MINISTRY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF
TECHNICAL AND VOCATIONAL EDUCATION

WORKED OUT EXAMPLES

ME - 01012

WORKSHOP TECHNOLOGY

A.G.T.I (First Year)

Mechanical Engineering

AGTI (Second Semester)
Workshop Technology (ME 02012)
Chapter One
Engineering Materials

No. 1 Distinguish between the tensile test and impact test. (No. 5*, Chapter One)
Solution:

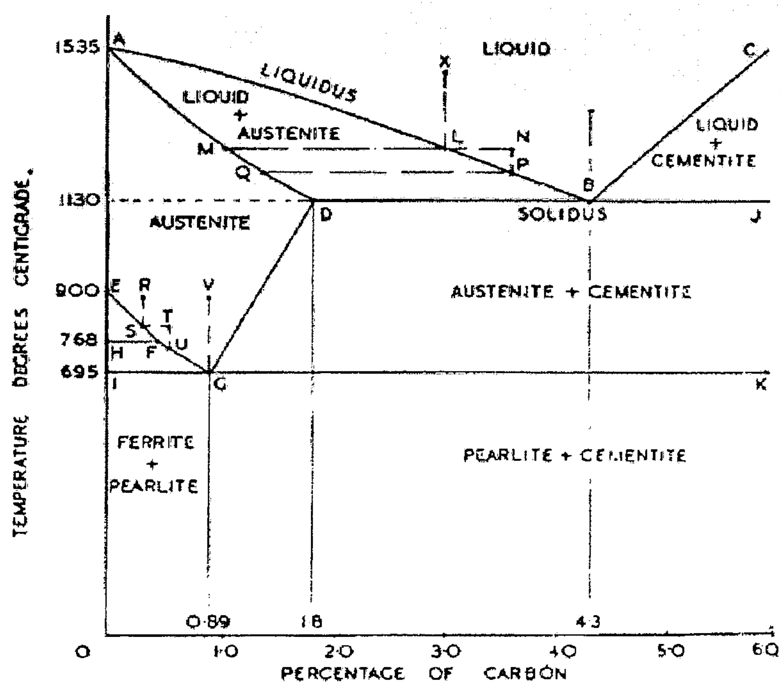
The Tensile Test

This is a very old-established test and isprobably the most widely used of any. Briefly it consists in applying a tensile load, i.e. a pull, to a specimen of material and measuring the loads at which fracture occurs or at which the material ceases to be etc.

Impact Tests

A high value of the yield-point stress or of the ultimate strength is not always an indication that a material is suitable for withstanding the loads it may be subjected to in service. If the loads are applied suddenly, as blows, it will sometimes be found that a material giving very high values in the tensile test will fracture under much lighter blows than a material giving poorer tensile test results. To determine the suitability of a material under these impact conditions various forms of impact test have been evolved.

No. 2 Draw the sketch of equilibrium diagram and write the short note for the following. (a) annealing, (b) normalizing. (No. 7*, Chapter One)
Solution:



Equilibrium diagram

Annealing

This consists in slowly heating the steel to a temperature somewhat above that defined by the line EGK , for the given carbon content, and then letting it cool down in the furnace or at a very slow rate. The objects sought are threefold: first, to relieve any internal stresses remaining in the metal as the result of previous treatment; secondly, to soften the steel by producing a peralitic structure; and thirdly, to bring the steel to a condition suitable for subsequent heat treatment.

Normalizing

This is done by heating the steel to temperatures somewhat above those defined by the line EGD and letting it cool in air. It produces a homogeneous structure consisting either of finely laminated pearlite or sorbite; it also reduces the size of the crystal grains which may have been increased by prolonged heating during earlier processes. Normalized steel is usually stronger and harder and may be more machinable than an annealed steel.

No. 3 Define the terms of heat treatment and describe the heat treating methods and explain any three of them. (No. 12*, Chapter One)

Solution:

The Heat Treatment of Steels

Broadly speaking this phrase covers the processes by which the required structures, and consequent physical properties, are obtained in the steel by heating it to suitable temperatures and then cooling it at suitable rates. The chief treatments are:

1. Annealing
2. Normalizing
3. Hardening
4. Tempering
5. Stress relieving
6. Carburising, nitriding, and other processes for producing surface hardness.

