

Multi-Component Mixing Head for “Foamed In-Place” Gaskets

ROBERT PIERCE

*Cannon USA
1235 Freedom Road
Cranberry Twp., PA 16066*

CHRISTIAN CAIRATI

*Cannon Afros SpA
Via Galileo Ferraris 65
21042 Caronno Pertusella (Italy)*

ABSTRACT

The increasing demand for flexibility in production pushed the development of a new generation of reliable multi-component mixing heads for micro-pouring and very low-output applications.

With the new Multi series, Cannon has introduced the concept of multi-component heads into low-pressure technology, offering unbeatable advantages where frequent production changes are required.

On this basis, pouring different formulations can be changed from shot to shot: from Thixotropic to low-viscosity chemicals, from Polyurethanes to silicone-based formulations. This ability is appreciated by those manufacturers of the various automotive appliances and electrical parts that commonly apply gasketing, insulation or gluing techniques.

INTRODUCTION

Analyzing the applications where gaskets, insulations and adhesives are used, one finds that users demand flexibility and improvement of the quality of the finished manufactured product.

The advent of new technological solutions and production methods has made the range of materials and mixtures, which can be used to make gaskets, seals and fastenings even more varied.

In addition, the need to limit costs leads to the greater use of automation to increase production capacity, reduce the use of manual labor and operate frequent and efficient changes of production, optimizing the times of carrying out the single operations and eliminating the waste of costly raw materials.

In the ambit of developing and perfecting the Gasketing technology dedicated to this specific type of application, the Cannon specialists have thoroughly investigated user requirements and needs with the objective of

implementing an innovative, versatile and complete package (dosing machine + mixing head + washing system).

Together with the car industry, the first large market in which innumerable industrial applications based on the gasketing technology have been developed, the electrical component and technical lighting sectors can be considered the main users of foams for expanded gaskets and glues.

In particular for what concerns the lighting industry, which requires high degrees of protection (IP65 or Nema 4 and over), the types of lamp which adapt well to the “in situ” application of the gasket generally fall in two large groups: 1 - industrial leak-tight ceiling lights and outside residential lamps, where polyurethane foams are used; 2 - road projectors or high-intensity lights (floodlights), for which bi-component silicones which can resist high temperatures (generally higher than 100°C) are used.



Figure 1. Electrical Boxes Typical PU and Adhesives Application



Figure 2. Industrial Lamps Foamed in Groove with Standard PU



Figure 3. Thixotropic Silicon Gasket on High Power Lamp

On the other side, typically production of electrical boxes, panels, cabinets, and cabins require low-viscosity polyurethane foams (for pourings inside seal channels) or thixotropic formulations (for pouring on flat surfaces) are used for the foaming of expanded gaskets and bi-component glues for the fastening of inspection glasses. The use of silicone systems is becoming more common in the electrical sector for reasons opposite to those described above. In fact, the silicone foam guarantees good mechanical properties and seal at low temperatures as well (down to -50°C).

LOW-PRESSURE MULTI-COMPONENT HEAD

On these basis, it is easy to understand how standard mixing and dosing systems (i.e. capable of dispensing two different components) are extremely limiting when frequent changes of formulation are required: this led to the idea of developing a multi-component mixing head at low pressure for micro-pourings.

The Cannon B1-Multi, which is now standard on all the new-generation plants, has been specially designed to cover an output range from 0.2 to 15 g/s; equipped with

six pneumatically-controlled injectors: four dedicated to the chemical components and two to the washing systems.

With the adoption of this mixing head, the users of both sectors now have the enormous advantage of being able to meter and pour up to four different materials, in substance answering all needs of production flexibility and management of the chemicals.

Adopting this solution, a producer of electrical boxes and cabinets can feed the head with a Polyol for low-viscosity polyurethane (component 1), a Polyol for Thixotropic polyurethane (component 2), an adhesive for gluing (component 3), and finally with an Isocyanate compatible with all the other elements (component 4).

