FOREIGN TECHNOLOGY DIVISION

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ABSTRACT: In a discussion of aircraft assembly, the author points out that rivets are not only heavy but also impair the structural property of an aircraft because holes are punched in its walls. As a result, welding and gluing are finding wider application in aircraft assembly. Both techniques are described briefly and it is then observed that their only drawback is that the parts thus assembled usually need more extensive inspection. Finally, the author discusses the hermetic sealing technique. Hermetic seals are essential for high-altitude flying. Three types of seals are considered: (1) Surface seal, where the sealing material is applied to the whole surface of the assembled aircraft. (2) Seam seal, where the sealing material is applied only between the joints of the plates and between the rivets, screws, etc. (3) Compound seal, a combination of the first two types. Orig. art. has: 7 figures. English Translation: 7 pages.

AIRPLANES: ADVANCES IN ASSEMBLY TECHNIQUES

Advances in the Assembly Technique of Airplanes, II. Welding·Plastic Cementing·Hermetic Sealing

Wu Chen-wen

In the case of airplanes, a decrease in weight of 1 kilo has tremendous significance. However, riveting not only increases the weight of the airplane but also requires the drilling of holes on it which affects the strength of the structure of the plane. In the future, welding and plastic cementing will take the place of riveting.....

OTHER ACCESSORIES

Supersonic flying adds many small adjustments to the airplane. For example, the position of the current adjusting cone in the intake of the engine needs to be regulated so that the formation of the "excited wave" is located at the most beneficial position. In order to increase the efficiency of the engine, the area of the tail jet has to be continuously adjusted. These minor adjustments can all be accomplished by accessories. The adjustments, however, have to be very precise. Deviations of several millimeters are not permissible.

In addition, various other accessories are also used in the plumbing system on the airplane. For example, when we carry out a surgical operation, the blood vessels need to be clamped to prevent an excessive loss of blood. When an airplane is in the process of major repair, it is also necessary to cut it in halves. When the front part is separated from the rear without the use of clamps, the oil pipes will automatical-

ly stop the oil flow. This happens because the "self-sealing valves" designed by accessory designers are functioning.

If we had a cut in the skin, in a short time the blood will coagulate by itself. This is due to the action of the blood platelets and coagulin. When the pipe lines in an airplane are damaged, is it possible that fuel will continuously flow to waste? No. This will not happen, we have our "flow adjuster" at work.

With the continuous rise in flying altitude and speed, the working condition of the pilot is also continuously turning worse. For example, at an altitude of 20,000 meters, the air is already relatively thin. The pressure is only 41 mm mercury column which corresponds to 0.54 of that of the surface pressure on earth which calls for hermetic sealing of the cabin, a "cabin pressure regulator" and "safety valve of cabin pressure" and, other accessories to safeguard that the pressure in the cabin does not become too low. When the flying speed reaches twice the speed of sound, the temperature on the surface of the airplane reaches 117°F. If air at this high temperature is directly led into the cabin, no pilot can stand it. This requires then a "heat dissipator," "turbine cooler," "evaporator" and other accessories to exercise their skills.

We shall not mention any more examples here. In all, at the technical advances of airplanes to this date, the functions of accessories have assumed tremendous importance. Their design and manufacture have become one of the most important components in aviation industry.

WELDING

According to the statistics made abroad in 1962: in the joining technique used on airplanes in the world, welding constitutes 30% while estimates for ten years from now would indicate an increase of welding to about 60%. The extensive use of welding in aviation industry

dates sometime after 1955. According to newspaper reports there is a kind of mid-air refueling plane which has 900,000 welding spots. A jet passenger plane has also about 30,000 spots. In some countries, the number of spot welding machines used in airplane manufacturing plants have increased four and a half times from 1958 to 1963. At present, on an airplane with the largest amount of welding jobs, the labor spent in welding has come to 70% of the total labor. In the assembling of airplane parts, the main part of welding is spot welding and roll welding. Welding is applied very extensively especially in the case of the assembling of certain stainless steel parts. It has replaced riveting. But, the inspection procedure of welding is more complex and the mastering of the welding technique is also highly complicated. The whole picture is still that spot welding and roller welding are more economical than riveting. They also have the special advantages in the better outward appearance of the aircraft and the airtightness of the cabin.

Figures 1 and 2 show the equipment used in spot welding and roller welding.

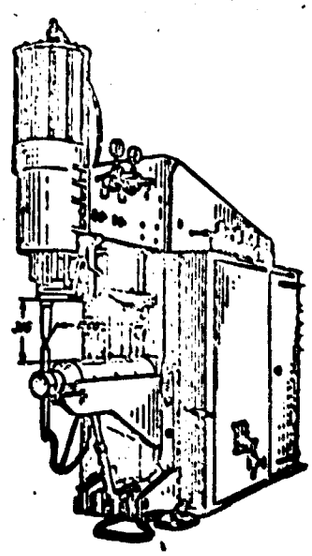

Fig. 1. Spot welding machine.

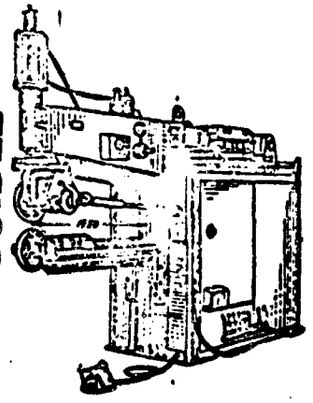

Fig. 2. Roller welding machine.

