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Fabrication of wing assembly

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ABSTRACT

Missile wings are used to control the surfaces and produce lift on the body. The wing includes a number of components like panels, lock tab, pins, tubes, and lamina. The performance of the actuation system plays a decisive role in determining the performance of the flight control system for a highly maneuverable missile. To produce the lift on aerodynamic control surfaces called wings. The manufacturing processes of wing components involve different operations like CNC milling, drilling, wire cut EDM, grinding, heat treatment and inspection.

Keywords— *Wing, MDN250, SAE4340, 15-5PH steel, 17-4PH steel, CNC, Stability, Aerodynamics*

1. INTRODUCTION

Aerodynamic controlling surfaces are used to control the missile. Fin, wing and tail are the three major aerodynamic control surfaces used to steer the flying object. A wing is a type of fin that produces lift, while moving through air or some other fluids. The wing or main lifting surfaces of a guided weapon are usually fixed. Wings have streamlined cross sections that are subjected to aerodynamic forces and act as airfoils.

Major important item in an aerodynamic missile configuration is wing or main lifting surfaces. Wing control is commonly used for longer range missiles. Wings are provide on the missiles near the center of gravity or fixed on the missile motor. The primary advantage of wing control is that the deflection of the wing produces a very fast response with little motion of the body. The major disadvantage of the wings must usually be quite large in order to generate both sufficient lift and control effectiveness, which makes the missiles rather range overall. In addition, the wings generate strong vortices mass adversely interact with the tails causing the missile to roll. Generally wings have the same role as in an aircraft by providing lift. Wings are the oldest type of control surface. Moreover, wings cannot work independently and most cases used as vortex generator for efficient working of fins. Wings are mostly used subsonic cruise missiles. The problem is that the wings must be long enough to produce necessary lift.

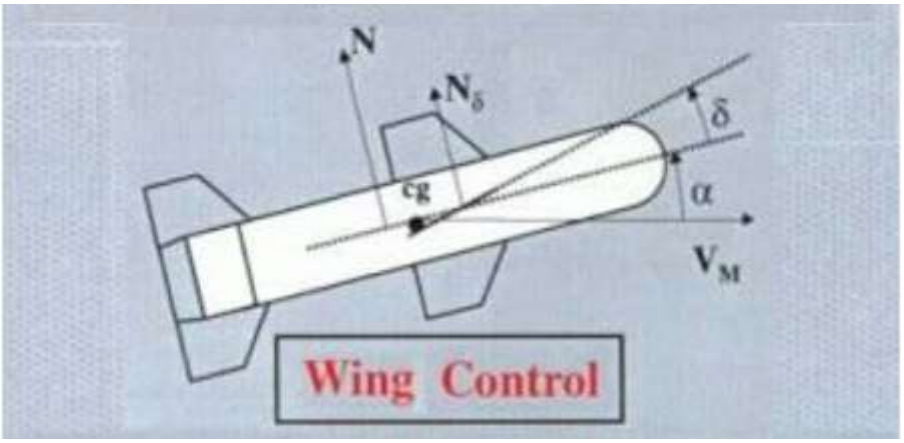

Fig. 1: Wing control

Missiles have four wings. They are arranged 90 degrees to each other. Wings are move clockwise and anticlockwise direction and takes folding and unfolding movement. Wings are fixed front side of the missile motor casing. They are fixed center of the missile or near centre of gravity for mass balancing.

2. MANUFACTURING PROCESS OF WING

The manufacturing processes of wing components starts with raw material inspection, material cutting, heat treatment and other machining operations followed by inspection. The list of components and their manufacturing processes are listed below

Table 1: List of components and their manufacturing processes

Nomenclature	Material	Quantity	Machining operations
Inboard panel	MDN 250	4	Raw material cutting, conventional and CNC milling, heat treatment, wire cut EDM, grinding and inspection.
Outboard panel	SAE 4340	4	Raw material cutting, drilling, CNC milling, heat treatment, grinding, water jet cutting, and inspection.
Lock tab	Custom 465	4	Raw material cutting, drilling, milling, turning, heat treatment, grinding and inspection.
Hinge pin	15-5 PH	4	Raw material cutting, turning, drilling, wire cut EDM, heat treatment, grinding and inspection.
Lock spring	15-5 PH	4	Raw material cutting, rough turning, CNC turning, grinding, inspection.
Inboard tube	15-5 PH	4	Raw material cutting, turning, drilling, EDM, heat treatment, grinding and inspection.
Outboard tube	15.5 PH	4	Raw material cutting, turning, drilling, heat treatment, grinding and inspection.
Lamina	17-4 PH	88	Raw material cutting, CNC turning, drilling and final inspection.
End lamina	17-4 PH	96	Raw material cutting, rough turning, CNC turning and inspection.

