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RESEARCH ARTICLE OPEN ACCESS

Automotive Spray Gun Technologies

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ABSTRACT
Automotive spray guns are the fundamental tools for automotive painting. They are necessary for all types of automotive coating which consider liquid based paints. In this article we will discuss the types of spray guns, applications, and advanced technology in spray guns.
Keywords **–** Spray guns, operation, selection criteria, best practice, advanced technology, parts.

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I. INTRODUCTION

The central elements in automotive finishing tasks are spray guns. Air pressure is used in spray guns in order to spread the paint on a certain surface. Any type of substrates or surfaces can be painted using these guns. In 1888 spray guns were invented in USA and then continuous developments have been added to optimize their performance, capacity, cost and environmental effect.

1.1 Advantages of spray guns given below

-Various types of surfaces can be painted effectively
-Allowing paint to be uniformly applied on the surface
-Process cost and time can be saved
-Can be used for either manual or automated use
-Applications diversity

In this article we are going to shed the light on the spry guns' principles and several types of automotive spray guns, operation, process best practice, criteria for selecting the appropriate spray gun and advanced technology in spray guns. The importance of this article lies in distinguishing various types of spray guns for the various applications and various paints' types in addition to the advanced technology in using spray guns which takes into consideration reduction in paint wastes, air pressure, environmental impact and optimum transfer efficiency.

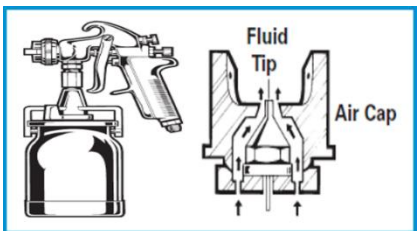
II. PRINCIPLES OF AIR SPRAY

The simplest method of automotive coating is spray application where a specific volume of coating material is used to cover surfaces or intricate shapes. It is easy to obtain a smooth finish by giving uniform film thickness.

In order to apply the paint in to the surface compressed air is used through the gun in order to atomize the paint. At the cap of the gun air and paint are mixed together in a controlled way after entering the gun through separate passages. The spray guns are classified in two ways the paint feed system and the location of paint container.

2.1 Suction feed gun

Figure (1) shows the suction feed system where the cup is attached below the gun and the paint is drawn by means of suction to the gun. This type of guns is suitable for small quantities of paint and many color changes. It is identified by the extending fluid tip beyond the face of the air cap.



"Fig.1" Suction feed gun

2.2 Gravity feed gun

Figure (2) shows the Gravity feed system where the cup is attached at the top of the gun. Gravity carries the paint down.

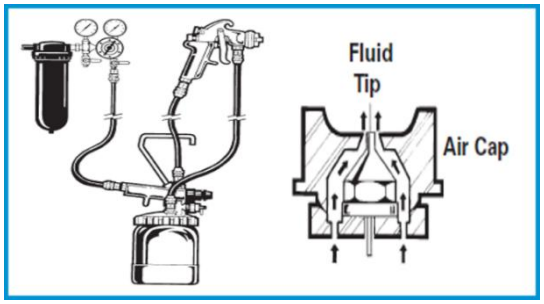
"Fig.2" Gravity feed gun

The paint is held in the cup and then released into the chamber of the spray gun below. The blended paint with pressurized air is released and atomized. This gun is much easier to handle and excellent choice for vehicle restoration.

For detail finishing and small applications gravity feed is considered ideal as they require less air pressure and have less overspray.

2.3 Pressure feed gun

Figure (3) shows positive pressure feed system where the container is positioned some distance away from the spray gun.



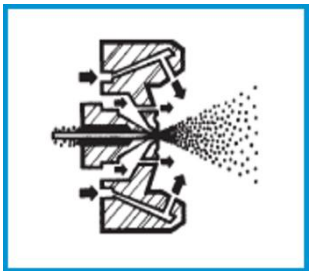
"Fig.3" Pressure feed gun

When large quantities of paint need to be applied and fast application is required pressure feed system is considered ideal.

