SKEM4153
ROBOT TECHNOLOGY FOR AUTOMATION

CHAPTER 4
Robotics and Spray Painting

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Robotics and Spray Painting

- The success of a painting robot installation depends on the ability of the installation engineers to eliminate those variables within the workplace to which the robot cannot adapt.
- As with other applications, part placement must be consistent time after time.
- Since the path of the robot through the entire cycle now determines quality of the finish, variations in line speed and position cannot be tolerated.
- Small variations in the spray pattern or the amount of material delivered - variations which are quickly and easily accounted for by the human operator -must be eliminated in robot operations.

Robotics and Spray Painting

- The paint itself must be consistent batch to batch and day to day. Small changes in viscosity, solids, pressures and temperature must be eliminated and maintained at the same level day after day.

- Factors such as air flow within the paint booth can cause enough of a change to render the paint job unsatisfactory. Since robot installations are usually more expensive, complex and “touchy” (more easily put out of order than other installations), the question might be “Why bother?”

- The answer is that finishing materials have dramatically increased in price. The most compelling reasons for a robot is material savings and the consistency of application.

- Most robotic installations can provide a 30 percent savings in paint use over a manual set-up.

Industrial Coating Methods

Immersion

Dipping
Electrodeposition

Flow Coating

Spray Coating

Air spray
Airless spray
Electrostatic spray

Health Hazards

Fumes and Mist in air

Toxic

Breathing problems

Noise from nozzle

loud shrill

Fire Hazards

Atomised into fine mist mixed with air causing flash fires

Potential Cancer Hazards

Cancinogenic ingredients

Benefits of Robotic Spray Painting

Deal with hostile environment

Noise
Cancinogenic materials
Particulate matters airborne

Use Less Energy

Reduced fresh air requirements
Reduced exhaust
Reduced energy cost

Improved Quality Paint

Less Dirt
Uniform build obtained
Consistent quality level
Cope well with specialised spray techniques

Benefits of Robotic Spray Painting – cont.

Quality improvements result in:

Reduced warranty
Reduced in-house repairs

Reduced material costs

Reduced Direct Labour Costs

Characteristics of Spray Painting Robot

Continuous Path Control

needs many DOF

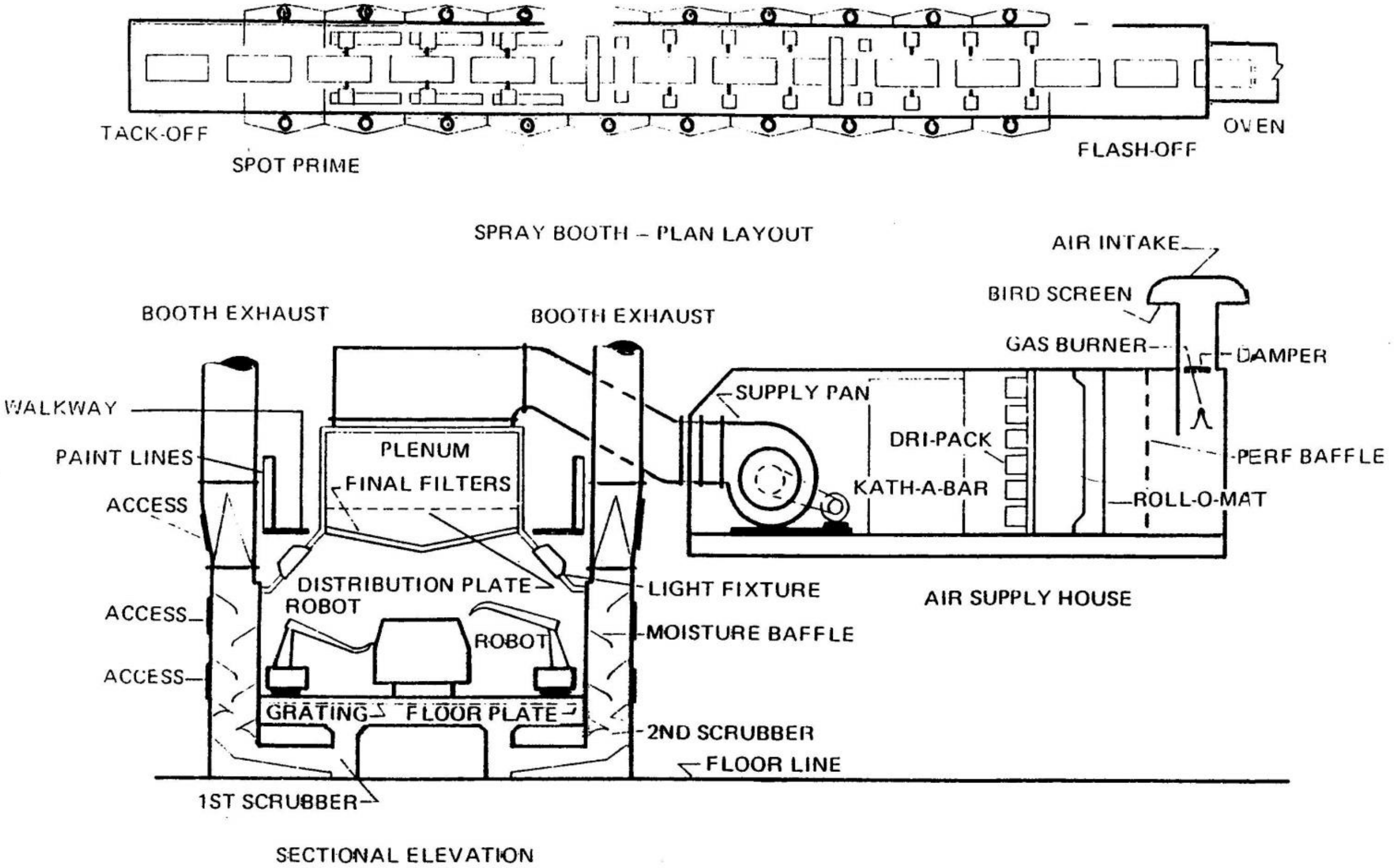
Hydraulic Drive Preferred

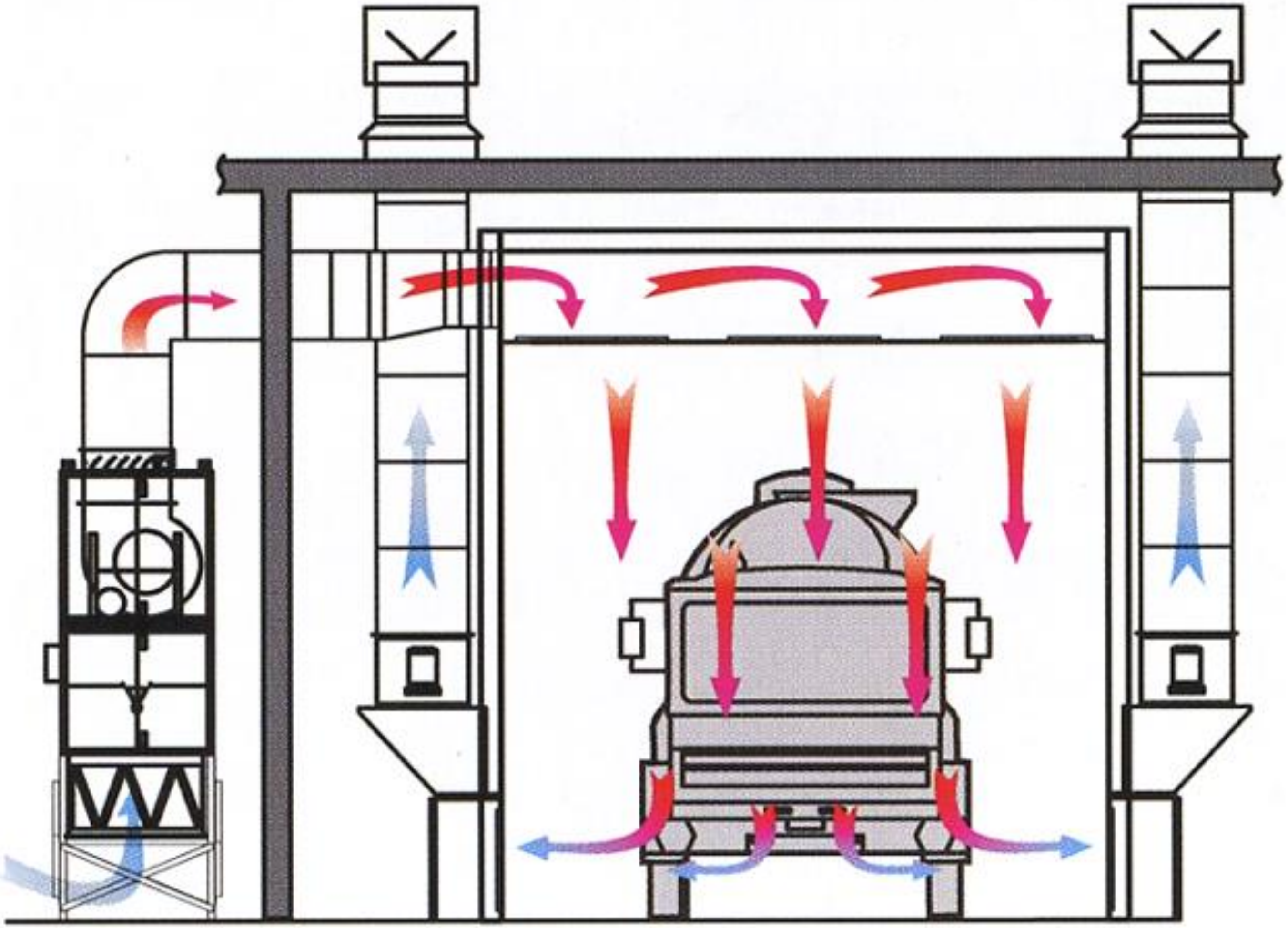
spark may ignite fumes
pneumatic is too jerky

