CONVENTIONAL AIRSPRAY

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Principles of Compressed Air

To understand conventional air spray painting, it is first necessary to understand some principles of compressed air. When air is compressed, it can become a powerful energy source when it is released in a controlled manner. When it is released, compressed air rapidly expands back to its natural state. This explosive action can be harnessed to move pistons and other mechanisms. In spray painting, the compressed air is released by the spray gun where the expanding action atomizes the paint and carries it to the surface to be painted. All air is under pressure. The air pressure at sea level is 14 pounds per square inch (psi). By comparison, air compressors, can increase this pressure to 100 psi or more to power spray painting equipment.

Compressed Air in Spray Painting

In conventional air spray painting, it is necessary to maintain compressed air at a specific pressure and volume. Air volume is measured in cubic feet per minute (cfm). Spray paint pressure tanks, air caps, spray guns and other spray painting equipment are all designed to operate under specific ranges of air pressure and air volume.

Air pressure and air volume are directly related to each other. Air compressors are rated by the volume of air (cfm) they can deliver. Air pressure is the driving force in conventional spray painting. Air pressure may be regulated, that is raised or lowered, by adjusting the regulator on the compressor.

It is most important to maintain proper air pressure at the gun to properly atomize and spray the paint. If the volume of air being compressed and delivered drops, the pressure of the air at the point of use will drop. As the compressed air is released at the spray gun, there must be an adequate supply of compressed air to replace it or the pressure will drop. Therefore, effective high production spray painting, requires selecting an air compressor that produces more than the total pressure and volume of air needed.

The Air Compressor

The air compressor is the power source for conventional air spray. It must be one that meets or exceeds the air requirements necessary for atomizing the coating. The key to successful conventional air spraying is adequate air pressure and volume of air. An inadequate supply of air will cut production rates and may cause the gun to operate improperly.

The spray painter should be familiar with the workings, possible problems, and maintenance procedures for the air compressor because it is very important to the total operation of a conventional spray painting system. Although the spray painter may do little more than turn the switch on and off and perform routine maintenance, the more that is understood about the proper operation of the compressor, the more trouble-free the spray painting work will be.

Double-Regulated and Single-Regulated Pressure Tanks

For production and for maximum control, a double-regulated pressure tank should be used. As Figure 1-9 shows, the basic parts of a double-regulated pressure tank are:

(A) clamp-on lid
(B) fluid supply hose
(C) pressure regulators
(D) pressure gauges
(E) safety relief valve
(F) gasket
(G) agitator
(H) material pick up tube
(I) air supply hose

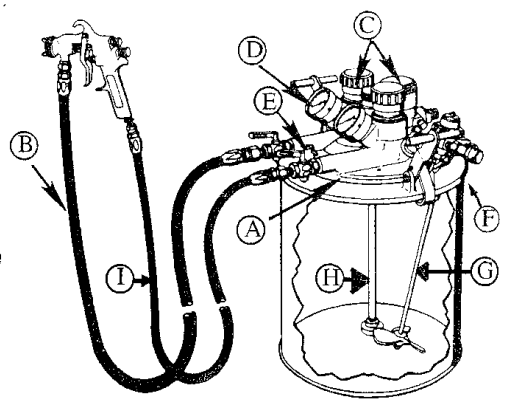


Figure 1-9—*Double-Regulated Pressure Feed Paint Tank*

One regulator adjusts the air pressure going into the tank, which controls the rate at which the paint will flow out to the gun. The other regulator adjusts the atomizing air pressure delivered to the spray gun. The greater the air pressure on the contents inside the paint tank, the faster the paint will flow from the tank into the fluid hose.

On tanks that have only one regulator, or single-regulated tanks, the spray painter can add an atomizing air adjusting valve on the air inlet of the spray gun. Single regulators on the paint tank control the air to the tank, not to the spray gun.

Use of Pressure Tanks

Controlling pressure is one of the most important adjustments the operator must make. The lowest possible operating pressure should always be used. Higher air pressures will waste paint because of increased fogging and overspray. Excess pressure can also cause defects in sprayed finishes.