III. INTERNAL AND EXTERNAL MIX GUNS

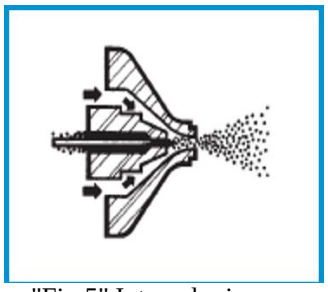
3.1 External mix gun - Internal mix gun

Outside the air cap fluid and air mixes and atomizes in the external mix gun shown in figure (4). It can be used for all types of paints and for fast drying and high-quality finishes.



"Fig.4" External mix gun

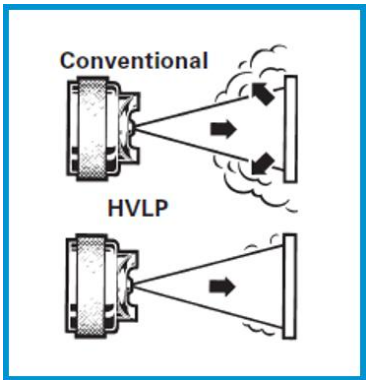
In internal mix gun paint and air are mixed inside the air cap as shown in figure (5). When low paint volumes and low pressure are available or slow-drying paints are being sprayed internal mix gun can be used. It is a good choice when a high-quality finish is required or spraying fast-drying paints.



"Fig.5" Internal mix gun

3.2 HVLP (High-Volume/Low-Pressure)

This system delivers the paint at low pressure less than 10 psi and a high volume of paint between 15-22 CFM where paint is atomized into low speed and soft pattern and less lost paint in overspray. HVLP delivers higher transfer efficiency than higher pressure systems.



"Fig.6" Conventional vs HVLP overspray

Due to its high transfer efficiency HVLP is environmentally acceptable.

3.3 Parts of Spray gun

The spray gun consists of the following parts:

3.3.1 Flow regulator

This part controls the quantity of paint to be sprayed through the nozzle and therefore controls the shape of the paint jet. It is located in the trigger or handle. The worst practice in using the regulator is when the operator tightens the flow regulator a lot this exerts a very high pressure on the trigger causing deformation in the flow regulator which in turns generates drips. Adjusting the flow from an external source is better such as the restrictor or fluid regulator and not the gun.

3.3.2 Air head

The most important part in the gun is the air head. It is highly affecting the quantity and the quality of the paint. The mixture of the paint and air can occur internally or externally.

3.3.3 Nozzle

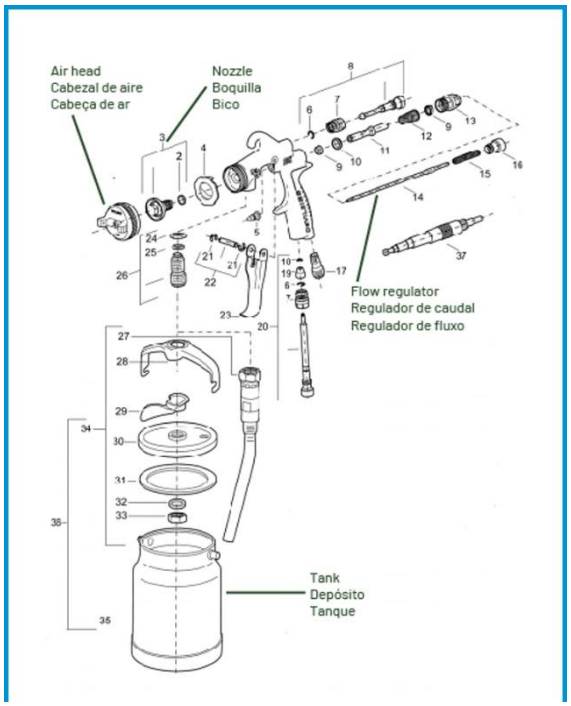
This part expels the paint where several interchangeable nozzles are used for the spray gun to

enable the operator to choose the appropriate one to use. The most common types of nozzles are:

