8th Edition

SPECTROMECH 2022

DECEMBER 2022

TECHNIQUE POLYTECHNIC INSTITUTE

DEPT: MECHANICAL ENGINEERING

Vision of the Institution

- To be a premier institute in pursuit of excellence in technical education and skill development committed to serve the society

Mission of the Institution

- To promote excellence in learning, teaching and technology transfer
- To improve the quality of skilled workforce through a structured programmed and professional skills training
- To inspire students to learn and facilitate their overall development with social orientation and values

Vision of the Department

- To be a centre of excellence in Mechanical Engineering to impart technical & professional skills to cater industrial requirements while considering environmental aspects fulfilling societal obligations

Mission of the Department

- To impart the necessary technical skills among students
- To enhance the interaction with industry
- To produce competitive& employable Diploma Engineers
- To inculcate ethical & professional values among students

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- **Successful career (PEO #1):** To provide students strong foundation of technological fundamentals, necessary to analyze, design, manufacture using modern technological tools to become successful professional in real life world

- **Adaptability with new learning environment (PEO #2):** To build up the aptitude for an understanding of requirement analysis, ability to adopt new working environment and solves complex problem especially in multidisciplinary in nature
- **Keeping pace with developing world (PEO #3):** To provide adequate exposure to promising radical change in technology, training and opportunity to work as teams in cross functions project with effective communication skill and leadership qualities

- **Integration with the society (PEO #4):** To promote student awareness on the life sustained learning by bringing them to their professional principles of practice based on professional ethics of codes so as to achieve the ability to integrate in to the world of practicing professionals for collaborations, mutual support and representing the profession to society.

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Published by
DEPARTMENT OF MECHANICAL ENGINEERING
TECHNIQUE POLYTECHNIC INSTITUTE, HOOGHLY
WEST BENGAL-712102.

FOREWORD

Heartily welcome to our sixth edition of Mechanical Engineering Technical magazine 'SPECTRO MECH' in 2022. We excited to report that the Department of Mechanical Engineering continues to grow to meet our vision of the department which is analyze by Faculty Course Assessment Report (FCAR). Mechanical Engineering is one of the largest enrolled department in the collage with more than 504 under graduate student over the period of 2010-2022 more than 58 students are already placed at various companies as well as higher studies within the pandemic period. All the initiatives are possible by the efficient contributions of alumni, friends, faculty members and staffs.

I would like to express my appreciation to all the authors of the article in this issue of the Magazine. Our goal is to create quality education for the student of the twenty first century. The success of 'SPECTRO MECH' depends on energetic and joint effort of all stake holders of the Institution. I would appreciate your feedback and any suggestion for improvement.

Soumendra Nath Basu
Executive Director
Technique Polytechnic Institute

CONTENT

LOW COST AGRICULTURAL MACHINES

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ABSTRACT:
In Indian Agriculture, Generally tractors or cultivator machines are commonly used for ploughing. Before this method farmers uses the traditional method this is time consuming and hardworking and costly. So we are introducing a new machine. This Machine useful for agriculture in India is of a much larger level. All machine high price and useful for agriculture but not affordable to farmers. So we have created a new machine with this problem in mind to increase the maximum weed removal capacity of the tiller blade in the new design. We have added some extra parts to this machine to help improve the maximum weed removal efficiency. First removing parts are three long tiller blades for tilling operation for Creates favourable environment for crop growth and the second part is cutter attachment for crop and grass cutting. This machine performs both tilling and crop cutting operation.

INTRODUCTION:
In India currently farmers are unhappy to spend money for ploughing operation because of raise in petrol price day by day. To solve this problem, we made an electric power tiller and cutter machine which is power by battery to electric motor. The battery is ecofriendly and easily recharge. The power tiller is mainly used in farming operation for preparing a seedbed on upper level of land. The portable power tiller is not only the large soil mixing capacity compared to the other machine but also good weed cutting capability.
In a market various power tiller machine is available and it is operated on internal combustion engine. It running on engine the petrol or diesel is needed it is big problem, because this tiller machine creates a pollution in environment and it is dangerous for human health. To solve this problem we decide this portable electric power tiller and cutter ma chine.
This is cost-effective and pollution free.in this portable electric power tiller we added some more useful accessories, which are wheel attachment and cutter attachment is used to cut the growled crop in soil and grass in gardening.

The Need of the Project
For making farmers life comfortable during tilling work, earlier farmers were using Traditional farming method which is time consuming, hardworking and costly, hence we introduce new technology. Normally, the machines are used for the agricultural use in India which is of higher stage. All machines were used in farm are high price and not reasonable to farmers, hence to overcome this trouble we were make this model. This working model of power tiller is reducing man power & Rescuing the risk. This machine reduce the cost, improve the soil properties. This battery operated power tiller reducing the use of fossil fuel and improving the productivity of agriculture.

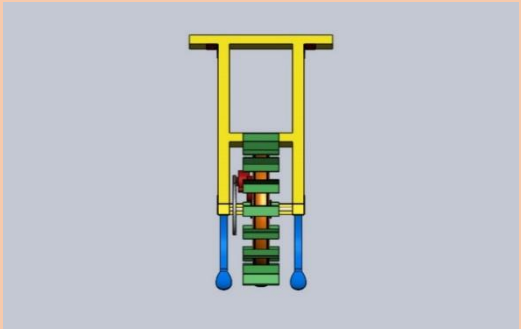
HISTORY OF POWER TILLER
Agriculture has been an integral part of the human ecosystem. However, traditional farming methods require a lot of human effort and are very time consuming. Farm tilling is one of the most labor

intensive operations in agriculture. Manual tiling of fields is very strenuous task while tractors incur high capital along with heavy fuel consumption costs.

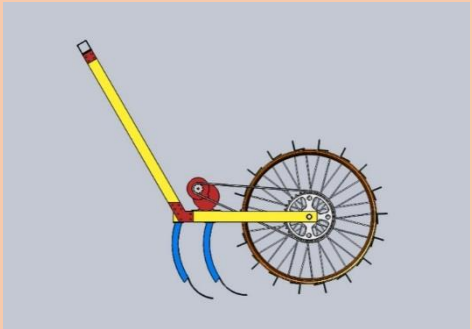
This low-cost portable battery charged electric power tiller machine is a one-stop modern solution to enhance the conventional agriculture methods of farming, as it reduces the human effort, at a very negligible price using motorized tilling mechanism. The electric power tiller helps reduce the time and cost involved in tilling using a smart portable design thereby increasing the productivity and efficiency in agriculture.

The Portable Electric Power Tiller delivers a load of advantages including:
Automatic Operation
Battery Powered No Fuel Needed
Portable and easy to operate
Cost-effective as compared to a tractor
Replacement for animal power & human effort.
Reduces tilling time
The machine makes use of a wheel with welded angles to provide efficient gripping on soil. The wheel design is developed to provide a firm grip on soil strong enough to drag the cultivator forks while tilling process. A switch provided on the handle is used to switch on off the machine. The machine is driven by an electric motor which uses a sprocket chain arrangement to drive the pulling wheel.
A battery is used to power the motor with a force capable of pulling the forks through soil. The 3 x cultivator forks allow for easy and narrow tilling exactly as needed for farming. The portable lightweight design makes it easy to control the direction of machine while in use. Also it can be easily carried around in vehicles or by hand for transporting the machine. Thus the electric power tiller provides a smart innovative fuel free mechanism to farm and garden tilling.

Components
- Electric Motor
- Bicycle Wheel
- Chain Sprockets
- Wheel Angles
- Bearing
- Shaft
- Battery
- Switch
- Electrical & Wirings
- Mounts and Joints
- Supporting Frame
- Screws and Fittings

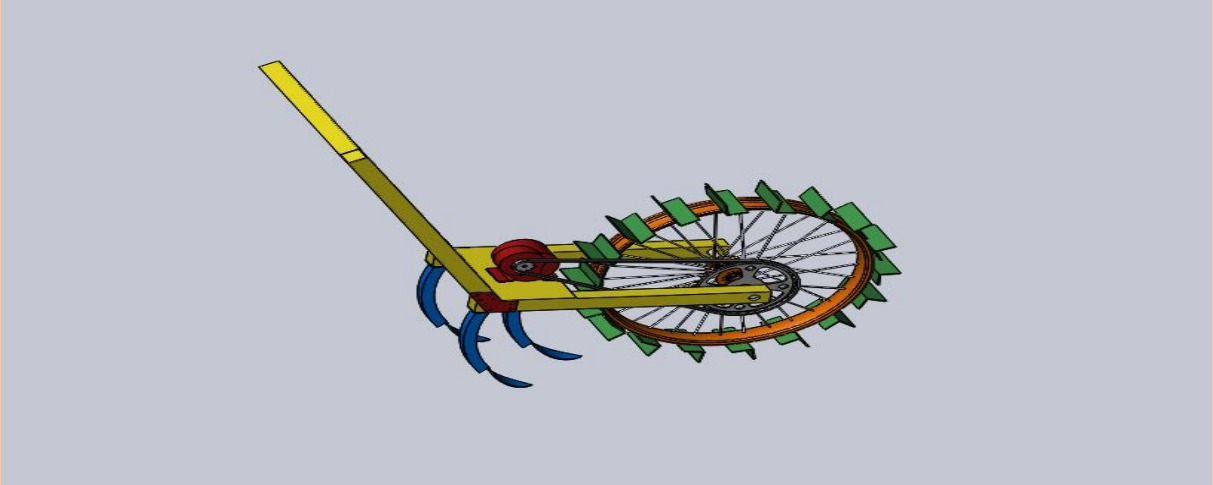


Front View



Side View

Power Tiller is smaller in size and has less operating cost which makes it suitable for adoption by small scale farmers. It is much more productive than draft animals and efficient than human labors in doing farm activities. A farmer having small land holdings and a farmer of hilly area can make use of Power Tiller to mechanize his farm.



Farm mechanization is a crucial need for modern day farming to increase farm productivity and to Decrease the drudgery of farmer. Moreover it helps in timely completion of farm activities and also in reducing various unwanted losses.
However, we see that the extent of farm mechanization varies highly between under developed, developing and developed countries. In countries such as USA and Western Europe it is 95%, in Russia 80%, 75 % in Brazil, China 70 %, and India 45 % and 23% in Nepal. In short, if we compare Agricultural productivity of these countries, the country with greater mechanization definitely has greater productivity.

Therefore Power Tiller will be a good choice for a farmer of those countries where mechanization is limited due to various factors. Here we will know about Power Tillers, what type of work we can perform with them, cost and other specifications. Let's get to know about Power Tillers in Details.

Know about Power Tiller:-

Power Tiller popularly known as Walking Tractor is a two wheeled versatile tractor where a man walking behind controls it during operation. In contrast to other farm tractors with four wheels it has only two wheels and is small in size which enables it to work in small land area. Additionally, It has two extended handles rather than steering where an operator keeps his hand to control the direction and speed. Although there are some models in which seating arrangement is there, but most are controlled by operator walking behind.
Power Tillers are powered by petrol or diesel IC engines having power range of 8-30 HP. Different modifications of these tillers within size and functions are available at different costs. Power Tiller can perform functions such as preparatory ploughing, puddling, seed bed preparation, wedding, harrowing etc. In addition to these it can be used as a prime mover for threshing, reaping, cutting, harvesting, levelling, boring etc. In fact power tillers can also be used as a transportation method for transporting farm products nearby.