Pressure tanks are constructed of steel and must meet nationally accepted standards for pressurized vessels. This means they must be capable of safely holding one and a half times as much pressure as the working limits established for the tank.

Gaskets are an integral part of pressurized systems. A gasket is compressed by the lid, sealing pressure inside the tank. Gasket material is chemically compatible with the paint or solvent.

INTRODUCTION

The spray gun is a precision instrument engineered to deliver paint and atomized air to the gun nozzle, producing an effective pattern of atomized paint.

TECHNICAL INFORMATION

Parts of a Conventional Air Spray Gun

Figure 2-1 illustrates the basic parts of a conventional air spray gun. Each of the parts has a specific purpose:

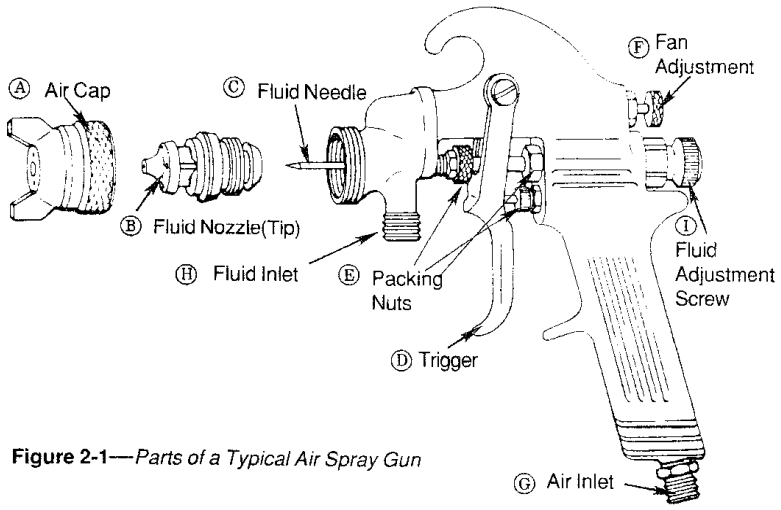


Figure 2-1—*Parts of a Typical Air Spray Gun*

(A)Air Cap: Directs the jets of compressed air into the stream of paint coming out of the fluid tip. The cap will be either an internal or external mix. The one shown in Figure 2-1 is an external mix air cap, meaning that the air mixes with the paint after it leaves the gun.

(B)Fluid Nozzle (Tip): Controls the amount of paint released from the gun. As the paint leaves the fluid tip of the gun it meets the jets of air from the air cap.

(C) Fluid Needle: Acts as a starting and stopping valve for the flow of the paint.

(D) Trigger: Operates the air valve and the fluid needle.

(E)Packing Nuts: Prevents fluid leakage.

(F) Fan Adjustment Valve or Air Adjusting Screw: Controls the air supply to the air cap and determines the size and shape of the spray pattern.

(G) Air Inlet: Connects to the air hose.

(H) Fluid Inlet: Connects to the material hose.

(I) Fluid Adjustment Screw: Controls the travel of the fluid needle to allow more or less material through the fluid tip.

Fan Adjustment Valve

The size and shape of the spray pattern formed by the gun is determined by adjusting the fan adjustment valve shown in Figure 2-2. This valve controls the flow of air to the holes in the extended points or horns of the air cap. These holes in the air cap are known as the horn holes.

If the fan adjustment valve is closed, the spray pattern will be a small circle. As the valve is opened by turning the screw at the back of the gun, jets of air will be directed at opposite sides of the circular pattern, changing it to an oval or fan shape.