- Airless
- Airless Air Assisted
- Low Pressure Aspersion
- Electrostatic

3.3.4Tank

The spray gun parts are shown in figure (7) below:



"Fig.7" Spray gun parts

IV. AIRLESS SPRAY GUN

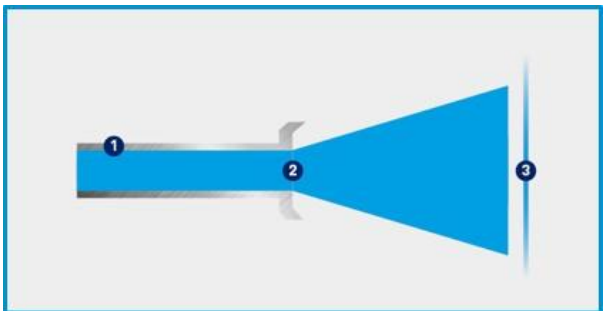
This system uses high pressure to push the paint out. In spite of the compressed air used to force out the paint, paint is not mixed with the air at any time during the spraying process. The piston creates the pressure in airless systems and compresses the paint when passing through a very small craft. The flat finishing pattern is obtained when the paint after that passes through a hole of oblique or longitudinal shape. This in turns avoids paint over-spray. In high viscosity paints which require high power this system is considered ideal. The operation of diaphragm or piston airless paint pumps can be done pneumatically or electrically. Because airless systems save paint and cover more in each application, they are considered ideal for large surfaces painting in a short time. The airless air assisted technology is similar to airless but air is sued to soften the paint pattern which passes through a very small nozzle when generated by the pump. Adjusting the pump pressure relative to the gun's nozzle correctly is very important in these systems.

Advantages of airless spray guns:

No matter of the amount of solids present in the paint, airless spray guns provide economical and easy way of applying coatings. The key reasons for using airless spray guns are given below:

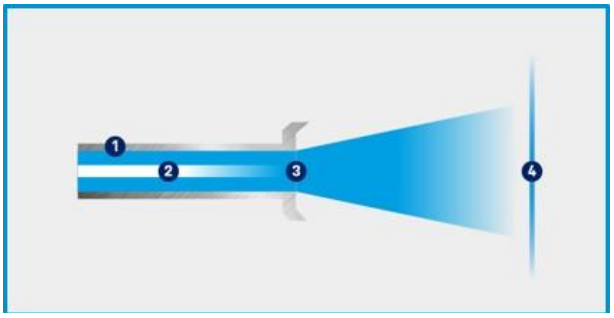
1. Quality: a high-quality finish can be obtained by applying even coat of paint on all types of surfaces.
2. Flexibility: Wide range of coating materials can be used with airless spray guns for both exterior and interior jobs with the ease of transporting from site to site.
3. Speed: airless spray guns complete the job in less time economically.

The spray atomization in the airless spray is shown in figure (8), where (1) fluid tube, (2) fluid and (3) surface.



"Fig.8" Airless spray atomization

The spray atomization in the air assisted spray is shown in figure (9), where (1) fluid tube, (2) compressed air, (3) fluid and (4) surface



"Fig.9" Air assisted spray atomization

V. ELECTROSTATIC SPRAYING

Paint particles are charged by the electrostatic sprayers when pass through the electrode in order to produce higher transfer efficiency.

The paint is electrostatically charged when it passes through the electrostatic field generated between the grounded object and the electrode on the front of the gun. Even coating is resulted from attracting paint charged particles to the grounded object.