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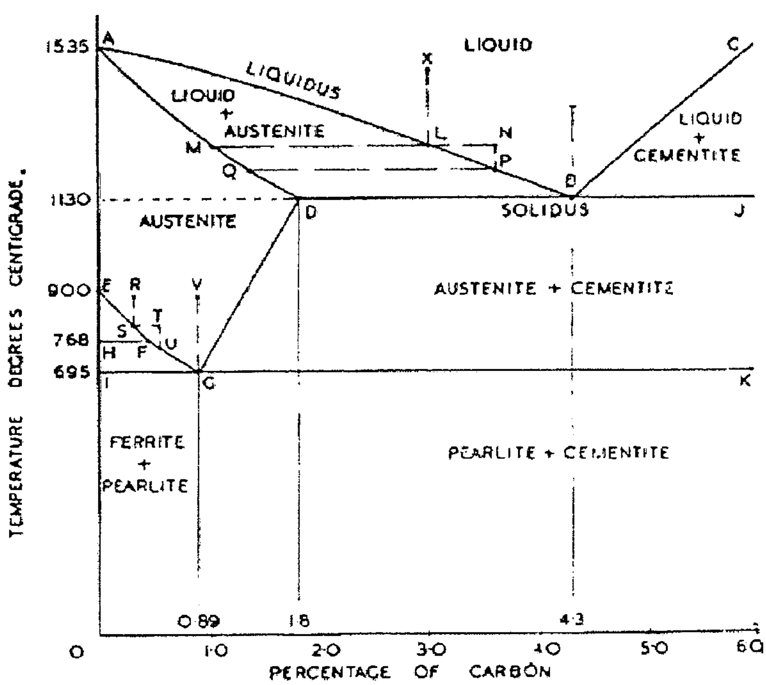

Equilibrium diagram

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Hardening

This is done by heating the steel to temperatures equal to those used, for the same carbon content, in annealing and then quenching it in water or oil or, sometimes, in other substances. Usually a martensitic structure is desired as the result of hardening and with plain carbon steels this requires very rapid cooling. The addition of certain elements enables the cooling rate to be much lower and this is one of the most important advantages of the alloy steels, the less drastic quenching required obviating distortion and cracking difficulties.

No. 4 Name the types of liquid heating baths and discuss any one of them. (No. 18*, Chapter One)

Solution:

Liquid Heating Baths

Another type of heating equipment commonly employed in heat treating operations is the pot type furnace used for liquid heating baths,

Both molten lead and molten salt baths are used for the heating of steel in operations involving hardening, annealing, tempering, etc. Molten lead is a fast-heating medium and gives complete protection to the surfaces of the steel. With a melting point of 621°F (327°C), lead may be used successful from 700°F to about 1600°F (370-870°C). Lead oxidizes readily with the formation of a dross, making a dirty bath, and gives trouble because of the sticking of lead and dross to the surfaces of the steel being heated. This can be overcome by suitable lead coverings such as wood charcoal, coke, carburizing compounds, slats, etc. The steel can be further protected from lead sticking to its surfaces by the use of a coating of a thin film of salt or some other material, which is applied to the steel before it is placed in the lead bath. Dipping of warm steel into a saturated brine solution and allowing it to dry leaves a protective salt film on the steel. The use of a water emulsion containing bone charcoal, rye flour, potassium ferrocyanide, and soda has proved successful. The steel is dipped into the emulsion and allowed to dry before placing in the lead bath.

Molten salt baths have been found to be satisfactory for the heating of many steel parts that are to be given heat treatments. They transmit heat quickly and uniformly and afford a protection to the steel during the heating cycle. Upon removal of the steel from such a salt bath, a thin film of salt adheres to it, giving further protection from air prior to the quenching, etc. Although the ideal salt bath ahs not been discovered, if care is used in the selection of a salt and precautions are exerted in its use and maintenance, good results may be expected.