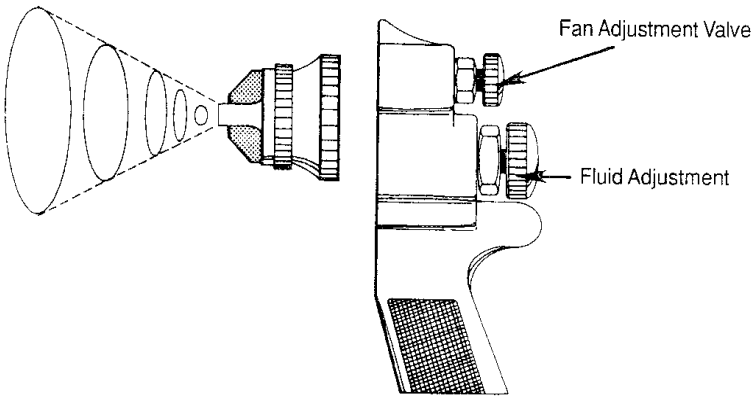


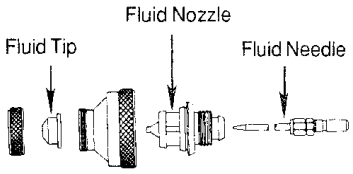
Figure 2-2—*Typical Spray Gun Control for Adjustment of Spray Pattern*

The Fluid Tip and Needle

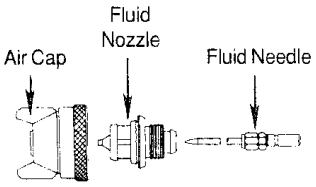
Figure 2-3 shows the design of the fluid tip or nozzle and fluid needle used to control the paint flow through both the external and internal mix air cap types of spray guns.

When the trigger is pulled, the needle is drawn out of the fluid nozzle and the paint is allowed to flow to the air cap. When the trigger is released, the needle seats itself in the fluid nozzle, stopping the flow of paint. Fluid needles and fluid nozzles come in a number of matching sizes, measured by the size of the orifice, or opening, through which the paint flows. The fluid nozzle and the needle must always match each other in size, so that the needle will fit tightly into the tip to shut off the flow of paint when the trigger is released.

Adjustments of the flow rate can be made by either increasing or decreasing the air pressure to the paint tank or by changing to another size fluid tip and needle. The fluid adjustment valve can also be used to regulate the paint flow.



Internal Mix Air Cap



External Mix Air Cap

Figure 2-3—*Basic Types of Fluid Tip and Needle Designs*

The fluid tip and needle are chosen according to the viscosity of the paint and the desired rate of flow. Manufacturers provide charts to guide spray painters to choose the correct fluid tip and needle size.

Figure 2-4 shows the general range of fluid tip sizes and operating pressures used in spraying different types of paint and coating materials. The most accurate way to determine the best fluid tip or nozzle size and matching operating pressures to use for spraying is to refer to the technical manuals provided by the equipment and material manufacturer.

Air Caps

Air caps and fluid tips can be changed on the spray gun. The air cap fits over the fluid tip and is connected to the gun by a threaded ring. The spray painter chooses the air cap and fluid tips according to the type of paint being used and the application rate desired. There are external and internal mix air caps that can be used on the same gun body. The spray pattern can be changed by rotating the position of the air cap. A horizontal spray pattern is created by turning the air cap to an "up-and-down" or vertical position. A vertical spray pattern is created by turning the air cap to a "side-to-side" or horizontal position. Although it may sound strange, the position of an air cap will create a spray pattern that is opposite of the actual air cap position (Figure 2-5).

CONVENTIONAL AIR SPRAY

Types of Coating Materials	Fluid Pressure (in psi)	Atomizing Air Pressure (in psi)	Fluid Nozzle Size (in inches)	Air Cap Volume (in cfm at 50 psi)
Acrylics	5—10	50—60	.040—.052	14—16
Alkyds	25—30	30—40	.070—.086	12—14
Chlorinated Rubber	8—12	50—65	.070—.078	12—14
Coal Tar Epoxies	80—100	70—90	.187—.375	16—20
Epoxies	20—30	50—70	.059—.070	12—14
Epoxy-Esters	25—30	30—40	.070—.086	12—14
Neoprene & Hypalon	10—20	50—70	.046—.070	12—14
Phenolics	25—30	30—40	.070—.086	12—14
Phenolics Catalysed	20—30	50—70	.059—.070	12—14
Polyesters	40—70	20—40	.086—.110	14—16
Polyurethanes	10—25	30—50	.040—.052	12—14
Silicones	10—20	40—70	.040—.052	13—15
Vinyls	15—25	60—90	.059—.030	14—16
Water-Based Coatings	15—30	30—45	.070—.086	14—15
Zinc-rich Coatings	15—25	40—60	.070—.086	15—18