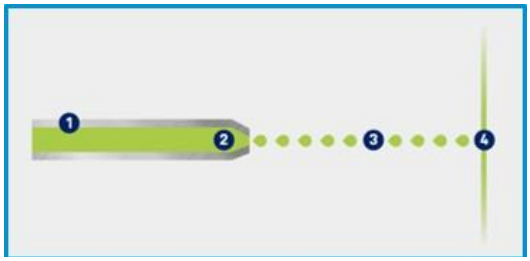
Advantages of electrostatic spray guns:

Electrostatic spray guns possess high transfer efficiency which saves money and time, less VOCs (Volatile Organic Compounds), faster production, less cleanup and excellent finish quality.

1. Solvent borne coatings: They include low to high solid coatings, two-component coatings, lacquers, enamels can be all trusted to provide durable finishes. Air spray electrostatic gun or air assisted airless electrostatic gun can be used for these coatings.

2. The wraparound effect: When the paint is charged electrostatically as it passes through the electrostatic field, the grounded (neutral) surface attracts the charged particles to form even coating. The charged paint then wraps itself around the object in order to increase the coated surface space. The efficiency of paint wrapping around the surface is determined by the following parameters:
- Spray gun voltage potential
- Ground efficiency
- Coating polarity
- Velocity of air in the spray booth

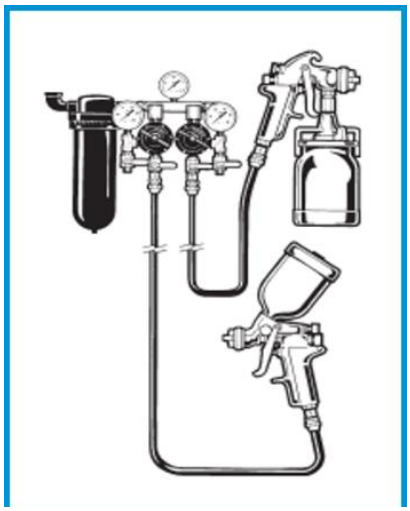
3. Coating resistivity: Coating resistivity is important to determine the correct coating. A paint probe is used to measure coating resistivity in megohms per centimeter of resistance. Coating resistivity between 25 and 50 megohms per centimeter reflects the best electrostatic results achieved.
Getting the paint formulated from the manufacturer for electrostatic use is typically the best solution
Electrostatic spraying is shown in figure (10) where (1) fluid tube (2) high voltage DC to fluid (3) charged fluid (4) grounded surface



"Fig.10" Electrostatic spraying

VI. OPERATION

For the Suction and Gravity Feed Equipment Hook-Up, the air supply must be connected from compressor outlet to the inlet of the air filter regulator. The air supply hose must be connected from the regulator outlet to the spray gun air inlet. Attach the cup to the gun after the paint being mixed and strained into the cup as shown in figure (11).


"Fig.11" Suction feed and Gravity feed system connection

A test pattern in horizontal position should be sprayed. The paint begins to run when holding the trigger open. The paint distribution across the pattern full width should be even. If there is a problem in the fluid tip or air cap, the paint distribution will be not even.

Begin spraying after rotating the air cap back to a normal spraying position if the pattern resulted from the test seams normal. Air pressure set at approximately 30 psi if the fluid adjusting screw opened to the first thread, on clean paper few passes can be made with the gun. Air pressure can be increased slightly in case of improper paint atomizing and another test pass can be made. Rechecking air pressure and paint viscosity are required in case of screw is widely opened and the pattern seems starved for paint, the paint may be too heavy or the pressure is too high. The fluid adjusting screw should be turned clockwise to reduce paint flow in case of paint spraying too heavily.