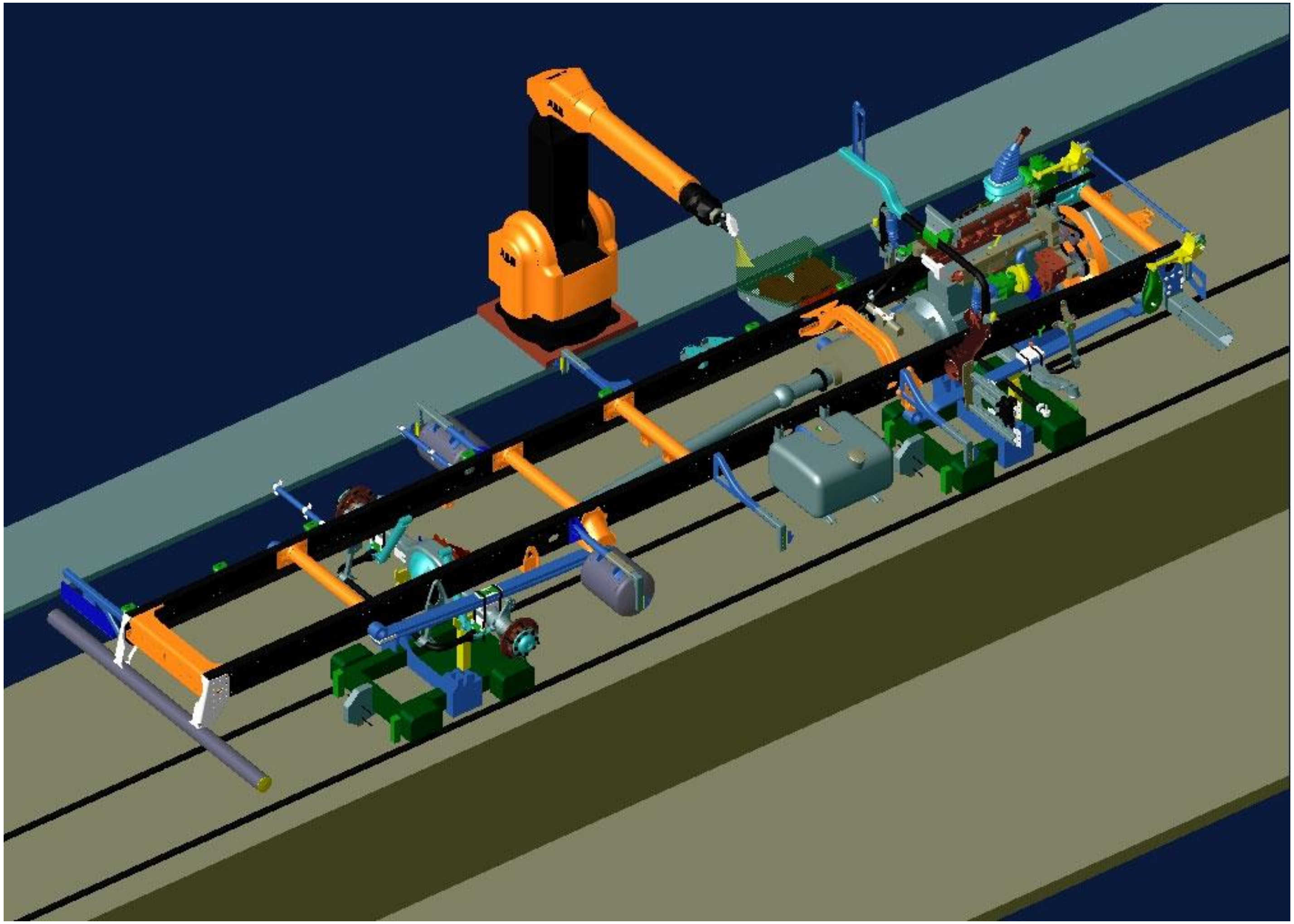
Lead through Programming

Multiple Program Storage

Spray Painting Application Set-up







AIRLESS SPRAY SYSTEMS

The Efficient Choice
For Many Liquid Painting Applications

Conventional Air System vs Airless System

What are the limitations of using air systems?

Limitations of Conventional Air Spray

- Excessive overspray and bounce back
- Poor painting efficiency
- High quantity of solvents required to reduce paint and improve spray ability
- Low production rate since air spray, in many cases, requires two coats to achieve desired paint coverage
- Low potential paint output of air spray guns limits production speeds
- High maintenance costs of booths and filters due to over sprayed paint

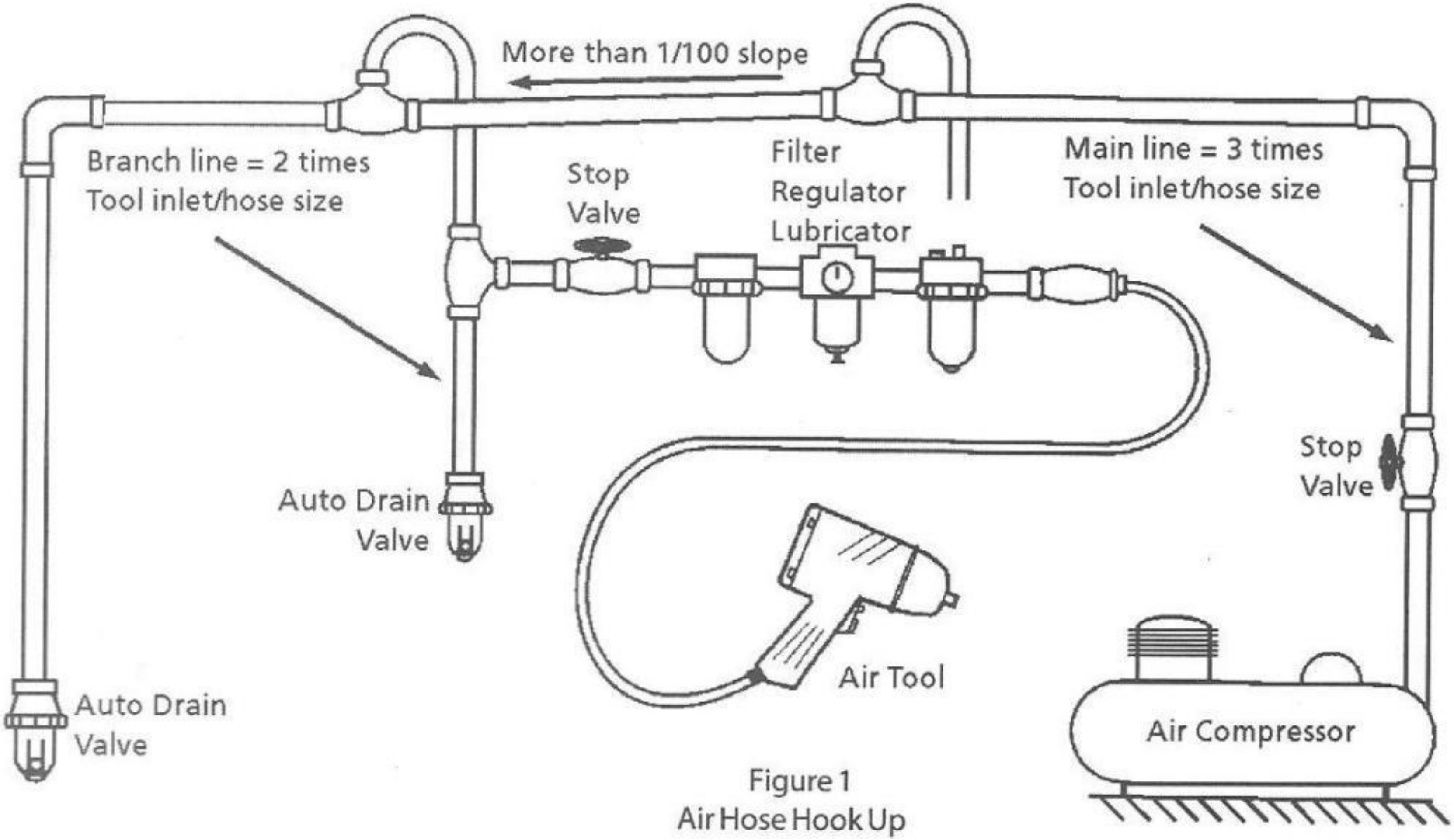


Figure 1
Air Hose Hook Up

Effects of Conventional Air Spray

Fig.1: On internal surfaces *particles mixed with air rebound and fail to cover corners and recesses.*