PLASTIC CEMENTING

In recent years, plastic cementing has developed to be a new method of joining which has gained rapid advances in the airplane manufacturing industry. According to reports: in 1944, structure of metal-to-wood joints have been used abroad on bombers. Later on, this type of plastic cementing is also used on jet airliners and jet bombers. There is a bomber model, the body and the wings of which are 90% made of a honeycomb structure. Part of this honey-comb structure is made up of two aluminum plates sandwiched together by a plastic cement (Figs. 3 and 4). The metal rotating blades of helicopters are classical examples of this type plastic cemented honeycomb structure.

The testing requirements of plastic cementing are more in number and this is one of the drawbacks of plastic cementing. Most metal-to-metal joints require such testings as fatigue, shear, and impact, etc. In the case of honeycomb structures, besides the above-mentioned tests it has to go through some special testing such as rupture of the cover, vibration, etc.

In the process of plastic cementing, inspection work is of utmost importance. In the airplane manufacturing plants of many countries, strict rules on the inspection of plastic cemented joints are established. In the last few years, the use of supersonic waves in the inspection of plastic cemented joints is widespread. But, in the actual fulfillment of plastic cementing, the simple technique of hitting it and listening carefully to the sound it produces is still very much in use by most inspectors.

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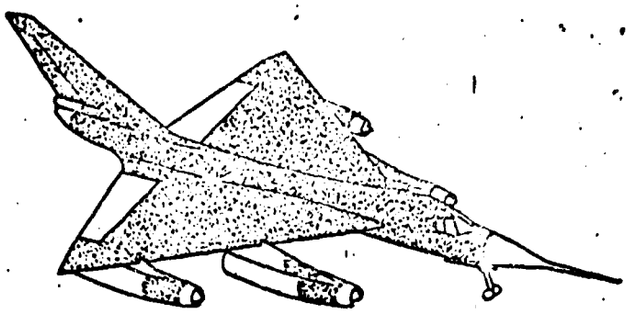

Fig. 3. One type of bomber the body and wings of which are made up of 90% of honeycomb structures.

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Fig. 4. Plastic cemented honeycomb structure.

THE DEVELOPMENT OF THE HERMETIC SEALING TECHNIQUE

Ever since the appearance of a hermetically sealed cabin suitable for flying at high altitudes, there also appears a technique of guaranteeing the tightness of the sealing. Prior to this, although certain parts of the plane need to be tightly sealed to prevent the seepage of rain and water, but these require only rather simple techniques. Lately, the range of the application of the hermetic sealing technique gets to be larger and larger. The area that needs to be sealed also becomes larger and larger. Practically the cabins of all military planes and commercial passenger planes adopt this sealing technique. The wings of many planes have become hermetically sealed fuel storage spaces, which make them the integral fuel tanks (Fig. 5). Their common characteristic is that through the use of the hermetic sealing technique and the necessary corresponding materials, the demand of sealing certain parts is met.

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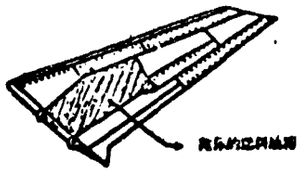

Fig. 5. The positioning of the integral fuel tank in the wing of an airplane. A) An integral unit of a fuel tank.

There are many methods of hermetically sealing an airplane but, in general, they may be divided into three kinds:

1. Surface seal: sealing material is painted over already assembled parts.

2. Crevice seal: the sealing material is plugged into the crevices between the parts to be joined or between rivets and screws.

3. Mixed seal: combining the two above methods and carry out the sealing.

The airtight sealing of cabins is accomplished by the mixed seal method. But with the continuous advances in the technique of sealing and the improvement in the sealing material the structural format of sealing is also continuously being simplified. For example, the sealing of an integral fuel tank was accomplished in the past by pouring the sealing liquid into it after the parts had been riveted. In order to make the sealing liquid flow to every corner, it was necessary to rotate and turn the parts every which way and then pour out the remaining sealing liquid and the inside of the parts baked dry. This working procedure is very complicated. In the last few years, the structure of the sealed integral unit of fuel tanks has become very simple. In some cases, an aluminum envelope or sealing plastic film is installed on the riveting rod. In other cases, a pure aluminum gasket is installed at the rivet. To insure airtightness under simple structural conditions

is one of the most important developments in the assembly technique of airplanes.

In addition to the above mentioned advances in the assembling techniques, soldering has also been very widely applied to the shell of airplanes. The principle of soldering is to join the melting solder to the non-melting metal base. The solder is made of such colored metals as copper, silver and tin. Soldering is one of the forms of making a joint which has been mastered by our ancestors for quite some time. In the manufacture of airplanes, it is used in making electrical connections of wires, and control systems. It has also been used in the manufacture of heat dissipators and low pressure containers, etc. Recently, soldering has also been developed to make joints of structures of stainless steel and heat resistant sandwich structures. But, summarizing all aspects, soldering still lags behind all the other forms of making a joint. We shall not go into the details here.