Functions of Power Tillers:-

1. Preparatory ploughing: Power Tillers can perform moderate level of sloughing with a mound board or rotary plough attached to it. Small farmers having less land holdings can use this tiller to plough their land. Moreover it is a best match for hilly terrace regions where other large machines can't operate.
2. Puddling : Power Tillers are nowadays widely being used for mechanized rice cultivation. There is indeed a provision in Power Tiller to replace the wheels with iron cage wheels to perform puddling. Puddling in done with the help of rotavators much quickly than of traditional method.
3. Seed bed preparation: Power tiller makes Seed bed preparation work quicker and perfect. We can do harrowing, levelling, ridge forming, bund making etc. with the help of a tiller.
4. Intercultural operations and others: Not only small farmers but also large farmers use power tiller to perform different intercultural operations. It is used for weeding, bund forming, etc.
5. Sowing: Power tiller operated seed drill and seed cum fertilizer drill can do sowing operation efficiently on the field.
6. Spraying and fertilizer application: A power tiller can be used to operate medium sized power sprayers in the field. Fertilizer application either through seed drill or through spraying is also possible with the machine.
7. Cutting and harvesting: A power tiller can also do reaping and harvesting operation with the help of mower and reaper which is attached in front of it. Other different harvesting machines can also be attached to the tiller such as potato digger etc.
8. Threshing: A small farm sized axial thresher is attached to the tiller to perform threshing operation. The threshers are of 5-20 HP capacity which apart from threshing separates and cleans grains from straws and collects the grains.
9. Pumping: Power tiller can power the function of pump for irrigation purpose from canal, well or any irrigation source. Tiller hydraulic pump are available in the market where power is transferred with the help of rubber band from tiller to the pump.
10. Transportation: For transportation purpose we can attach a trailer to the power Tiller. Different types of trailer, standard or hydraulic having up to 2 tons of carrying capacity can be attached to the tiller. Farmer can then use the same for transporting farm Products within short range.

MOTIVATION AND OBJECTIVE

1) To replace the use of non-renewable energy source and to make use of other renewable energy source.
2) This may decrease the investment on fuel, and its price.
3) These make farming more effective and easier.

METHODOLOGY

Following is the methodology used to design and fabricate our portable electric tiller.

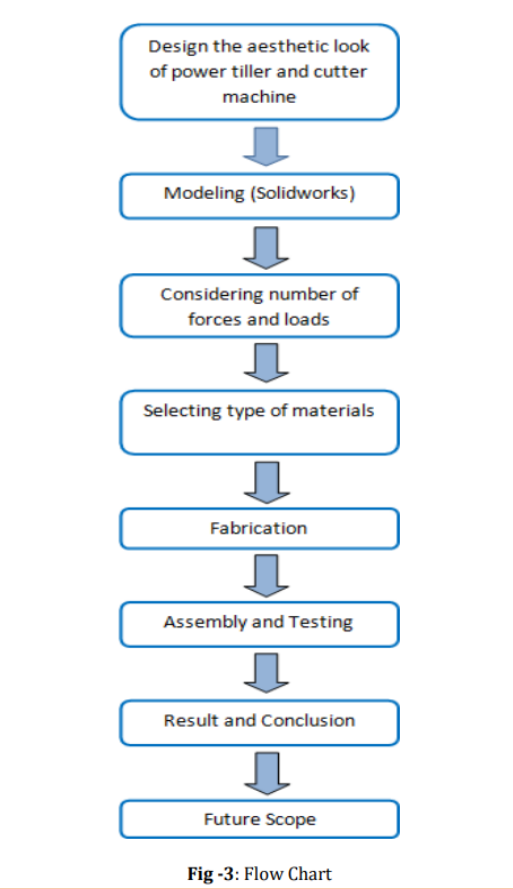


Fig -3: Flow Chart

Design Calculation of the components:-

A) Shaft Axle -

: POWER = $\frac{2\pi NT}{60*1000}$ KW

GIVEN,

POWER OF THE MOTOR =1 KW

RPM OF THE MOTOR =300 RPM

TORQUE = $\frac{60*1000}{2*\pi*300}$

$TORQUE_{AVG}$ = 31.83 N-M

$TORQUE_{MAX}$ = 50 N-M

WE KNOW,

$$\frac{T}{J}=\frac{\tau}{R}=\frac{G\theta}{L}$$

BY CONSIDERING STRENGTH,

$$\frac{T}{J}=\frac{\tau}{R}$$

T= TORQUE

J= POLAR MOMENT OF INERTIA,
τ= SHEAR STRESS
R= RADIUS OF THE SHAFT,

$$\frac{T}{J}=\frac{\tau}{R}$$

$$\frac{50*1000}{\frac{\pi}{32}*D^4}=\frac{70}{\frac{D}{2}}$$

$$D^3=\frac{50*32*1000}{2*70*\pi}$$

D=15.37 mm

WE KNOW,

$$\frac{T}{J}=\frac{G\theta}{L}$$

Θ= ANGLE OF CONTACT
G= MODULUS OF RIGIDITY
L= LENGTH OF THE SHAFT
Θ= 1° = $\frac{\pi}{180}$ rad
J= $\frac{\pi}{32}$ D^4 mm^4
T= $50*10^3$ N-mm
L= 300mm

$$\frac{50*10^3}{\frac{\pi}{32}d^4}=\frac{G*\pi}{180*300}$$

$$D^4=\frac{50*10^3*32*180*300}{200*10^3*\pi^2}$$

D=14.46 mm

: POWER = $\frac{2\pi NT}{60*1000}$KW

GIVEN,
POWER OF THE MOTOR =1 KW
RPM OF THE MOTOR =300 RPM
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BY CONSIDERING STRENGTH,

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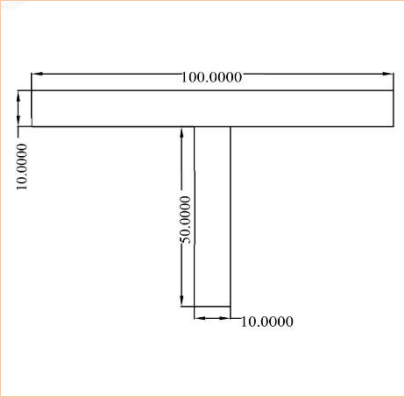
$$D^4=\frac{50*10^3*32*180*300}{200*10^3*\pi^2}$$

D=14.46 mm

So, safe diameter of the shaft 14.46mm.
According to market availability we are consider shaft diameter 15.00mm.

B) Frame Design Calculation:



GIVEN AREA,
$a_{1=100*10}$mm= 1000 mm y_1 y_2
a_2= 50*10 mm = 500 mm

$$y=\frac{a1*\ y1+a2*y2}{a1+a2}$$

$$y\ =\frac{1000*5+500*35}{1000+500}$$

y=45

$I_{xx}= I_1+I_2$

$I_1=I_{G1}+a_1*h_1^2$

$=\frac{100*10^3}{12}$ +100*10(y_1-y)^2

$=\frac{100*10^3}{12}$ +100*10(55-45)^2

=1141667 mm^4

$I_2=I_{G2}+A_2*h_2^2$

$=\frac{100*50}{12}$+500*(Y'-Y_2)^2

$=\frac{100*50}{12}$+500*(45-25)^2

=412499.99mm^3

$I_{YY}=I_1'+I_2'$

$I_1'=\frac{10*10^3}{12}$

$I_2'=\frac{50*10^{33}}{12}$

I_{YY}=837499.99mm^4

$IP=I_{XX}+I_{YY}$

=1249999.98mm^4

$\frac{T}{IP}=\frac{\tau}{45}$

$\tau=\frac{50*1000*45}{1249999.98}$

=1.80 N/mm^2

It is less than Permissible Shear Stress of Mild Steel.

So, Design of Frame

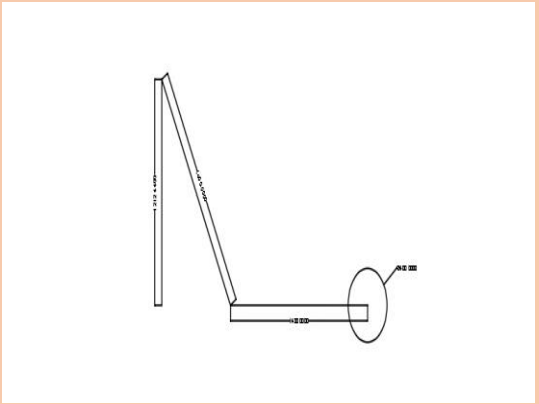
T=50*10^3 N.mm

F=T*L

=50*10^3*1400

=70,000,000

=7*10^7



$Cos\Theta=\frac{1200}{X}$

$X=\frac{1200}{Cos30^\circ}$

T_1=30 N_1=300

$N_2=\frac{30*300}{300}$

=300

N.B.: Design & Estimating works are in progress.

COMPONENTS OF POWER TILLER:-
4.1 Electric Hub Motor

Rated Voltage: 24V DC, Output Power: 250W Rated Speed: 3300rpm, Reduction Ration: 9.78 Teeth On Sprocket: 9

4.2 Two Wheeler Wheel Rim

Fig -4.1: Electric hub motor

Fig -4.2: Two wheeler wheel rim

Fig -4.3: Controller

Type: Brush Controller
Rated Volt: 24V, Rated Power: 250 Watt

Spoke: 36, Rim Diameter: 49 Cm Spoke Length: 18.5 Cm, Rim Width: 6.8 Cm

WORKING AND MODIFICATION

This portable electric power tiller and cutter machine is operated on battery power. The tiller machine is running on electric motor which uses a chain and sprocket mechanism arrangement to drive the bike wheel rim. A lithium-ion battery is used to power hub motor with tiller blade through soil. The tiller blade allow for easy and narrow tilling accurately as needed for farming and on left side of the machine is cutter attachment is attached for crop or grass cutting. While cutting operation we remove tiller blade and attach wheel attachment for easy work. The machine is portable due to simple in construction of machine the maintenance is very less. The price of machine is very low as compared to other IC engine operated tiller machine so as the farmers can purchase the machine easily.

The machine makes use of a bike wheel rim with welded angles to provide efficient gripping on agriculture soil. The wheel rim design is developed to provide a firm gripping on agriculture land strong sufficient to drag the tiller machine blade while tilling process. A switch is provided on the right side of handle is used to switch on or off the machine. The machine is run by an electric hub motor Which uses a chain and sprocket mechanism arrangement to run the pulling bike wheel rim a lithium-ion battery is used to power the hub motor with a force capable of pulling the tiller blade through agriculture soil. The three J Shaped tiller blade allow for simple, easy and narrow tilling exactly as needed for farming. The light weight and portable design of tiller machine makes it easy to handle and control the direction of machine around in any vehicles or by hand for transporting the machine.

This tiller machine provides a smart new fuel free system for farming and gardening. This tiller machine provides a smart new fuel free system for farming and gardening. This Machine Works 2 to 3 hours

FABRICATION:-

Following the selection of materials that are light in weight, durable, and readily available, such as T section bar. Several machining processes are performed on the material. Clamps, Handle, supports, T section bar frames, and other elements are tiller blade and cutter blade manufactured. In the fabrication, we do cutting, drilling, welding and shaping operations. Other operations are bending of tiller blade. Bench-wise clamping is used to prepare the clamps

ADVANTAGES AND DISADVANTAGES

ADVANTAGES-

1) Automatic Operation
2) Battery Powered no fuel needed.
3) Portable and easy to operate.
4) Cost- effective as compared to a tractor.
5) Replacement for animal power and human effort.
6) Simple in design.
7) Easy to maintain.
8) Cheap in cost.
9) Pollution free.
10) Eco-friendly
11) User friendly
12) It has low running cost.

DISADVANTAGES

1) It needs charging when battery runs out.
2) Clean after every use.

APPLICATION OF POWER TILLER

1) In agriculture field for preparation for seed sowing.
2) For Ploughing.
3) Weed removal.
4) For softening land.
5) For harvesting small crops.
6) For cultivation of soil.
7) Soil preparation for seed sowing.
8) Crop cutting.
9) Unwanted grass cutting.
10) A number of common weeding tools are designed to ease the task of removing weeds from gardens and lawns.

13. FUTURE SCOPE

1) Various processes along with ploughing could be done such as seeding and spraying by adding more attachments
2) More operations can be included to the machine like pesticide sprayer, tiller and many other machines for various operations.