Effects of Conventional Air Spray

***Fig.2: On external surfaces** turbulent air spray creates excessive overspray and high material waste.*

Conventional Air vs. Airless Systems: Selecting the Best Method

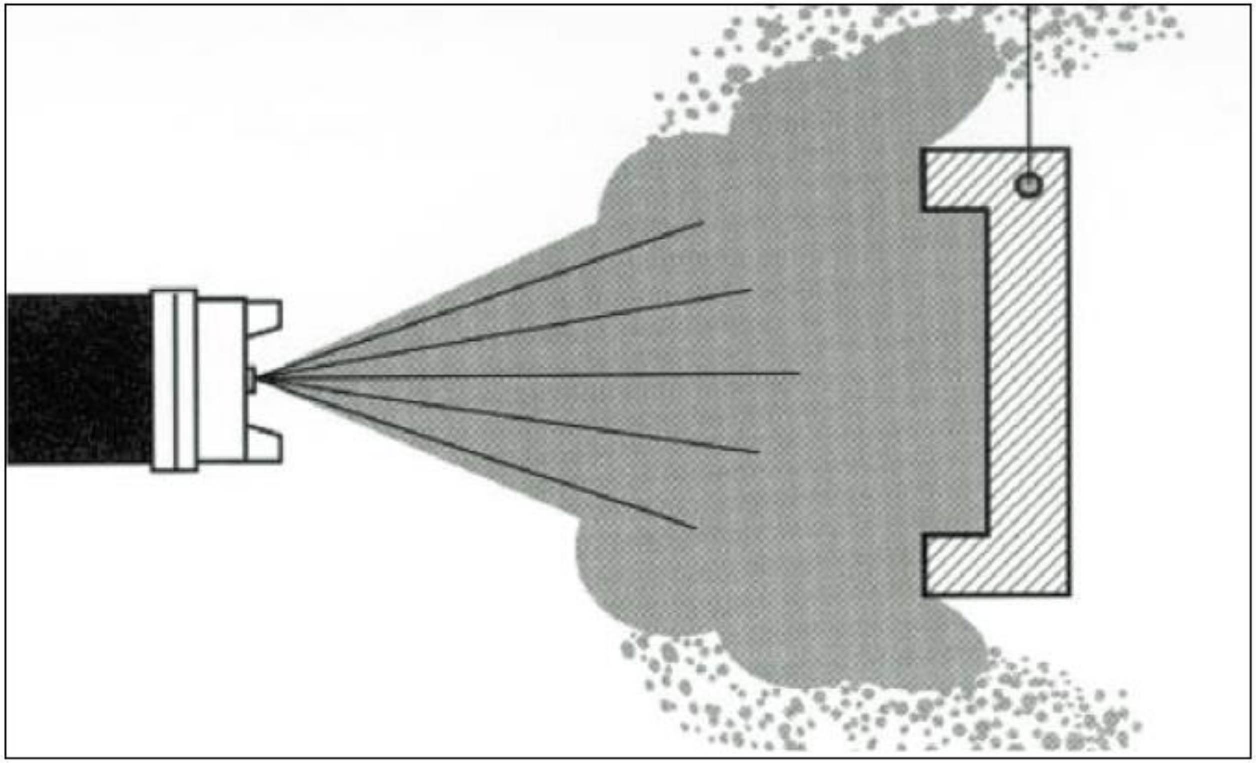


Fig.3: Conventional air spray creates a “cloud” as high-pressure air jets atomize coatings. As coating particles are blown at high speed toward the part, many are dispersed into the air.

Effects of Conventional Airless Spray

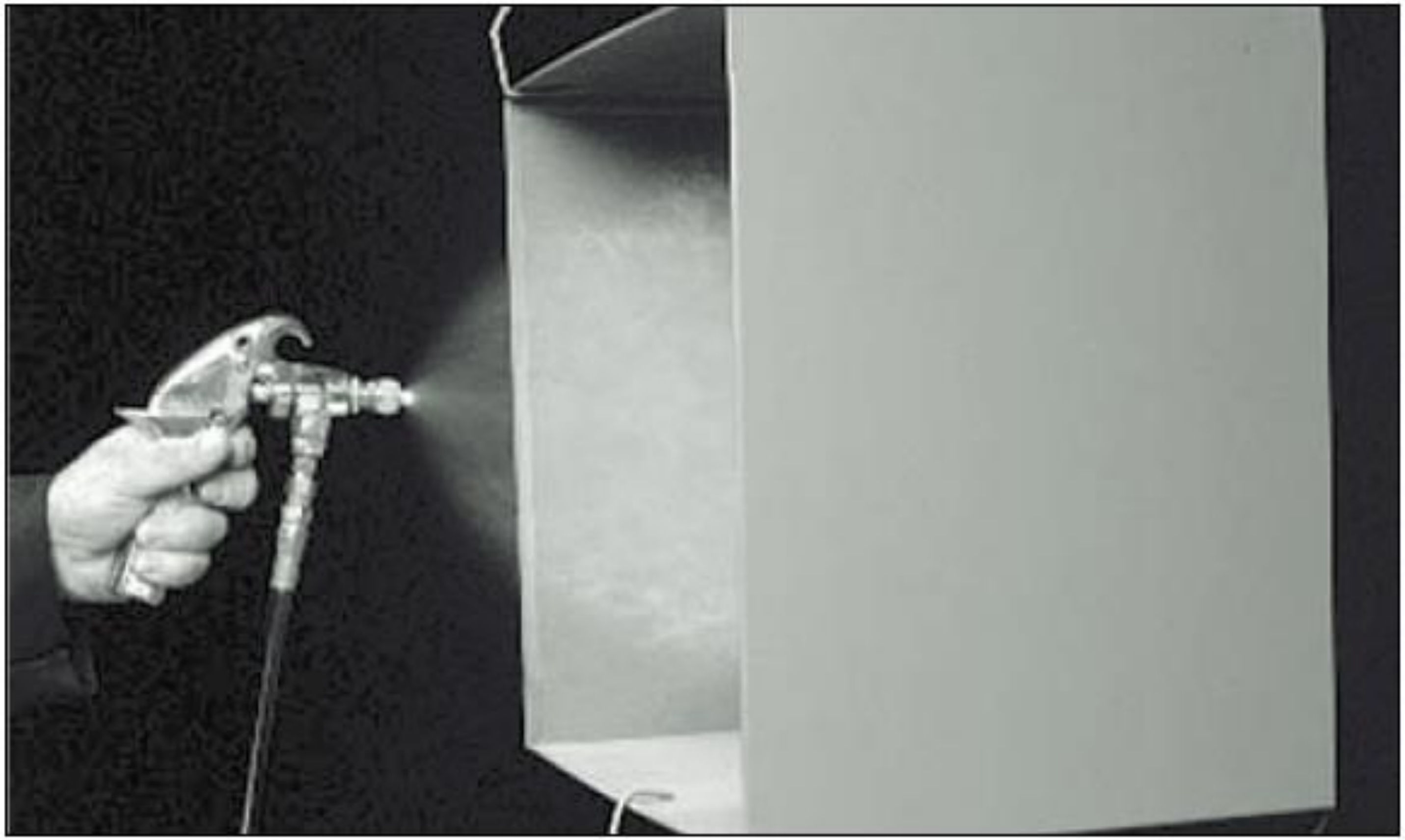


***Fig.4: On internal surfaces** no visible bounceback indicates easy-to-control spray for improved first-pass coverage.*