On the other hand, a producer of lamps can instead have a Polyol line (component 1), an Isocyanate line (component 2) for the preparation of polyurethane foams and another two lines dedicated for the silicone foams (component A and component B).

In this way, simply selecting the pouring program preset and saved in the control system, while performing a head washing cycle the formulation can be easily and rapidly changed from one shot to another.



Figure 5. Cannon B1 Multi Mixing Head



Figure 6. B1 Multi on Cartesian Robot

As it has already been said, each circuit is independent and can keep the components perfectly separate until they enter the mixing chamber, thus preventing any possible cross-contamination of the components.

The B1-Multi head has a compact and simple structure, providing reduced maintenance and ease of operation. This last aspect, not by chance, is considered a crucial factor for working in multi-component mixing and injection regime and obtaining the maximum benefit from the use of this technology.

The need to guarantee the perfect cleaning of the device through simple and quick washing operations, so that the formulate can be changed quickly, is an unavoidable constraint.

Cannon designers and engineers have put great effort into defining the internal geometry of the mixing chamber and of the screw profile, these two elements have a great effect on the effectiveness and efficiency of the component mixing and the washing system.

PRESSURED AIR: A REVOLUTION IN MIXING HEAD CLEANING

Cannon has always been very aware of environmental issues, developing many years ago the EcoCleaner, a mixing head cleaning system which allows the use of chlorine-free cleaners. Depending on the cleaner used, the final mixture is generally a non-toxic waste that, in some cases, can be disposed of as urban waste.

The Cannon EcoCleaner is really a “closed circuit” washing unit which can use these environmentally friendly cleaners for a very long time, without requiring any direct maintenance, and with the big economical advantage that the cleaner can be recycled on the

production line (in comparison with those systems where the waste must be disposed of after each pouring).

With this system, mixing head cleaning is highly efficient for all formulations and results in the working time between maintenance cycles being increased.

Although having a washing system with very low environmental impact, the constructional features of the B1 Multi head have stimulated and given a new impulse to improving the already excellent washing technologies in use.

In this context a project was started which investigated the use of pressurized air as a cleaning agent, which could integrate the action of liquid detergent. In collaboration with some selected customers an intense testing activity was undertaken in the most demanding working conditions.

And what better analysis could be performed than that concerning the effects of the incompatibility between polyurethane and silicone mixtures. This aspect, as well as having effects on the conception and design of a metering and mixing unit which will use both materials, must be able to guarantee the perfect cleaning of the parts where the components meet and mix to ensure the quality of the final foam and be able to manage the passage from one material to the other quickly.



Figure 7. Cannon EcoCleaner Washing System

It is a well known fact that silicone is an additive, which is used in dispersion in polyol to stabilize the polyurethane foam and prevent collapse. The metering of this component must however be extremely accurate because outside the allowed tolerances of each formulation, the presence of a greater or smaller quantity of silicone would in each case cause the expanded foam to collapse.

Thus, while in the passage from the use of polyurethane to silicone the imperfect cleaning of the mixing chamber would not affect the quality of the primary product, the passage must instead be managed with greater care as any residues of silicone would irremediably contaminate the polyurethane foam making it unusable.



Figure 8. Street Lamps with Silicon Foams



Figure 9. Cover for Street Lamp Post



Figure 10. Emergency and Outdoor Residential Lamps

Thanks to the results reached one can show how implementation of a mixing head washing process based on the use of repeated jets of air at high pressure can reduce the use of unchlorinated ecological detergents by 75% and reduce the relative costs of management and disposal. Moreover, using air one can remove more foam residues in the form of solid already reacted waste, which is cheaper to dispose of.

The washing cycle developed by Cannon for the B1-Multi head is essentially based on the combined and sequential action of pressurized air and the Ecocleaner device: this explains why there are six injectors on the mixing head (four for the components, one for the air and one for the ecological cleaner).

