shot-peening contour-forms and strengthens wing skin

Controlled peening with steel shot contour-forms wing skins for DC-10. Increased fatigue strength is a by-product.
Automatically Fed Punch Press

At the Heintz Div. of Kelsey Hayes, Philadelphia, a USI-Clearing coilfeed line automatically feeds a 500-ton, 4-point Clearing press. Operation is hands-off and the highest order of efficiency prevails, including the matter of changing dies. Satisfying the replacement automotive market with fenders and doors for models produced as far back as 11 years is the responsibility of the Heintz Div. Short-order runs demand the utmost in automation.

Die setting, with powered bolsters and hydraulic die clamps, is done in two or three hours including the matter of adjusting the press, setting the feed and producing the first trial part.

New HF Weld Process

A new “current penetration” welding process adopted in the auto industry, as well as applications of beam, tube-finning, and other weld processes in other industries, are reported in Newsletter No. 12 issued by AMF Thermapool, Inc., New Rochelle, N.Y. The four-page publication will be of particular interest to design and manufacturing engineers and management in the auto industry, as well as in other metal fabricating and using plants.

Materials and blanking press cost savings are cited for adoption of the 10 Kilohertz “CP Bar Butt” process for joining auto frame blanks. Brief items reported include “traveling” tube welding mills in a Canadian plant, increased usage and profitability of HF-weld tube finning mills, and the first use of an HF-weld structural shapes mill in a steel service center.

Patent For Roll Forming System

A U.S. patent has been awarded to Howard A. Greis, president of Kinefac Corp., Worcester, Mass., a subsidiary of MPB Corp., covering a roll-forming machine system for producing annular parts such as the outer races of bearings. This new development offers significant advantages such as higher productivity, lower material costs and superior quality parts, it is claimed.

In the rolling system, an essentially cylindrical or annular blank is placed inside a female die which has an axial constraint at one end. A male die is inserted within the blank after which a pair of driven rolls engage the female die at one side and the male die at the opposite side. This forces the two together and provides the necessary rotational torque.

Clip Angle Press

A second-generation clip angle machine will now punch and shear clip angles in one operation. Development work has been completed by W.A. Whitney Corp., Rockford, Ill., on the 845-A Clipmaster, which will process long lengths of angle (64 feet) through the machine with an automatic feed system, punch both legs of the angle—either single or double row (second pass required)—and shear the clip angle to the required length with a repetitive accuracy of ±1/32 inch. No layouts or templates are required.
By Albin G. Troka, Engineering Editor

Serving the aircraft industry for over 20 years, Metal Improvement Company's Peening Divisions have "controlled" shotpeen formed aluminum wing panels of numerous models of aircraft. Representing expanded use of the process are 11 plants strategically located in the U.S., Canada and England.

At the Toronto plant, 80-foot long wing skins are contoured by shotpeening for the McDonnell Douglas DC-10 jetliner. The Carlstadt, N.J., Div. is currently forming the F-15 wing skins and Grumman's "Intruder" center section cover. The new Northrop "Freedom Fighter" and Lockheed anti-submarine "Viking" wing skins are done at the Los Angeles Div. Also, an NC machine, designed and built by Peenamatic, shot-peens the center section of the Grumman F-14 aircraft at Farmingdale, N.Y.

Metal Improvement Co. is a subsidiary of the Curtiss-Wright Corp., a veteran in aerodynamics.

Shot-peen forming is a die-less cold-work process where the surface of the finished part is bombarded with round steel shot in special machines under fully controlled conditions; namely, size of ball used, velocity of the ball, and distance of wheel modules or nozzles from the part to be worked. Every piece of shot acts as a tiny peening hammer.

Aluminum wing panels formed and saturation-peened at the MIC Toronto, Canada, plant vary from 5 to 7 feet in width and tapering to 18 inches at the outboard end. Wing panel lengths vary from 38 to 80 feet. Thickness of panels are compound tapers, tapering from inboard to outboard, forward to aft.

The main wing tank structure is covered with three upper and four lower panels, all differently shaped. Upper panels are 7075-T651 while lower panels are 2024-T351 aluminum alloy.

Wing panels are normally trimmed to size after shot-peening, although there are applications where panels are finished—machined before shot-peening. Here, contour dimensions are precisely controlled so that the wing panels are ready for post-process treatment.