Effects of Conventional Airless Spray

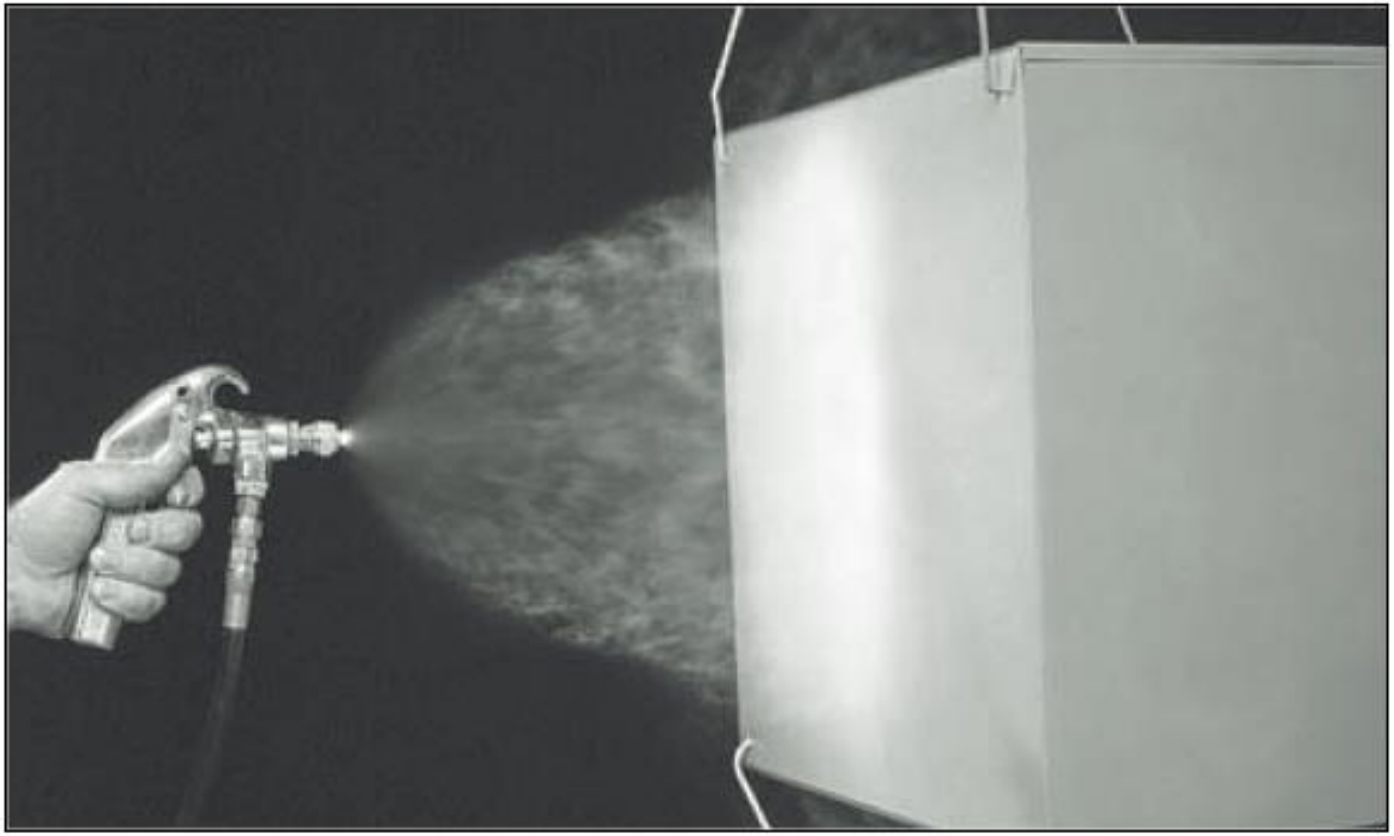


***Fig.5: On external surfaces** soft spray creates little or no overspray for minimal waste and cleaner, safer operating environment.*

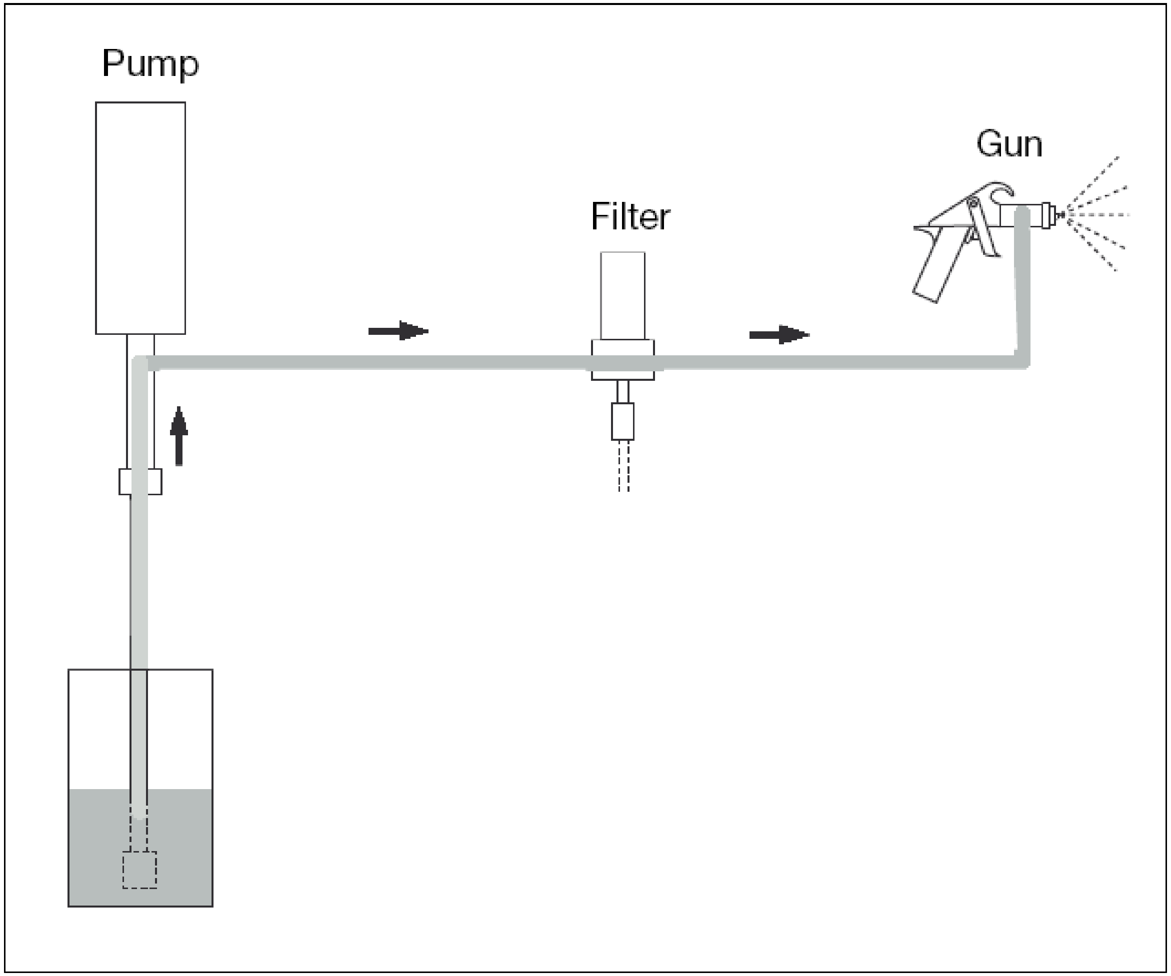


Fig.6: Conventional Airless System

Characteristics of Spraying Velocity

Photographs taken at 1/10,000 of a second reveal the differences between a turbulent spray and a "soft" spray.

Fig.7: Air Spray. *At test pressures of 60 psi, an average of 600 parts of air were used to atomize one part of paint. The large volume of air means excessive turbulence, paint bounce, and overspray.*

Characteristics of Spraying Velocity

Photographs taken at 1/10,000 of a second reveal the differences between a turbulent spray and a “soft” spray.

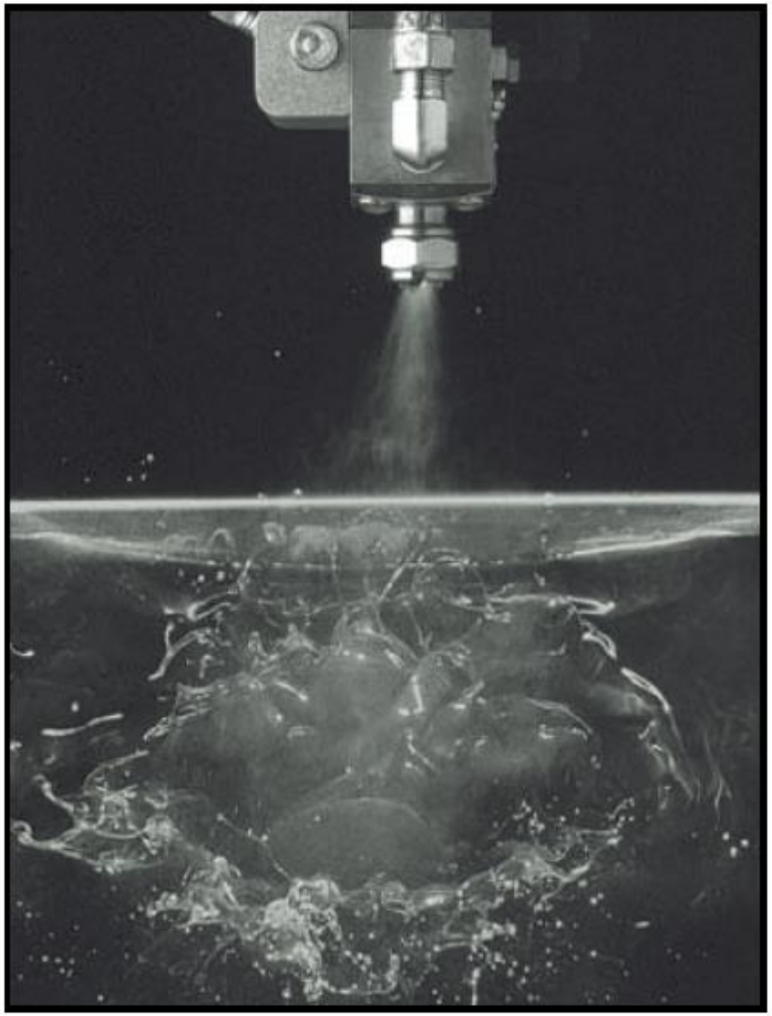


Fig.8: Airless. *Hydraulic pressure during test was 1500 psi, but there is no air discharge to carry paint particles long distances from the gun.*

Characteristics of Spraying Velocity

Photographs taken at 1/10,000 of a second reveal the differences between a turbulent spray and a "soft" spray.