3) By making modification same machine with able to changing the different rotary tool for different purpose example rotary tool for cutting purpose, digging purpose.
4) By making further modification using large power generated solar panel.
5) By making modification in increasing the speed of the motor.

14. CONCLUSIONS

Today in the world fuel prices and environmental pollution increases day by day. So control environmental pollution, to save fuel and bio product this project is design. For this model requires low investment at the starting stage but its gives more energy output with low maintenance. Our new project developed battery powered is minimizing the harmful effort of manual tiller. Here in our project we conclude that by using this machine we reduce the farming cost, animal use, and air pollution and manpower. Our main objective is to help the farmers.

_____X_____

"Courage is like a muscle. We strengthen it by use." —Ruth Gordo

SPECTROMECH 2022

8th Edition December, 2022

JET PROPULSION

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Introduction

Jet propulsion, similar to all means of propulsion, is based on Newton's Second and third laws of motion. The jet propulsion engine is used for the propulsion of aircraft, missile and submarine (for vehicles operating entirely in a fluid) by the reaction of jet of gases which are discharged rearward (behind) with a high velocity. As applied to vehicles operating entirely in a fluid, a momentum is imparted to a mass of fluid in such a manner that the reaction of the imparted momentum furnishes a propulsive force. The magnitude of this propulsive force is termed as thrust.

For efficient production of large power, fuel is burnt in an atmosphere of compressed air (combustion chamber), the products of combustion expanding first in a gas turbine which drives the air compressor and then in a nozzle from which the thrust is derived. Paraffin is usually adopted as the fuel because of its ease of atomization and its low freezing point.

Jet propulsion was utilized in the flying Bomb, the initial compression of the air being due to a divergent inlet duct in which a small increase in pressure energy was obtained at the expense of kinetic energy of the air. Because of this very limited compression, the thermal efficiency of the unit was low, although huge power was obtained. In the normal type of jet propulsion unit a considerable improvement in efficiency is obtained by fitting a turbo-compressor which will give a compression ratio of at least 4 : 1.

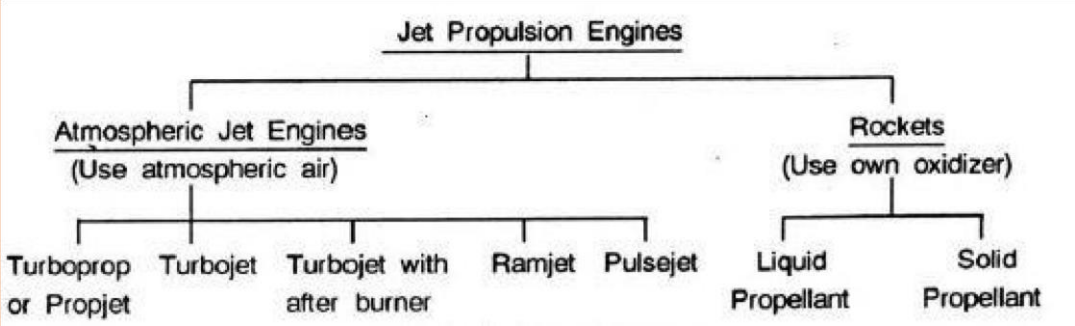


Figure Classification of Jet propulsion Engines

Turbojet Engine

The turbojet engine is similar to the simple open cycle constant pressure gas turbine plant, except that the exhaust gases are first partially expanded in the turbine to produce just sufficient power to drive the compressor. The exhaust gases leaving the turbine are then expanded to atmospheric pressure in a propelling (discharge) nozzle. The remaining energy of gases after leaving the turbine is used as a high speed jet from which the thrust is obtained for forward movement of the aircraft

The essential components of a turbojet engine are:

An entrance air diffuser (diverging duct) in front of the compressor, which causes rise in pressure in the entering air by slowing it down. This is known as ram. The pressure at entrance to the compressor is about 1-25 times the ambient pressure.

A rotary compressor, which raises the pressure of air further to required value and delivers to the combustion chamber. The compressor is the radial or axial type and is driven by the turbine.

The combustion chamber, in which paraffin (kerosene) is sprayed, as a result of this combustion takes place at constant pressure and the temperature of air is raised.

The gas turbine into which products of combustion pass on leaving the combustion chamber. The products of combustion are partially expanded in the turbine to provide necessary power to drive the compressor.
The discharge nozzle in which expansion of gases is completed, thus developing the forward thrust.

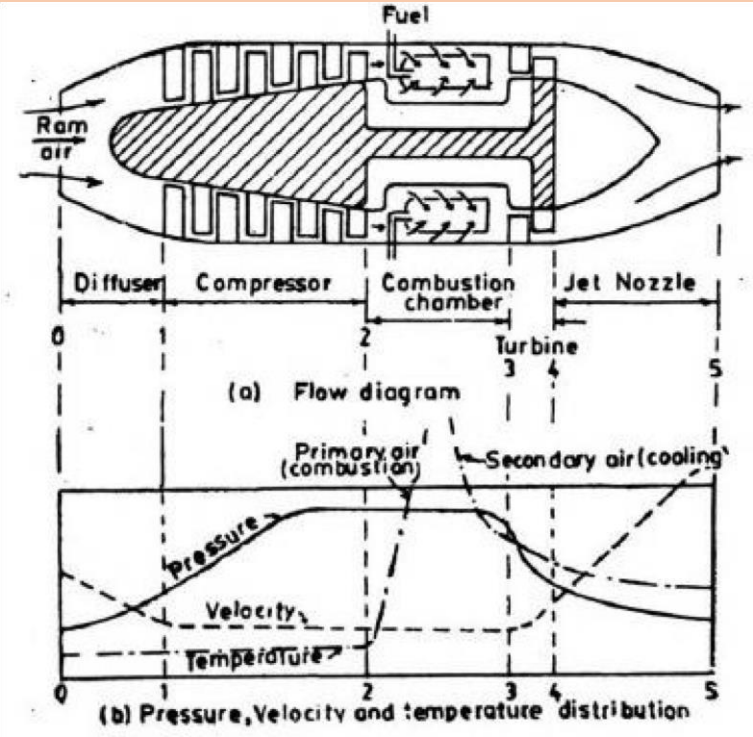


Figure Turbojet engine

Working Cycle:
Air from surrounding atmosphere is drawn in through the diffuser, in which air is compressed partially by ram effect. Then air enters the rotary compressor and major part of the pressure rise is accomplished here. The air is compressed to a pressure of about 4 atmospheres.

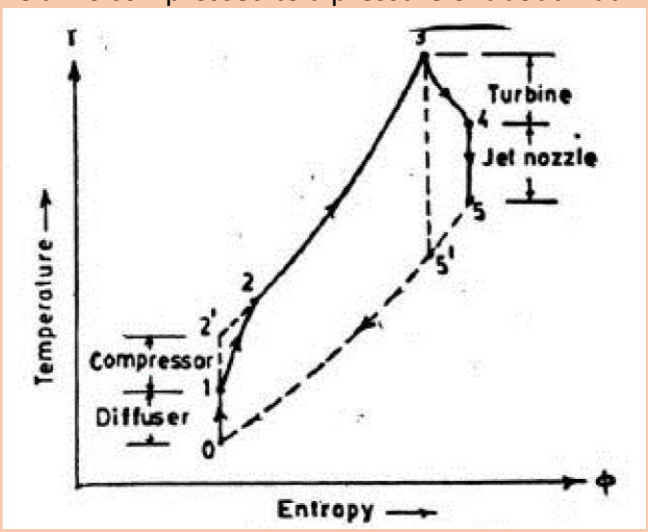


Figure T-S diagram of turbojet engine

From the compressor the air passes into the annular combustion chamber. The fuel is forced by the oil pump through the fuel nozzle into the combustion chamber. Here the fuel is burnt at constant pressure. This raises the temperature and volume of the mixture of air and products of combustion.

The hot gases from the combustion chamber then pass through the turbine nozzle ring. The hot gases which partially expand in the turbine are then exhausted through the discharge (propelling nozzle) by which the remaining enthalpy is converted into kinetic energy. Thus, a high velocity propulsion jet is produced.

Thrust power, propulsive efficiency and thermal efficiency

The jet aircraft draws in air and expels it to the rear at a markedly increased velocity. The action of accelerating the mass of fluid in a given direction creates a reaction in the opposite direction in the form of a propulsive force. The magnitude of this propulsive force is defined as thrust. It is dependent upon the rate of change of momentum of the working medium i.e. air, as it passes through the engine. The basis for comparison of jet engines is the thrust. The thrust, T of a turbojet engine can be expressed as,

$$T = m (V_j - V_o)$$

Where,
M = mass flow rate of gases, kg/sec
V_i = exit jet velocity, m/sec
Vo = vehicle velocity, m/sec
The above equation is based upon the assumption that the mass of fuel is neglected. Since the atmospheric air is assumed to be at rest, the velocity of the air entering relative to the engine, is the velocity of the vehicle, Vo. The thrust can be increased by increasing the mass flow rate of gas or increasing the velocity of the exhaust jet for given Vo. Thrust power is the time rate of development of the useful work achieved by the engine and it is obtained by the product of the thrust and the flight velocity of the vehicle. Thus, thrust power TP is given by

$$TP = Tv_0 = m (v_j - v_0) v_o \text{ Nm/s}$$

The kinetic energy imparted to the fluid or the energy required to change the momentum of the mass flow of air, is the difference between the rate of kinetic energy of entering air and the rate of kinetic energy of the exist gases and is called propulsive power. The propulsive power PP is given by,

$$PP = m\frac{(v_j{}^2 - v_o{}^2)}{2} \text{ Nm/s}$$

Propulsive efficiency is defined 'as the ratio of thrust power and propulsive power and is the measure of the effectiveness with which the kinetic energy imparted to the fluid is transformed or converted into useful work. Thus, propulsive efficiency is given by,

$$\eta_p = \frac{TP}{PP} = \frac{m\left(v_j - v_o\right)}{1} \times \frac{2}{m\left(v_j{}^2 - v_o{}^2\right)}$$

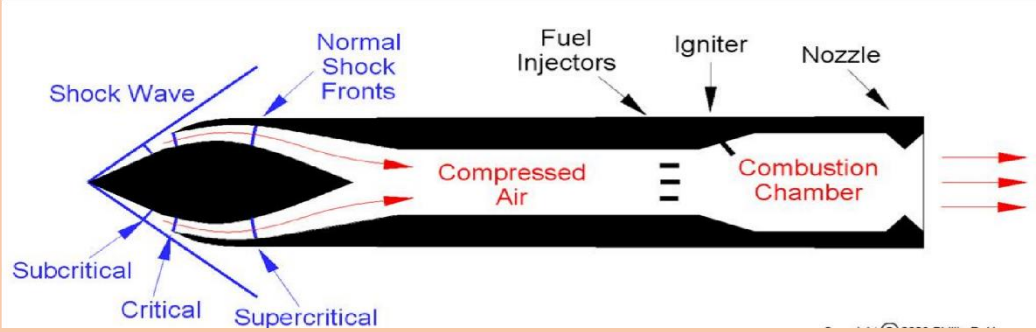
Thermal efficiency of a propulsion is an indication of the degree of utilization of energy in fuel (heat supplied) in accelerating the fluid flow and is defined as the increase in the kinetic energy of the fluid (propulsive power) and the heat supplied.
Thus,

$$\text{Thermal efficiency} = \eta_T = \frac{Propulsive\ power}{heat\ supplied} = \frac{Propulsive\ power}{Fuel\ flow\ rate \times C.V.of\ fuel}$$

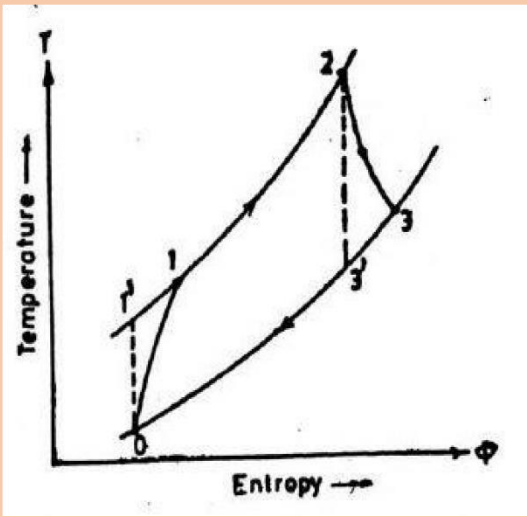
The overall efficiency is the ratio of the thrust power and the heat supplied. Thus, overall efficiency is the product of propulsive efficiency and thermal efficiency. The propulsive and

overall efficiencies of the turbojet engine are comparable to the mechanical efficiency and brake thermal efficiency respectively, of the reciprocating engine.

