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SOME IMPRESSIONS OF THE PARIS AERO SHOW

By J. D. North.

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The critical appreciation of foreign engineering products is a task of considerable difficulty. They are as much indigenous as cooking or dress, and arouse easily enough the innate xenophobian instincts which to a greater or lesser degree pervade the human race. To see something different arouses incredulity and even hostility. A writer on psychology has termed this innate hostility to novelties "alexic" because it arises from a train of thought which conveys to the mind some danger of disturbance to its preconceived opinions and to the personality some risk to its reputation, established or otherwise. So was Wagner hissed and Picasso ridiculed; not as foreigners in a national sense, but men of strange ways in their profession.

We ought to put severely out of our minds the idea that our methods are necessarily generally applicable or even, (if it be possible to do so), that they are right. The statement that an engineering product is difficult to make, often on analysis is found to mean that the critic does not know how the product may be or is made, and his criticism is purely a subconscious "alexic" impulse. Although I have outlined the pitfalls that beset the critic, I have not much confidence in my ability to avoid them in giving a critical appreciation of the Salon

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de l'Aeronautique.

Considering first the question of general arrangement one should find here indication of some definite logical purpose to attain, either special aerodynamic advantages, economic structure, manufacturing economy, or special facilities for military functions such as good views, free arcs of gunfire, etc. One very characteristic type of structure arrangement is shown in Fig. 1, types of which are seen in the Nieuport-Delage, 42C and 48C, and in the Breguet type 19 and 26T. A special feature of this arrangement is that in order to obtain a favorable angle for the lift wires or corresponding structure these wires are attached to the landing gear. In the case of the Breguet, a very considerable relief of the compression in the top wing spars is obtained in this manner, while in the Nieuport 42C, a small bottom plane exists to stabilize the long supporting strut to the principal parasol wing. The disadvantage of this type of structure, which offers certain undoubted economies from the point of view of weight, is the limitation placed upon landing gear travel and the susceptibility of the whole wing structure to be damaged by bad ground conditions. As is well known, the shock-absorbing mechanism of the Breguet airplane is accommodated within the wheels, which are of cast aluminum alloy. In the case of the Nieuport, the axle fairing, which is exaggerated almost to a small wing, is extended beyond the landing gear supporting struts so that the shock-absorbing mechanism is carried in bending, and the wheels pushed out far enough to clear the diagonal strut. In the case of the 42 C.1, the wheel is also displaced forward in relation to the diagonal strut. It would appear to be almost impossible to associate this class of structure with the shock-absorbing capacity demanded by English custom. The elastic travel on these airplanes is ample for taxying purposes and for landing under reasonably favorable conditions; but the vertical velocity of descent with which they can deal is very small compared with that of average English practice. Experience of landing gears during the war did not lead to any conclusive evidence in favor of the replacement of elastically sprung landing gears with small travel by hydraulic shock-absorbing devices, but post-war experience of the favorable influence on maintenance, of the more efficient type of shock-absorbing mechanism seems to indicate a real military and commercial advantage.

The alternative type of airplane is a single-seat fighter with parasol wings, as exemplified in the Gourdou-Leseurre. In this case the supporting struts of the parasol are taken from the fuselage and the struts themselves are stabilized by additional structure, following in fact, the lines of the older Morane-Saulnier wing arrangement. This structure is not a light one, and would appear to offer a considerable resistance, but it undoubtedly gives to a pilot a very exceptional forward and downward view. An interesting comparison is obtainable between the Gourdou-Leseurre fitted with a "Jupiter" and one fitted with a Lorraine engine, a slight advantage in performance, particularly on climb and speed at height being indicated for the former. Particulars of the comparative details of the two airplanes were given in "Flight" of December 2, 1926. The internal arrangement of the cockpits of these airplanes is very compact and the bodies are small, but all the single-seat fighters appear to carry no electrical equipment for wireless or lighting, while the positions of the machine guns do not seem ideal from the point of view of accessibility. Whether these deficiencies are serious from a military point of view is a matter of opinion, but there is no doubt that they have greatly assisted in simple and compact body arrangement.

The Dyle and Bacalan, a twin-engined bomber, is constructed on lines which have already been tried, without conspicuous success, in the United States. The very thick section of middle wing on which the engines are mounted, undoubtedly does afford ready engine accessibility, but such aerodynamical information as is available in respect of this type of installation indicates an abnormally large propeller interference.

