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Advanced Two Dimensional Spray Painter with Scissor Lift Mechanism

R. Hariharan, Vishal Kumar, S. Sandeep, C. Arul Murugan and Dipankarkar

Abstract--- *Painting is the operation of applying paint on the surfaces which are physically contacted and lie in the visual areas. This is done to protect the surface from rust, erosion, decomposition, etc., as well as to have good aesthetics. Different methods of painting system are used in modern technology in which one of the most common method is spray painting. It is used to produce a uniform coating and an excellent finish. But this can also be a tedious task and also the spray is hazardous. So the use of advanced system is needed for spray painting applications. This is because the machine can do the operation precisely and also it eliminated danger to human health. This project proposes the idea of using a double scissor lift arrangement to lift the paint sprayer in the vertical axis and a lead screw drive to move it in a horizontal axis. The scissor lift is used because it can be used to achieve a good height and also it is easily portable. The system is more compact and easy to handle and also with the help of electrical implementation it can be fully automated.*

Keywords--- *Scissors, Paint Sprayer, Hazardous, Fully Automated.*

I. INTRODUCTION

Painting is the operation of applying paint on the surfaces which are physically contacted and lie in the visual areas. This is done to protect the surface from rust, erosion, decomposition, etc., as well as to have good aesthetics. Different methods of painting system is used in modern technology in which one of the most common method is spray painting. It is used to produce a uniform coating and an excellent finish. But this can also be a tedious task and also the spray is hazardous. So the use of advanced system is needed for spray painting applications. This is because the machine can do the operation precisely and also it eliminated danger to human health.External wall surfaces are subject to continual attack from the weather, the environment and chemical attack. Internally, walls have to withstand constant impact, abrasion and industrial processes which are increasingly complex and demanding from both a hygiene and an appearance point of view.

External Wall Protection

Externally, walls are subject to many external influences; rain, wind, snow and fluctuating temperatures being the most usual causes of erosion and damage to buildings.

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However, increased industrialisation has added more aggressive pollutants to the environment, accelerating the damage to building surfaces. So many liquid coatings provide durable protection of all types of building fabric from degradation due to environmental factors.

Internal Wall Protection

Internally, walls have to withstand constant impact, abrasion and industrial processes which are increasingly complex and demanding from both a hygiene and an appearance point of view.

Hygienic Wall Coatings

Tiles have, for many years, been used to line walls in kitchens, showers, changing rooms, dairies and many other areas where an easy clean or water resistant finish is required. Increased tightening of hygiene regulations has made the use of tiles less acceptable due to the potential for dirt build up and microbiological growth in the grout lines. Also, over time, tiles can become damaged and cracked, causing further hygiene issues. Liquid coating systems can be applied directly over existing tiled surfaces to provide a totally seamless, easy to clean finish.

Impact Resistant Wall Coatings

In public buildings, such as hospitals, airports and schools, walls are subject to impact damage from bags and trolleys. Once cracked, wall coating can potentially provide breeding grounds for germs and dirt. Liquid coatings based around a reinforced embedment coat provide strong, durable and seamless wall coatings.

Anti Graffiti Wall Coatings

Graffiti and its removal, costs local authorities, public utilities and other organizations millions of pounds every year. However, by using the correct coating system these costs can be significantly reduced. Traditional methods of graffiti removal, particularly on masonry surfaces, usually involve some form of abrasive cleaning which actually damages the surface fabric of the structure. Anti-Graffiti Coatings overcome this expensive operation by providing an easy to clean surface. Anti-Graffiti coatings are available in both pigmented and clear finishes.

Decorative Wall Coatings

In public buildings, reception areas, showrooms etc., multi-coloured decorative systems are often preferred to monochromatic colour finishes. Liquid coatings provide internal decorative finishes by incorporating PVA flake into our high performance wall coatings giving protection combined with an aesthetically pleasing finish.

Tanking/Waterproofing

Concrete surfaces of tunnels, subways and cellars which are below the water table are prone to ingress of moisture particularly if no effective damp proof membrane exists between the earth and the concrete. Cementitious Waterproofing Compound provides a chemically bonded waterproof layer which will resist hydrostatic pressures up to 7 bar. For this type of huge categories in paint coating we need to put so much of effort. In these categories such type of tunnel walls coating human beings not able to do. For such type of places we need to use paint spraying machines.

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II. TYPES OF AUTOMATIC PAINT SPRAY MACHINES

1. Horizontal Reciprocating Machine

This coats flat objects such as steel plate, plywood, etc., which can be carried on a lay-down conveyor under the spray gun. The motion of a horizontal reciprocating machine, together with the movement of the conveyor, may be described as a series of 'W's". The spray guns are fixed at right angles to the surface of the product. When using one spray gun with a 6 inch spray pattern, the product will move 3 inches for every stroke of the machine. For a more uniform coat, an overlap is provided to cover the previous stroke using one half of the effective portion of the spray pattern of the previous strokes. The spray gun moves six inches past the product and is turned off. The gun is turned on six inches before starting the next stroke. Triggering the gun helps to keep the fluid nozzle clean.