Salts may be used for low-temperature tempering. They usually consist of nitrates and may be used in a range of temperatures form 300°F to 1000°F (149 to 538°C). Salt baths used in temperature ranges of 1000°F to 1650°F (about 538 to 895°C) consist mainly of sodium carbonate, sodium chloride, sodium cyanide, and barium or calcium chloride. In a temperature range of 1800°F to 2400°F (980° to about 1315°F) salt baths are made from mixture of of barium chloride, borax, sodium fluoride, and silicates. Precautions should be observed in the use of salt baths in order to prevent moisture from coming into contact with the fused salts. With the cyanide salts, precautions should be observed because of their poisonous nature.

Chapter Two
Foundry

No. 5 List the tools and equipments for foundry shop. (No. 3*, Chapter Two)
Solution:

Tools and equipments for foundry shop are:

Bellows, brushes, bench reamer, dust bags, draw pin, chaplets, crucibles, crucible tongs, flasks, riddles, sponges and swabs, sprue cutters and gate cutters, towels, slicks and lifters.

No. 6 How many classes of moulds are divided into and explain them? (No. 5*, Chapter Two)
Solution:

Molds are divided into three classes, green sand, dry sand and loam.

Green sand molds are made of sand in its green or natural state and may be poured with metal as soon as they are completed. About 85% of all molds made in the foundry are of green sand.

Molding sand must be selected with great care, as much of the success or failure of the casting depends on the sand mold. Molding sand for green sand molding must have the following qualities:

1. Ability of the sand grains to stick together so that the fine detail of the pattern may be transferred to the casting.
2. Ability to permit the air in the mold and the gas and steam created during pouring to escape freely.
3. Ability to resist the burning action and the pressure of the molten metal.

The chemical composition of natural molding sand should be about 80% to 90% silica, 5% to 10% alumina or clay (the bonding agent), and a small percentage of lime, magnesia, and other elements.

Dry sand molds are made of a special mixture of sand rammed in its damp state. When the mold has been completed it is placed in an oven to bake. This process removes all moisture from the mold and leaves the body of the mold firm and dry. Dry sand molds are used extensively in making molds for engine cylinders and cylinder blocks.

Loam molds are used to make large intricate castings. They are constructed around skeletons of patterns and depend upon brickwork for the inner and outer support of the mold. The mold face is composed of a loamy mixture of sand. This type of mold, like the dry sand mold, must be thoroughly dried before metal is poured into it. Loam molding represents the work of a highly skilled craftsman who works with skeletons and sweeps of patterns and a blueprint. The loam mold is more costly than either the green sand or dry sand mold but is of advantage in that expensive and complicated patterns are not required.

No. 7 Explain about green sand moulds and dry sand moulds. (No. 10*, Chapter Two)
Solution:

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Chapter Three
Welding

No. 8 Define welding, weldment and joint. (No. 3*, Chapter Three)
Solution:

Welding is "a materials joining process used in making welds," and a weld is "a localized coalescence of metals or nonmetals produced either by heating the materials to suitable temperature with or without the application of pressure of by the application of pressure alone and with or without the use of a filler material." Coalesence means a growing together or a growing into one body and is used in all of the welding process definitions.

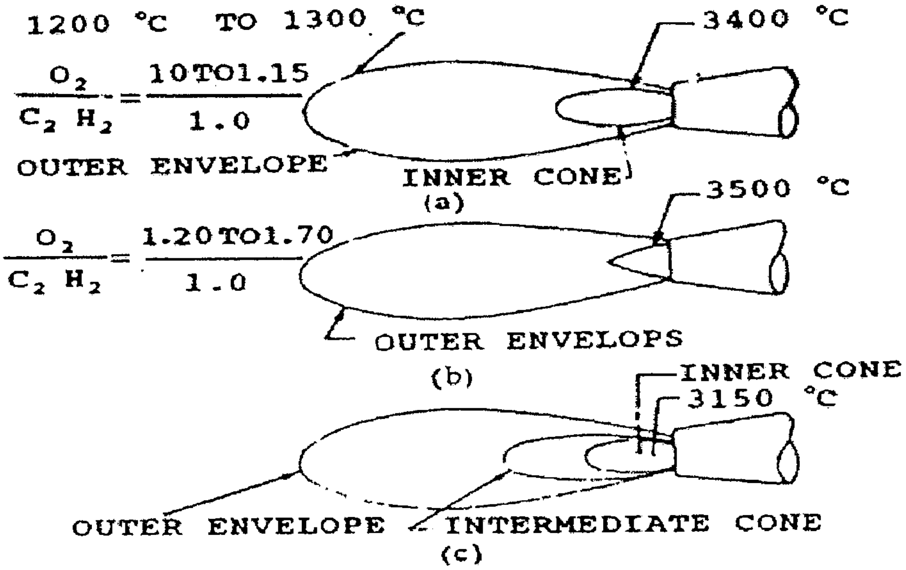
A weldment is an assembly of component parts joined by welding. A weldment can be made of many or few metal parts. A weldment may contain metals of different compositions and the pieces may be in the form of rolled shapes, sheet, plate, pipe, forgings, or castings. To produce a usable structure or weldment there must be weld joints between the various pieces that make the weldment.