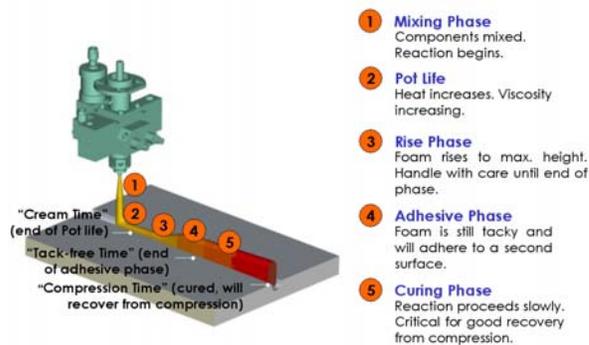
SOME STEPS BACK: WHAT IS CANNON FOAM-IN-PLACE TECHNOLOGY?

To better understand the growing and changing gasketing market it is better to first answer the question “What is Cannon Foam-In-Place technology (FIP)?” It is a pouring process to produce a foamed gasket, which is applied as a liquid or semi-liquid, and cures to a solid on the substrate.

The foams can be made of one component, such as hot melt or cured urethane moisture; or two components, such as polyurethane or silicone.

One-component foams are produced by mechanically mixing air into resin, while two-component foams are produced by a blowing reaction in the blended material. In both cases, the liquid or semi-liquid material must be applied to the substrate very accurately since curing will occur wherever the material is applied.

The FIP chemical formulation is accurately metered by a low-pressure dispensing mixing head: Isocyanate



and Polyol for polyurethanes or A and B components for silicones. The materials are combined at ratios from 1:1 up to 10:1 depending upon the physical properties desired.

The mixing head, generally mounted on a manipulator arm, follows a predetermined pattern on the part to be gasketed. After the material is distributed, the chemical reaction begins and a resulting increase in viscosity allows the FIP gasket to remain in the exact location where it was applied. The material will then begin to adhere to the substrate and cure. Typically, the length of the cure is directly correlated to the physical properties desired. The longer the cure time of the FIP gasket, the better the compression set properties of the final product. It should also be noted that the compression set properties are dependent upon the chemical formulation used.

FIP products are used for seals and gaskets: a seal implies that the space between the surface and the material does not separate, while the gasket surfaces are opened and closed. Both seals and gaskets can be used to insulate, dampen out vibration or sound and prevent the passage of air, particles or water.

The typical market for FIP has been to replace the current technology of strip, die cut and molded gaskets. FIP products offer a price advantage over other gaskets, particularly where compression and recovery of physical properties is desired. Perhaps the most important value of FIP gaskets is the benefit of the foam actually tearing before delaminating from the substrate.

WHY FIP GASKETS?

The Cannon Gasketing process offers several advantages, not only from a cost point of view, but also technologically and in the quality of the final product. In order to achieve a very accurate gasket lay-down, allowing high repeatability and consistency in the process, meeting quality standards and reducing any possible production scraps, the foaming phase must be robotically (not manually) assisted.

Since the resulting foamed gasket is continuous with no recognizable joints or cut ends, the foam in-situ gasket is characterized by excellent performance in comparison with other kinds of seals. The material, during the curing phase, forms an external skin eliminating any open cells on the gasket surface, guaranteeing a superior barrier against potential leakages.

High levels of automation mean that only one single operator is needed to drive the entire system, representing a significant reduction in labor cost, which is often a high proportion of the total cost of a seal or gasket production. Gasketing lines can sometimes be integrated in the part production line, with full automation requiring no operators at all. Furthermore, since the foam in-situ process foams the gasket with perfect adhesion onto a wide range of substrates of the end product, significant cost savings can be achieved, as additional finishing stages, such as gasket gluing and assembling, are no longer required.

Last but not least, other economical benefits lie in the fact that:

- a gasket inventory is no longer required
- the flexibility of the Cannon foaming process enables the processor to create a dedicated gasket (exact dimension and pattern) according to his current specific need
- Cannon Gasketing is a “room temperature” technology: no heat is required for the chemical reaction, so there is no increase in energy consumption
- the raw materials cost less than those used to produce other kinds of gaskets.

All these factors contribute to an investment payback in very reasonable time.



