



Synthesis of double slider mechanism used for spray painting

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Abstract

This paper aims at designing of a cost effective spray painting mechanism for consistent and even painting of large area by automatic painting using Inversion of Double slider crank mechanism. This will improve the operation efficiency thereby reducing the paint wastage.

Keywords: Scotch Yoke Mechanism, Automatic Spray-painting, slotted link mechanism,

1. Introduction: Spray Painting refers to a painting technique in which a device sprays a paint coating onto a surface. It compresses air to atomize and direct them onto a surface. Airbrushes are hand-held and used instead of a brush for detailed work such as photo retouching, painting nails or fine art. They are used for covering larger area with even coating of paint.

In manual operation, air gun is being held 15- 25 cm from the surface moving back and forth by a skilled labor, thus ensures even coating.

1.1 Objectives: As Spray machine is generally manually operated in Industries, Uneven coating and wastage of paint has been a major area of concern.

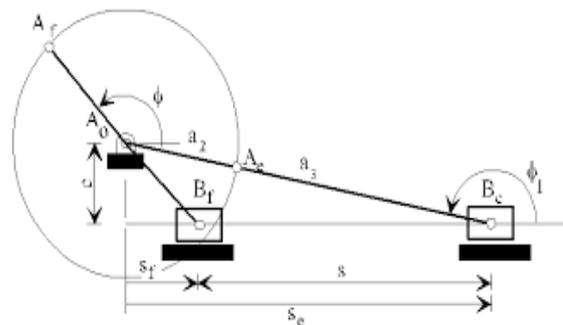
The most frequent human errors are:

1. Non-uniform hand movement.
2. Variable paint thickness.
3. Tiresome job to do.

Therefore there is a time to change the conventional methods.

2. A proposed method for Automatic spray painting.

The basic idea is employing the use of Slotted link mechanism (also called scotch Yoke mechanism) for automatic pressing of the gun trigger.



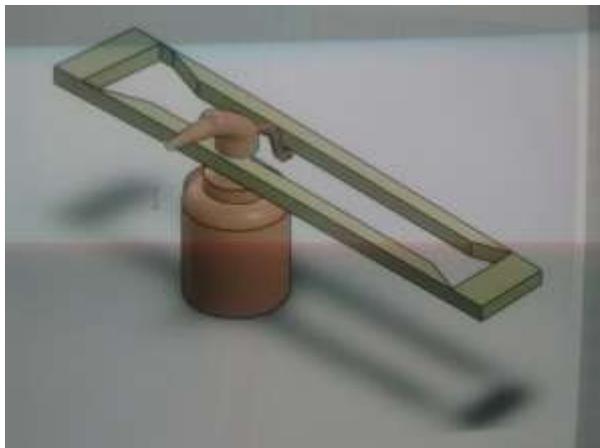
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Source:

https://ocw.metu.edu.tr/pluginfile.php/6885/mod_resource/content/1/ch7/sec2/img2.gif

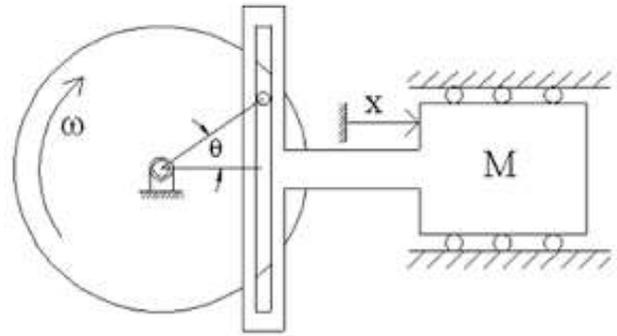
When the gun or nozzle moves inside the section, the trigger presses and depresses automatically. The trigger is at rest at the ends but as the gun moves in than due to space the trigger adjusts itself by getting pressed.

This pressing of the gun trigger results in the coming out of the spray. The intensity of paint coming out first increases and then remains constant throughout.



2.1 Scotch yoke Mechanism:

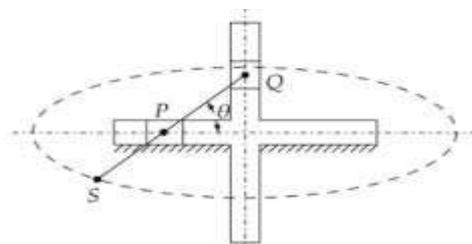
The **Scotch yoke** (also known as **slotted link mechanism**¹) is a reciprocating motion mechanism, converting the linear motion of a slider into rotational motion, or vice versa. The piston or other reciprocating part is directly coupled to a sliding yoke with a slot that engages a pin on the rotating part. The location of the piston versus time is a sine wave of constant amplitude, and constant frequency given a constant rotational speed. This setup is most commonly used in control valve actuators in high-pressure oil and gas pipelines.



Source: https://www.researchgate.net/profile/Minho_Hwang/publication/311753497/figure/fig8/AS:850390295777280@1579760254118/Scotch-yoke-mechanism.ppm.