2.1 Manufacturing process for wing inboard panel

Wing inboard panel contains different machining operations. They are raw material cutting, conventional and CNC milling, drilling, heat treatment, wire cut EDM, grinding and inspection.

2.1.1 Inboard panel processes flow chart

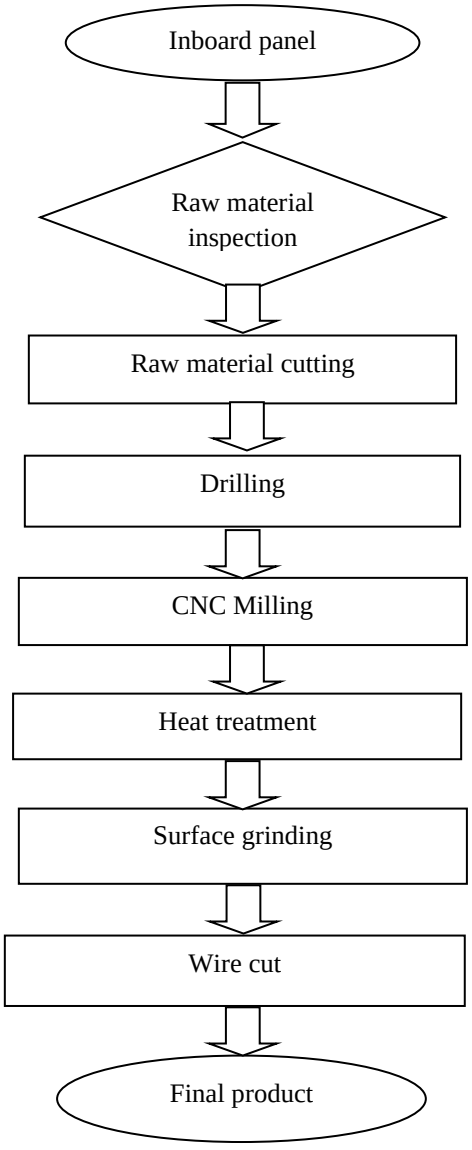

Fig. 2: Inboard panel processes flow chart

Fig. 3: Inboard panel wing

2.2 Manufacturing process of wing outboard panel

SAE 4340 stainless steel is used for outboard panel discussed in chapter 4. Manufacturing of outboard panel have different operations like raw material inspection, CNC milling, grinding, heat treatment and wire cut EDM.

2.2.1 Outboard panel flow chart

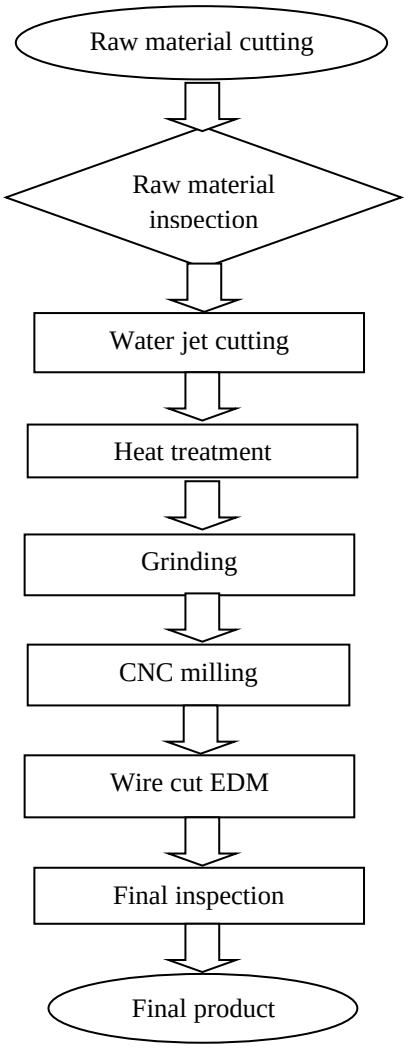

Fig. 4: Outboard panel flow chart

Fig. 5: outboard panel

3. WING ASSEBLY PROCESS

Assembly is a lengthy process involving several automated and manual steps. Each of these steps must be executed properly by paying utmost attention to detail. Minor error in any of the step in the assembly process will lead to the failure of the final assembly.

