An Introduction To
Air Atomising Spray Guns

Trainee: .................................................................

Course Date: .........................................................

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Introduction

The Air Atomising spray gun is the most popular type of spray application equipment used throughout the World today. There are 100’s of different models and hundreds of thousands of guns used for everything from food flavouring to lacquering lipstick containers. Despite being manufactured by many different equipment manufacturers around the world the air atomising spray gun design has a basic layout and construction that is common to every type. These notes will explain the layout of DeVilbiss air atomising guns and the function of the components in them.

In these training notes we shall be discussing the main line, high production guns that DeVilbiss UK manufactures and sells. However, as you will see, there are similarities and common design features with the other gun types that we manufacture.

Gun Body
The body of all DeVilbiss spray guns is manufactured from aluminium alloy. To produce better strength and durability in the main-line guns the aluminium bar is drop forged to increase the body strength. The forging process involves two separate hits, the first to give the basic gun body shape and the second to finalise the dimensions and shape and to improve marking and lettering definition. The excess flashing is trimmed off and then the body is pickled in acid to refine the grain structure and clean the outside surface. Approximately 30% of the material is machined away during the machining of the various holes. After machining any remaining sharp flashing marks are fettled off to give a smooth finish.

Polishing is carried out in two operations, the first by hand to prepare and polish the difficult areas and the second machine operation where the larger, easier exterior surfaces are polished. Any residual polish compound or cutting oil is removed during a hot ultrasonic wash and rinse.

If the body is to be Electroless Nickel plated or Anodised it must be finished and polished to a high standard before the final process is carried out. If not, an inferior surface finish is the result.

Die cast gun bodies are produced in a similar way, although their grain structure is not as strong as drop forging. Gas or blowholes in the casting is sometimes a problem, so quality checks after casting and during machining are important. Pressure die-casting is used so that several gun bodies may be cast at the same time and reduce the possibility of gas holes. This type of body is normally used for lower quality guns.

Polished gun finishes have been the DeVilbiss standard for many years, but in recent years this has been supplemented by anodised or Electroless nickel-plated. This is in response to the need for a finish that will not tarnish on exposure to waterbased gun wash or paint products. Both finishes also have the advantage of being easier to clean than bare polished aluminium.

Air Supply Connection
The compressed air supply hose is connected to the gun using a threaded connection at the base of the gun handle.

The size and type of thread used depends upon the country where the gun is made and/or used. BSP threads are used in the UK and the majority of European countries, NPSM is fitted for the US and some Middle and Far Eastern markets. However, in 1998 we started to use a universal thread suitable for both BSP and NPSM connections. All DeVilbiss main-line guns designed and manufactured from this time on now use this thread.

**Fluid Inlet Connection**

The fluid hose is connected to the gun using a threaded connection on the underside of the gun head. Alternatively, gravity gun cups are attached to the body using a thread machined into the gun top. On pressure guns customers sometimes attach a male quick detachable connector onto the thread for easy removal and cleaning of the gun after spraying operations have finished.

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**Notes:**

Fine Tuner (Air Adjusting) Valve
This valve controls the flow and volume of compressed air passing through the gun air passageways. It therefore has the ability to alter the atomising air pressure at the air cap, by introducing a restriction to the airflow.

This particular valve is fitted on some DeVilbiss suction/pressure gun bodies or is available as an accessory for other guns that have been machined ready for its fitting. Evidence of this machining is a hexagon key screw fitted into the handle base.

On most DeVilbiss suction/pressure gun bodies the valve is located adjacent to the air inlet on the handle bottom, in line with the air hose.

Alternatively, on a DeVilbiss GFG/GFV Gravity gun body it is traditionally located at the top rear of the body. However, on later DeVilbiss gravity gun bodies, such as the GTI-G, it will be found in the same location as on the suction/pressure body.

Notes:

Main Air Valve
All modern DeVilbiss designed guns feature an air valve that is separate to, and not on the same centreline as, the fluid needle. It is positioned under the fluid needle shaft in the handle of the gun, directly behind the trigger. This separation is a deliberate intent to make the construction of the two items simpler and easier to maintain.