2. Vertical Reciprocating Machines

Designed to produce a vertical stroke, these machines are normally used in conjunction with overhead conveyor systems, but can be adapted to other types. The design of these machines and controls axe determined by the size, shape, type of material being sprayed, production requirements and budget allowed by the customer.

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3. Rotatory Spray Machines

These do the same basic operation as a horizontal reciprocating machine, but are able to operate at higher conveyor speeds.

The machine rotates at about 20 RPM and the spray pattern coverage in conjunction with the conveyor, covers the object with a series of overlapping arcs-the flatter the arc, the more unform the coating. Four arm rotary spray machines are recommended for up to 50 feet per minute. Eight arm rotary spray machines are recommended for any conveyor speed over 50 feet per minute. A limitation of this machine is that it cannot handle abrasive materials because of the rotary seals it uses.

4. Spindle Machines

An automatic spraying system consisting of exhaust system, conveyor (chain on edge type) and spray gun controls with the exception of loading and unloading portion (*optional equipment). Most types of products coated with this machine conform to spherical or cylindrical shapes. Square shapes require two rotational units. The object is placed on a specially designed work holder and rotated or spun in froRt of one or more spray guns. For a fine uniform finish the product must be rotated at least a minimum of two revolutions in the front of each spray gun. Depending upon the shape and size of the product, the minimum spacing of the work holder is normally every other pin; greater spacing between work holders can be as desired. The spindle conveyor chain is available in l%, 2, or 3 inch pitch, depending on requirements. Conveyor path can be arranged to suit the individual needs.

5. Robots

Robots axe spraying machines that virtually duplicate complex human hand, wrist, and arm motions. They are computer-controlled for production line spraying and offer particular advantages in hazardous areas, and where the work is repetitive.

Robots can be powered either electrically or hydraulically and are well suited for precision work.

6. Short Stroke Reciprocating Spray Machines

Sometimes called oscillators, SSRM normally oscillate over a range of 1 to 24 inches with adjustment capability in 1-inch increments. They can be oriented for either vertical or horizontal motion.

7. Automatic Spray Machines For Mouldings

Used in the finishing operation of flat and profiled mouldings, either continuously or inte4ttently for strip lengths in any combination. Capable of high production speeds (up to 36,000 ft. per hr.) these machines can be mounted with up to four spray heads, each individually controlled.

Spray booths usually are not required since exhaust systems are integral with the machine. So in this point of concern we made a proposal called advanced two dimensional paint spraying machine.

This project proposes the idea of using a double scissor lift arrangement to lift the paint sprayer in the vertical axis and a lead screw drive to move it in a horizontal axis. The scissor lift is used because it can be used to achieve a good height and also it is easily portable.

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The system is more compact and easy to handle and also with the help of electrical implementation it can be fully automated.

III. LITERATURE SURVEY

Dhaval Thakar, Chetan P. Vora

This paper gives basic information about small and medium scale industries manufacturing components have to paint for protecting from rusting so the spray application consumes maximum time and paint which required the skilled worker emerged with the application. They cannot manage robotic arrangement for higher efficiency so the rise of the such process have to be made which is affordable, gives better accuracy, consumes minimum time for coating so objective has to developed such mechanism which coat the object with the dipping technique having semi-automatic arrangement which is suitable for our requirement and which can be valuable for small and medium scale industries.

P. Keerthanaa, K. Jeevitha, V. Navina, G. Indira, S. Jayamani

They studied that automatically paint the wall surface of given dimension has been designed and implemented in effective manner. The approach uses Infrared transmitter and Infrared receiver to identify the appearance of wall. The microcontroller unit to regulate the movement of the DC motor. The robot wipe out the hazards caused due to the painting chemicals to the human painters and also the nature of painting techniques that require imitated work and hand rising makes it dull, time consuming. The robot is cost effective, reduces work force for labors, and reduces time consumption. The drawback of the project is that the robot continues painting later the end of the wall so it can be eliminated by adding some indicating objects such as alarm.

Prof. Dinesh B. Shinde, Sanket D. Ingole, Rohit P. Gomase - Design & fabrication of remote operated 3-axis spray painting machine

Painting is a process of applying paint on surface of any object or wall. But wall painting is time and effort consuming process. It is also hazardous, boring and exhausting technique which makes it an excellent case for automation. Painting had been automated in most of automotive industry but not yet for the construction industry and also for the house wall painting.

There is a strong need for a movable robot that can move to paint interior walls of household buildings. In this paper, the conceptual design of remote operated wall painting robot is described consisting of an electric spray gun that paint the walls vertically and is fitted on a movable robot base to give the linear feed motion to cover the painting surface.

The design objective is to fulfill the foundation of simplicity, easy handling, low cost, reducing human effort and constant painting. IR sensors are fitted to adjust the distance limits and maneuver in the room area. A remote operated system is designed to guide the vertical motion of electric spray gun with the help of lead screw and electric motor. Also plan to move the base in horizontal direction.