The joint is "the junction of members or the edges of members which are to be joined or have been joined."

No. 9 Explain the three types of welding flame with neat sketches. (No. 5*, Chapter Three)
Solution:

Welding flames can be classified broadly into the following three categories.

1. Neutral or balanced flame.
2. Oxidising flame.
3. Carburising or reducing flame.



Various type of flame
(a)neural(b)oxidizing and (c)reducing

Neutral Flame

A neutral flame is produced when almost equal volumes of oxygen and acetylene drawn from the cylinders burn at the tip of the nozzle. It consists of two clearly visible zones as shown in (a) It is the most widely used flame and consists of a luminous blue inner zone. This type of flame is used for welding of mild steel, stainless steel, copper, aluminum and their alloys.

Oxidising Flame

When more than one volume of oxygen is mixed with one volume of acetylene an oxidizing flame is produced. This type of flame as shown in (b) used as a cutting flame or preheating flame.

Reducing Flame

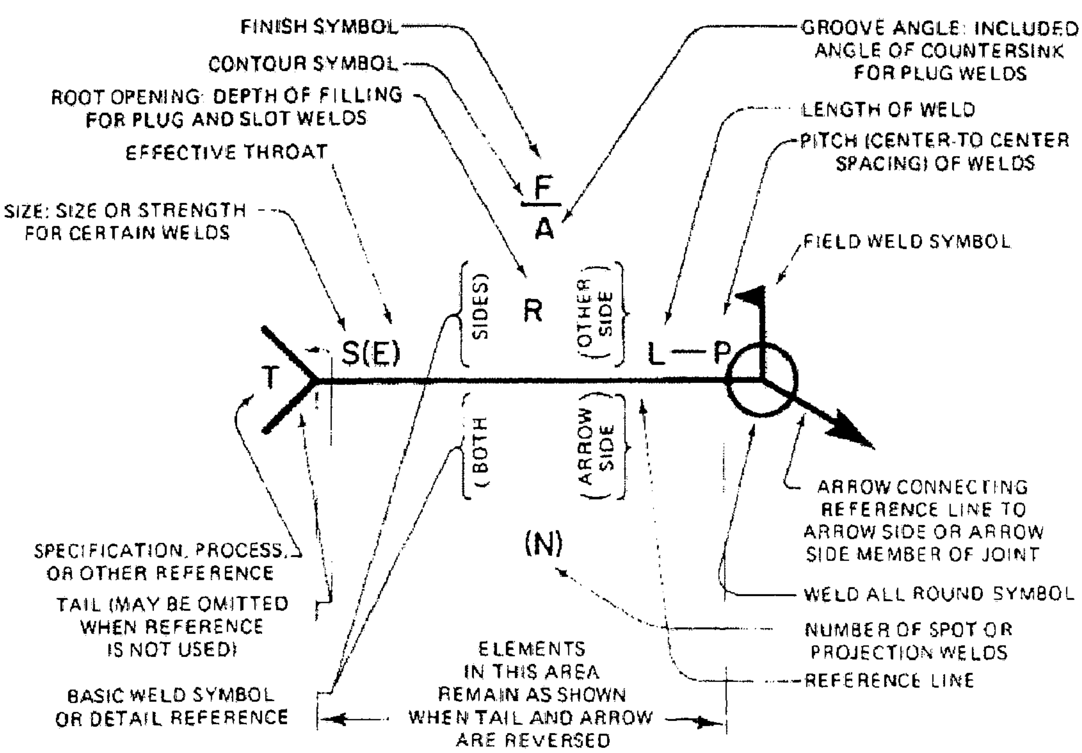
A reducing flame is produced by burning of more than one part acetylene with one part of oxygen. As reducing flame consists of excess carbon, its use ensures that steel will absorb carbon. This flame consists of three distinct zones (a) inner cone (b) intermediate cone and (c) outer envelop.