The DC-10 panels are first placed on a 100-foot long mobile table, and then drawn through the shot-peening machine. The speed of the sled is part of the peening sequence program. The entire surface of the table-mounted wing panel travels under the enclosed blast mechanism. This machine has six centrifugal wheel modules, each firing a shot pattern that covers 1/6 of the skin surface. It delivers 1,800 pounds of shot per minute.

The unique mobility of the wheel module gives precision control of shot stream direction, intensity and forming pattern. This mobility allows "mid-stream" changes or corrections. These modules are self-contained, airless, hollow center-fed with reversible blades. The wheels are hydraulically moved perpendicular to the skin plane.
and at right angles. Wheel speeds and locations are operator-dialed to satisfy individual panel requirements. These wheel speeds determine the wing panel shape. Steel ball velocity is up to 300 fps. An average wing area of 304 square feet is shot-peened to a maximum gap tolerance of 0.060 inch.

Contour forming may also be carried out by an air blast gantry and at other stages. In this operation, both sides of a panel are peened to stretch the metal. By varying the intensity and pattern of coverage, angles from 3 minutes to 3 degrees are obtainable within a single panel.

Quality Control

Control procedures on the DC-10 wing skin program are very detailed. Step by step operations are outlined to carry the part through the shot-peening process to completion. These procedures call out specific check points to validate the accuracy of the peening, accuracy of the intensities utilized for saturation peening, accuracy of the pre-stressing where pre-stressing is utilized, and finally surface accuracy of the sanding, which is one of the final operations.

Although a reasonably accurate standard procedure can be established, slight variations in the original billet may enforce departures from such standard. A knowledge of what to do based on previous experience plus the capability of equipment to adjust parameters remain as basic requirements, in this work.

QC Follow-Through

Wing panels arrive from the mill aboard flatbed railroad cars, stacked in horizontal layers. They are carefully unpackaged and each serial number verified to assure that materials are properly certified and registered. Next, the skins are inspected for possible damage and any evidence of corrosion.
Once approved, they are moved into storage racks and await scheduling to the shot-peen machine.

A permanent job number is assigned which remains with each unit throughout processing to shipment. In addition, routing and inspection documents accompany the skin through each process step, from receiving, inspection, degreasing, through the peen-forming. Traceability is an F.A.A. requirement.

Female checking fixtures are used to qualify wing panel contour. These “gages” consist of rigid, solid steel frames with aluminum boards which can be exchanged for left or right contours.

Qualified wing skin is moved to a decontamination area for cleaning. A special solution is used to remove the tiny steel particles of shot-peened media from aluminum surfaces. A totally clean surface is necessary to facilitate anodizing. This is done after the wing panel is final-trimmed at the Douglas plant.

At this point, the shot-peened wing panel is placed on trestles where both sides are sanded. The exterior surface of the lower panel is finished to 40 rms or better. Other surfaces are sanded to 63 rms.

Now, a final contour check is made. Then, each unit is moved to another area where a mylar chart overlay is used to locate final thickness checkpoints. Readings from an ultrasonic digital caliper device are documented to record the final thickness of the skin panel. They are then rubber stamped, oiled and wrapped for temporary storage to await shipment to the nearby Douglas Aircraft assembly plant in Canada.

Tools Are Important

Maintenance of contour checking fixtures for the DC-10 wing forming program has top priority. Inspections
This 84-foot long completed wing assembly for DC-10 jetliner will eventually be shipped to Douglas Aircraft Co., Div. of McDonnell Douglas Corp., Long Beach, Calif.

are made periodically and fixtures leveled, where necessary, to within 0.010 inch, end to end. Optical methods are used to maintain these tolerances from a 90 foot distance.

Machine maintenance is also important. All functioning or moving members of the machine are constantly checked for calibrated function rates.

Wheel speeds are checked on a scheduled basis. Repeatability in the forming process is related to the accuracy to which the process parameters are controlled. Since it is the kinetic energy of impact which forms the wing skin, variation in energy level through faulty equipment could result in a loss of contour.

The Toronto plant is said to be the only one in the industry specifically designed and built for wing panel forming. Team work is attributed to the amazingly short time in which the facility was created. From contract signing to on-stream shot-peen forming production required only four months. While the plant was being built and equipment installed, the company’s Carlstadt, N.J., division was used to train Canadian personnel and produce parts for the first DC-10s.

In addition to forming metal parts, the process imparts greater resistance to fatigue failure and stress corrosion cracking in susceptible alloys. This is accomplished by providing a preferential compressive stress on the surface.

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