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Dr. S.K. Rajesh Kanna, N. Anand, R. Mohanraj - Intelligent Vision Based Pneumatic Wall Painting Machine: an ANN Approach

Painting the wall is normally done manually, which is very difficult and troublesome for humans to work in an upright position and also very dangerous for eyes and skin. Due to fatigue and surrounding environment, painting might not even all over the wall. To overcome these difficulties, an intelligent pneumatic wall painting machine has been designed and fabricated using vision and neural system. The machine has the arm which can extend upto 25 feet by carrying the pneumatic spray gun. The camera in the arm captures the image of the wall and the obtained image has been processed and gives as the input to the trained artificial neural network.

Dhaval Thakar1, Chetan P. Vora2 - A Review on Design & Development of Semi-Automated Colour Painting Machine.

Painting is the practice of applying paint, pigment, colour or other medium to a surface (support base). The medium is commonly applied to the base with a brush but other objects can be used. In art, the term painting describes both the act and the result of the action. However, painting is also used outside of art as a common trade among craftsmen and builders. Paintings may have for their support such surface as walls, paper, canvas, wood, glass, lacquer, clay, leaf, copper or concrete, and may incorporate multiple other materials including sand, clay, paper, gold leaf as well as objects.

Andhale Satish1, Ansari Md. Aiman2, Ashtekar Keshav3, Asnewar Swapnil4, Prof. Sonawane D.P.5, Prof. Bhane A.B.6 - Automatic Wall Painting Using Lead Screws

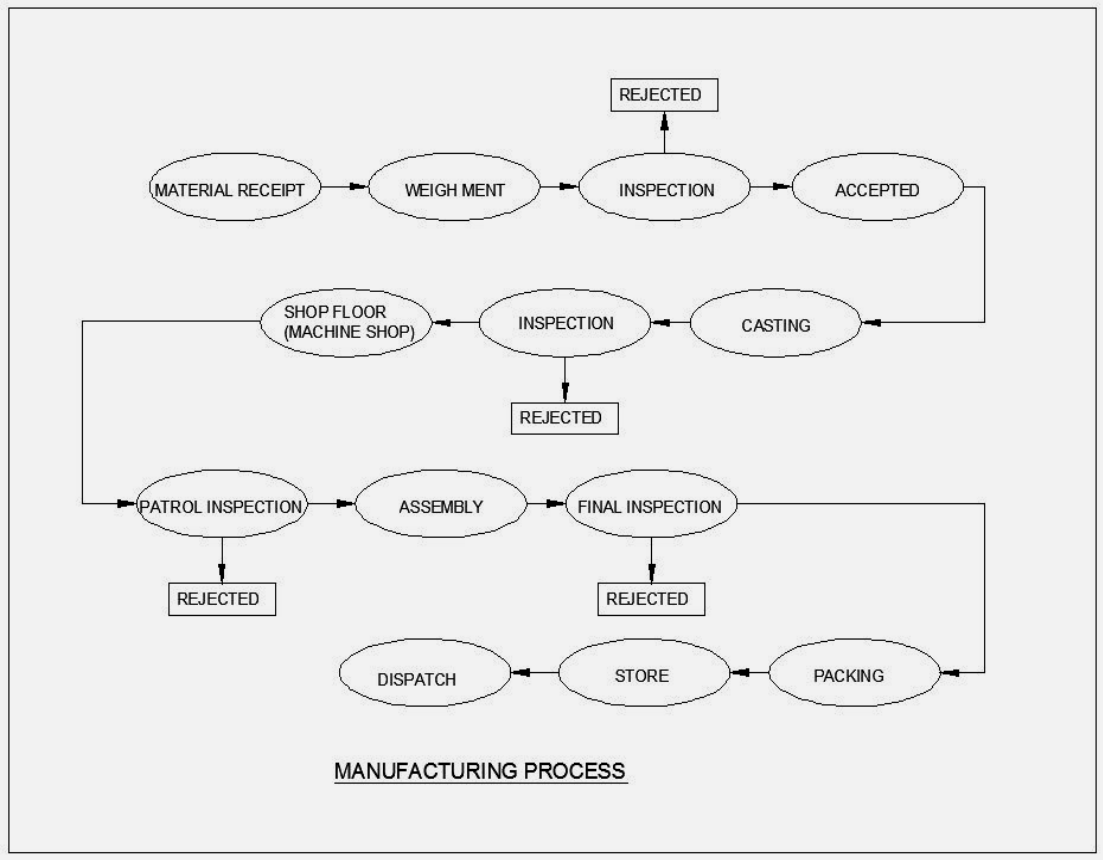
The aim of the project is to design, develop and implement Automatic Wall Painting Using Lead Screws which helps to achieve low cost painting device. The chemicals used in painting can be hazardous to human health eye and skin infections. Also conventional painting is time and effort consuming, and also the method of operation (rising hand again and again for painting) makes it boring. These factors motivate the development of an automated painting system.