Ramjet engine



A french engineer, Rane Lorin invented and patented the first ram jet in 1913. It is a steady combustion or continuous flow engine. It has the simplest construction of any propulsion engine consisting essentially of an inlet diffuser, a combustion chamber, and an exit nozzle or tailpipe.



Since the ram jet has no compressor, it is dependent entirely upon ram compression. Ram compression is the transformation of the kinetic energy of the entering air into pressure energy. After the ram jet is boosted, the-velocity of the air entering the diffuser is decreased and is accompanied by an increase in pressure. This creates a pressure barrier at the after end of the diffuser. The fuel that is sprayed into the combustion chamber through injection nozzles is mixed with the air and ignited by means of a spark plug.

The expansion of the gases toward the diffuser entrance is restricted by the pressure barrier at the after end of the diffuser; consequently, the gases are constrained to expand through the tail pipe and out through the exit nozzle at a high velocity. Sometimes, the pressure barrier is not effective and that there are pulsations created in the combustion chamber which affect the air flow in front of the diffuser. The cycle for an ideal ram jet, which has an isentropic entrance diffuser and exit nozzle, is the Joule cycle as shown by the dotted lines in fig.

The difference between the actual and ideal jet is due principally to losses actually encountered in the flow system. The sources of these losses are:

- Wall friction and flow separation in the subsonic diffuser and shock in the supersonic diffuser.
- Obstruction of the air stream by the burners which introduces eddy currents and turbulence in the air stream.
- Turbulence and eddy currents introduced in the flow during burning.
- Wall friction in the exit nozzle.

Pulsejet engine

Paul Schmidt patented principles of the pulse jet engine in 1930. It was developed by Germany during World-War-II.

The pulse jet engine is somewhat similar to a ram jet engine. The difference is that a mechanical valve arrangement is used to prevent the hot gases of combustion from flowing out through the diffuser in the pulse jet engine.

The turbojet and ram jet engines are continuous in operation and are based on the constant pressure heat addition (Bryton) cycle. The pulse jet is an intermittent combustion engine and it operates on a cycle similar to a reciprocating engine and may be better compared with an ideal Otto cycle rather than the Joule or Bryton cycle.

The compression of incoming air is accomplished in a diffuser. The air passes through the spring valves and is mixed with fuel from a fuel spray located behind the valves. A spark plug is used to initiate combustion but once the engine is operating normally, the spark is turned off and residual flame in the combustion chamber is used for ignition. The engine walls also may get hot enough to initiate combustion.

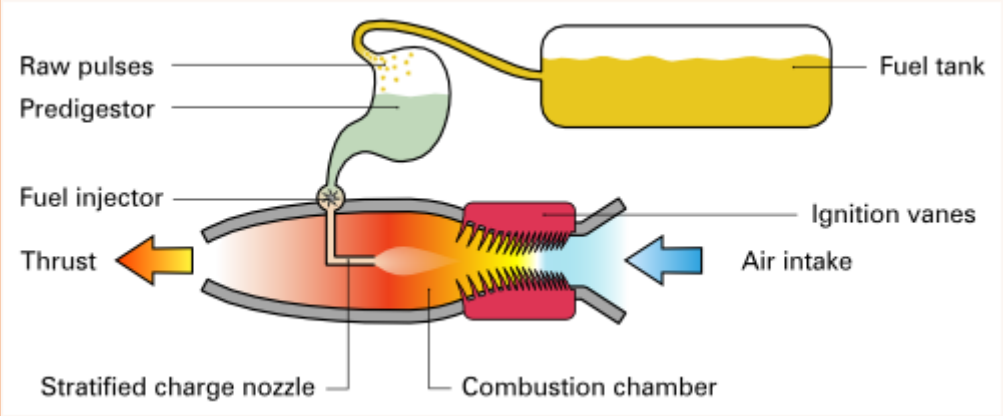


Figure Pulsejet engine

The mechanical valves which were forced open by the entering air, are forced shut when the combustion process raises the pressure within the engine above the pressure in the diffuser. As the combustion products cannot expand forward, they move to the rear at high velocity. The combustion products cannot expand forward, they move to the rear at high velocity. When the combustion products leave, the pressure in the combustion chamber drops and the high pressure air in high pressure air in the diffuser forces the valves open and fresh air enters the engine.

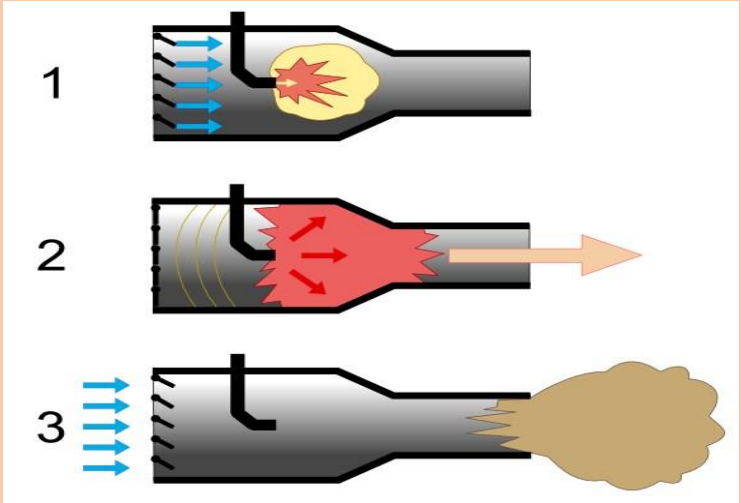


Figure Valves position for Pulsejet engine

Since the products of combustion leave at a high velocity there is certain scavenging of the engine caused by the decrease in pressure occasioned by the exit gases. There is a stable cycle set up in which alternate waves of high and low pressure travel down the engine. The alternating cycles of combustion, exhaust, induction, combustion, etc. are related to the acoustical velocity at the temperature prevailing in the engine.

Despite the apparent noise and the valve limitation, pulse jet engines have several advantages when compared to other thermal jet engines.

- The pulse jet is very inexpensive when compared to a turbojet.
- The pulse jet produces static thrust and produces thrust in excess of drag at much lower speed than a ram jet.
- The potential of the pulse jet is quite considerable and its development and research may well bring about a wide range of application.

Rocket engine

A rocket engine is a type of jet engine that uses only stored rocket propellant mass for forming its high speed propulsive jet. Rocket engines are reaction engines, obtaining thrust in accordance with newton's third law. Most rocket engines are internal combustion engines. Vehicles propelled by rocket engines are commonly called rockets.

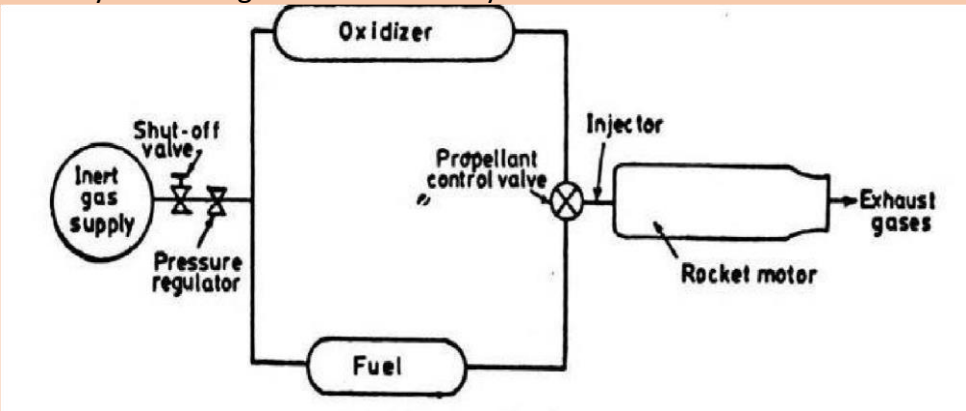


Figure Pressure feed rocket jet

Principle of operation:

Rocket engines produce thrust by the expulsion of an exhaust fluid which has been accelerated to a high speed through a propelling nozzle. The fluid is usually a gas created by high pressure combustion of solid or liquid propellants, consisting of fuel and oxidiser components, within a combustion chamber. The nozzle uses the heat energy released by expansion of the gas to accelerate the exhaust to very high (supersonic) speed, and the reaction to this pushes the engine in the opposite direction.

Propellant

Rocket propellant is mass that is stored, usually in some form of propellant tank, or within the combustion chamber itself, prior to being ejected from a rocket engine in the form of a fluid jet to produce thrust. Chemical rocket propellants are most commonly used, which undergo exothermic chemical reactions which produce hot gas which is used by a rocket for propulsive purposes.

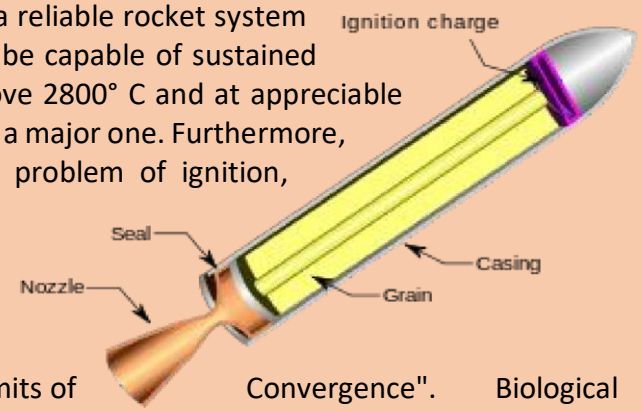
The particular **advantages** of the rocket are,

- Its thrust is practically independent of its environments
- It requires no atmospheric oxygen for its operation.
- It can function even in a vacuum.
- It appear to be the simplest means for converting the thermochemical energy of a propellant combination (fuel plus oxidizer) into kinetic energy associated with a jet flow gases.

Applications:

- Artillery barrage rockets
- Anti-tank rockets
- All types of guided missiles
- Aircraft launched rockets
- Jets assisted take-off for airplanes
- Engines for long range, high speed guided missiles and pilotless aircrafts
- Main and auxiliary propulsion engines on transonic airplanes

Despite its apparent simplicity, the development of a reliable rocket system must be light in weight and the rocket motor must be capable of sustained operation in contact with gases at temperature above 2800° C and at appreciable pressures. The -problem of materials in consequently a major one. Furthermore, owing to the enormous energy releases involved, problem of ignition, smooth start up, thrust control, cooling etc. arise.



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"Develop success from failures. Discouragement and failure are two of the surest stepping stones to success." —Dale Carnegie

SPECTROMECH 2022

8th Edition

December, 2022

INDUSTRIAL USE OF COMBINATION SET

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Fitting Workshop Instructor

Combination Set

The combination set, as its name implies, is a tool that has several uses. The set consists of a blade (graduated rule), square head, protractor head, and centre head. The grooved rule is used with each head. The groove permits the rule to be moved into position and locked.