Figure 2-4—*Range of Pressures and Gun Nozzle Sizes for Spraying Common Coating Materials*

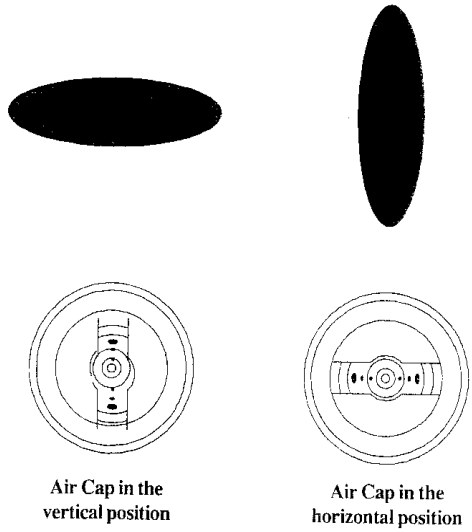


Figure 2-5—*Air Cap Position and Pattern Shapes*

Atomization in the External Mix Air Cap

External mixing means that the compressed air and paint are mixed as they are sprayed from the air cap and fluid tip.

The external mix air cap can be identified by the protruding sides, called horns, wings, or ears that extend from the air cap. A number of small orifices are found in the air horns, in addition to holes found in the face of the air cap. Figure 2-6 shows the basic design of the air cap and illustrates how the mixing of paint and air occurs.

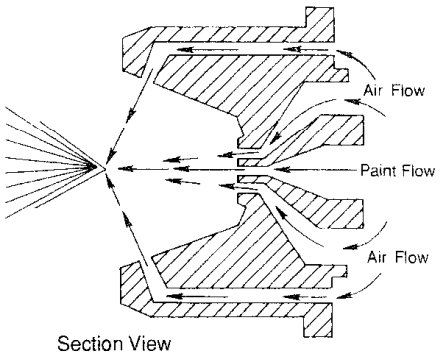


Figure 2-6—*Illustration of an External Mix Air Cap*

In general, the air from the orifices in the face of the air cap, or in some cases the circular opening around the fluid tip, partially atomizes the paint and drives it toward the surface to be painted. The air from the horn holes completes the atomization and shapes the spray pattern. To form a perfect spray pattern, equal amounts of air must be expelled from each of these orifices. A clogged or partly blocked orifice will distort the pattern. Figure 2-7 shows how these various orifices may be arranged on a typical external mix air cap.

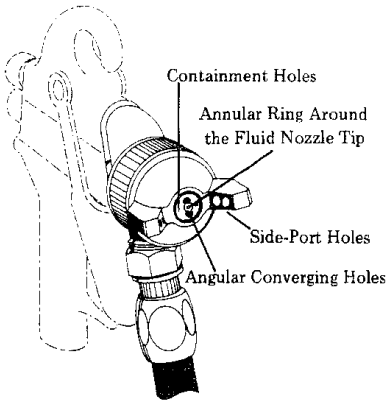


Figure 2-7—*Illustration of Orifices in an External Mix Air Cap*

The external mix nozzle can produce a finer mist than the internal mix nozzle. It can be used with fast drying paints because there is little chance of the paint drying before it is released from the gun.

Gravity Feed Cup Gun

Gravity feed spray guns are ideal for automotive refinishing, touch-up spraying and small batch production spraying.