The airplane as a structure can be interpreted in many varied forms, and its very versatility in this respect allows free rein to the imagination. It is probably true that quite a few airplanes are built in accordance with certain general arrangements in consequence of a "brain-wave" on the part of a designer, who produces a novelty without logically knowing the reasons for the arrangement which he adopts. In some cases the results are successful, and in others the type dies a natural death. There is probably more imagination used in the general arrangement of continental designs than in England, but if sometimes results indicate a stroke of genius there is by no means always any real engineering advantage.

The characteristic arrangement of most of the airplanes at the Salon requires a structure design to withstand very large bending, and in many cases comparatively slight compression loads. This has naturally had a definite influence on the type of spars adopted. The structure of the Breguet 19 and the Nieuport C.21 was shown at the last exhibition two years ago. In the case of the monoplane, or "sesquiplane," the plain box girder of aluminum sheet with laminated flanges satisfactorily meets the requirements of heavy variation in bending moment. As in wings of this class deflection is very important, there will probably be little advantage in using a steel spar with undoubted added complications of manufacture. An example of a steel spar of similar type, intended, I believe, for the Dyle and Bacalan airplane, is shown on the stand of a steel maker. The construction is of similar type to the spar already described; although the web has been lightened to an N girder, the absence of corrugation makes it necessary to use very thick material, and the spar must be heavy. Incidentally, a spar of similar type is shown in aluminum bronze, autogenously welded. Although this material is excellent from a corrosion point of view, it is hardly suitable for light structures on account of the low value of Young's modulus and high specific gravity. The top wing spars of the Breguet have bulbous booms riveted to a single plate web, the web being reinforced with pressed sections riveted on. The lower spars consist of built-up channel sections back to back, with a solid drawn tubular section over them roughly in the form of a figure eight. Another characteristic feature of this type of airplane is the member which connects the upper and lower wings, or the planes and the landing gears in the case of the monoplane or sesquiplane. In the Nieuport airplane two huge "Y"-formed sheets of duralumin are pressed out and riveted together to form a branching strut of streamline section riveted along its fore and aft edges, apparently without internal support, the shell being sufficiently strong in itself. In the case of the Breguet strut, which is in the form of a double "Y", an elaborate internal channel structure is used to support the shell, the four ends of the double "Y" terminating in ball and socket joints. It would appear that the labor involved in dealing with the large amount of not very accessible riveting on the Breguet strut must make it a very much more expensive manufacturing proposition than the Nieuport.

One must examine constructional details in the light of one's own ideas as to the economic lines of structural development. In order that metal construction may be sufficiently flexible to adapt itself to different sizes and types of airplanes, it is necessary that it should be constructed to allow for changes in the sizes of the airplane or the design. For example, my own firm, Boulton & Paul, Ltd., have been for some time past concentrating their attention on the realization of a manufacturing system, the elements of which shall be adaptable to airplanes of biplane construction of 2,000 to 20,000 pounds, gross weight, and in which there shall be enough common features between the elements of various sizes to reduce the tool equipment and use of skilled labor to a minimum, to keep down the number of different parts on different airplanes and to simplify the problem of maintenance and repair, the principle of which would, in common with the constructional system, pass from one airplane to another. It is difficult to see in the Salon any signs of a similar endeavor.