No. 10 Describe the eight elements of welding symbols. Draw the standard location of elements of a welding symbol. (No. 17*, Chapter Three)

Solution:

The welding symbol consists of the following eight elements, which may or may not all be sued in each symbol.

1. Reference line. (Always show horizontally)
2. Arrow.
3. Basic weld symbol.
4. Dimension and other data.
5. Supplementary symbol.
6. Finish symbol
7. Tail.
8. Specification, process or reference.

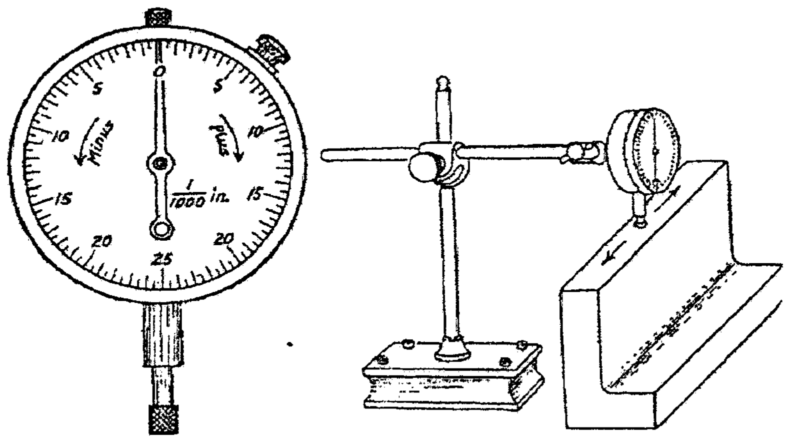


Standard location of elements of a welding symbol

Chapter Four
Measuring Tools

No. 11 Explain briefly the dial gage. (No. 3*, Chapter Four)
Solution:

The Dial Gauge



Dial gage on clock indicator

Two drawbacks to the use of the scribing block for tests of parallelism are: (1) the accuracy depends upon the sensitiveness of our "feel" with the bent end of the scriber on the work. (2) If the heights differ at each of the faces being tested, our test does not give an accurate measureof the difference. These objections are overcome by the use of a dial gauge, the essential part of which is like a small clock with a plunger projecting at the bottom (it is often called a "clock indicator"). Very slight upward pressure on the plunger moves it upwards and the movement is indicated by the dial finger, which is generally arranged to read in 1/1000 in of movement. For very accurate work, gauges reading in 1/1000 ths may be obtained. The head is supported on a base and upright very much like that of a scribing block, and for testing parallelism it is used in much the same way. A diagram of the gauge and its application is shown.

No. 12 What measurement can be taken with vernier caliper? (No. 7*, Chapter four)
Solution:

The VERNIER CALIPER, unlike the micrometer caliper, can make both inside and outside measurements, over a large range of sizes. It is manufactured as a standard item in 6 in., 12 in., 24 in., 36 in., and 48 in. lengths. The 6 in. and 12 in. sizes are most commonly used. The vernier caliper can make accurate measurements to 1/1000 (0.001) in.

The vernier principle is found on the following other measuring tools:

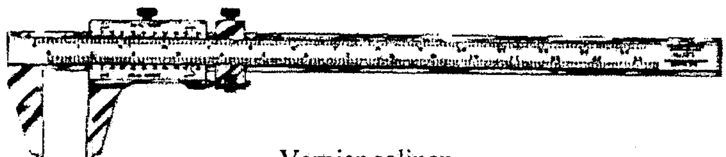
VERNIER HEIGHT GAGE is designed for use in tool rooms and inspection departments on layout, jig and fixture work to measure or mark off vertical distance and locate center distances in thousandths of an inch.