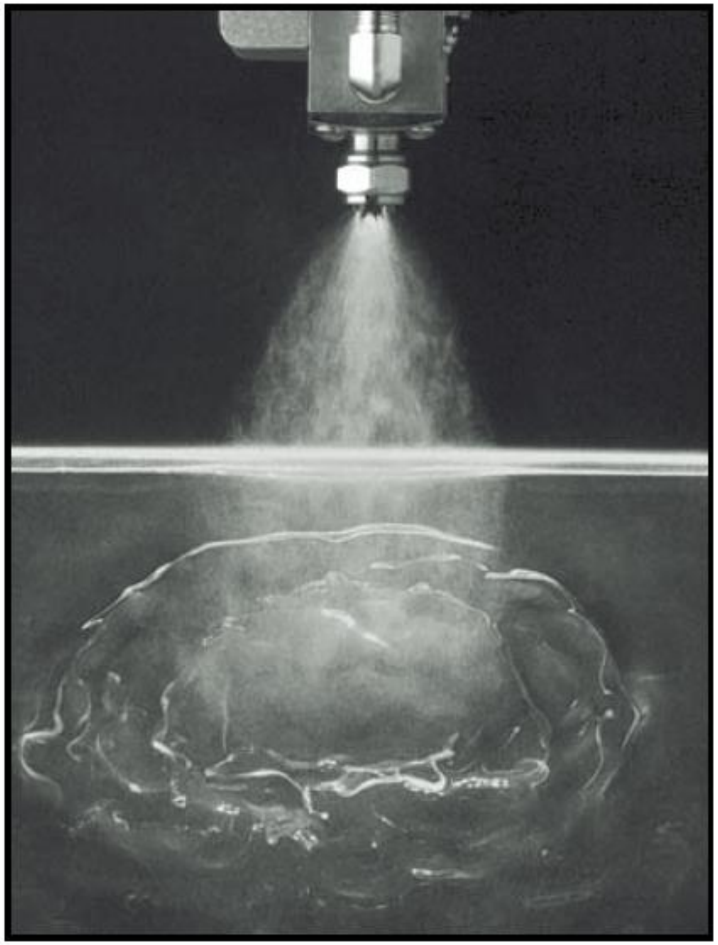


Fig.9: Heated Airless. *Spraying at 600 psi without air produces a soft, direct spray with minimum bounce and overspray.*

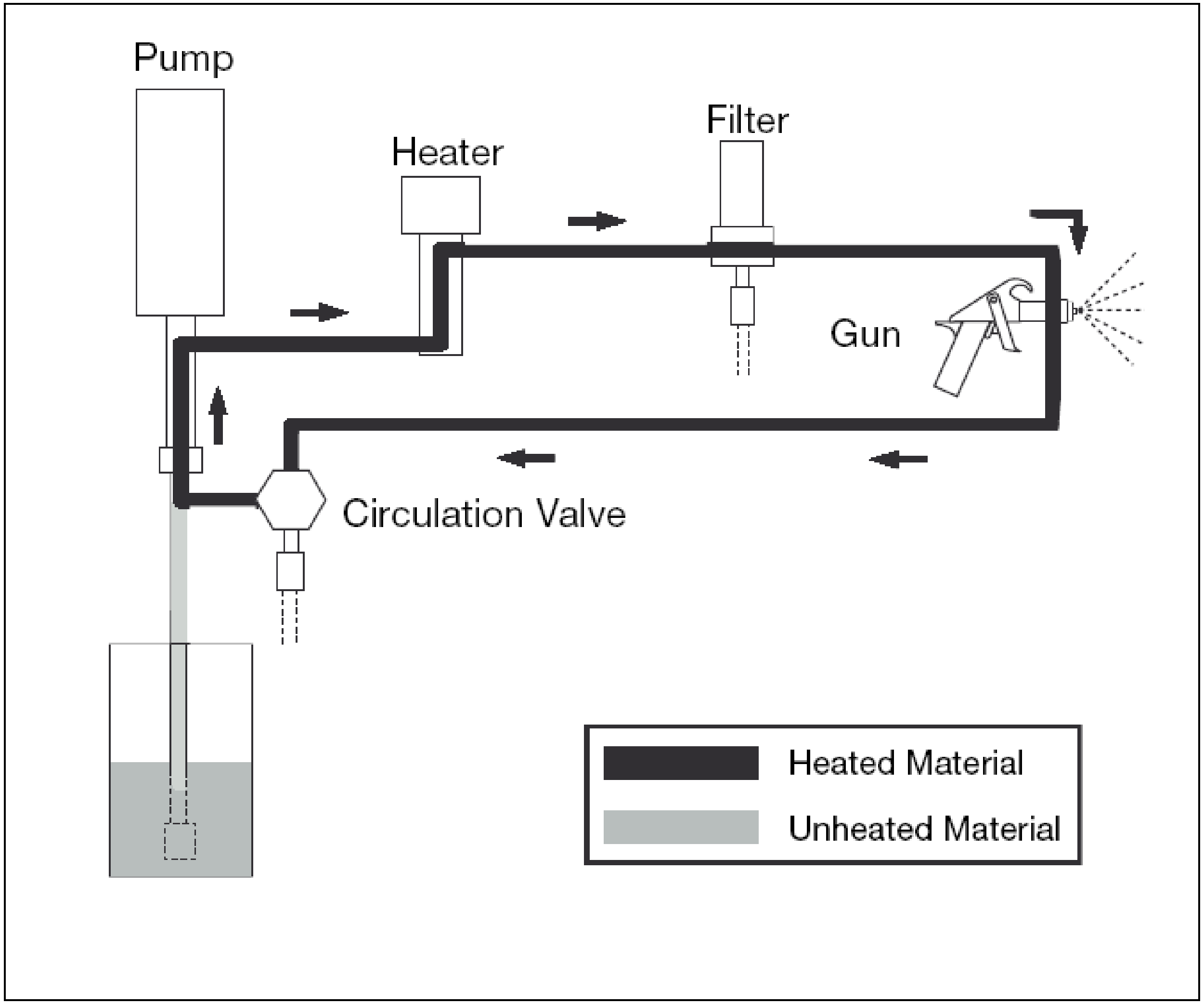


Fig.10: Heated Airless Circulating System

Heated Airless System

What are the advantages of using heated airless systems?

Improved Material Usage

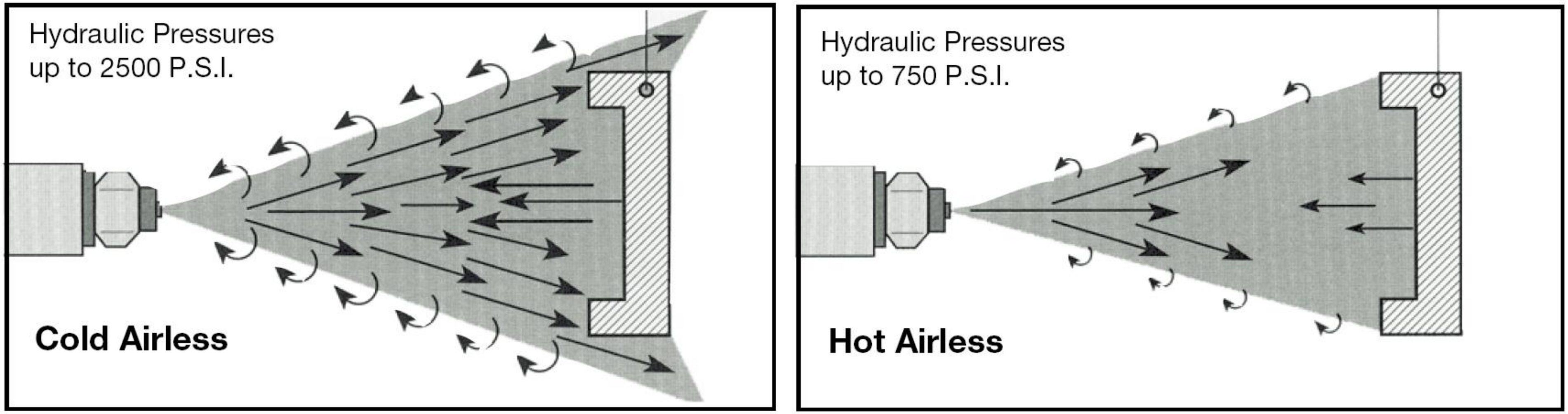


Fig.11: As heat is applied, solvent vapor pressure increases so atomizing pressure can be reduced. Lower pressure results in lower particle velocity and a softer spray. Better coating coverage and less solvents improve material savings.