VII. BEST PRACTICE

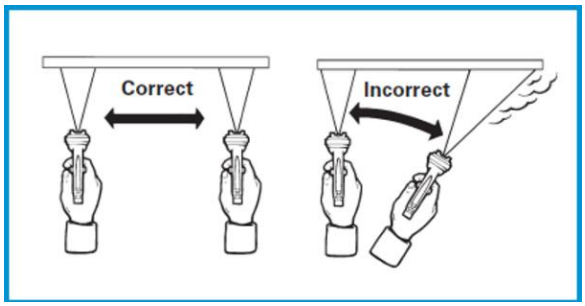
For HVLP guns must held 6" to 8" or 8"-10" for gravity and suction feed guns perpendicular to the surface being sprayed. Sags and runs are caused from uneven paint build due to tilting the gun in any direction.

Before spraying the surface edge, the gun must be triggered fully depressed and moving should be in continuous motion until reaching the other edge. The trigger should be released but keeping continuous motion for few inches until reversing for the return stroke.

Maintaining 50% overlapping in each stroke is important as streaks will appear on the finished surface when overlapping is less than 50%. As the

paint flows at a constant rate constant speed of the gun motion must be kept.

Correct and incorrect spray techniques are shown in figure (12).



"Fig.12" Correct and incorrect spray techniques

7.1 Selection criteria for appropriate spray gun

There are various variables that control choosing criteria of spray gun as follows:

7.1.1. Application

The objective of use is the most important factor in selecting the appropriate gun.

The following questions should be asked before selection:

a. What kind of paint will be used?

b. Will it be used by operators or an automated system?

c. On what surfaces will the paint be applied?

d. Whether the spray will be performed externally or internally inside a booth.

7.1.2 Frequency of use

Spray guns are made with different capacities and using the guns for several hours a day will affect the gun performance in the long run. The tank capacity plays an important role in this regard.

7.1.3 Price

The spray gun price is not a dominant factor but should be taken into consideration in industrial economic wise.

7.1.4 Equipment and accessories needed

Equipment and accessories need are important as well as the spry gun used such as:

- Tanks
- Compressor
- Cups
- Hoses
- Filters
- Regulators

7.2 CCM Advanced Spray Gun Technology

-Low pressure spraying of most paints
-High quality finish for auto applications
-Easily clean design
-Suitable for application of Nano coatings
-Saving approximately 30% of the paint
-Significantly reduced maintenance costs
-Reduced diffusion of particles into the atmosphere reducing negative impact on environment

7.3 Environmental Attributes of the Technology

-Up to 95% reduction in paint particles in the atmosphere
- Significant reduction in solvents required
-Compared to standard spray guns there is 70% energy savings

"Fig.13" CCM advanced spray gun technology

7.4 Advantages of The Low Energy Spray Gun

-Emissions reduced below EPA limits
-Transfer Efficiency 85%
-Spray 70% solids at 10psi
-Lower electrical and air costs
-Extraction filter longer life
-Meets and better EPA BAT notification
-Safer applications of Nano paints
-Engineering control safety factor
-6 - 9 Months use of spray tip
-Spray gun maintenance < 3 min
-Micro spray fan adjustment
-Reduced carbon footprint
-60% Waste reduction
-Air cap and needle suit all spray tips

VIII. CONCLUSION

Automotive spray guns are the core elements of automotive coating. Several types of guns are used in coating based on the type of application, frequency of use, price and equipment and accessories. The types of spray guns provide

flexibility of selection to the user where the quantity of paint, air pressure required, uniformity of the paint, environmental impact and process economy are important keys.

The main four parts in most of the spray guns are the nozzle, the flow regulator, the tank and air head. All types of spray guns operate with the aid of compressed air but in different ways.

Advanced technology in spray guns implied low air pressure usage, high quality finish, suitable for Nano coating, reduced diffusion of particles in atmosphere up to 95% which is very important to keep clean environment. In addition to all mentioned advantages, there is transfer efficiency up to 85% and up to 60% reduction in wastes.

Performing the best practice in automotive painting in terms of distance from the gun to the surface, perpendicular spraying and keeping spray overlapping amount is very important to achieve good results.

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