A very complete exhibition is given by the Section Technique of the methods of manufacture of the Breguet 19. Here is an airplane which, with a good performance, has some remarkable records to its credit, and which, having been made in large quantities, has been produced at a very reasonable cost. The tooling up of the job appears, however, to be uniquely associated with that particular airplane. One notices particularly, in the construction of both spars and ribs, and in fact, all the elements of the wings, an enormous amount of riveting, much of which does not lend itself too well to mechanical execution. It is particularly interesting, inasmuch as experience leads us to believe that such a feature has an important bearing on cost, to know that in spite of the work involved the airplane has still been economically produced. A very liberal use of light alloy stampings is found in the Breguet construction, and some of these stampings are remarkable examples of the drop stamper's art, notably the stampings shown in Fig. 2, the halves of which go to form the joint between the bottom spar and the top, being riveted together on the two sides of the figure-eight section tube. The corrugated part of the stamping tapers down from the lugs from about 3 mm (.118 in.) thick to 2 mm (.079 in.) thick. One might have suspected that the examples of this article which were exhibited were specimens specially made for show purposes, but on examination of the way in which this stamping is used on the actual construction of the Breguet wings, it is evident that an extraordinarily high standard of stamping accuracy in a very difficult part has been achieved. This is only one of many examples of light alloy stampings on the Breguet, and their profusion, notably in the rear fuselage joints which contain three fairly large stampings at each joint, is evidence that they must be produced very economically. The exhibit of the Forges Foulain would seem to indicate that the art of the drop stamper in the manipulation of light alloys had advanced in France to a high pitch. We have here an opportunity for valuable technical development. Some of the alternative types of joint construction to these stampings which are seen on various airplanes exhibited are not very pleasing. Where Breguet has had to make joints which it has not been possible to stamp, the duralumin struts are fitted into welded steel sockets. Welded steel fittings are also used in elevators, for example, to attach the ribs to the tubular spars and to the leading edge. One presumes that no trouble has been experienced, but the solution of the problem of attaching these members seems unnecessarily crude without being the most economical. In the construction of the S.E.C.M. 150 T some most remarkable examples of complicated tube joints made up from sheet are to be seen. The press work involved in these joints must be extraordinarily difficult and expensive, and there are a very large number of different joints on the airplane, while the fittings, owing to the varying angles and numbers of struts which they house, could not possibly have a general application. It is interesting to note that in some cases the difficulty of getting in the last member has caused the designer to close the socket with an aluminum block as in Fig. 3, using a stupendous number of small bolts for the purpose. Both in this case and in the large number of small split-pinned bolts in each fuselage joint on the Breguet, there would seem to be inevitably heavy assembly costs. Presumably all these airplanes are designed on the assumption that they will go into production on such a large scale that the complete tooling up for any individual design is justified.

There are one or two examples of metal-covered wings, the Wibault, a straightforward construction on Dornier lines, and the Avimeta which seems to be an offspring of the large twin fuselage Schneider shown at the last exhibition, and a metal monoplane exhibited by the S.I.M.B., which is of considerable technical interest, the wings being constructed of channel sections running parallel to the span of the airplane, turned inwards and riveted together on their inner edges after the manner of the Breguet cowling. An exhibit on the duralumin stand of strip up to 8 in. wide and 18 ft. long, tapering from 12 to 18 gauge along its length, enables one to appreciate how such a structure can be made economically. In the wings the channels are parallel to one another, while assembly panels are fitted to the underside of the wing to enable the riveting work to be completed, and to give accessibility to the interior of the structure. A similar constructional arrangement is used for the body, but with the streamline form the channels are no longer parallel and, consequently, must be more expensive to produce. The possibility of obtaining taper strip as a commercial proposition opens up a wide field of technical development. It is not possible to say whether this taper strip was actually used in the S.I.M.B., but it would be safe to say that if it was not it soon will be.

Besides the steel spar already referred to exhibited by Messrs. Holzer, there is also shown on their stand a number of drawn corrugated sections of heat-treated nickel-chrome steel. This material is of a similar class (3 per cent nickel, 1 per cent chrome) to that which is generally used for steel construction in this country, but the sections are of much thicker material than we are accustomed to, and the corrugations are of a very slight nature. It is understood that Messrs. Holzer are pursuing their experiments with regard to corrugated steel spars. On the Dyle and Bacalan airplane there are a number of built-up steel box struts of the type shown in Fig. 4 but, as one would expect from this type of section, the steel is of about 18 gauge in order to avoid local buckling. The design, in fact, strikes one as very crude and heavy. It is impossible to believe that such members can compare favorably with steel tubes of appropriate material. Steel construction is also illustrated in the Fiat airplane, on which the halves of the spar have been pressed out into a channel section and riveted together as in Fig. 5, the spars being lightened in the web by perforations which, incidentally, give access for the riveting operation. Here again the thickness of the material rendered necessary by the nature of the design would suggest that the spar is uneconomically heavy compared with modern English practice. The accessibility to the top and bottom parts of the spar allowed by the perforation of the webs is also used to permit the ribs to be riveted directly on to the spars, a type of assembly which has been found rather expensive. Some of the light alloy ribs which were exhibited are made up from channel sections, a form of construction which in aluminum alloys has not been found to be very satisfactory from the point of view of vibration. In many cases there is evidence of considerable elaboration of the joints, possibly due to difficulties which have been experienced in this direction. In the case of the Fiat, square section tubes of very light gauge are used, a form that is expensive and necessitates elaborate jointing.