Higher Film Build

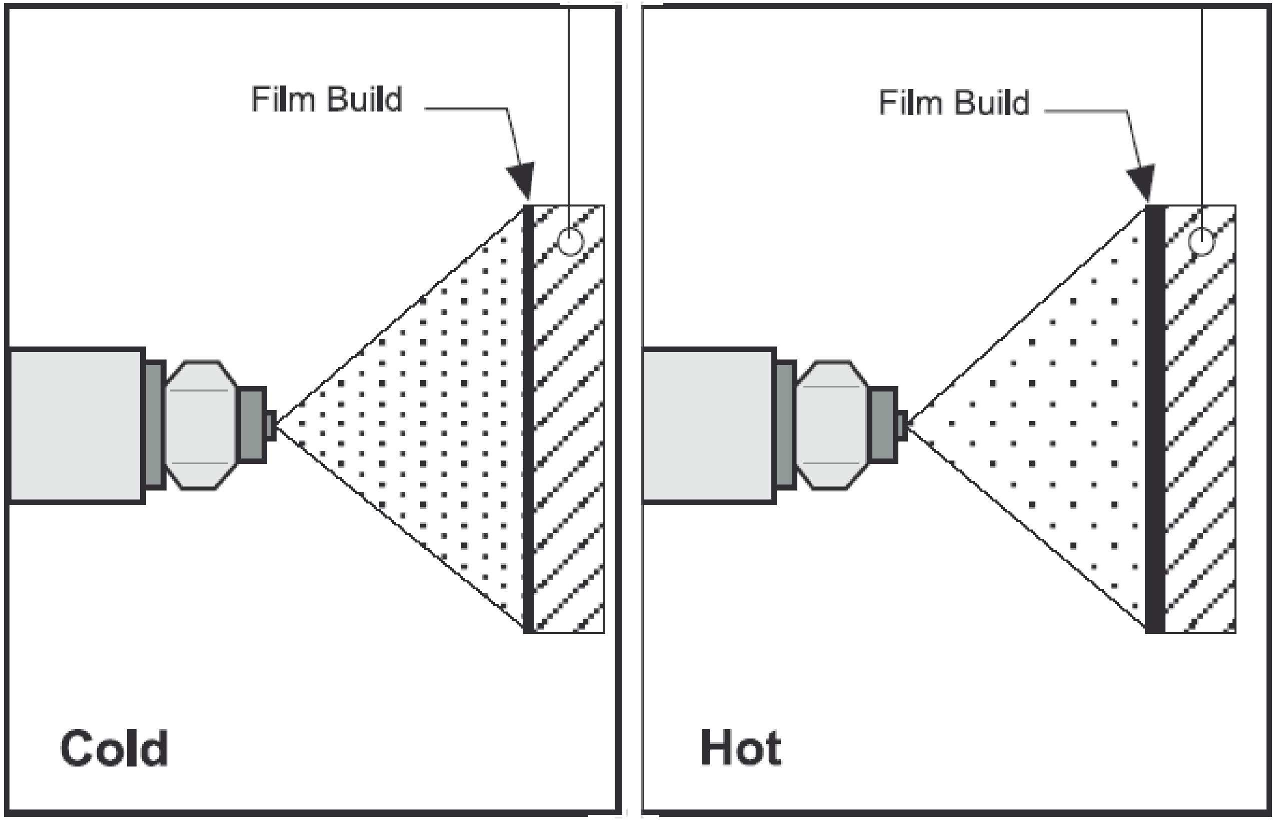


Fig.12: Heating coatings reduces viscosity and improves spray ability. A higher film build can be applied without sags or runs, and often equals two air-sprayed coats.

Benefits of Heated Airless Systems

- Reduced overspray and material waste due to softer spray
- Higher paint film build with single-pass coverage
- Reduced touch-up for fewer rejects
- Excellent for coating large parts and open-floor spraying
- Reduced maintenance of booths and filters due to reduced overspray
- Improved labour savings
- Reduced compressed air consumption