Pressure Feed Cups

The pressure feed cup container is similar to a small pressure feed paint tank. The cup is usually mounted directly on the gun, but may be connected to it by hoses like a pressure feed tank. The pressure feed cup must have a lid assembly that can be sealed tightly. The lid assembly is often part of the gun itself. The cup may have single or double regulators to control the air pressure. These regulators are essential if accurate control is required. The design of a pressure feed cup spray gun is shown in Figures 2-9 A and B.

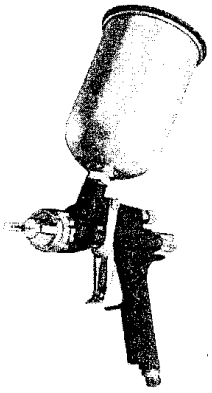


Figure 2-9A—*Gravity Feed Cup Gun*

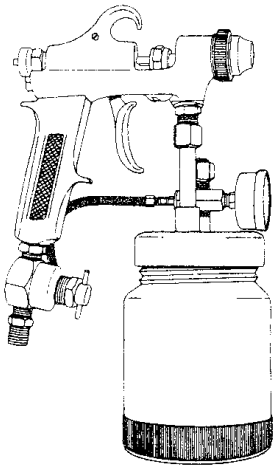


Figure 2-9B—*A Typical Pressure Feed, Internal Mix Cup Spray Gun*

Suction Feed Cups

The suction feed cup container does not receive air under pressure from the compressor. It is vented to allow air to enter from the atmosphere. When the compressed air flows through the spray gun, the paint is sucked into the gun by the vacuum created. The design of the suction feed cup spray gun is shown in Figure 2-10.

Suction feed cups are used when colors must be changed frequently and when only small amounts of paint are needed. The suction cup obviously cannot be used if the spray painter must turn the gun upside down or sideways. The cup must be held upright to keep the vents open.

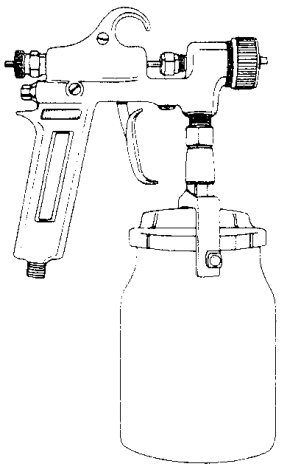


Figure 2-10—A Typical Suction Feed, External Mix Cup Spray Gun

Larger diameter hoses need a larger volume of air to maintain the pressure. One way to counteract pressure loss is to use a larger hose for most of the distance to the spray gun and add a short section, about ten feet, of a smaller ID hose at the spray gun end of the hose line. The addition of this reduced hose size at the gun is helpful in cutting down the loss of air pressure caused by long hose runs. The restriction of the air in the smaller hose after it has passed through the larger ID hose maintains air hose pressure.

Ideally, the shortest length of air hose should always be used, but this is often impossible. There are situations in which the applicator will need to use the spray gun at some distance from the paint tank.

Determining Hose Sizes

Decisions about hose size must be made according to the conditions on the job. Generally, the hose from the compressor to the pressure tank should be at least 7/16-inch ID to keep air pressure loss to a minimum between these two pieces of equipment. With production guns, a 5/16-inch atomizing air hose is often used if the length is more than twelve feet. A 1/4-inch hose might be used for smaller, low-production guns or if the length is less than twelve feet.

The size of the fluid hose is determined by the volume and pressure of material required at the gun. Production guns generally call for 5/16-inch to 3/8-inch ID fluid hose. Smaller guns often use 1/4-inch ID hose. The use of heavy materials may call for fluid hoses as large as 1/2-inch to 3/4-inch ID.

Start-Up Procedures for Pressure Tanks

When the proper size air compressor, air hoses and fluid hoses have been selected, the system is ready to be set up. With a pressure tank system the system is made ready for use as follows:

1. Attach air hose from compressor tank, or control device such as an air regulator, to air inlet on the pressure tank lid. Connect atomizing air hose and paint hose to the spray gun. Tighten all connections with a hose wrench. Do not use pliers or pipe wrenches.