A.Arun Raja, S.Kalaimagal - Design of Automated Image Injecting and Painting Robot

Wall painting is a repetitive, exhausting and hazardous process which makes it an ideal case for automation. There is a strong need for a mobile robot that can move to paint interior walls of residential buildings.

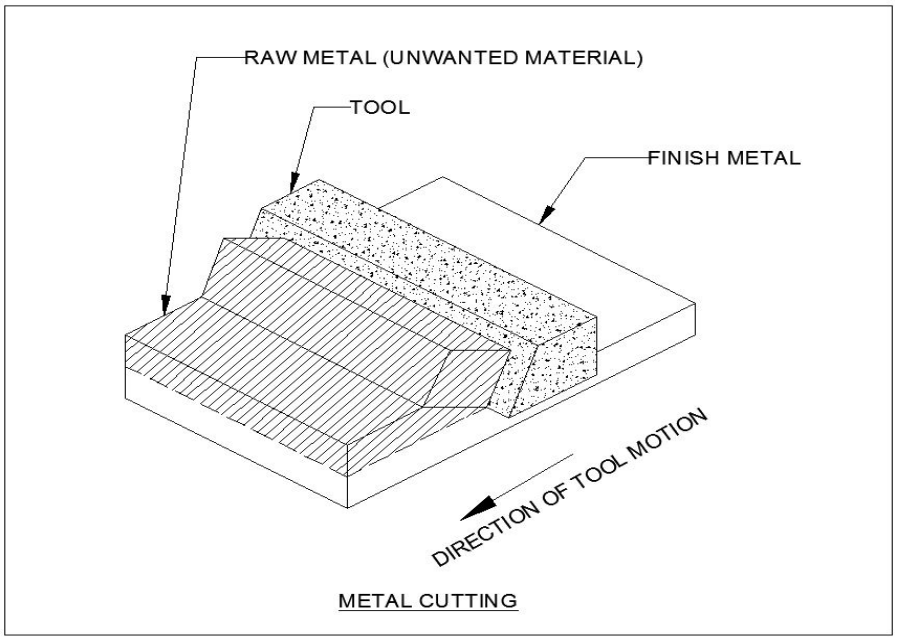
IV. MANUFACTURING PROCESS

Manufacturing processes are the steps through which raw materials are transformed into a final product. The manufacturing process begins with the creation of the materials from which the design is made. These materials are then modified through manufacturing processes to become the required part. Manufacturing processes can include treating (such as heat treating or coating), machining, or reshaping the material. The manufacturing process also includes tests and checks for quality assurance during or after the manufacturing, and planning the production process prior to manufacturing.



V. METAL CUTTING

Metal cutting or machining is the process of by removing unwanted material from a block of metal in the form of chips.



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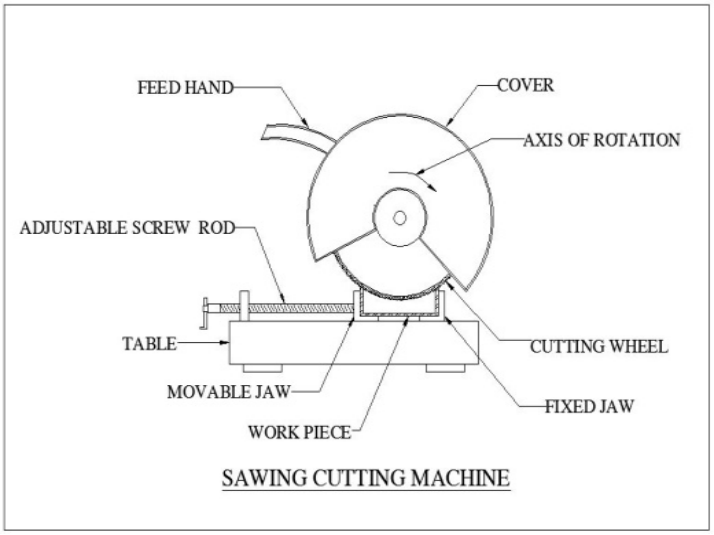
Cutting processes work by causing fracture of the material that is processed. Usually, the portion that is fractured away is in small sized pieces, called chips. Common cutting processes include sawing, shaping (or planning), broaching, drilling, grinding, turning and milling. Although the actual machines, tools and processes for cutting look very different from each other, the basic mechanism for causing the fracture can be understood by just a simple model called for orthogonal cutting.

VI. SAWING

Cold saws are saws that make use of a circular saw blade to cut through various types of metal, including sheet metal. The name of the saw has to do with the action that takes place during the cutting process, which manages to keep both the metal and the blade from becoming too hot. A cold saw is powered with electricity and is usually a stationary type of saw machine rather than a portable type of saw.