Before the actual assembly process manufacturers thoroughly check the PCB design file to check the functionality and manufacturability. This stage, which is termed as DFM, checks design specification of a PCB, whilst analyzing any missing, redundant or potentially problematic features. The stage helps detect design errors and allows the designer to instantly clear all the flaws, which in turn leads to successful production.

An assembly line is a manufacturing process in which parts are added as the semi-finished assembly move from work station to work station where the parts are added in sequence until the final assembly is produced. By mechanically moving parts to the assembly work and moving the semi-finished assembly from work station, a finished product can be assembled faster and with less labor than by having workers carry parts to station piece for assembly.

In wing assembly inboard panel is the base and it has radius in the base. And it is welded to the motor casing in the missile. After welding process heat treatment is produced on the panel. Then the lock spring is arranged on the inboard panel in the reference hole and lock tab is fixed above the spring. Lock spring and lock tab are used to control the moving mechanism. Hinge pin is fitted on one end of the wing and inboard tube front and outboard tubes are assembled on the other end of the inboard and out board panels. Inboard and outboard panels are attached with the help of tubes and pins. All the parts are assembled as per the CAD modeling.

Fig. 6: Wing assembly

4. INSPECTION

Inspection is the means by which poor quality is detected and good quality is assured in products that are produced in a production process. Inspection is usually carried-out manually via the use of various technologies that examine specific variables (quality characteristics of the product), or product attributes (to ensure product conformance to previously-set standards).

4.1 Co-ordinate measuring machine

In co-ordinate metrology the actual shape and dimensions of an item are measured, and compared against desired shape and dimensions, as might be specified on a part drawing. Co-ordinate measuring machines (CMM) is an electromechanical system that has been designed to evaluate relevant dimensions of an item against a required standard.

A coordinate measuring machine is a device for measuring the physical geometrical characteristics of an object. The machine is manually controlled by an operator or it may be computer controlled. Measurements are defined by a probe attached to the third moving axis of this machine. Probes may be mechanical, optical, laser, or white light, amongst others. A machine which takes readings in six degrees of freedom and displays these readings in mathematical form is known as a CMM.

A coordinate measuring machine is also a device used in manufacturing and assembly processes to rest a part or assembly against the design intent. By precisely recording the X, Y and Z coordinates of the target, points are generated which can then be analyzed via regression analysis for the construction of features. These points are collected by using a probe that is positioned manually by an operator or automatically via direct computer control (DCC). DCC CMMs can be programmed to repeatedly measure identical parts, thus a CMM is a specialized form of industrial robot.

Fig. 7: Coordinate measuring machine

5. NON CONTACT MEASURING MACHINE (FLASH200)

A non – contact measuring machine (Flash 200) is a device for measuring the physical geometrical characteristics of an object. The machine is manually controlled by an operator or it may be computer controlled. Measurements are defined by laser sensors.

The OGP Flash 200 is a full-featured benchtop automatic measurement system, and the smallest member of the Flash family of digital measurement systems. Innovative design features offer an "elevating bridge" and an embedded computer which means the system takes up little space on a bench top while providing an ample 200mm x 200mm x 150mm measuring range and extensive measurement capabilities. And it has an accuracy of 4 micro meter in X & Y axes and 5 micro meter in Z-axis.

The Flash 200 has patented innovations that let you do more, and do it faster. The computer controlled LED array backlight tracks X-axis motion of the optics with no moving parts. Smart Ring light is standard for the ultimate flexibility in surface illumination. Flash 200 is multi-sensor capable and comes standard with a high quality Zoom 12 Accu-centric zoom lens that auto-calibrates with every magnification change.

Fig. 8: Non-contact measuring machine (flash 200)

6. CONCLUSION

The assembly of wing components can be inspected on Co-ordinate Measuring Machine (CMM) and Non-Contact Measuring Device (Flash 200) for precision. It reveals the fact that missile wing assembly requires inspection for each component manufactured to follow the process flow chart at their level for direction control to prevent the defective components.

These components are used on missiles and hence require to be highly precisely machined for an Aerospace component. How the component is machined and manufactured with all its accuracies and clearances required to assemble these components. The quality and inspection methods adopted were observed and studied in great detail. Each and every part of the component is checked for its accuracy and all these details are recorded.

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