EXPERIMENT NO: 11

Experiment 11: To make pattern for given casting with all necessary allowances, parting line running system details.

Apparatus:

Steel rule, out side caliper, Mortise Chisel, inside chisel, peering chisel, Firmer Chisel, Wood rasp half round file, outside gauge, outside chisel, Try square, Handsaw, Mallet, Sandpapers, Teak Wood given size

Types of Allowances

Shrinkage Allowance: Shrinkage allowance is a critical aspect of manufacturing processes that involves compensating for the reduction in size that occurs when materials cool and solidify after casting or molding. By intentionally increasing the dimensions of a pattern, shrinkage allowance ensures that the final product attains the desired size and shape, accounting for the material's characteristic shrinkage during the cooling and solidification stages.

Machining Allowance: Machining allowance is a crucial aspect of manufacturing that involves adding extra material to a pattern or workpiece to account for the material that will be removed during subsequent machining operations. This allowance ensures that the final product meets the required dimensional accuracy and surface finish by providing sufficient material for machining processes like milling, turning, or grinding.

Draft Allowance: Draft allowance refers to the intentional taper or angle added to vertical surfaces of a pattern in manufacturing and pattern making. This allowance is crucial for facilitating the easy and smooth removal of the pattern from the mold or casting. By incorporating draft allowances, manufacturers ensure that the pattern can be demolded without causing damage to the mold or compromising the integrity of the final product.

Finishing Allowance: Finishing allowance is an additional amount of material intentionally added to a pattern or casting to account for the material that will be removed during the subsequent finishing operations. It allows for machining, sanding, polishing, or painting, ensuring the final product achieves the desired surface quality, dimensional accuracy, and aesthetic appearance. The finishing allowance plays a critical role in achieving the desired level of refinement and appearance in a wide range of manufacturing processes and applications.

Patternmaker's Shrinkage Allowance: Patternmaker's Shrinkage Allowance is a specific type of allowance used in woodworking and pattern making. It accounts for the natural shrinkage that occurs in wood as it dries after being machined. By adding this allowance to the pattern dimensions, pattern makers ensure that the final product retains the intended size and shape once the wood has fully dried.

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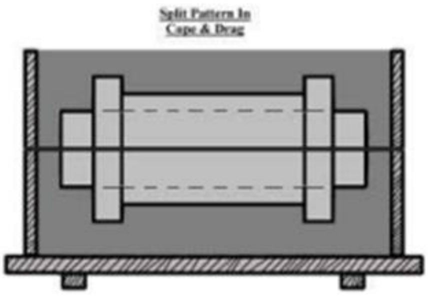


Procedure: Match the two rectangular wood pieces of stock and fix them together by wood screws at either end in the excess portion of wood. This must give a firm clamping of the wood pieces to turn into single piece. In body portion of the pattern mark a center link using marking gauge and extend it to the dressed end. Using the race with counter sunk make indentations at the center of each and to form locations for the head stock and tail stock center. The wood stock is turned on the wood turning lathe using appropriate gauge and finally finished the dimensions. Sanding paper No. ½ or No.0 does smooth finishing The sand paper should be moved laterally on the rotating work.

Precautions: 1. The tools are kept sharp to cut freely without burning and also without much pressure to cause chipping. 2. Maintain proper turning angles. 3. Be alert to avoid accidents.

Result: The Required Split pattern is prepared

EXPERIMENT NO: 12

Experiment 12: Investigate the casting defects and suggest remedial measures.

Apparatus:

Theory:

Defects in castings occur due to various causes. Although it is quite difficult to establish a relationship between defects & causes, casting defects are roughly broken down into four main categories:

- Gas Defects
- Moulding Material Defects
- Pouring Metal Defects
- Metallurgical Defects

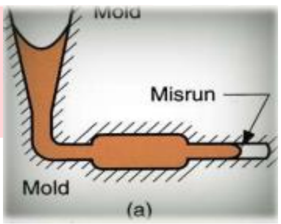
Different types of casting defects are:

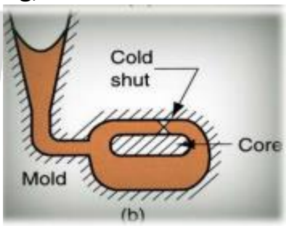
MISMATCH: The casting that does not match at the parting line is known as Mismatch or Mould shift.

