TECHNICAL MEMORANDUMS

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

No. 440

METAL AIRCRAFT CONSTRUCTION AT VICKERS

Some Interesting New Forms Developed

From "Flight," September 15, 1927

Washington
December, 1927

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

TECHNICAL MEMORANDUM NO. 440.

METAL AIRCRAFT CONSTRUCTION AT VICKERS.*

Some Interesting New Forms Developed

It is comparatively easy, with any form of metal construction, to design for maximum efficiency from the strength-weight point of view. But often it is found that sections which give a very high value of this ratio are difficult and costly to produce in the shops. On the other hand, it is very easy to design forms which are cheap to produce, but in nearly all cases it is found that such sections fail to develop anything like the full strength of the material. It is true that in time of war the actual cost in money is of secondary importance, but what is of the very greatest importance is the question of man-hours, and any form of metal construction which requires a disproportionate number of man-hours is practically doomed, no matter how excellent it may be in the matter of strength for weight.

In evolving the new forms of metal construction at Vickers' Weybridge Works, these considerations have been kept prominently in mind, with the result that simplicity is the keynote of the design. In fact, it seems likely that in case of urgent demand, Vickers would be able to produce duralumin aircraft parts at almost any rate required, and in the main by semi-skilled, or even unskilled labor. At the same time, the forms of construction

*From "Flight," September 15, 1927.

evolved are such that the resulting structure is considerably lighter than the corresponding wood structure, for the same strength, or conversely, for the same weight, the duralumin structure is a great deal stronger, so that efficiency has by no means been sacrificed on the altar of simplicity.

As far as the wing construction is concerned, the basis of the Vickers system is the novel form of spar web. Mr. Sutherland, of Vickers, terms this rather aptly a "wandering web," from the fact that the web, made from a single strip of the metal, meanders along from front face to rear face and back to front face of the spar. In order to give the necessary rigidity, vertical flutings are stamped in the web in places where it meets the front and rear faces, the fluting forming a sort of short strut, which prevents the secondary buckling of the sheet under compression loads.

The "wandering web," it will be seen, forms alternately the spar front wall, the diaphragm or bulkhead, and the spar rear wall, the diaphragm being diagonal instead of, as is more usual, at right angles to the spar walls. By arranging the web in this manner, a very great deal of work is saved. To begin with, there are no separate diaphragms to stamp out, which saves one operation at least, and probably two or more. Then, from the fact that the web is a continuous strip, there is far less riveting to be done than would be required were the diaphragms separate pieces needing to be attached to walls and flanges.

Special workshop tools have been designed for the manufacture of this "wandering web," and the operation of producing it has been reduced to one of extreme simplicity, a couple of men attending to the strip as step by step it moves through the machine. Since most of the secrets of quick metal construction relate to the machine tools used rather than to the form of the finished sections which they produce, we shall refrain from describing in detail the special stamping machine which Vickers use for the manufacture of their "wandering web." To watch it at work, however, strongly reminds one of the expression "turning them out like hot cakes."

Next in importance to the "wandering web" comes the spar flange, and here Vickers make use of three different types, each with its own advantages, according to the size of spar and the place in the airplane where the spar is to be used. The three types are illustrated in Figure 1, and it will be seen that they are simple L sections, simple channel sections, and double T sections. The manner in which the different sections are used is also illustrated. One feature all three have in common, however: the ease with which all rivets can be reached. This is naturally an important item in the rapid and cheap production of the spars. One of the figures (Fig. 2(7)) shows a very complicated duralumin spar, which not only tapers in a vertical plane, but also in a horizontal. Although naturally less easy to make than a spar of plain rectangular section with no taper,

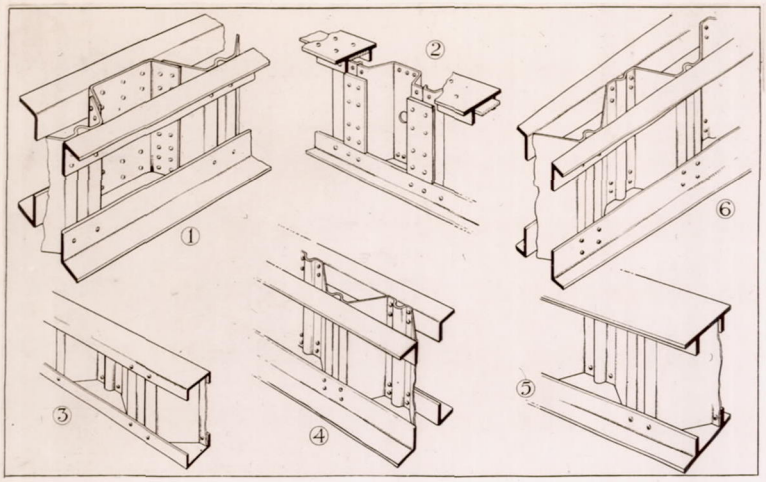
this double-taper spar is not unduly difficult to make, and it will be seen that the "wandering web" is still used, although the parallel strip has to be tapered off after the web is in place. L section corners of relatively thick gauge are used in this spar. A feature of the new Vickers spars is that standard sections are used almost exclusively, so that the work of shaping is done almost entirely by the makers of the material, the extruded double T section being one such example.