Some very fine examples of die castings in the light alloy, marketed under the name of "Alugir," which appears to be of the type of "Y" alloy (4 per cent copper, 2 per cent nickel, and $1\frac{1}{2}$ per cent magnesium) are shown. The company exhibiting these (Etablissements Metallurgiques de la Gironde) confine their foundry operations in this class of material to die castings, with the exception that in certain cases sand cores are used for pistons. The die casting in this class of material, judging from characteristic prices of work exhibited, has been brought to a very economical stage of manufacture, both as regards the dies and the articles themselves. Many of the parts exhibited were for railway work, but die casting is useful in aeronautical work, and with light alloys in particular, there is no doubt that there is a very substantial gulf separating die castings from sand castings as a satisfactory engineering product, principally due, I think, to the chilling. Castings in materials of this type can be heat-treated and give very favorable mechanical properties. Some equally good examples of drop forgings are also to be seen made from this material, while it is stated by the stampers to be slightly more plastic at forging temperatures than the duralumin class; but there does not seem to be anything to choose between the appearance of the finished products in either class of material. On the duralumin stand, besides the remarkable exhibit of taper strip, there are some very large examples of solid-drawn tube work, which would seem to indicate that the French company must cast very large ingots. There are also some fine examples of forgings for propellers (see Fig. 6). Given the possibility of obtaining forgings of this type at a reasonable price - and the figures quoted were certainly quite commercial - the problem of the metal propeller resolves itself really into one of machine generating, which is by no means new and certainly not insoluble. The examples of propellers machined from these forgings were not very good from an aerodynamic point of view, nor, except for the show exhibits on the duralumin stand, did they appear to be very well machined. The prices stated for machining operations were, however, very low, and it would seem that the development of satisfactory propellers on these lines cannot be very far distant. The machining on these propellers was, I believe, carried out by a copying operation from a wooden former, which seems a less satisfactory operation than the use of a proper generating machine. An extraordinarily large propeller forging was also shown on the duralumin company's stand but a superficial examination led one to the conclusion that the boss was not entirely sound. It is, of course, quite natural that difficulties should be experienced with such very large forgings, even though smaller propellers required for ordinary aircraft are quite satisfactory.

In the matter of engine installation, particular interest naturally attaches to the installation of the "Jupiter" engine, of which there were very many examples. It is interesting to note that no airplanes were shown fitted with helmets although the rudimentary fairings on the Gourdou-Leseurre are probably a token of that firm's earlier interest in helmeted cowling. Much of the cowl work seemed very flimsy and awkward to remove, and one would expect difficulties of maintenance in service; this is the more disappointing as French cowl work is usually so neat.

A very bold and simple arrangement is to be found on the Fokker stand where, by making use of a spinner on the propeller, the cowling is reduced to 9 plates, one between each cylinder, of 18 gauge thickness, not beaded in any way but lightly creased to give stiffness. Each of these plates sits on four bosses and is secured from jumping off the boss by a safety pin. This type of cowling fixing has, of course, been used by Fokker for some time, and even if it is rather shocking from an engineering point of view, would seem eminently practicable if it stands up to service.

These criticisms have been written some time after a visit to the Show, and without making any notes and without attempting to notice either everything that is good or everything that is bad. They are merely an endeavor to set out for the information of others those points which appealed to me personally as an aeronautical engineer. The great advantage of exhibitions is that they make one think, since owing to the unfortunate secrecy which surrounds aircraft work due to its military nature, there is a grave danger of sections of the aeronautical community, if not individuals, becoming self-centered. Where the work of others is exhibited for our inspection and interest, we must always realize that some of the things we fail to appreciate, we may not understand. If we have a difficulty in reconciling, in the light of our experience, the costs of the manufacture of various types of metal construction with the work involved therein, and if we find a difficulty in understanding how airplanes of certain aerodynamical features give certain performances, we ought to remember that one explanation may be that individually each of us still has a lot to learn.