SAWING CUTTING MACHINE

The circular saw blades used with a cold saw are often constructed of high speed steel. Steel blades of this type are resistant to wear even under daily usage. The end result is that it is possible to complete a number of cutting projects before there is a need to replace the blade. High speed steel blades are especially useful when the saws are used for cutting through thicker sections of metal. Along with the high speed steel blades, a cold saw may also be equipped with a blade that is tipped with tungsten carbide. This type of blade construction also helps to resist wear and tear. One major difference is that tungsten tipped blades can be re-sharpened from time to time, extending the life of the blade. This type of blade is a good fit for use with sheet metal and other metallic components that are relatively thin in design.

VII. WELDING

Welding is a process for joining similar metals. Welding joins metals by melting and fusing **1,** the base metals being joined and **2,** the filler metal applied. Welding employs pinpointed, localized heat input. Most welding involves ferrous-based metals such as steel and stainless steel. Weld joints are usually stronger than or as strong as the base metals being joined.

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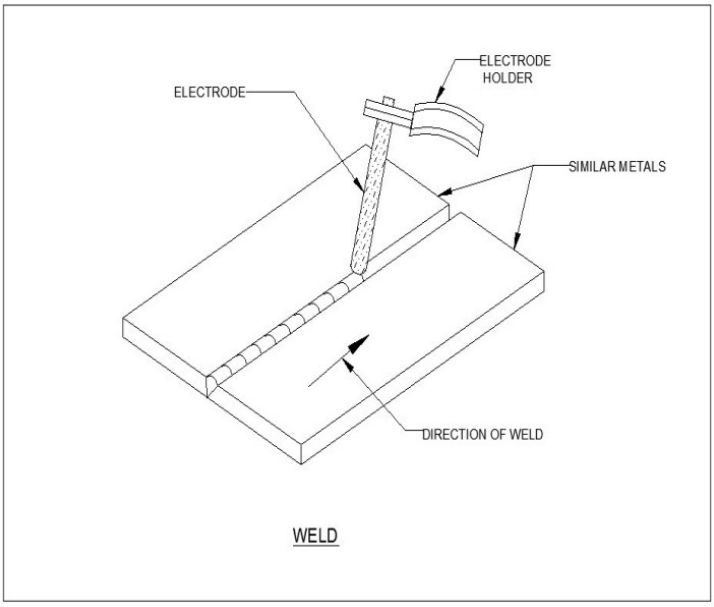
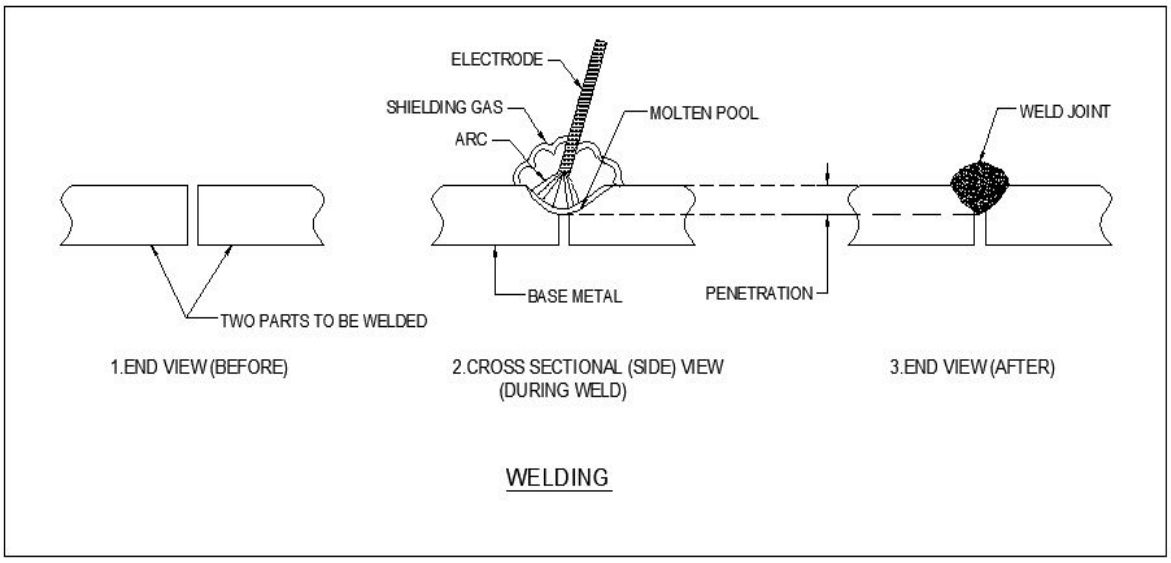


Welding is used for making permanent joints. It is used in the manufacture of automobile bodies, aircraft frames, railway wagons, machine frames, structural works, tanks, furniture, boilers, general repair work and ship building.

a. Operation

Several welding processes are based on heating with an electric arc, only a few are considered here, starting with the oldest, simple arc welding, also known as shielded metal arc welding (SMAW) or stick welding. In this process an electrical machine (which may be DC or AC, but nowadays is usually AC) supplies current to an electrode holder which carries an electrode which is normally coated with a mixture of chemicals or flux. An earth cable connects the work piece to the welding machine to provide a return path for the current.