2. Open the relief valve on the tank. Keep valves to tank and hose closed.

3. Fill tank or removable tank liner with paint.

4. Fasten lid to tank. Tighten clamps.

5. Close relief valve.

6. Start the compressor.

7. Open the valve to pressurize the tank.

8. Open the fan and fluid adjusting valves on the spray gun to achieve the desired pattern.

Determining Operating Pressures

At this point, the final decision must be made by the applicator as to the best pressures to be used for the job. Using the manufacturer's specifications as a guide, the operator will determine the operating pressure settings as follows:

1. Remove the air cap from the gun, exposing the fluid nozzle.

2. Bleed system of foreign material until the coating runs clean.

3. Trigger the gun and increase the fluid pressure until a stream of coating shoots out about three feet before it begins to fall into a container on the floor. Release the trigger.

4. Replace the air cap, and starting with the air and fluid adjusting valves on the gun in a closed position, slowly increase the air and fluid pressure by about five pounds at a time until you achieve the desired atomization.

5. Spray a small area of surface. If the coating seems too dry, reduce the air pressure or increase the material tank pressure until you achieve a desirable test spray pattern and finish.

INTRODUCTION

The key to successful spray painting is to master basic spray gun techniques. The correct techniques mean high quality finishes with a minimum of paint loss. Poor techniques waste paint, cause unnecessary cleanup problems, and tire the operator.

TECHNICAL INFORMATION

The applicator's goal is to produce the ideal spray pattern. The spray pattern is the shape and consistency of the spray of paint when it hits the substrate. The basic spray patterns are shown in Figure 4-1.

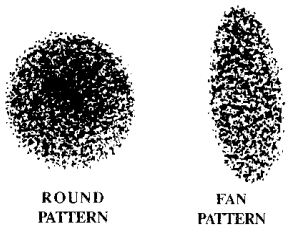


Figure 4-1—*Basic Types of Spray Patterns*

The ideal pattern is a long oval in which the paint is evenly distributed and finely feathered, with a clearly defined edge. This is the pattern which should be formed when the trigger is fully depressed. The trigger should be thought of as an on/off switch and should not be used to control the spray pattern.

Adjusting Spray Pattern Shape

When an **external mix** air cap is used, the shape of the pattern is determined by the applicator's adjustments to the fan adjustment valve on the gun. This valve controls the supply of air to the air cap orifice holes. When the fan valve is only slightly open, the pattern will be a small circle. As the valve is opened, the circle becomes a longer and narrower oval shape, called a "fan." The same amount of paint is deposited no matter what shape is used but it will be more concentrated and thicker on the surface when the small round pattern is used than when the pattern is fan-shaped.

Figure 4-2—*Range of Spray Patterns*

In **internal mix** air caps, the pattern is determined by the opening in the cap. To change the spray pattern, the air cap must be changed.

Depending on the size of the spray gun, the size of the pattern generally ranges from 4 to 15 inches.

The spray pattern can be directed in either a horizontal or vertical position, depending on the needs of the painting job. The width of the spray pattern determines which direction is the best position for the job. The direction of the pattern can be changed by rotating the spray gun air cap a quarter turn. In the vertical air cap position, the spray pattern is horizontal position; in the horizontal position, the spray pattern is vertical. The comparison of the vertical and horizontal spray pattern positions are shown by the position of the air horns in Figure 4-3.

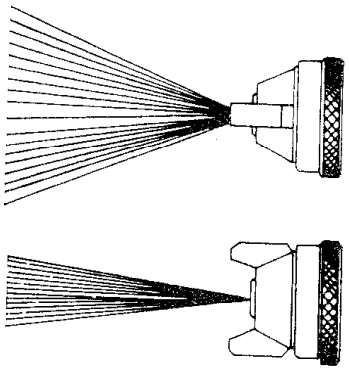


Figure 4-3—*Horizontal and Vertical Patterns and Air Cap Positions*

How to Operate the Spray Gun

To become a skilled applicator with the spray gun, there are four principal techniques that must be mastered:

1. Keeping the right distance between the gun and the substrate.
2. Holding the gun perpendicular, or at right angles, to the substrate.
3. Overlapping strokes for a smooth, streak-free finish.
4. Timing of triggering in the spray strokes.