Figure 11. Electrical Cabinets with Standard and Thixotropic PU



Figure 12. Covers



Figure 13. Floodlight with Silicon Foams

CANNON GASKETING TURNKEY SYSTEMS

The multi-component Cannon Gasketing technology has typically been applied to the electrical enclosure, lighting, automotive and appliances markets. The main reason for this is based upon the market efforts to cut costs, add flexibility on process and continuous quality improvements in the final part, customer acceptance of the gasketing material and the improvement of the automated turnkey system.

Cannon has applied its manufacturing philosophy - to be at the customer's disposal to provide bespoke, engineered solutions, and increasingly featuring higher process flexibility to suit a wide range of production needs and quick production changeovers - to this specific market, and has become in a very few years a worldwide supplier of complete Gasketing production systems.

A typical Cannon Gasketing turnkey plant for electrical door and cabinet is composed of a multi-component low-

pressure metering unit, three-axis Cartesian manipulator for mixing head handling and the shuttle tables complete with fixtures where the parts are manually positioned. The parts loaded with the tooling on the platens are foamed while a second platen is unloaded/loaded for the next batch run of parts.

As usual at Cannon, dedicated solutions can be engineered according to the specific needs of each customer, providing complete technical support and possibility of trials prior to the purchase of a complete foaming island.

Consequently with the kind of part and material to be foamed and relevant compatibility, the production process can include committed surface treatments: e.g. plasma ray, gas flaming, chemical primerization etc.

Moreover, on demand many other technological devices can be synergically integrated to the plant, such as: visual control systems to ensure the respect of the requested quality standard and the automatic handling, positioning and identification of the parts to be foamed.



Figure 14. Standard Gasketing Plant with Cartesian Robot and Shuttle Table



Figure 15. Plasma Treatment

LOW-PRESSURE MULTI-METERING UNITS FOR GASKETING

The range of available Polyurethane low-pressure metering units has been enlarged, consolidating the presence of Cannon in sectors where micro-pourings and small outputs are required, and opening new interesting opportunities towards what are generally called “Specialities”: metering equipment is also suitable for silicones, epoxy resins and elastomers.

Progress is driven by the ever-growing market demand for metering machines requiring simplicity of management, high technical and quality standards, efficiency and reliability, with the need to keep investment costs low to produce more and implement highly-automated processes.

Cannon low-pressure Gasketing machines are the actual response to these needs for several reasons: they are the sum of the experience gained in dealing with hundreds of different projects and of the analysis of the inputs collected with constant and close cooperation with the customers.

These metering units can solve the production problems of small and medium-size businesses, combining simplicity in operation with advanced technological content, guaranteeing the highest level of performances and final product quality.

Also this industrial solution well represents the Cannon philosophy of independence from the chemical suppliers. In fact the metering and mixing equipment can process different formulations from different chemical suppliers and have the flexibility to use any kind of chemical system suitable for these applications.



Figure 16. Cannon Gasketing Three Component Dosing Unit

An unbeatable support that Cannon’s customers recognize as a plus is the opportunity to have full access to the Cannon Laboratory facilities, where dedicated trials can be planned in order to evaluate chemicals, test machinery and foamed gaskets and clarify all their possible technical requirements before the final order of the equipment is awarded. Further development of the process continued in the Cannon Lab throughout the evaluation phase of the manufacture.

PART HANDLING SYSTEM

The handling equipment covers the moving and placing of parts in the correct foaming position, holding parts in position during the foaming process, removing them from the process area after foaming and storing them during the polymerization period.

A variety of different solutions are available depending on part size, productivity required, space availability and possible fitting into existing production lines, such as:

- automatic buffer loading system complete with conveyor belt, a variable-geometry holding system for the different part sizes and a pallet racking system for foam in-situ parts;
- shuttle-tables available in different sizes and dimensions;
- n-position foaming drum, reducing space and increasing plant productivity;
- pallet carousel line;
- double and multi-position turntable.

Obviously, dedicated solutions can be engineered according to each customer’s specific needs.