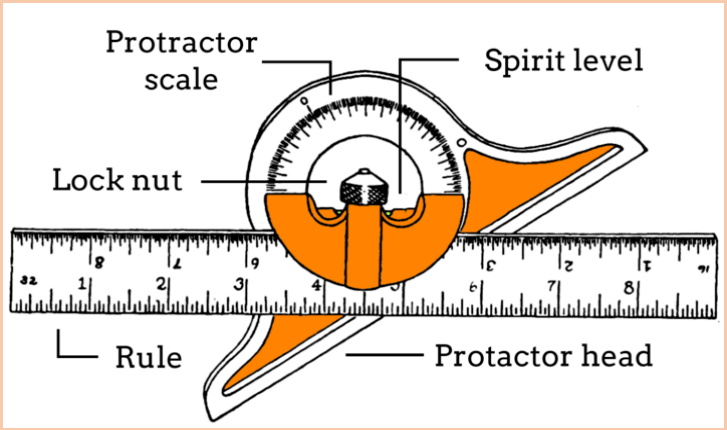


Figure Combination set

Note: While using the combination set make sure to remove burrs and chips, and wipe the head and workpiece clean. Check the sharpness of the scriber point if you are marking lines.

Blade (Rule)

The blade is designed to allow the different heads to slide along the blade and be clamped at any desired location. The groove in the blade is concave to eliminate dirt buildup and permit a free and easy slide for the heads. By removing all the heads, the blade may be used alone as a rule.

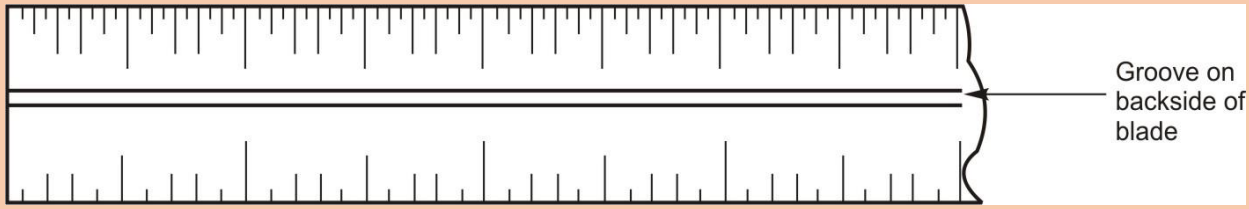


Figure Blade with groove

Square Head

A combination square has a ruled blade with an angled head that slides along the blade and can be repositioned by locking nut at any desired place along the graduated, rule-type blade to suit the job. The square head is designed with a 45o and 90o edge. The square head and blade can also be used as a marking gauge to scribe lines at a 45o angle. A convenient scriber is held frictionally in the head

by a small brass bushing. By extending the blade below the square or above the square, it can be used as a depth gage or height gage. Level in the angled head is used to make sure your work is true horizontal (level) or true vertical (plumb). The trick is to always use the longest level possible. The level makes it convenient to square a piece of material with a surface and at the same time will indicate if the edge or surface of the material is level. The square head can also be used as a simple level.

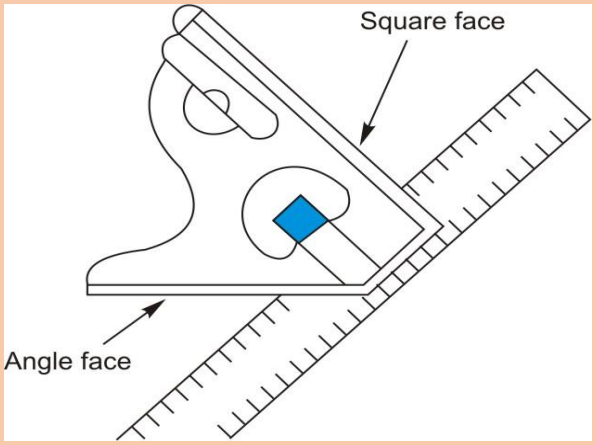


Figure Square head

Using square head

1. For checking angles, rest the head on its square face to check a 90o angle and on its angled face to check 45o.

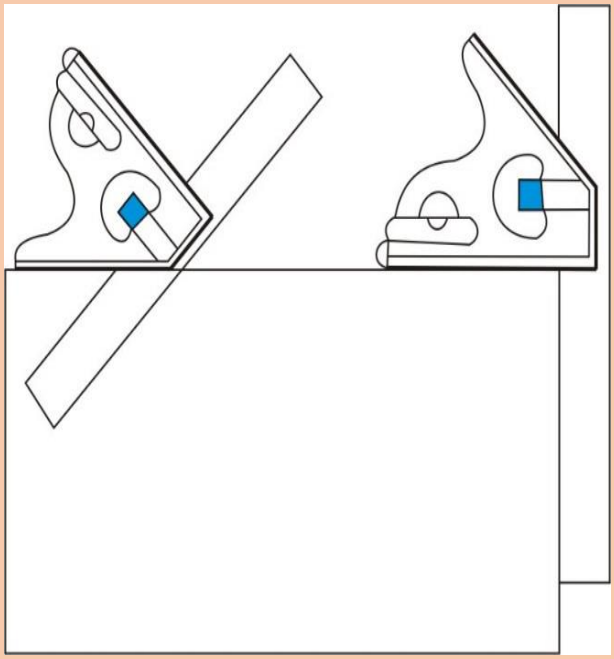


Figure Use the head to check for level

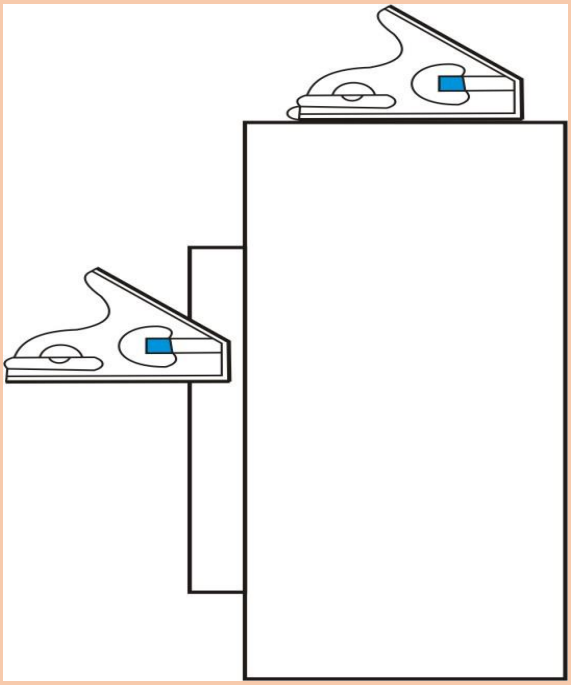


Figure checking horizontal surface

2. For measuring depth, loosen the locking nut, rest the square face flat on the reference surface and push the rule into the depth. Tighten the locking nut, remove the rule and read the depth.

3. For checking horizontal surface, rest the square face of the head on the surface with blade removed and reinstall the blade and check vertical surfaces by holding the blade against the vertical member to see that it is plumb.

4. For laying out a line, move the blade until it extends the required distance from the head. This measurement is read on the scale of the blade. Lock the blade and the square head using locking nut and position the head firmly against the reference surface. Scribe the required line.

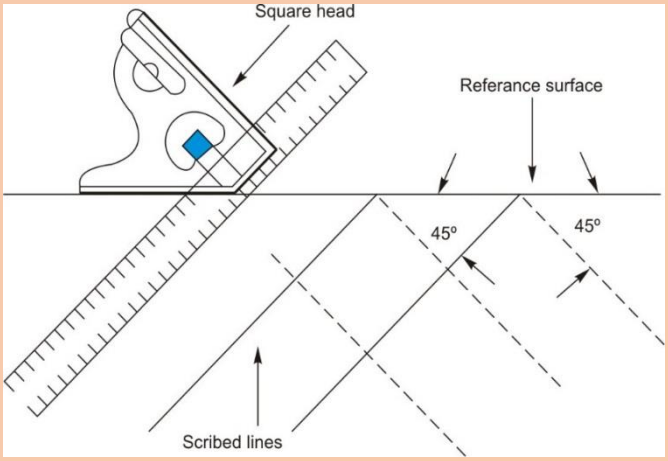


Figure Scribing lines at 45 degree using square head

5. For measuring length hold the head firmly against the reference surface. Move the blade until it exactly splits the measured point. Read the dimension on the blade of the square head.

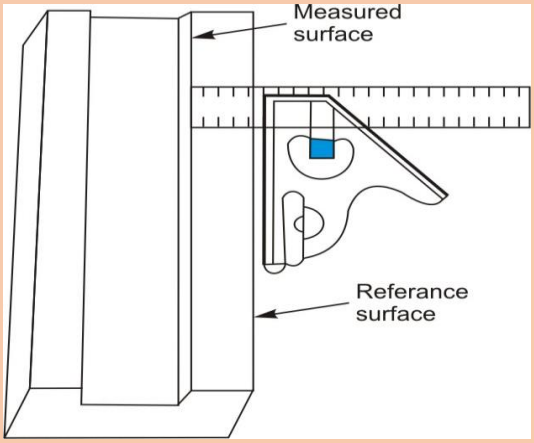


Figure Measuring surface using square head

Protractor Head

The protractor head is equipped with a revolving turret that is graduated in degrees from 0 to 180 or to 90 in either direction. It is used to measure or lay out angles to an accuracy of 1°. The base of the protractor head is held against the reference surface. The blade is held to the turret. The revolving turret is turned until the included angle of the blade and protractor head coincides with the angle to be measured. Using protractor head for measuring and marking an angle 1. Loosen the revolving turret locking nut to allow the turret to be rotated when a slight force is applied.

2. Press the flat face of the protractor head against the reference surface.
3. Position the protractor head so that the blade and turret may be moved to the desired angle and mark off the angle.
4. For measuring an angle bring the blade down gently to the work piece and adjust it. The desired angle is reached when there is no light showing between the measured surface of the work and the blade.
5. Tighten the locking nut. Read the graduation on the turret that coincides with the reference mark on the protractor head.

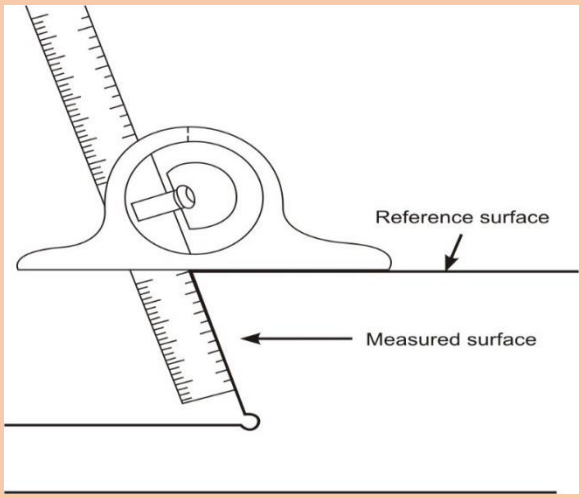
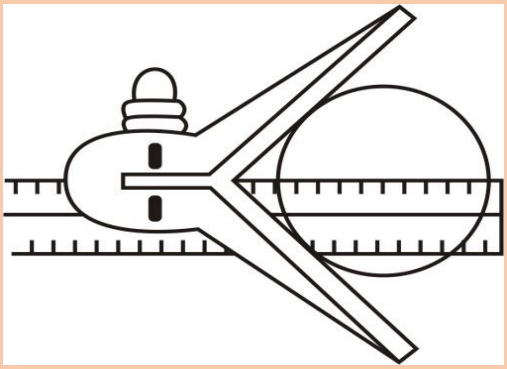


Figure using protractor head

Centre Head

The centre head, when inserted on the blade, is used to locate and lay out the centre of cylindrical workpiece. Using the centre head

1. Place the "V" legs of the centre head against the outer Surface of the cylindrical workpiece. Hold it in this position.
2. Scribe the centreline with a sharp scriber along the blade.
3. Turn either the round base 900 or the centre head over. Hold the centre head firmly against the bar.
4. Scribe the second centreline along the blade.