VERNIER DEPTH GAGE is ideal for measuring depth of holes, slots and recesses. It is ordinarily fitted with a 6 in. or 12 in. blade.

GEAR TOOTH VERNIER CALIPER is used to measure gear teeth, forming and threading tools.

UNIVERSAL VERNIER BEVEL PROTRACTOR, is designed for the precision layout and measurement of angles.The vernier caliper is composed of a graduated beam with a fixed measuring jaw and the vernier slide assembly. The movable jaw, vernier plate, clamping screws and adjusting nut, makes up the slide assembly. The slide moves as a unit along the beam.

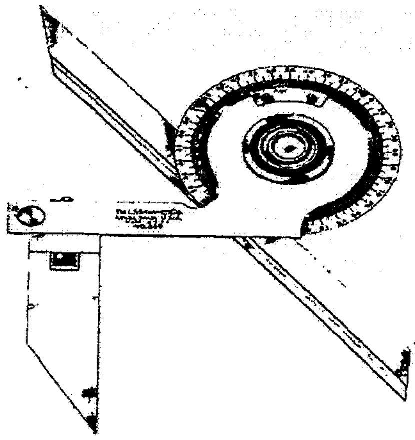
Unlike other vernier measuring tools, the caliper beam is graduated on both sides. The OUTSIDE measurements are taken on the scale reading from left to right. When the jaws are together, the "O" on the outside measuring scale will be aligned with the "O" on the vernier plate.



Vernier caliper

No. 13 Why is the measuring certainty of an universal bevel protractor 5 minutes. (No. 19*, Chapter Four)

Solution:



The universal vernier bevel protractor

The universal vernier bevel protractor, is a finely made tool with a dial graduated into degrees, a base or stock, a sliding blade that can extended in either direction or set at any angle to the stock. The blade can be locked against the dial by tightening the blade clamp nut. The blade and dial can be rotated as a unit at any desired position and locked by tightening the dial clamp nut. Fig shows a few application of this tool.

The protractor dial, graduated into 360 degrees, reads 0 – 90 degrees. Every 10 degrees is numbered, and each 5 degrees is indicated by a line longer than those on either side. The vernier scale is divided into twelve equal parts on each part of the "0". Every third graduation is numbered 0, 15, 30, 45, and 60 representing minutes. Each space equals 5 minutes.

To read the protractor, note the number of degrees that can be read up to the "0" line on the vernier plate. To this, add the number of minutes indicated by the line beyond the "0" on the vernier plate that aligns exactly with a line on the dial.

The minimum reading of the universal bevel protractor is 5 minutes, so the measurement can be made with 5 minutes accuracy.

Chapter Five
Machine Tools

No. 14 Explain about setting the shaper to machine a piece of work? (No. 2*, Chapter Five)
Solution:

To set the shaper to machine a piece of work, these adjustments must be made:

Vise position
Table elevation
Length of stroke
Position of stroke
Amount of feed
Depth of cut
Number of strokes per minute

No. 15 Define the cutting speed, feed. (No. 4*, Chapter Five)
Solution:

The cutting speed

The cutting speed is the distance traveled per minute by a point on the work surface in the direction of the main cutting motion. The cutting speed is expressed in metres per minute or feet per minute and is computed from the formula $v = \frac{\pi D n}{1{,}000}$ m/min or $= \frac{\pi D n}{12}$ ft/min.

In which,

D is the work surface diameter in mm; or in.
n is the workpiece speed in rpm

Feed

s is the tool movement along the axis of the work per revolution of the work. Feed is expressed in mm per revolution or in/rev.

No. 16 Explain the differences between lathe, milling and shaping machine. (No. 12*, Chapter Five)
Solution:

Lathe machine is a multi-purpose machine tool that is capable of doing a number of different types of operation. For example: surfacing, sliding, and screw cutting. Lathe fitted with a taper attachment can do almost every lathe operation except such specialized ones as the relieving of milling cuters and hobs and the turning of non-circular sections.