The operator needs to control the gap between the electrode tip and the work piece while moving the electrode along the joint.

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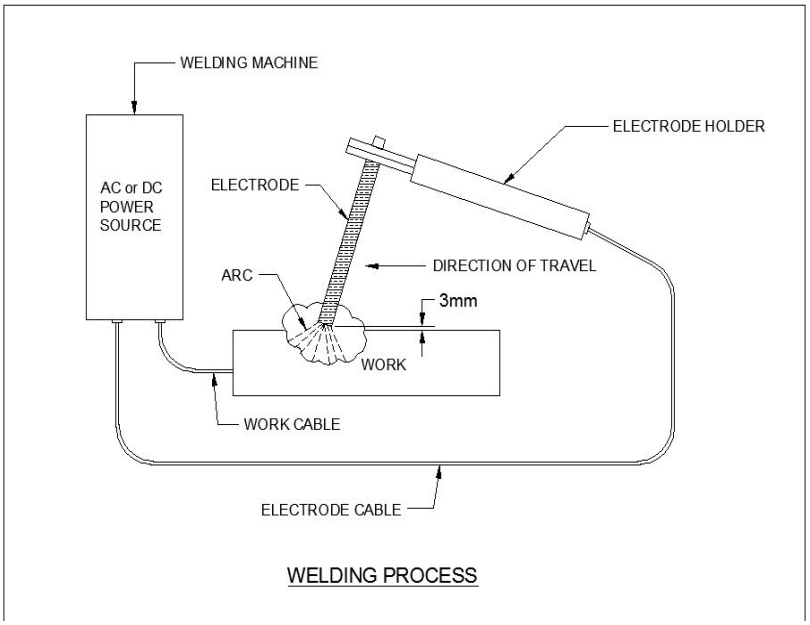
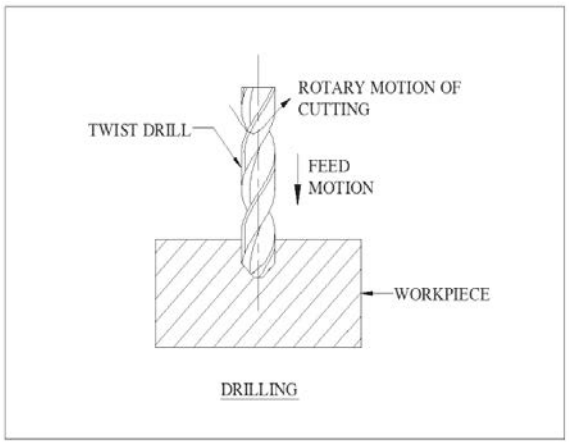


In the shielded metal arc welding process (SMAW) the 'stick' electrode is covered with an extruded coating of flux. The heat of the arc melts the flux which generates a gaseous shield to keep air away from the molten pool and also flux ingredients react with unwanted impurities such as surface oxides, creating a slag which floats to the surface of the weld pool. This forms a crust which protects the weld while it is cooling. When the weld is cold the slag is chipped off.

Drillng

Drilling is a cutting process that uses a drill bit to cut or enlarge a hole of circular cross-section in solid materials. The drill bit is a rotary cutting tool, often multipoint. The bit is pressed against the work piece and rotated at rates from hundreds to thousands of revolutions per minute. This forces the cutting edge against the work piece, cutting off chips (sward) from the hole as it is drilled.



Operation

The geometry of the common twist drill tool (called drill bit) is complex; it has straight cutting teeth at the bottom – these teeth do most of the metal cutting, and it has curved cutting teeth along its cylindrical surface. The