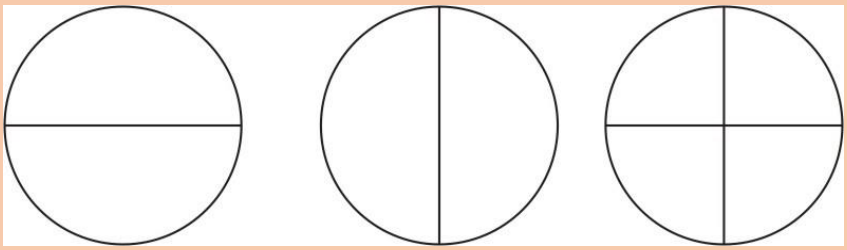


Figure Laying out centre on cylindrical workpiece using centre head

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"The only way of discovering the limits of the possible is to venture a little way past them into the impossible." —Arthur C. Clarke

GAS WELDING

PABIR KUMAR NASKAR
Workshop Instructor

Introduction: A very hot flame is produced by burning of the mixture gases coming through the torch tip. The edges to be welded are heated up to melting and a filler metal is also added to the melted parent metal to fil the cavity to complete the welding. This molten metal mixture when solidifies on cooling forms a welded joint. Many combinations of gases are used in gas welding, but the mixture of oxygen and acetylene is most commonly used. The working of the gas welding is shown in figure 1.

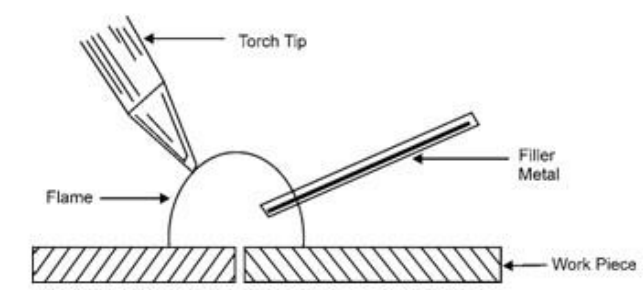

Fig 1: Working principle of gas Welding

Gas Welding Equipment

Details of Gas welding equipment are as under:

1. **Oxygen Cylinder:** As shown in Fig 6. Cylinder is made up of steel in capacity range 2.25 to 6.3 m^3. The cylinders are filled with oxygen at about 150 kg/cm^2 at 21°C. A safety valve is also provided on it. The cylinder can be opened or closed by a wheel which operates a valve. A protector cap is provided on the top of a cylinder to safeguard the valve.

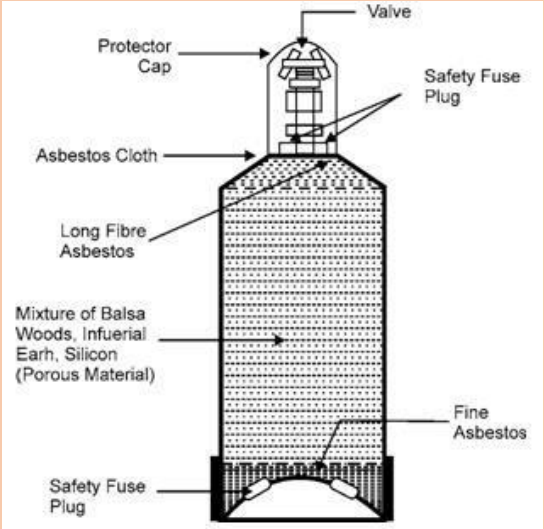

Fig 3: Acetylene Cylinder

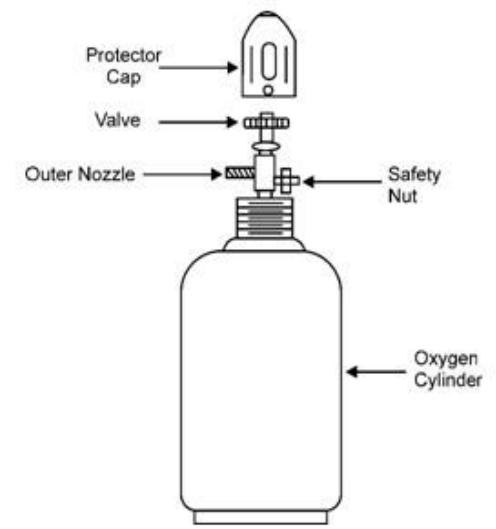

Fig 2: Oxygen Cylinder

2. Acetylene Cylinder: As shown in Fig. 7. Acetylene cylinders are also made up of steel. Gas is filled at a pressure of 18-20 kg/cm^2. The capacity of the cylinder is about 10m^3. Regulator valve and safety valve are mounted on cylinder. Safety plugs are also provided on the bottom of the cylinder. When filled into the cylinder, the acetylene is dissolved in acetone.

3. Regulator: Regulator is used to control the flow of gases from high pressure cylinder. A simple type of regulator is shown in the Fig. 4.

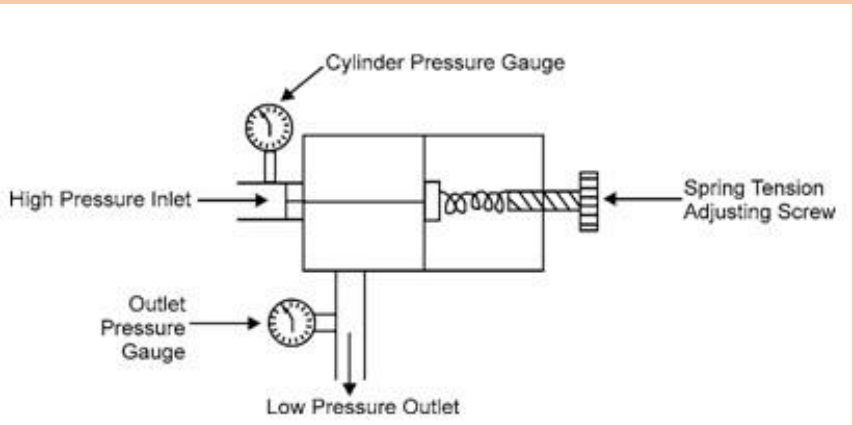

Fig 4: Regulator

4. Hoses: In oxy-acetylene gas welding the oxygen and acetylene are carried from the oxygen and acetylene cylinders to the welding torch through hoses. The colour coding is used to identifying the hose carrying the gas. The hose having blue colour carries oxygen and red colour is used for acetylene hose. These hoses are shown in figure 5.

Fig 5: Hoses

5. **Welding Torch:** Torch is a device used to mix acetylene and oxygen in the correct proportion and the mixture flows to the tip of the torch. Refer Fig. 6. For different types of jobs, different tips are used. The size of the tip is specified by the diameter of outlet hole. More than one hole is also provided in tips. The tip is screwed or fitted on the front end of the torch. There are two types of torches:

(a) Low pressure or injector torches

(b) Medium pressure or equal pressure torches

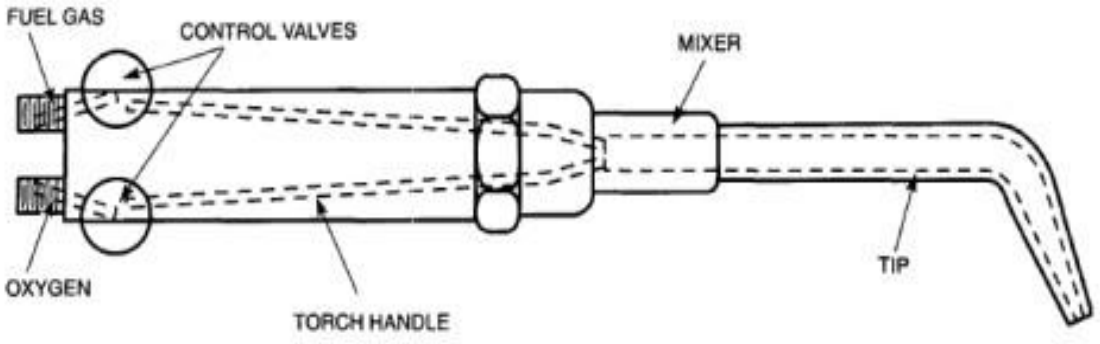

Fig 6: Welding Torch

(a) Low Pressure or Injector Torch: These torches are designed to use acetylene at low pressure. The pressure is kept very low up to 0.7 kg/cm^2. But the oxygen pressure is very high.

(b) Medium Pressure or Equal Pressure Torch: In this type of torch the acetylene is taken at a pressure equal to 1 kg/cm^2, the oxygen is always supplied at high pressure. Both types of torches are provided with two needle valves. One regulates the flow of oxygen and the second valve controls the flow of acetylene. A mixing chamber is provided to mix the gases.

6. Goggles: Gas flames produce high intensity light & heat rays, which are harmful to naked eye. To protect the eyes from these rays, goggles are used. Goggles also protect the eyes from flying sparks. The goggles are shown in figure 7.

7. Lighter: For starting the flame, the spark should be given by a lighter.

Match sticks should not be used, as there is risk of burning hand.

8. Fire Extinguishers: Fire extinguishers are used to prevent the fire that may break out by chance. Sand filled buckets and closed cylinders are kept ready to meet such accidents.

Oxy-acetylene Welding Process

The process of oxy-acetylene welding can be used for almost all metals and alloys for engineering purposes. A high temperature flame (3500°C) can be produced by this method. There are two systems of oxygen-acetylene welding.

(a) High Pressure System: In this process the oxygen and acetylene are taken for use from high pressure cylinders.

(b) Low Pressure System: In this system oxygen is taken from high pressure cylinder and the acetylene is produced by the action of Calcium carbide and water.

$$CaC2 + 2H2O = Ca(OH)2 + C2H2$$

A very hot flame is produced by burning of the gases coming through the torch tip. The edges to be welded are heated up to melting. A filler metal is also added to complete the welding. This molten metal mixture when solidifies on cooling forms a welded joint.

Oxygen cylinder and acetylene cylinder are filled with gases. Both the cylinders are attached with pressure gauges, regulators and cylinder valves. The cylinder containing oxygen is painted black whereas the acetylene cylinder is painted maroon. Hose pipes, are provided with each cylinder. These pipes or hoses are connected to welding torch.

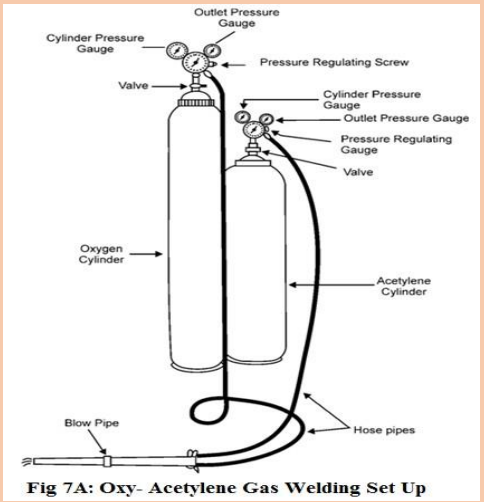

Fig 7A: Oxy- Acetylene Gas Welding Set Up

To start welding, the acetylene control valve is turned first. When acetylene comes out of the nozzle, it should be ignited with spark lighter. It will give a yellow-colored smoke flame. After it, oxygen cylinder valve is opened and supply is increased until a most suitable flame is obtained. Then the flame is focused on the edges to be welded. Flux and filler metal are also used. The edges and filler metal melt and a joint are formed after cooling of the molten metal. The chemicals which deoxidize the metal surface and provide inert

atmosphere around the molten metal are known as fluxes. The main function of flux is given below:

1. To prevent oxides on the hot surfaces.
2. To reduce the viscosity of molten metal.
3. It maintains a steady arc in case of arc welding.

Fluxes are available as liquid, powder, paste and gas. Powder flux is sprinkled on the surfaces to be welded or the filler rod is dipped into the powder. Liquid & paste fluxes are sprayed on the surfaces to be welded. Gas fluxes are used to form inert atmosphere around the joint to be welded.

We can obtain different types of flames according the requirement. There are three types of flames which are used for various purposes.