MIXING HEAD HANDLING SYSTEM

The quality of the end product greatly depends upon the correct and precise pouring and distribution of the foamed gasket. For this reason, Cannon has developed dedicated automatic mixing head handling based on a Cartesian system (with one or two movable axes and also available with one or two programmable pouring stations) and able to follow complex patterns with extreme accuracy and repeatability.

Cannon Cartesian handlings are driven by a proprietary electronic control supplied with an easy interface for the simple setting of all the production parameters, such as output and pouring values, different speed and acceleration ramps at the beginning and end of the patterns to obtain accurate overlapping.

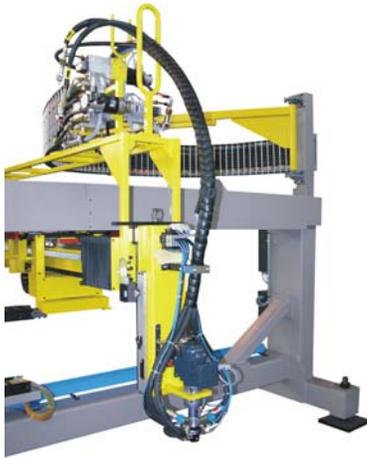


Figure 17. B1 Multi on Cannon Cartesian Robot



Figure 18. Cannon B1 Multi on ABB Anthropomorphic Robot



Figure 19. Cannon B1 Multi on KUKA Anthropomorphic Robot

In order to meet the widest customer production needs and technical specifications, offering more and more flexibility to end-users, a compact and rational complete production package has recently been designed based on anthropomorphic robots purchased from market-leading manufacturers.

This solution offers maximum flexibility in terms of complex gasket geometry to be poured and is a real space-saving installation: less than 10 sqm are required for robot, metering unit and washing system.

CONCLUSION

Cannon "Foam-in-Place" gasket technology has proved to be very successful, whenever and wherever it has been applied, such as in the automotive, electrical, appliance and lighting fields. Since its launch on the market the Cannon multi-component plant configuration has immediately gained great success and in less than two years a significant number of projects have been completed worldwide and, which is worth mentioning, close to the usual "advanced" markets, new sales opportunities have been also taken in North America, Eastern Europe, South America, Middle East and Far East countries.

Cannon's extensive experience and developmental laboratory has allowed our customers to realize Foam-In-Place as a viable opportunity for increased part quality as well as reducing overall part costs. FIP technology has provided customers with the unique ability to reduce inventory, add flexibility to the manufacturing workspace and increase the quality of the final part.

Cannon has the ability to globally respond to all technical aspects and engineering requirements in terms of project development. The industry requires full co-operation with the machinery manufacturer and raw material supplier from the beginning of the project to obtain the desired properties of a customized industrial solution.

Cannon activity is improving more and more in the foamed "in situ" gasket technology. Today the market fully recognizes Cannon as a first level supplier because of the high quality and performance of their installations and the specific technical and technological service supplied all around the world. Further to this, new upcoming applications and new market openings have allowed Cannon to exploit interesting business opportunities.

BIOGRAPHIES

Christian Cairati



Christian Cairati – born in Milan, Italy, in 1970 – has a technical background specializing in Plastics Technologie, a Masters in Quality System Management and Marketing & Communication Management. After several years spent in plastic processing companies as production manager, he worked for the Italian Association of Plastic Processing Machinery Manufacturers – Assocomplast as quality and marketing specialist. After a couple of years spent between South Africa and Great Britain working as marketing and communication assistant for the larger plastics technology dealers, he joined Cannon Afros in 2001, as Company Communication Manager.

Robert Pierce



Robert Pierce is a Product Manager at Cannon USA specializing in the Filter and Gasket Markets. He has been with Cannon for 13 years, and has contributed to Cannon with various previous positions of Technical Service Representative, Project Engineer, and Project Manager. In 1991 Robert graduated from the Pennsylvania State University, Behrend College, with a Bachelor of Science Degree, majoring in Mechanical Engineering Technology.