Milling machine is like a grinding machine. The wheel of the grinder turns but its center stays fixed, and the many tiny abrasive grians cut away chips of metal when the work is fed into the wheel. A milling cutter is a wheel with many cutting edges. Milling machine is very good for cutting flat, curved or irregular surfaces, slots, grooves, keyways, cams and many other shapes. The flutes on drills and the teeth on gears are two examples of spiral milling work.

Shaper is usually used to cut flat surfaces on metal. The work is held tightly in a vise or clamped to the table. The cutting tool is similar to the cutting tools used in a lathe. It is held in a tool holder which is moved back and forth in a straight line by a ram. The cutting tool peels of a chip each time the ram moves forward on a cutting stroke. The shaper is good for removing metal from flat surfaces, making keyways, slots and internal shapes.

Chapter Six
Bench Work

1.* What does scraping mean?
2.* What are the reasons for scraping?
3.* Describe the way to scrap a flat surface.
4.* Describe the way to scrap a round bearing.
5.* Define the frosting or flowering.

Chapter Six
Bench Work

No. 17 What does scraping mean? (No. 1*, Chapter Six)
Solution:

Scraping means shaving or paring off thin slices or flakes of metal to make a fine, smooth surface.

No. 18 What are the reasons for scraping? (No. 2*, Chapter Six)
Solution:

Reasons for Scraping

Scraping is an art. Much practice is needed to make a good true surface. It is slow, expensive work, and is seldom done today. It has been made almost unnecessary by surface grinding and more accurate machining and die casting processes.

Scraping is most often used in fitting soft bearings to a shaft, in correcting minor imperfections in machining, or in decorating flat machined surfaces as the ways on a lathe or drill press.

Machined surfaces usually are not perfectly true for a number of reason:

1) file scratches or tool marks need removing,
2) metal may be of unequal hardness or the metal may have been sprung while being clamped for machining,
3) the cutting tool may wear or have been sprung during the machining. If a very true surface is needed the high spots must be located and removed. This may be done by hand scraping or by several types of grinding machines.

Chapter Seven
Buffing and Metal Finishing

No. 19 Define the buffing and metal finishing. (No. 1*, Chapter Seven)
Solution:

Buffing means to polish with a wheel made of cloth or other soft material. Such a wheel is called a *buffing wheel*; it is coated with some kind of polishing material Buffing gives the metal a bright and shiny surface.

Metal finishing is the last operation or finishing touch that is given to a metal surface to make it look nice, to protect it from rusting, and to make it wear longer. A finish that is lovely to touch and lovely to look at is a beautiful finish. When you see a nicely finished surface, you want to touch it, feel it, look at it.

No. 20 Describe the way to buff a wheel. (No. 2*, Chapter Seven)
Solution:

Buffing Wheels

Buffing is done with wheels made of cloth, felt, or leather. Such wheels are called *buffing wheels*, Cotton or wool is used for *cloth wheels*. Pieces of cloth are laid one on another until they make up the thickness of the wheel; they are then sewed. *Felt wheels* are made of layers of *felt*, which is wool and hair or fur mixed and pressed together. Leather *wheels* are made of leather from walrus or bull-neck hides. Sheepskin is also used.

Brush wheels are set with *bristles*, thus forming brushes. They are used to polish and finish work and to get various effects in polishing.

Chapter Eight
Sheet Metal Work

No. 21 What is a sheet metal? How is it important on sheet metal work? (No. 1*, Chapter Eight)
Solution:

Sheet metal is metal in the form of a board, thin sheet, usually 3/16", or less, thick. Thicker metal is called *plate*.

Sheet-metalwork is the making of stove and furnace pipes, furnaces and ventilators, metal roofs, metal ceilings, metal signs, automobile and airplane bodies, boats, metal furniture, refrigerators, kitchenware, etc.

Much sheet metal is now used instead of wood. Things made of sheet metal are used on the farm, in the home, in offices, and in shops. In sheet-metalwork, the sheet metal used is usually *iron*, *galvanized iron*, *copper*, *brass*, *zinc*, *aluminum*, and *tinplate*.