Electrostatic Airless Systems

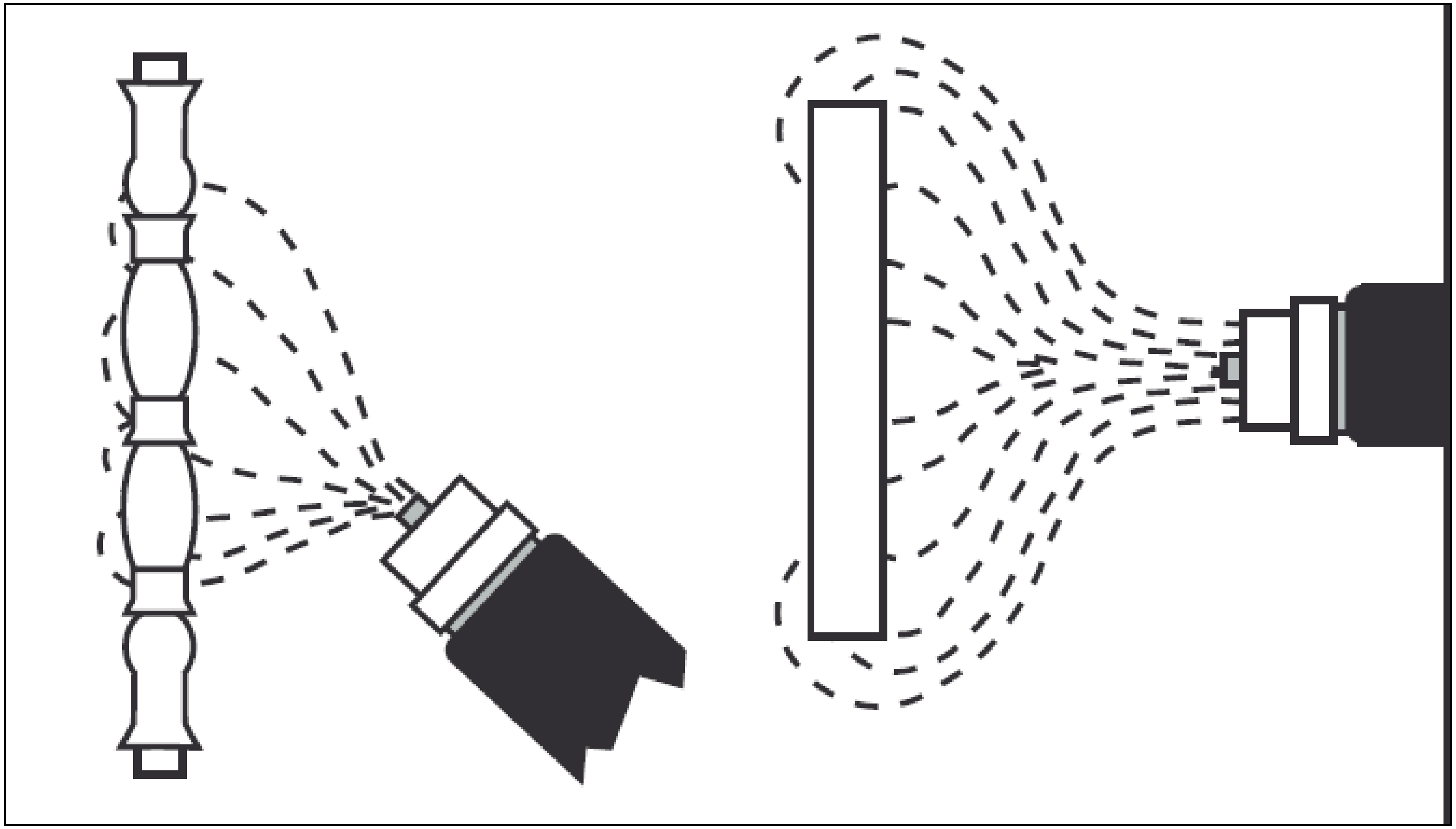


Fig.13: Electrostatic Wrap-Around Effect

Electrostatic Airless Systems

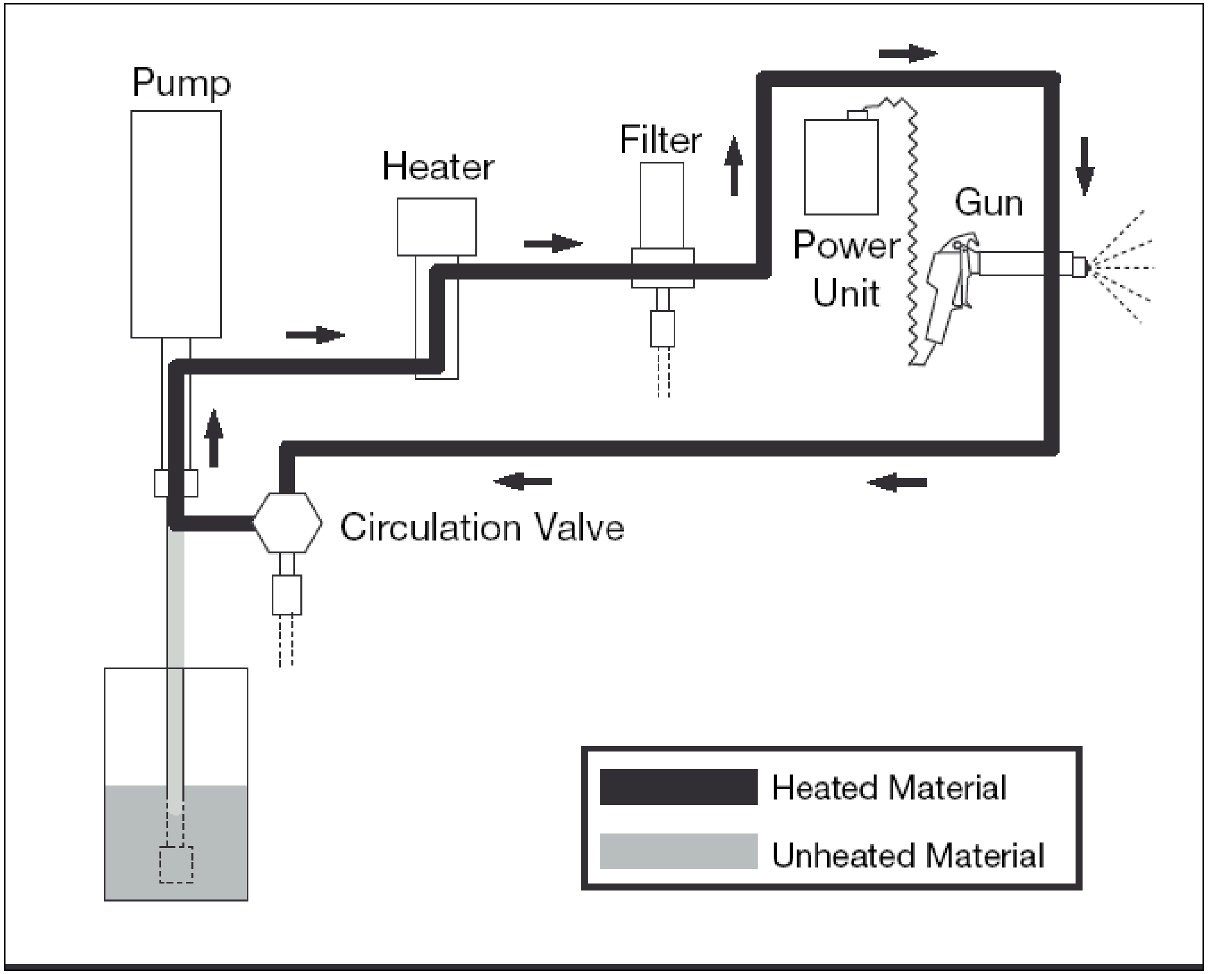


Fig.14: Heated Airless Electrostatic System

Electrostatic heated airless system

What are the benefits of electrostatic heated airless systems?

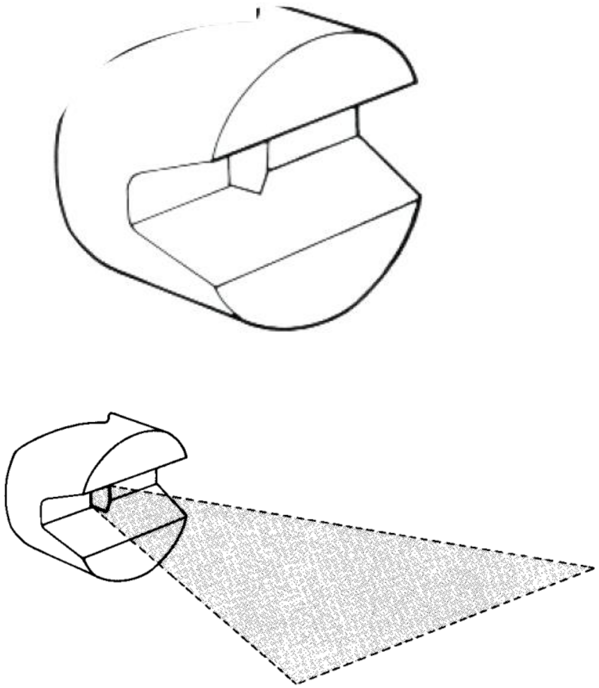
Electrostatic heated airless system

Added Benefits of Electrostatic Charging:

- Lowers paint costs with maximum material utilization
- Reduced labour costs due to high-speed painting capability
- Good coverage of edges, recesses and hard-to-reach

  areas for overall efficiency
- Uniform film deposition for improved finish quality
- Increased productivity with reduced rework and rejects

Nozzle Size and Design: Critical Factors to Consider



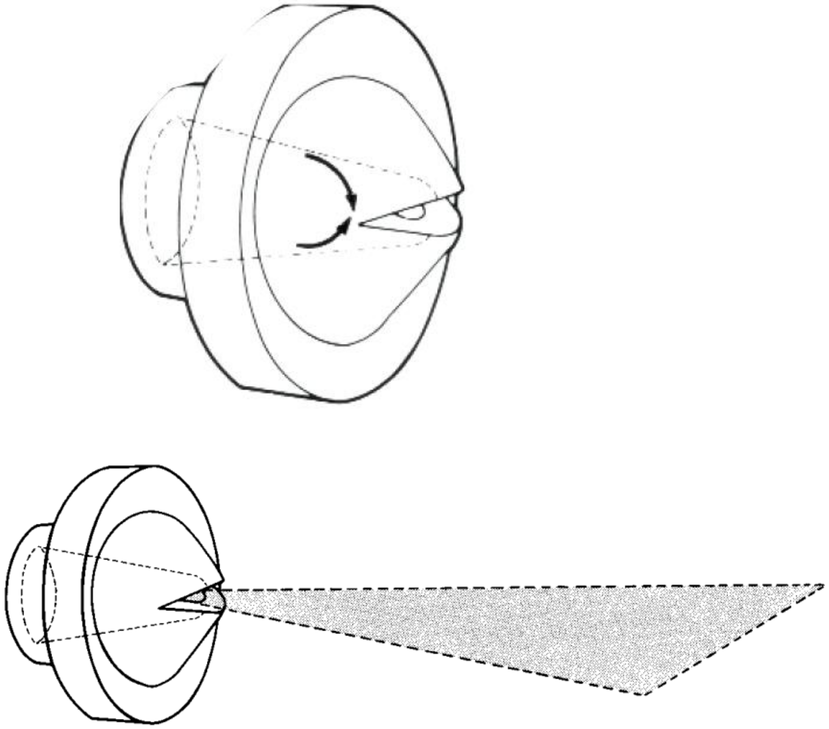
CROSS-CUT®

Cross-Cut

Nordson Cross-Cut nozzles utilize a proprietary method of generating more atomizing energy at the same fluid pressure. This type of nozzle can improve atomization of standard coatings and dramatically improve atomization of hard-to-spray coatings.

Using Cross-Cut nozzles, very low atomizing pressures have been demonstrated on high solids and cohesive coatings. Cross-Cut nozzles are also more resistant to plugging than dome-style nozzles, which allows the use of lower flow rate nozzles for smaller parts. Cross-Cut nozzles can greatly enhance electrostatic efficiency which depends on fine atomization and a low-velocity, soft-spray pattern.

Nozzle Size and Design: Critical Factors to Consider



DOME

Dome-Style

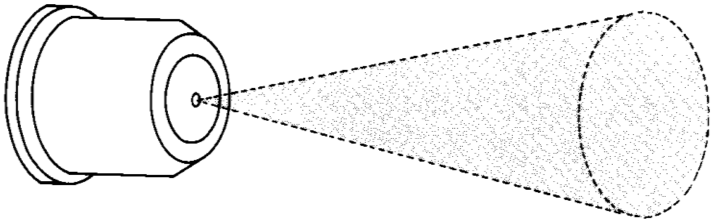
Dome-style carbide nozzles are the most commonly used type of airless nozzles. Variations in dome geometry and surface finish affect atomization and pattern uniformity. Dome-style nozzles are most effective for thin, easy-to-atomize materials.

Nozzle Size and Design: Critical Factors to Consider

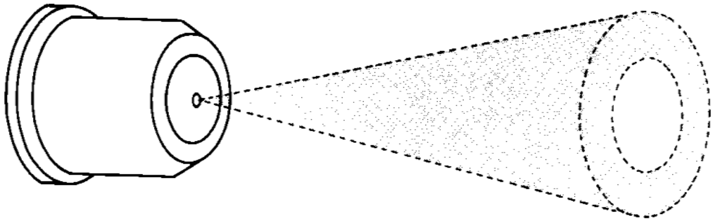
Conical Nozzles

- Conical nozzles are available with either a solid or hollow cone-shaped fan pattern. These fan patterns are shown in Figure 2.
- Conical nozzles are available in the following configurations:

- **Conical Flange Mount Nozzles** - are available with either hollow or solid patterns, and can be used on most automatic and manual airless guns with flange mounts.
- **Miniature Conical Nozzles** - are available with either hollow or solid cone patterns. They can be adapted to any flange-mount gun by using a P/N 042 XXX extension. Their many applications include the internal coating of small tubes and containers.