2.2 Design of Scotch Yoke Mechanism.

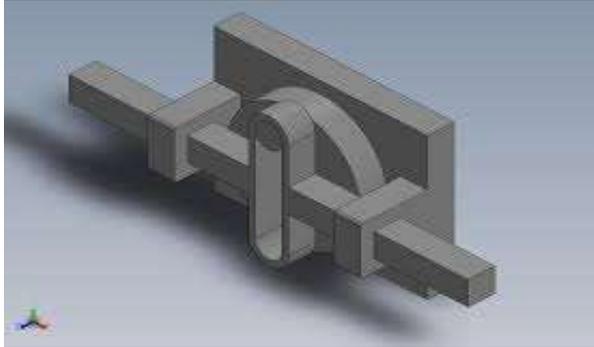
With variety of applications, the double slider crank mechanism is used in Industries. One of those applications is Scotch Yoke mechanism. The working principle of scotch yoke mechanism is to convert the rotary motion into the reciprocating motion. This is the inversion of the double slider crank chain mechanism. In elliptical trammel if any side block is fixed the scotch yoke mechanism is produced. The fixing of the block helps in the reciprocating action.



Source: https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcQqGs4cZo4_Na1uexSIDy6S1re6SBsz-gd0MQ&usqp=CAU.

Result obtained from CATIA shows slight discrepancies from the actual Mathematical calculation of Scotch Yoke mechanism.

Advantages of using CATIA for modeling provide easy access modeling and user friendly options. While performing the simulation, It allows dynamic movement of the system components (Cylinder extension, length of connecting rod etc.)



3. Materials used:

1. **Wood:** The selection of the type of wood was a major challenge for the construction of main frame. As the wood is a multifaceted and non homogeneous biological material, it influence the cutting operations. Keeping in mind the machining operation, cutting tool and other parameters, **Swartzia Madagascariensis (ironwood)** is used.



Source:

<https://i.ebayimg.com/images/g/x51AAOSwT5xZQKXA/s-1300.jpg>

2. **Painting Gun:** In finishing any component the most efficient combination of spray gun movements must be carefully planned in order to

produce the best results. . The spray gun stroke, or pass, is made by Fig 1a moving the gun parallel to the work and perpendicular (at right angles) to the surface. The distance from the gun to the work, for Conventional Air Atomizing guns, should normally be between 6 and 8 inches. Spraying should be carried out with straight uniform strokes moving across the surface in such a way that the spray pattern overlaps the previous stroke by a minimum of 50%. While this percentage may need to be increased for certain coating types, once established, it must remain constant for the duration of the work. Failure to do so will result in uneven coating thickness and poor visual appearance. . If the gun is held too close to the work surface, more paint will be deposited and the gun will need to be moved faster to prevent runs and sags and possible solvent entrapment. Likewise, if the gun is held too far from the work, the atomized droplets may dry completely before coming into contact with the surface.



Source:

<https://www.spraydirect.co.uk/acatalog/graco-airpro-conventional-pressure-feed-air-spray-gun-1,4mm-1000.jpg>.

3. **Aluminum Strips:** The thickness of this strip may vary depending upon the dimension of our main frame.

4. Ball Bearings: A ball bearing is a type of [rolling-element bearing](#) that uses [balls](#) to maintain the separation between the [bearing races](#).

The purpose of a ball bearing is to reduce rotational friction and support [radial](#) and [axial](#) loads. It achieves this by using at least two races to contain the balls and transmit the loads through the balls. In most applications, one race is stationary and the other is attached to the rotating assembly (e.g., a hub or shaft). As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling they have a much lower [coefficient of friction](#) than if two flat surfaces were sliding against each other.



Source:

<https://3.imimg.com/data3/TR/NW/MY-8556362/nmb-miniature-bearing-250x250.jpg>

5. Nuts and Bolts: A nut and bolt is a type of [fastener](#) with a [threaded](#) hole. We have used [hexagonal](#) nut and bolt pair, for similar reasons as the bolt head - 6 sides give a good granularity of angles for a tool to approach from (good in tight spots), but more (and smaller) corners would be vulnerable to being rounded off because it takes only 1/6th of a rotation to obtain the next side of the hexagon and grip is optimal.



Source:

https://www.collinsdictionary.com/images/full/nutsandbolts_513108736_1000.jpg

4. Fabrication and Manufacturing:

A hole is drilled on the wooden disc taken and bearing is fixed inside it. A rod was then inserted into the hole so as to behave as handle for rotation. This was covered by the elliptical cavity and joined by aluminum strips on both the ends. The gun was mounted by using nut and bolt so as to adjust if needed.

Finally, the trigger of the gun was connected to the mechanism with the help of ball bearing.

5. Result: The efficiency of this automated system is greater than the manually operated system and the difference can be noted.

6. Conclusion:

The efficiency is increased with the help of automation. The need of skilled operator is eliminated. It decreases the paint consumption thereby reducing wastage, thus profit margin is increased. This system can be integrated with minimum charges with the existing system.

7. Reference:

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