Types of Gas Flames

a. Oxidizing Flame: When the volume of oxygen gas is more than the volume of acetylene mixed into the torch. This flame is used for welding brass and is also used for cutting the metals.

b. Carburizing Flame: When the volume of acetylene mixed is more than oxygen, carburizing flame is formed. This flame is used for welding nickel, monel etc.

c. Neutral Flame: It is known as balanced flame. Oxygen and acetylene gases are mixed in equal volumes. Neutral flame is used for normal welding of steel, cast iron etc.

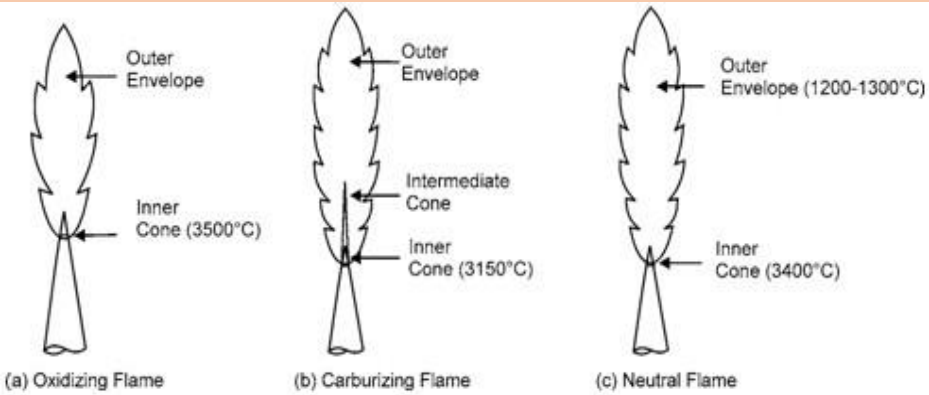

Fig 8: Types of Flames

Applications

Oxy-acetylene welding is particularly used for sheet metal work. All the metals can be welded with proper filler metals. Same equipment may be used for cutting purposes.

Advantages of Oxy-acetylene Welding

The main advantages of oxy-acetylene welding are given below:

1. Equipment is cheap as compared to other welding process.
2. It can be used for welding of all types of metals.

3. Maintenance of equipment is very less.
4. It is a portable process.
5. It can be used for cutting of metals of small thickness.
6. It is specially used for sheet metal work.

Disadvantages

7. It takes long time for heating the job as compared to the arc welding.
8. The heat affected area is more.
9. This is prone to corrosion and brittleness.
10. Gases are expensive and difficult to store.

Gas Welding Techniques

There are two types of gas welding techniques:

a. Left ward welding
b. Right ward welding

a. Left Ward Welding: In this welding the tip of the torch is held at 60 to 70° to the plates. And the filler rod is inclined at 30 to 40° in opposite direction. In this method, the plate edges are heated immediately after the molten metal. The torch tip and filler rod are moved slowly in the direction towards left. The technique is illustrated in the Fig.9.

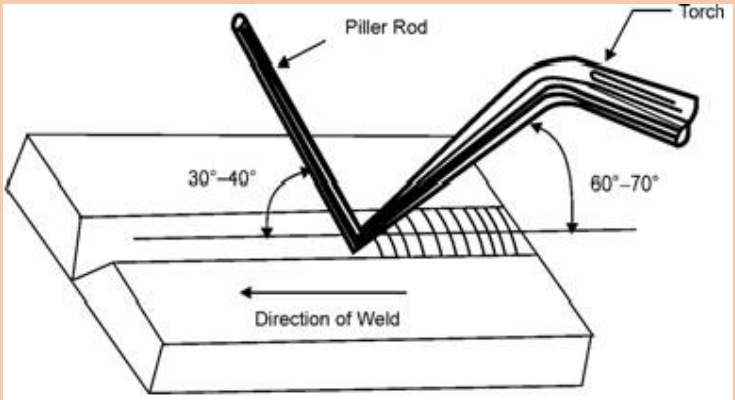

Fig 9: Leftward Welding

Right Ward Welding: In right ward welding the torch is kept at 40 to 50° to the job to be welded. Torch is moved towards right as shown in the Fig. 10. Right ward welding is done for heavy sections only.

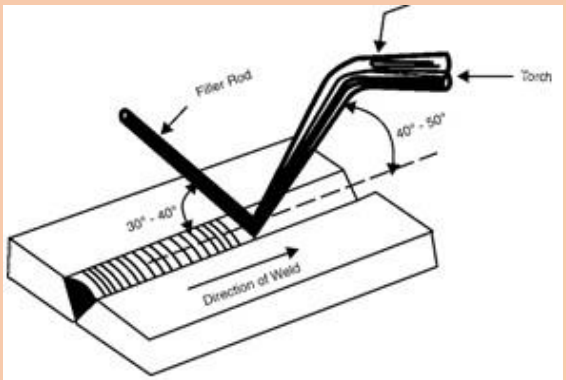

Fig 10: Rightward Welding

Filler: The rod which provides additional metal in completing the welding is known as filler. The composition of filler metal should be the same as that of the metals to be welded.

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"Don't worry about failure; you only have to be right once." —Drew Houston

SPECTROMECH 2022

8th Edition

December, 2022

CENTRE LATHE TURNING OPERATIONS - TAPER TURNING

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When the diameter of a piece changes uniformly from one end to the other, the piece is said to be tapered. Taper turning as a machining operation is the gradual reduction in diameter from one part of a cylindrical workpiece to another part. Tapers can be either external or internal. If a workpiece is tapered on the outside, it has an external taper; if it is tapered on the inside, it has an internal taper.

There are three basic methods of turning tapers with a lathe. Depending on the degree, length, location of the taper (internal or external), and the number of pieces to be done, the operator will use either one of the following methods:

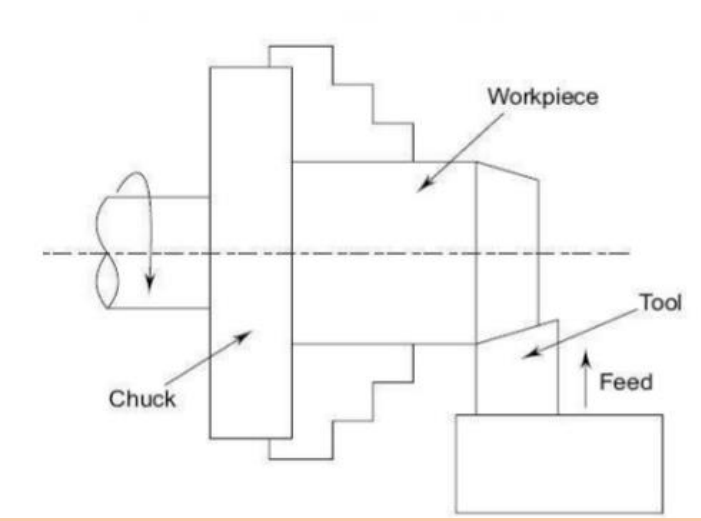
- Form tool method
- Compound slide method
- Tailstock method
- Taper turning attachment

With any of these methods the cutting edge of the tool bit must be set exactly on centre with the axis of the workpiece or the work will not be truly conical and the rate of taper will vary with each cut.

Form tool method:

The tool is ground and shaped at a particular angle which is needed in taper turning. This method is used in mass production for producing a small length of taper where accuracy is not

a criterion. The form tool should be set at right angle to the axis of the work. The carriage should be locked while taper turning by this method.



Advantage

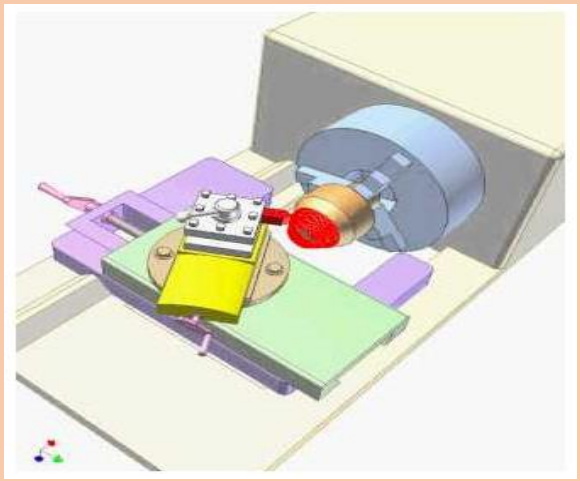
- Once the tool is made with cutting edge at particular angle, as long as tool is aligned perpendicular to the axis of the lathe, one can easily turn the jobs at required angle.

Disadvantage

- There is only one angle value possible for the tool to be ground at a time.

Compound slide method

Generally short and steep taper are produced using this method. In this method the work piece is held in the chuck and it will be rotated about the lathe axis. The compound rest is swivelled to the required angle and then it will be clamped in position.

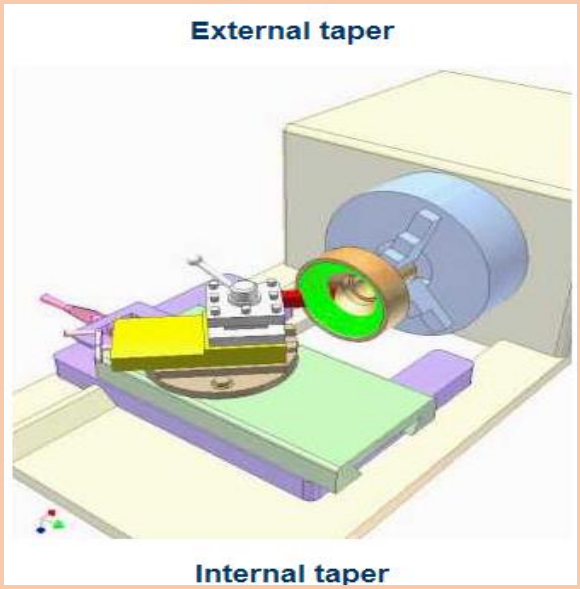


Advantage:

- Both internal and external taper can be produced
- Steep taper can be produced
- Easy setting of the compound slide

Disadvantages:

- Only hand feed can be given
- Threads on taper portion cannot be produced
- Taper length is limited to the movement of the top slide.

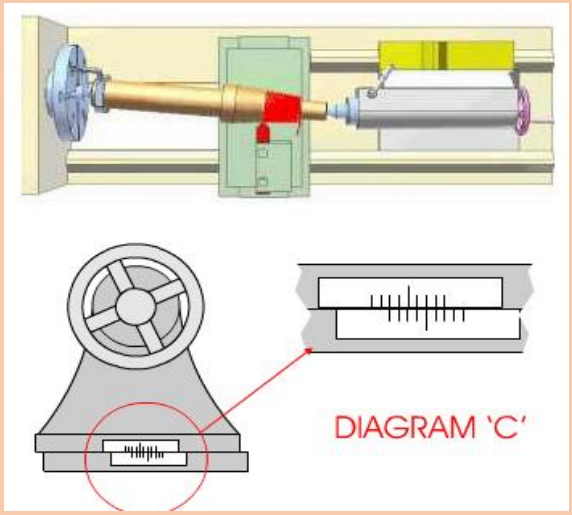


Tailstock method Videos

In this method the job is held at an angle and the tool moves parallel to the axis. The body of the tailstock is shifted on its base to an amount corresponding to the angle of taper. This method. The taper can be turned between centres only and this method is not suitable for producing steep tapers.