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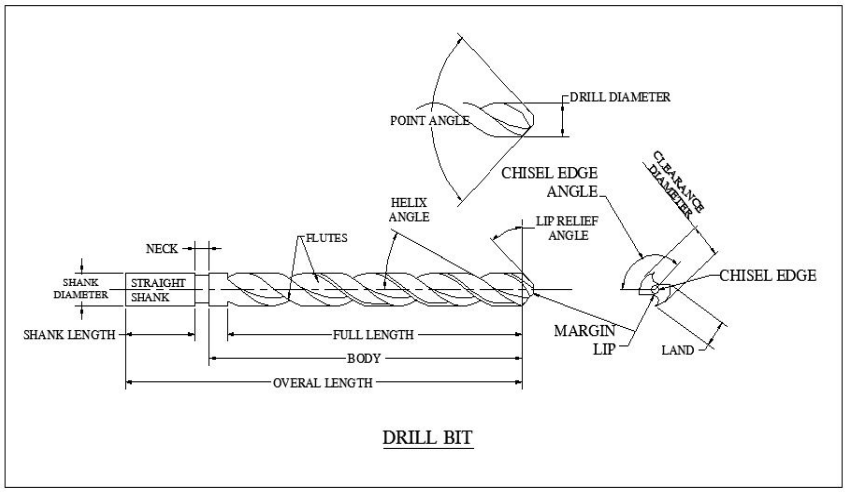
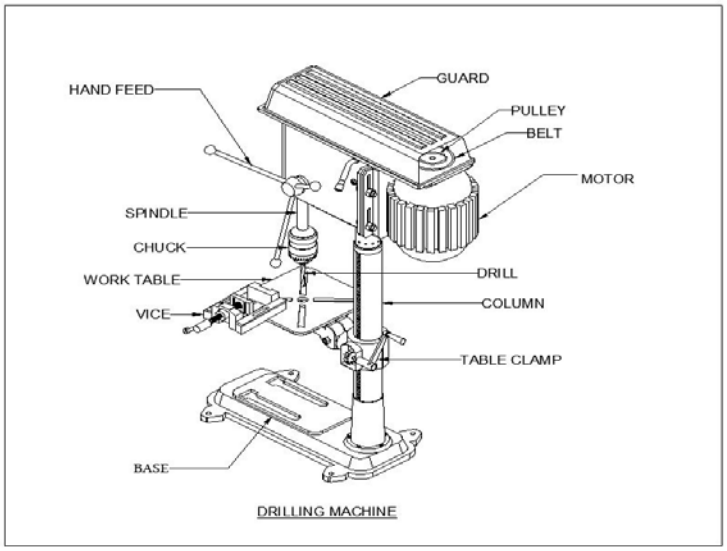
grooves created by the helical teeth are called flutes, and are useful in pushing the chips out from the hole as it is being machined. Clearly, the velocity of the tip of the drill is zero, and so this region of the tool cannot do much cutting. Therefore it is common to machine a small hole in the material, called a center-hole, before utilizing the drill. Center-holes are made by special drills called center-drills; they also provide a good way for the drill bit to get aligned with the location of the center of the hole. There are hundreds of different types of drill shapes and sizes; here, we will only restrict ourselves to some general facts about drills.



DRILL BIT

Common drill bit materials include hardened steel (High Speed Steel, Titanium Nitride coated steel); for cutting harder materials, drills with hard inserts, e.g. carbide or CBN inserts, are used;

In general, drills for cutting softer materials have smaller point angle, while those for cutting hard and brittle materials have larger point angle; If the Length/Diameter ratio of the hole to be machined is large, then we need a special guiding support for the drill, which itself has to be very long; such operations are called gun-drilling. This process is used for holes with diameter of few mm or more, and L/D ratio up to 300. These are used for making barrels of guns;



DRILLING MACHINE

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Drilling is not useful for very small diameter holes (e.g. < 0.5 mm), since the tool may break and get stuck in the work piece; - Usually, the size of the hole made by a drill is slightly larger than the measured diameter of the drill – this is mainly because of vibration of the tool spindle as it rotates, possible misalignment of the drill with the spindle axis, and some other factors; For tight dimension control on hole diameter, we first drill a hole that is slightly smaller than required size (e.g. 0.25 mm smaller), and then use a special Type of drill called a reamer. Reaming has very low material removal rate, low depth of cut, but gives good dimension accuracy.

VIII. DETAILS OF COMPONENTS USED COMPONENTS

- Dc motor
- Scissor lift mechanism
- Pneumatic cylinder
- Hand lever solenoid valve
- Lead screw
- Paint sprayer
- Base frame

Dc Motor

The electrical motor is an instrument, which converts electrical energy into mechanical energy. According to faraday's law of Electromagnetic induction, when a current carrying conductor is placed in a magnetic field, it experiences a mechanical force whose direction is given by Fleming's left hand rule. Constructional a dc generator and a dc motor are identical. The same dc machine can be used as a generator or as a motor. When a generator is in operation, it is driven mechanically and develops a voltage. The voltage is capable of sending current through the load resistance. While motor action a torque is developed. The torque can produce mechanical rotation. Motors are classified as series wound, shunt wound motors.

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Scissor Lift Mechanism

Material : mild steel

Length : 20 to 25 cm

IX. PNEUMATIC CYLINDER

Double Acting Pneumatic Cylinder

Stroke length: Cylinder stoker length 160 mm = 0.16 m

Quantity : 1

Seals : Nitride (Buna-N) Elastomer

End cones : Cast iron

Piston : EN – 8

Media : Air

Temperature : 0-80 º C

Pressure Range : 8 N/m²

Design of Piston rod:

Load due to air Pressure.