Keeping the Right Distance Between Gun and Substrate

With experience, the applicator will learn to judge the best distance for the paint being used and the desired film coverage. The best position and distance is the one which gives the most usable spray pattern.

Holding the Gun Perpendicular to the Substrate

The gun should always be at right angles to the substrate. The stroke, or movement of the gun, is made by moving the gun parallel to the substrate as shown in Figure 4-4.

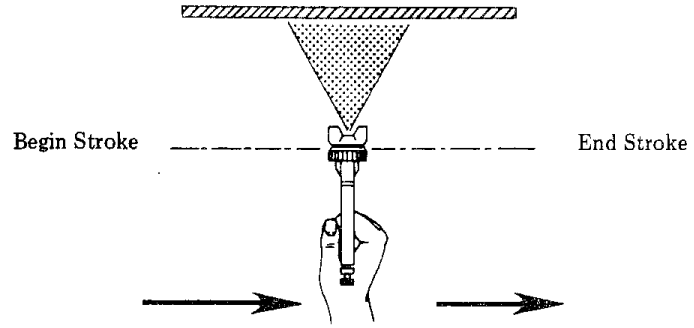


Figure 4-4—*Proper Spray Gun Distance, Motion and Perpendicular Position*

Even small changes of distance may make a difference in the spray painting finish. Thinners and solvents in the paint begin evaporating as soon as they are exposed to the air. The greater the distance the paint travels through the air, the drier it will be when it comes in contact with the painting substrate. The best pattern is produced when all spray paint droplets travel nearly the same distance.

A downward tilt of the spray gun will deposit more paint at the top of the spray pattern than at the bottom, as Figure 4-5 shows. This will cause streaks in the final paint film. Tilting also wastes paint since some of the spray droplets will bounce off the surface when they strike it at a slant.