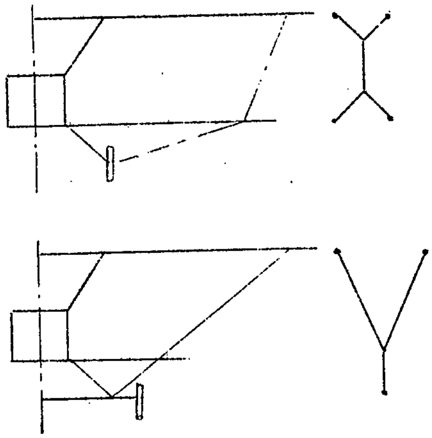

Fig.1 Above, a diagrammatic representation of the wing bracing of the Breguet airplanes. Below, that of the Nieuport-Delage 42.

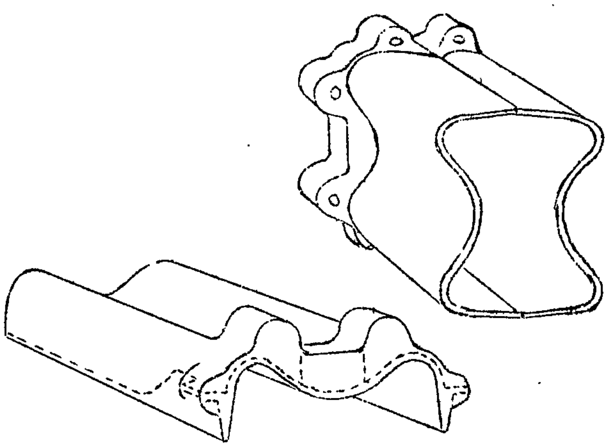

Fig.2 Details of the forged duralumin spar box of the Breguet 19. The dotted lines in the lower sketch give an idea of the manner in which the part was forged.

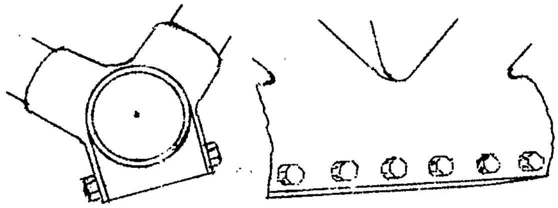

Fig.3 In certain of the S.E.C.M. joints aluminium blocks are used to close the socket, numerous bolts being used.

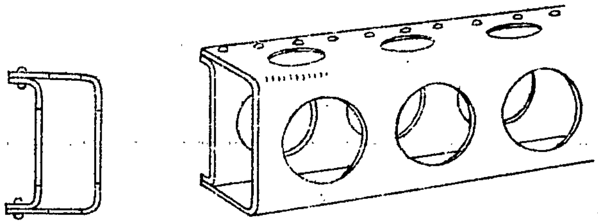

Fig.4 Built-up steel box struts of the type used in the Dyle and Bacalan DB10.

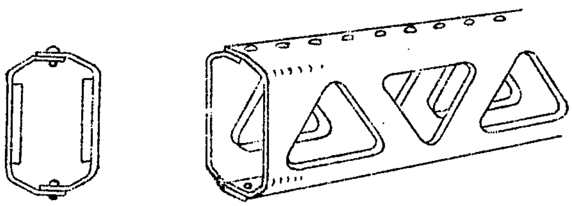

Fig.5 Details of the Fiat wing spars.

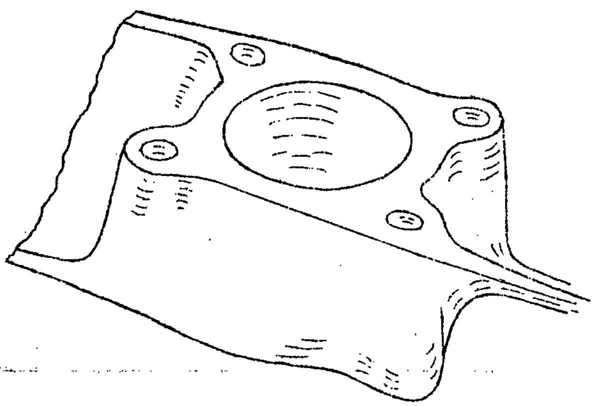

Fig.6 Boss of forged duralumin propeller, Comte patent.