The valve controls the on/off of the spraying air and works in conjunction with the Air Adjusting Valve to control how much air reaches the aircap. As the trigger is pulled, it hinges backward and presses against the end of the valve stem. This pushes the valve open, allowing air to flow through the gun passageways and out of the air cap.

At the rear of the valve is a return spring, which compresses during use and returns the valve to the closed position on release of the trigger.

Notes:
The trigger is a simple pressed steel lever, operated by the fingers of the sprayer. It acts upon the air valve and fluid needle, and is responsible for the correct “two stage” operation of the air valve and needle during spraying.

As the trigger is pulled back it applies pressure to, and opens, the air valve, pushing it back against its return spring. The trigger then comes to rest against the collar of the needle and its extra spring tension. Air is flowing at this point, but the fluid needle is still seated in the fluid tip preventing fluid flow. This is known as stage 1 and can be used for dusting down the component prior to spraying.

As finger pressure is increased further, the fluid needle is moved back, compressing its spring, and the fluid tip hole is opened. The fluid stream interacts with the already flowing air stream and atomisation takes place. This is stage 2.

It is important that the gun operates in this sequence to avoid ‘spitting' of unatomised fluid onto the workpiece. In the reverse way, on releasing the trigger, the fluid is shut off before air when releasing the trigger.

**Notes:**
This is also known as the Horn air or Spreader control valve. On suction/pressure style gun bodies it is located at the top rear of the gun, while on the GFG gravity gun body it is traditionally positioned on the side of the body, underneath the paint cup. Later gravity bodies, such as the GTI-G, have the valve at the top rear of the gun, in the same position as the suction/pressure style guns.

In the suction/pressure guns, the long stem of the valve runs inside the top air passageway of the gun body and locates into the rear of the chimney tube of the Air Baffle.

By turning the valve, the stem moves forwards and backwards on its thread and the size of the chimney opening is altered, thus regulating the flow of air to the air cap horn holes. The air emitted from the cap horn holes 'squeeze' the fluid column into the elongated fan shape. When fully closed, no 'squeezing' air is emitted and a round spray pattern results.

On a gravity gun the valve assembly is slightly shorter in length, but the same restriction process takes place in the top air passageway of the gun body.

Notes:                                                                                           
                                                                                           
Fluid Control Knob Assembly
This is positioned at the rear of the gun, the lower of the 2 knurled knobs. The complete assembly consists of a body bush, spring and screwed knob.

The body bush acts as a liner and guide in the gun body, allowing compressed air to flow around its outside surface while locating the fluid needle and spring with its inside surface. It also acts as a seal, preventing the compressed air from escaping along the axis of the fluid needle.

The rear of the fluid needle locates into the spring and, in turn that locates into the knob. The knob screws into the body bush. The collar on the fluid needle shaft locates into, and rests against the trigger.

On pulling the trigger, the needle is moved backward, allowing the material to flow out of the tip orifice. As the knob is screwed in, it moves forward, restricting the movement of the needle and therefore the amount of fluid that can be emitted from the tip. If the knob is fully screwed in, the needle cannot move and therefore no fluid can be emitted. In the same way, the air valve is not depressed so air is not emitted either.

It must be pointed out that the amount of fluid emitted from the fluid tip has a direct influence upon the spray fan size. A small amount will only give a small, elliptical pattern. As the quantity is increased, so the fan becomes larger until it reaches the size and limits of the air fan produced by the air cap. As the fluid flow increases the fan shape changes gradually into its final form. Once the limits of the air fan are reached, any additional fluid will ‘burst’ the pattern producing coarse atomisation at the fan top and bottom.

**Fluid Needle Packing and Adjusting Screw**
This is located in the rear of the spray head of the gun, immediately in front of the trigger, where the fluid needle enters the gun body.

The packing is compressed against the needle shaft and the inside of the cavity by rotating the hexagonal packing nut in a clockwise direction.

The needle packing prevents material from leaking out along the needle shaft while also stopping air from being sucked into the fluid passage (on a suction gun). It must be correctly installed, adjusted and kept lightly lubricated at all times to give optimum performance.

When adjusting the packing, the screw should be fully tightened and then gradually unscrewed until the needle can freely and smoothly move. Excessive wear or failure to periodically adjust the packing screw will lead to air being drawn into the fluid passageway, creating fluttering of the spray fan. A single drop of silicon free oil will aid the smooth movement of the needle without binding and sticking.