Diameter of the Piston (d) = 40 mm

Pressure acting (p) = 6 kgf/cm²

= 6 ×0.981

= 5.886 bar = 0.5886N/mm^2

Material used for rod = C 45

(data book page no 1.12)

Yield stress (σ_y) = 36 kgf/mm²

= 36×98.1

= 3531.6 bar

= 353.16N/mm^2

Factor of safety = 2(data book page.no 8.19)

Force acting on the rod (F) = Pressure x Area

= p x (Πd² / 4)

= 0.5886 x {(Π x 40²) / 4 }

F = 739.6 N

Design Stress(σ_y) = σy / F0S

= 353.16 / 2

= 176.5N/mm^2

∴d = $\sqrt{4F/\pi}$ [σy]

= $\sqrt{}$ (4×739.6)/ π[176.5]

∴ Minimum diameter of rod required for the load = 2.3 mm

We assume diameter of the rod = 15 mm

Length of piston rod:

Approach stroke = 160 mm

Length of threads = 2 x 20 = 40mm

Extra length due to front cover = 12 mm

Extra length of accommodate head = 20 mm

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Total length of the piston rod = 160 + 40 + 12 + 20

= 232 mm

By standardizing, length of the piston rod = 230 mm

Hand Lever Solenoid Valve

Valve type: 3/2 valve

Working medium: compressed air

Material: Aluminum and plastic

Lead Screw

Material: Mild steel

Diameter: 15mm

Paint Sprayer

Working medium: Compressed air.

Working type: gun type.

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X. MATERIAL: STAINLESS STEEL

Base Frame

Base frame gives sustainable place to whole setup

Material: Mild Steel

Quantity: As Per Requirement

Construction

Our proposed model "ADVANCED TWO DIMENSIOMAL SPRAY PAINTER WITH SCISSOR LIFT MECHANISM" need so many raw materials which are mentioned in above chapter.

For that materials first of all we purchased the raw materials based upon requirement and for that we've planned to how to buy. After bought we cut raw materials in required dimensions in precise manner by using hand wheel cutting machine. After that we've gone for some rough turning and finishing by using lathe and grinding machines. After that for assembly purpose we went for welding for permanent joint wherever we require and joined with rivets wherever we require rigidly fixed joints.

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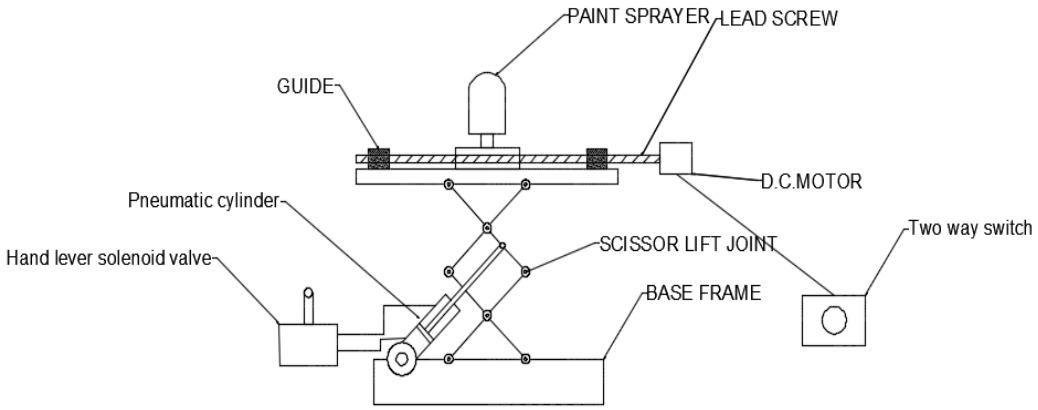
Working Principle

The system is capable of spraying the paint in two axis (X and Y axis). For Y axis control, scissor lift mechanism is used which consist of cross pairs of links which gets compressed and retracted based upon the requirement. This links occupy less space and provide high rigid structure to withstand the load. In other hand X axis is controlled by means of lead screw attachment and they are powered by means of electrical drive called DC motor, thus by powering the motor the sprayer which stores the paint moves in x direction, while the y axis movement is controlled manually.

2D Layout of the Model



XI. ADVANTAGES & APPLICATIONS

Advantages

- It is easy to operate
- The painting is done easily and takes lesser time
- The application of paint on the surface is uniform.
- It is economical
- It also eliminates the possible hazards due to the exposure to the paint spray.

Applications

- It can be used to speed and uniform painting applications.
- It can be used handling hazardous paint pigments.
- It can be used for painting outer walls of buildings, as it can easily reach the height, which is tough for a human.

XII. CONCLUSION

This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work.

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We feel that the project work is a good solution to bridge the gates between institution and industries. We are proud that we have completed the work with the limited time successfully. The "ADVANCED TWO DIMENSIONAL PAINT SPRAYER WITH SCISSOR LIFT MECHANISM" is working with satisfactory conditions. We are able to understand the difficulties in maintaining the tolerances and also quality. We have done to our ability and skill making maximum use of available facilities. In conclusion remarks of our project work, let us add a few more lines about our impression project work. Thus we have developed an "ADVANCED TWO DIMENSIONAL PAINT SPRAYER WITH SCISSOR LIFT MECHANISM" which helps to know how to achieve low cost automation. The operating procedure of this system is very simple, so any person can operate. By using more techniques, they can be modified and developed according to the applications.

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