ADVANTAGES

- Power feed can be given
- Good surface finish can be obtained
- Maximum length of the taper can be produced
- External threads on taper portion can be produced
- Duplicate tapers can be produced

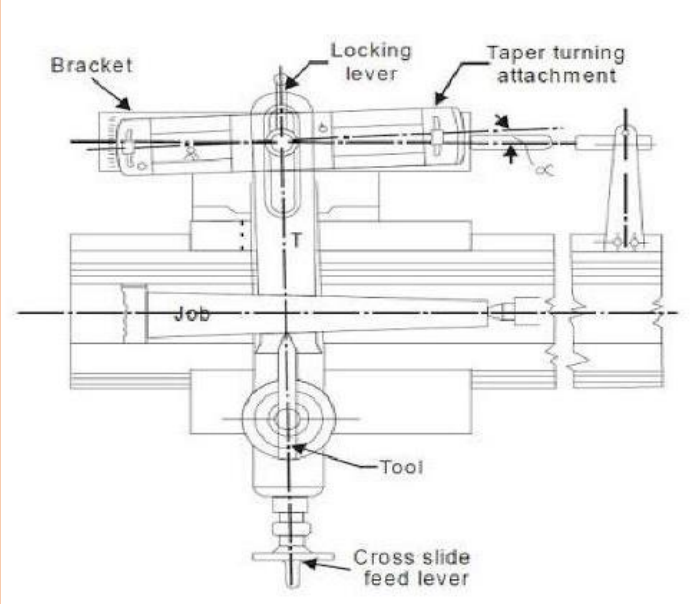


DISADVANTAGES

- Only external taper can be turned
- Accurate setting of the offset is difficult
- Taper turning is possible when work is held between centres only
- Damages to the centre drilled holes of the work
- The alignment of the lathe centres will be disturbed
- Steep tapers cannot be turned

Taper turning attachment method

Taper Turning Attachment is very much popular and fits on all lathe machines. In ordinary straight turning, the cutting tool moves along a line parallel to the axis of the work, causing the finished job to be the same diameter throughout.



When the diameter of a piece changes uniformly, from one end to the other, the piece is said to be tapered. Taper turning as a machining operation is the gradual reduction in diameter from one part of a cylindrical workpiece to another part. Tapers can be either external or internal. If a workpiece is tapered on the outside, it has an external taper; if it is tapered on the inside, it has an internal taper.

Advantages of Using Taper Attachment for Tapers:

- Both internal and external tapers can be produced.
- Threads on both internal and external taper portions can be cut.
- Power feed can be used.
- Lengthy taper can be produced.
- Good surface finish is obtained.
- The alignment of the lathe centres is not disturbed.
- It is most suitable for producing duplicate tapers because. the change in length of the job does not affect the taper.
- The job can be held either in chuck or in between centres.

Disadvantages of Taper Turning Attachment:

- Only limited taper angles can be turned.
- Cross feed must be disengaged for operation, time consuming.
- Only viable for large production

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"If you don't like the road you're walking, start paving another one."

—Dolly Parton

INDUSTRY 5.0

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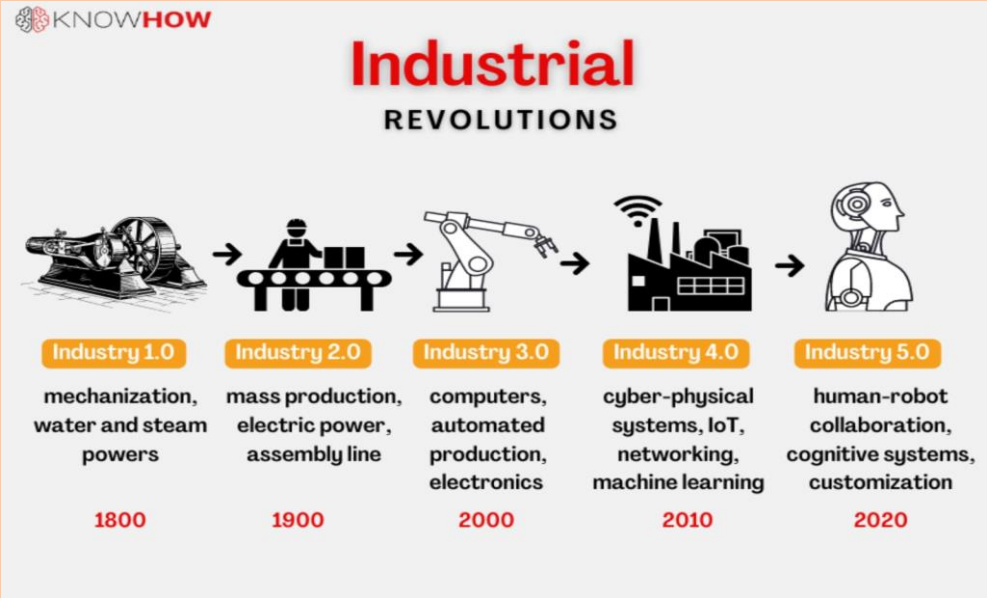
LECTURER IN MECHANICAL DEPT

Industry 5.0 is the latest evolution of the manufacturing industry, where digital technologies such as artificial intelligence (AI), robotics, and the Internet of Things (IoT) are combined with human skills and creativity to drive innovation and productivity. This paper aims to provide a comprehensive report on Industry 5.0, its key features, advantages, and challenges, as well as its potential impact on the manufacturing industry.



Key Features of Industry 5.0

Industry 5.0 emphasizes the integration of humans and machines, where workers are not replaced by technology, but rather work alongside it. The main features of Industry 5.0 include:

Collaborative Robotics: This involves the use of robots to support and collaborate with human workers. Robots can perform repetitive and dangerous tasks, allowing humans to focus on more complex and creative tasks.

Collaborative robotics has many benefits for manufacturers. Cobots can perform repetitive or dangerous tasks, such as welding, painting, or lifting heavy objects, allowing human workers to focus on more complex and creative tasks that require human skills and judgment. Cobots can also work around the clock, improving production efficiency and reducing labor costs.

In addition, cobots can help reduce workplace injuries and accidents. According to a study by the National Institute for Occupational Safety and Health (NIOSH), collaborative robotics can reduce the risk of musculoskeletal disorders and other injuries associated with manual labor.

However, there are also challenges associated with the adoption of collaborative robotics. One of the main challenges is the cost of cobots, which can be significantly higher than traditional robots. In addition, the integration of cobots into existing manufacturing processes may require significant investment in training, programming, and infrastructure.

Another challenge is the potential for job displacement. While collaborative robotics can improve productivity and efficiency, they may also displace human workers who perform the tasks that cobots are designed to do. It is important for manufacturers to consider the impact of cobots on their workforce and develop strategies to mitigate the negative effects, such as retraining or redeployment programs. Overall, collaborative robotics is an exciting area of innovation in the manufacturing industry. While it presents some challenges, the benefits of cobots are significant and can help manufacturers improve productivity, efficiency, and workplace safety.

AI and Machine Learning: AI and machine learning technologies are used to analyze data, identify patterns, and make predictions, enabling manufacturers to optimize processes and make more informed decisions.

In manufacturing, AI and ML are being used to optimize production processes, improve quality control, and reduce downtime. For example, predictive maintenance systems use ML algorithms to analyze sensor data from machinery and predict when maintenance will be required, helping to avoid unplanned downtime and reduce maintenance costs.

Augmented Reality: Augmented reality technologies can be used to enhance worker training, enabling them to learn new skills and perform complex tasks with greater precision and efficiency.

In the manufacturing industry, AR has the potential to revolutionize the way products are designed, manufactured, and maintained. One of the main benefits of AR in manufacturing is improved visualization and communication. AR technology can be used to create 3D models of products, allowing designers and engineers to visualize how the product will look and function in the real world. AR can also be used to overlay digital information onto physical objects, such as instructions or specifications, improving communication and reducing errors.

AR can also improve training and on boarding for employees. AR can be used to provide immersive training experiences, allowing employees to practice tasks in a safe and controlled environment. AR can also be used to provide real-time guidance and feedback to workers, improving efficiency and reducing errors.

Another benefit of AR in manufacturing is improved maintenance and repair. AR can be used to overlay digital information onto physical objects, such as maintenance instructions or troubleshooting guides. This can help workers to identify and resolve issues more quickly and accurately, reducing downtime and improving productivity.

Despite its many benefits, there are also challenges associated with AR in manufacturing. One of the main challenges is the cost of implementing AR technology, including hardware, software, and training costs. Another challenge is the need to integrate AR technology with existing manufacturing systems and processes, which can be complex and time-consuming.

Additive Manufacturing: Additive manufacturing, also known as 3D printing, is a manufacturing process that involves creating three-dimensional objects by layering materials such as plastic, metal, or ceramic.

One of the key benefits of additive manufacturing is the ability to produce complex geometries and shapes that would be difficult or impossible to achieve using traditional manufacturing techniques. This is because additive manufacturing builds objects layer by layer, allowing for greater design flexibility and customization.

Another benefit of additive manufacturing is the reduction in waste and material usage. Traditional manufacturing techniques often result in a significant amount of waste material, which can be costly to dispose of and harmful to the environment. Additive manufacturing, on the other hand, uses only the exact amount of material needed to create the object, resulting in minimal waste.

Big Data and analytics: Big data helps businesses collect and analyze data from multiple sources, providing insights that drive strategic decision-making. This allows businesses to make informed decisions in real-time, leading to improved operational efficiency and reduced costs.

Predictive Maintenance: With big data, manufacturers can predict equipment failures and schedule maintenance activities before they cause downtime or costly repairs. This improves production uptime and reduces costs associated with equipment breakdowns.

Improved Quality Control: Big data analytics can help manufacturers identify quality issues in real-time, allowing them to take corrective actions before the product reaches the customer. This leads to improved customer satisfaction and reduced costs associated with product recalls.

Personalized Products: Big data analytics can help manufacturers understand customer needs and preferences, allowing them to offer personalized products and services. This leads to increased customer satisfaction and loyalty.

Supply Chain Optimization: Big data analytics can help manufacturers optimize their supply chains by providing real-time insights into inventory levels, production schedules, and logistics. This improves efficiency, reduces waste, and lowers costs.

Overall, big data plays a crucial role in Industry 5.0, providing manufacturers with insights and tools to improve operational efficiency, reduce costs, and meet customer demands.

Advantages of Industry 5.0 :

Industry 5.0 offers several advantages for manufacturers, including:

Improved Productivity: By combining the strengths of human workers and digital technologies, Industry 5.0 can significantly improve productivity and efficiency.

Enhanced Flexibility: The ability to quickly adapt to changing customer demands and market trends is critical for manufacturers. Industry 5.0 enables manufacturers to be more flexible and responsive to customer needs.

Better Quality: Industry 5.0 technologies such as AI and machine learning can help manufacturers identify and correct quality issues in real-time, resulting in higher quality products.

Safer Workplaces: Collaborative robotics and augmented reality technologies can help reduce workplace injuries and accidents, creating a safer work environment for employees.

Challenges of Industry 5.0 : While Industry 5.0 offers many benefits, it also presents several challenges for manufacturers, including:

Workforce Skills: The integration of human workers and digital technologies requires a highly skilled workforce capable of operating and maintaining complex equipment.

Cyber security: The increased use of digital technologies in manufacturing creates new cyber security risks, which must be addressed to prevent cyber-attacks and data breaches.

Cost: Implementing Industry 5.0 technologies can be costly, requiring significant investment in new equipment, training, and infrastructure.

Regulatory Compliance: The use of new technologies may require manufacturers to comply with new regulations and standards, which can be a challenge for smaller companies.

Potential Impact of Industry 5.0:

Industry 5.0 has the potential to significantly impact the manufacturing industry, leading to increased productivity, efficiency, and innovation. It also has the potential to create new job opportunities for highly skilled workers, while also requiring them to continuously upgrade their skills to keep up with technological advancements. The increased use of digital technologies may also lead to new business models and revenue streams for manufacturers.

Conclusion:

Industry 5.0 represents a significant shift in the manufacturing industry, emphasizing the integration of human workers and digital technologies to drive innovation and productivity. While it presents several challenges, the potential benefits of Industry 5.0 make it a worthwhile

investment for manufacturers looking to remain competitive in an increasingly digital world. As Industry 5.0 continues to evolve, it will be critical for manufacturers to stay informed of new advancements and best practices to stay ahead of the curve.

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"I learned a long time ago that there is something worse than missing the goal, and that's not pulling the trigger." —Mia Hamm