**Notes:**

Air Baffle
This is positioned between the fluid tip and main gun body. It aids the correct location of the tip and controls the horn and atomising air used by the air cap. The paths taken by the two air streams can be seen in the gravity gun section view shown to the right. The various weirs and cavities created by the gun body, air baffle, fluid tip and air cap locating together, serve to even out the airflow and distribute the air correctly to give a well defined, stable spray fan.

In the rear of the baffle a stainless steel tube or chimney is fitted. A seal is needed between the baffle and gun body to prevent air leaking. On the GTI series guns this is machined into the air baffle itself, preventing the need for a separate seal.

With reference to the sectioned drawing; air is fed up the gun handle, around the body bush, through the main air valve and into the spreader control valve cavity. It is here that the air is split into two parts.

Atomising air passes along the left-hand passageway, through the inside of the baffle and through the ring of holes around the periphery of the fluid tip. The centre cavity of the air cap fills and supplies the atomisation and cleaning holes of the air cap.

The second, right-hand, pathway airflow is directed through the air baffle chimney and fills the annular cavity between the baffle exterior and inside of the air cap retaining ring. After flowing over a ‘weir’ the airflow collects in another cavity before passing up the horn hole drillings and out of the air cap.

Notes:

The Fluid Tip and Needle
The fluid tip is secured to the head of the gun by means of a thread in the gun body, trapping the baffle and its gasket against the body. The fluid needle seats into the back of the tip and seals against the tip inner profile to shut off or restrict the flow of fluid. The tip and needle function together to meter and direct the fluid into the atomising air stream.

The tip and needle are a matched set-up and must be selected as a pair.

Depending upon the gun model, fluid tips may be available manufactured from different materials. Normally, high-grade Stainless Steel is used to allow use with chemicals, foodstuffs and waterbased materials. However Nitralloy and Tungsten Carbide tips may be available for increased abrasion resistance with some guns. Tips fitted with a plastic inner seat are available for JGHV and JGA series guns that aid the tip and needle seating when using searching fluids like paraffin or oils.

The fluid tip external profile is an important surface, and must be regularly cleaned and examined. Any damage or contamination will disrupt the airflow and could affect atomisation or spray fan shape. Likewise, the conical seat on the rear of the fluid tip must remain undamaged and mate with its matching conical surface in the gun body. If these cones do not seat and seal then either air will be drawn into the fluid passage or fluid will leak out under pressure.

Notes:  

The Air Cap and Retaining Ring
These parts are located at the front of the gun and fit over the fluid tip. The air cap is specifically designed for use either with pressure or suction/gravity or both types of material feed. The air cap function is to atomise then shape and determine the size of the spray pattern. The retaining ring is designed to hold the air cap securely in place over and against the fluid tip.

Suction/gravity air caps are designed to generate a venturi to suck the paint from the cup. Pressure caps do not create this suction and have to be supplied with fluid from a pressurised material container or pump. Sometimes a particular design of fluid tip will need to be used with an air cap or it will not generate this suction or atomise the material correctly. Use the Service Bulletins or sales literature for the gun type you are using to check this information.

The air cap has three main sets of holes. The majority of atomising air comes from the large centre hole (1). With the fluid tip in place, this hole becomes a doughnut shaped ‘annular orifice’. Therefore the emerging air is shaped into a cylinder around the fluid column. The turbulence between the fluid and cylindrical air jet creates the atomisation. On the face of the air cap are the cleaning holes (2). These holes help to keep the front face clear of paint build-up generated by the atomisation process. Sometimes there will also be some additional or supplementary holes (5) to help keep the fan stable and well formed. The two lumps on the front of the air cap are called horns (3). Not surprisingly, the holes in them are called horn holes (4). These provide the squeezing air that forms the cylindrical fluid column into the fan shape.

Looking at the air flow diagrams in the air baffle and fan control sections, you can see that the centre annulus (1) cleaning holes (2) and supplementary holes (5) are fed from one source, while the horn holes (2) have their own separate source. By using the fan control valve the horn air quantity may be altered and the size of the fan altered. If no air emerges from these holes then there is no squeezing action and a round spray is produced.
Notes:

Parts Location Diagram