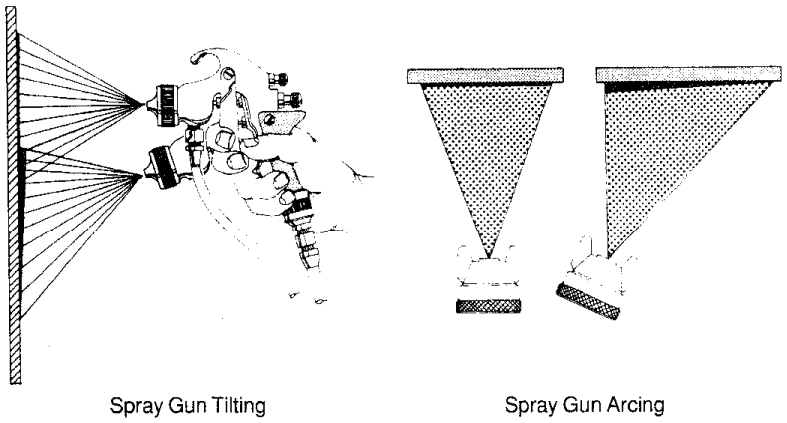


Figure 4-5—*Effects of Tilting and Arcing the Spray Gun on Paint Film*

TYPE AND DESCRIPTION OF PROBLEM	POSSIBLE CAUSE(S) OF PROBLEM
SPRAY PATTERN SHAPE PROBLEMS	
Too small pattern.	Not enough air reaching gun. Clogged air lines. Inadequate air supply from compressor. Too small fluid hose. Too small fluid tip. Fluid tip not opened wide enough. Paint to heavy. Dried paint in air cap openings. Lumps in the paint.
Heavy center pattern.	Air pressure or supply too low. Too much paint. Too narrow pattern. Paint too thick.
Heavy ends.	Dirt in air cap or fluid tip. Damaged orifice.
Dumbell pattern.	Too little paint. Too high pressure. Operator using brush-like or arcing stroke instead of spray stroke.
SPRAY GUN PERFORMANCE PROBLEMS	
Nozzle leaks.	Valve needle is dirty. Needle is not sealed tightly.
No paint flow.	Paint too thick. Clogged gun. Add blocked air vent.
Spitting gun.	Atomizing air pressure too high. Insufficient paint in tank. Air entering the fluid stream: could be caused by loose fluid tip, loose packing nut, suction feed only, or loose fluid connection.
Paint leaks from packing.	Packing nut too tight. Packing nut loose. Packing worn or dry.
Paint leaks from fluid tip.	Dry packing. Sluggish needle. Air cap and fluid tip not fitting properly. Cross threaded.

Figure 5-1—*Conventional Air Spray Problems and Their Causes*

TYPE AND DESCRIPTION OF PROBLEM	POSSIBLE CAUSE(S) OF PROBLEM
SPRAY COVERAGE PROBLEMS	
Orange peel: finish resembles the texture and appearance of an orange peel. Often found with lacquer and synthetic materials.	Improper thinner. Too high or too low atomization pressure. Gun held too far or too close to work. Gun stroked too rapidly. Fluid not thoroughly mixed or agitated. Drafts. Too low humidity for synthetics. Improperly prepared surface. Overspray hitting a previously painted area.
Streaks on finished surfaces.	Gun stroke too rapid. Gun too far from surface. Tilted gun. Improper lapping; too little overlap. Improper thinner.
Runs and sags.	Paint too thin. Too much paint. Tilted gun.
Excessive fog.	Too much air pressure. Gun held too far from surface. Gun held at improper angle. Paint too thin. Wrong fluid tip or cap.
Sandy or scratchy surface.	Overspray hitting a previously sprayed area. Air pressure too high. Gun too far from surface.
Film too thin; uneven film.	Gun too far from surface.
Too much film build with runs and sags.	Gun too close to surface.
Alligatoring Fisheyes Cratering	Improper substrate preparation. Substrate contamination.

Figure 5-2—*Conventional Air Spray Problems and Their Causes Continued*

Shutdown and Cleaning of Pressure Tank and Spray Gun

1. Close air inlet valve to the tank. Leave atomizing air to gun turned on.
2. Open relief valve on the pressure tank. This will depressurize the tank.
3. Open the tank lid carefully.
4. Remove paint from the tank. Clean the insert or interior of the tank by pouring a small amount of solvent into the container.
5. Pour enough solvent into the tank to also wash the interior of the spray gun and hose.
6. Turn air to gun off. Open air inlet valve to the tank.
7. Trigger the gun and allow the solvent to run through the gun until the solvent comes out free of paint particles.
8. Close air inlet valve to the tank. Open relief valve on the pressure tank. This will depressurize the tank.
9. Remove the air cap and fluid tip. Care should be taken whenever cleaning the fluid tip due to possible scaring or burring of the orifices, this could distort the spray pattern.
10. The air cap and fluid nozzle may be placed in a small container of solvent. Never submerge the spray gun in solvent, this could dissolve the oils in the leather packing and other lubricating oils on gun parts. Care should be taken when cleaning air cap and fluid nozzle because they are easily damaged.
11. If water based paints have been used, wipe the needle, fluid nozzle and air cap with light oil or mineral spirits.
12. Clean all threaded connections on the gun. Dried paint here could cause a loose fit when the spray gun is used again, or it could cause cross threading. Wipe the gun with a solvent-soaked cloth.
13. Reassemble the gun carefully. When reinstalling the fluid tip or fluid nozzle the gun must be triggered to avoid nozzle damage. Improperly reassembled guns will leak air and paint, and could be damaged if operated when they were improperly assembled. Always use manufacturer's equipment recommendation.