Causes: Worn out or bent clamping pins. • Misalignment of two halves of pattern. • Improper location & support of core. • Faulty core boxes. • Loose dowels.

Remedies: Increase strength of mould & core. • Provide adequate support to core. • Proper alignment of two halves of the pattern. • Proper clamping of mould box. • Repair or replace dowels & pin causing mismatch.

MISRUN & COLD SHUTS: When the metal is unable to fill the mould cavity completely & thus leaves unfilled cavities, it is called as misrun defect. When two metal streams meeting in the mould cavity, do not fuse together properly, causing discontinuity or weak spot inside casting, it is called as cold shuts.

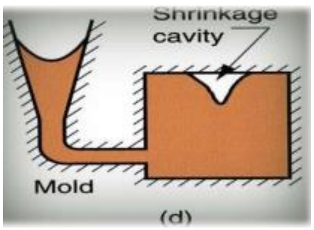




Causes: Low pouring temperature. • Faulty gating system design. • Too thin casting sections. • Slow and intermitted pouring. • Improper alloy composition. • Use of damaged pattern. • Lack of fluidity in molten metal.

Remedies: Smooth pouring with the help of monorail. • Properly transport mould during pouring. • Providing appropriate pouring temperature. • Modifying the gating system design.

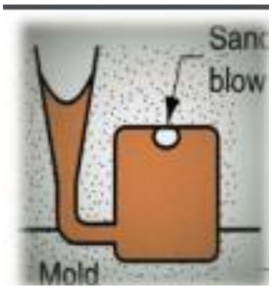
SHRINKAGE CAVITY: Shrinkage cavity is a void on the surface of the casting caused mainly due to uncontrolled and haphazard solidification of the metal. Shrinkage defects can be split into two different types: 1) External shrinkage 2) Closed shrinkage defects



Causes: Inadequate and improper gating & risering system. • Too much high pouring temperature. • Improper chilling.

Remedies: Ensure proper directional solidification by modifying gating, risering & chilling system

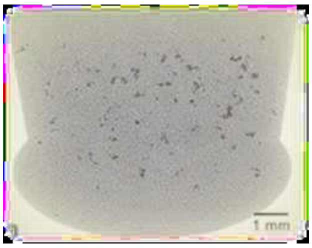
BLOW HOLES Balloon shaped gas cavities caused by release of mould gases during pouring are known as blow holes.



Causes: Ramming is too hard. • Cores are not sufficiently baked. • Excess moisture content. • Low sand permeability. • Excessive fineness of sand grains. • Rusted chills, chaplets & inserts. • Presence of gas producing ingredients.

Remedies: Baking of cores properly. • Control of moisture content in moulding sand. • Use of rust free chills, chaplets & inserts. • Provide adequate venting in mould and cores. • Ramming the mould less harder

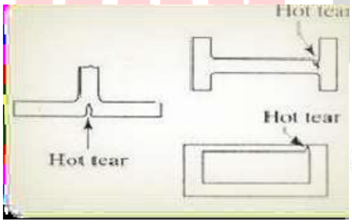
POROSITY: Porosity is in the form of cavities caused due to gas entrapment during solidification

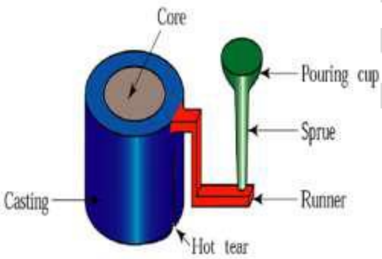


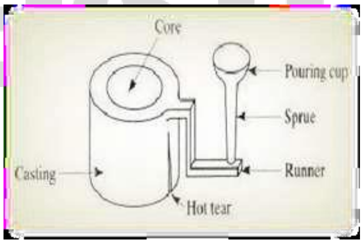
Causes: High pouring temperature. • Gas dissolved in metal charge. • Less flux used. • Molten metal not properly degassed. • Slow solidification of casting. • High moisture and low permeability of mould.