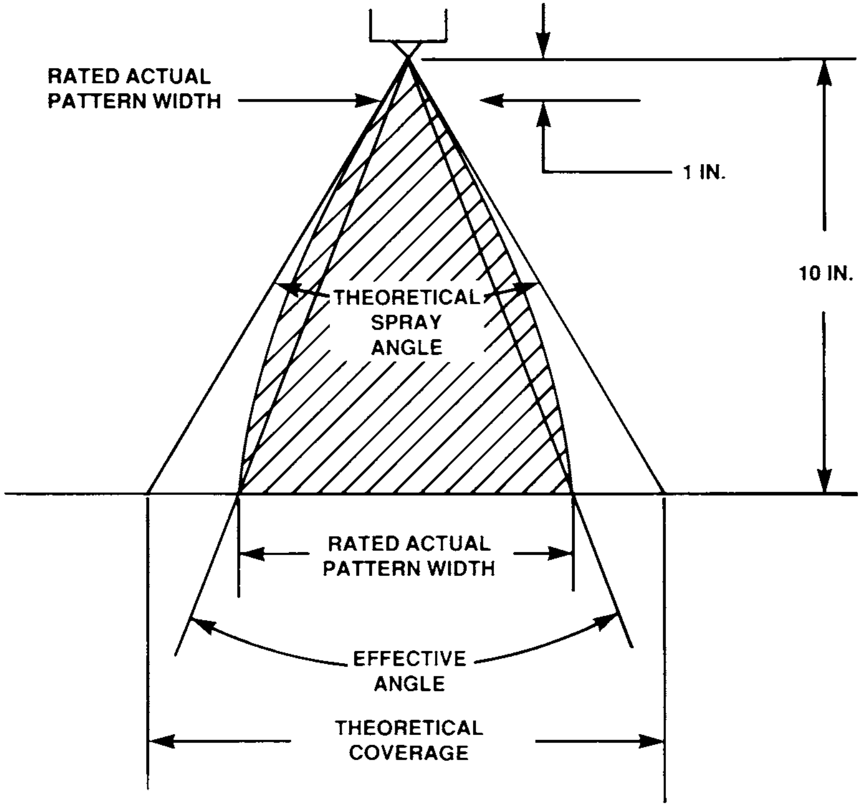


SOLID

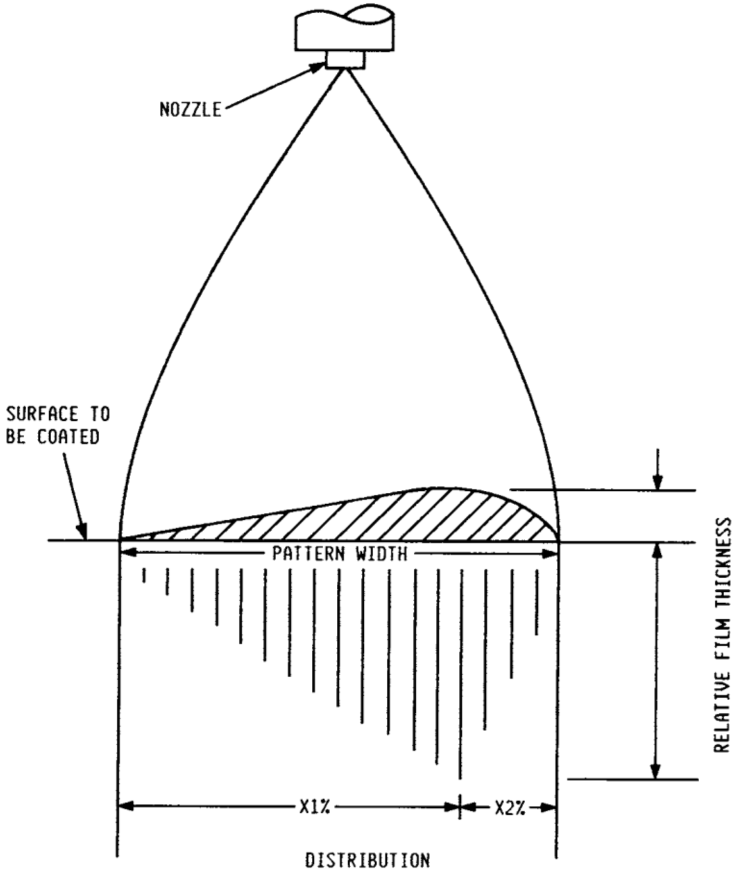


HOLLOW

Actual and theoretical pattern width and angle

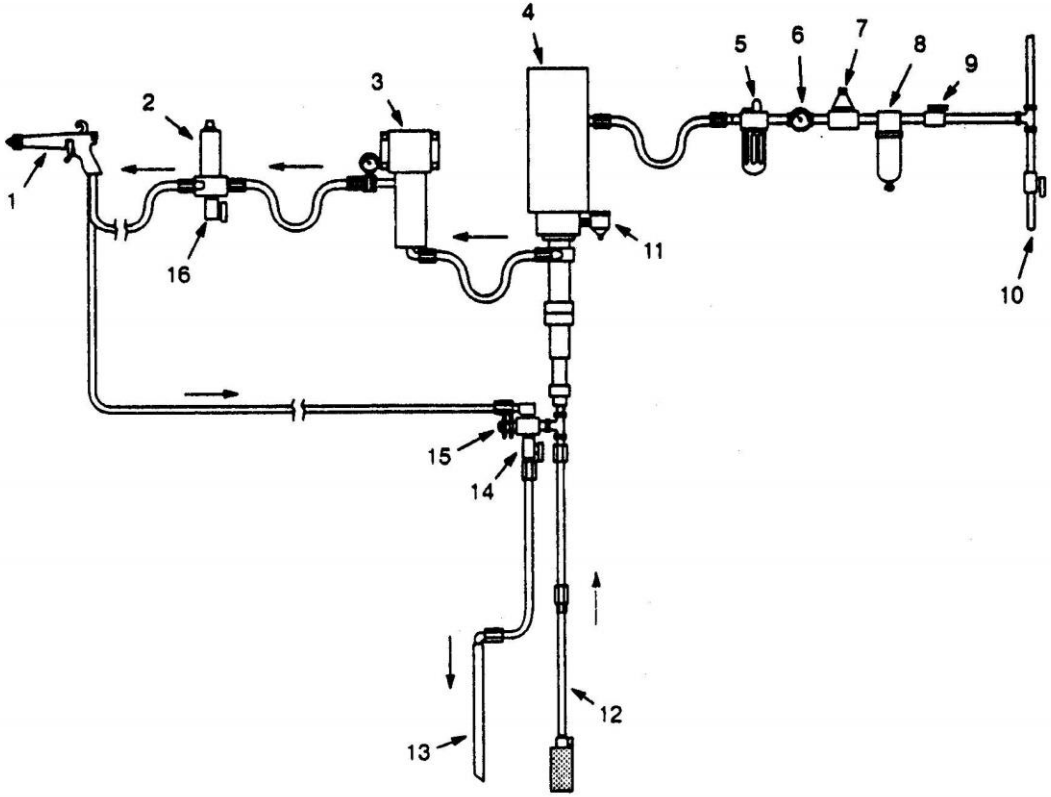


Controlled pattern distribution



System Overview

1. *Spray gun*
2. *High pressure fluid filter*
3. *Heater*
4. *Pump*
5. *Air lubricator*
6. *Air pressure gauge*
7. *Air pressure regulator*
8. *Air filter*
9. *Shut-off valve*
10. *Drop leg and drain valve*
11. *Solvent chamber filler cup*
12. *Siphon and strainer*
13. *Drain-off rod*
14. *Drain-off valve*
15. *Circulating valve*
16. *Filter drain valve*



Comparison of Efficiency of Various Types of Systems:

• Air atomised gun	30%
• Airless gun	40%
• Electrostatic hand gun	64%
• Electrostatic automatic	80-90%

*(source: Nordson Inc.)

Paint lost due to overspray, drips, excessive film build.

Control of variables

- Control of nozzle
  - On-Off operation
- During spray cycle
  - Paint flow rate
  - Fluid/air pressure
  - Atomisation process control
- Paint variables
  - Viscosity
  - Specific gravity
  - Temperature

TEXT AND REFERENCE BOOKS

- **Textbook:**

1. James A. Rehg: Introduction to Robotics in CIM Systems. Fifth Edition, Prentice-Hall. 2003.

- **Reference book:**

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4. Richard K. Miller, Industrial Robot Handbook. Van Nostrand Reinhold, N.Y. (1987).