Remedies: Regulate pouring temperature • Control metal composition. • Increase flux proportions. • Ensure effective degassing. • Modify gating and rising. • Reduce moisture and increase permeability of mould.

HOT TEARS or HOT CRACKING: Hot tears are ragged irregular internal or external cracks occurring immediately after the metal have solidified.



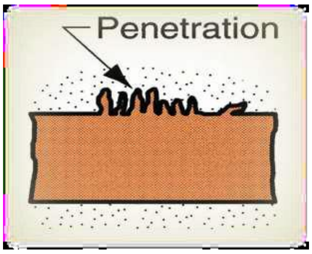


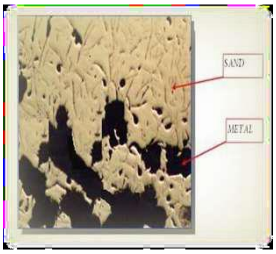


Causes: Lack of collapsibility of core & mould. • Hard ramming of mould. • Faulty casting design.

Remedies: Providing softer ramming. • Improve casting design. • Improve collapsibility of core & mould.

METAL PENETRATION: Penetration occurs when the molten metal flows between the sand particles in the mould.

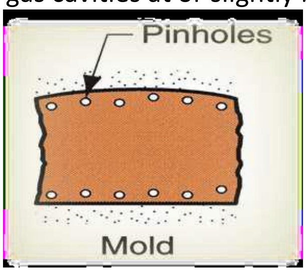




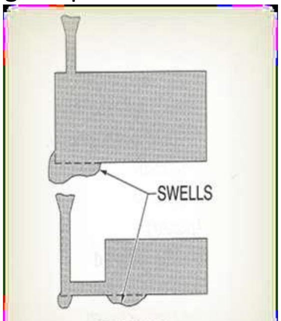
Causes: Low strength of moulding sand. • Large size of moulding sand. • High permeability of sand. • Soft ramming.

Remedies: Use of fine grain with low permeability. • Appropriate ramming.

PIN HOLES: Formation of many small gas cavities at or slightly below surface of casting is called as pin holes.



Causes: Sand with high moisture content. • Absorption of hydrogen/carbon monoxide gas in the metal. • Alloy not being properly degassed. • Sand containing gas producing ingredients.
Remedies: Reducing the moisture content & increasing permeability of moulding sand. • Employing good melting and fluxing practices. • Improving a rapid rate of solidification.



SWELLS

SWELL: A swell is an enlargement of mould cavity by localized metal pressure.
Causes: Insufficient or soft ramming. • Low strength mould & core. • Mould not being supported properly.
Remedies: Sand should be rammed evenly and properly. • Increase strength of mould & core
DROP: Drop is a projection on drag part of casting due fall of its cope part.

Drop

Causes: • Low green strength of the moulding sand. • Low mould hardness. • Insufficient reinforcement of sand projections in the cope.
Remedies: • Moulding sand should have sufficient green strength. • Provide adequate reinforcement to sand projections and cope by using nails and gaggers. • Ramming should not be too soft.
RAT TAILS or BUCKLES: Slight compression failure of a thin layer of moulding sand is called as rat tails & more severe compression failure is called as buckles i.e. buckling of sand.

Rat tail

Causes: • Excessive mould hardness. • Lack of combustible additives in the moulding sand. • Continuous large surfaces on the casting.
Remedies: • Suitable addition of combustible additives to moulding sand. • Reduction in mould hardness. • Modifications in casting design.

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