Ribs of duralumin tubes are used with the Vickers spars, the standard rib being riveted as shown in Figure 3. To facilitate repairs, a slightly different form of rib, with removable bottom flange, has been standardized. This can be simply slipped over the spars and the bottom flange bolted in place, so that the user does not have to do any riveting when replacing a damaged rib.

The all-duralumin construction evolved by Vickers also includes the interplane struts, which are made as shown in Figure 5, of two sheets of duralumin of thick gauge, externally riveted together at the edges. Again, there are no hidden rivet heads, and the operation is simplicity itself. The struts have been found to be remarkably stable under load, and to develop a high safe loading stress. Aerodynamically, being of streamline section, they are probably as efficient as struts without the small projecting front and rear edges.

The fuselage construction which accompanies the wing con-

struction described above is on somewhat different lines, and may be said to be a development of the Wibault type of construction, Vickers having recently built under license a number of airplanes of this type for a foreign government. Fundamentally, the fuselage construction makes use of T sections for longerons and struts, the joints between the two being as illustrated. Figure 4 is self-explanatory.



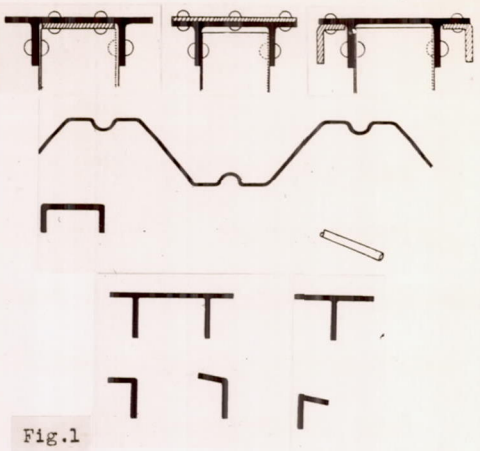


Fig.1

["Flight" Copyright Sketches

Some standard sections used for spar flanges. The zig-zag line shows the formation of the "wandering web."

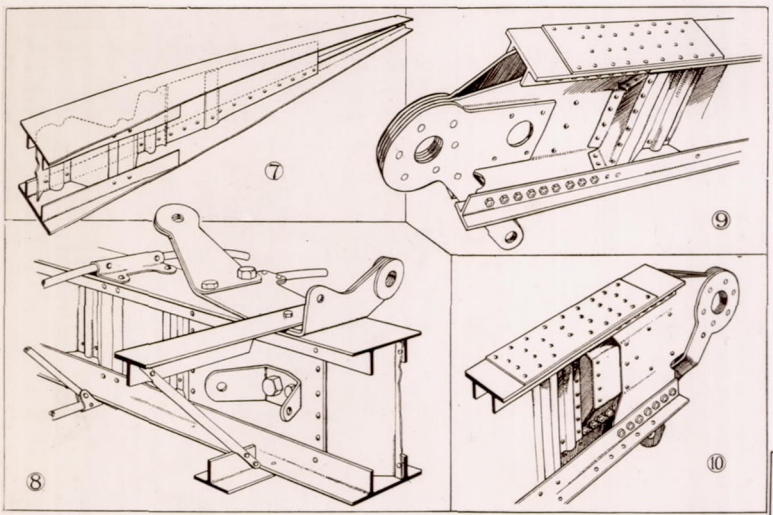


Fig.2

["Flight" Copyright Sketches

A splice in the "wandering web" is shown in (1), and special reinforcement for compression strut in (2). Various flange forms are illustrated in (3), (4), (5) and (6), all using the same "wandering web." The manner of tapering a spar end down is shown in (7). In (8) a typical wing strut fitting is shown, while (9) and (10) show end fittings for attachment to centre-section.

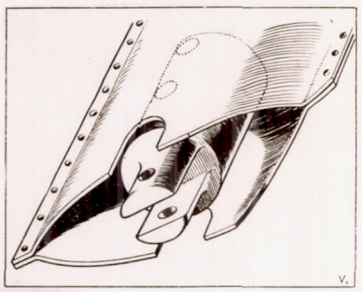


Fig.5

["Flight" Copyright Sketch

VICKERS METAL CONSTRUCTION: Inter-plane struts are made from sheet Duralumin, the strut being of streamline section as shown. The end fitting is a simple fork end.

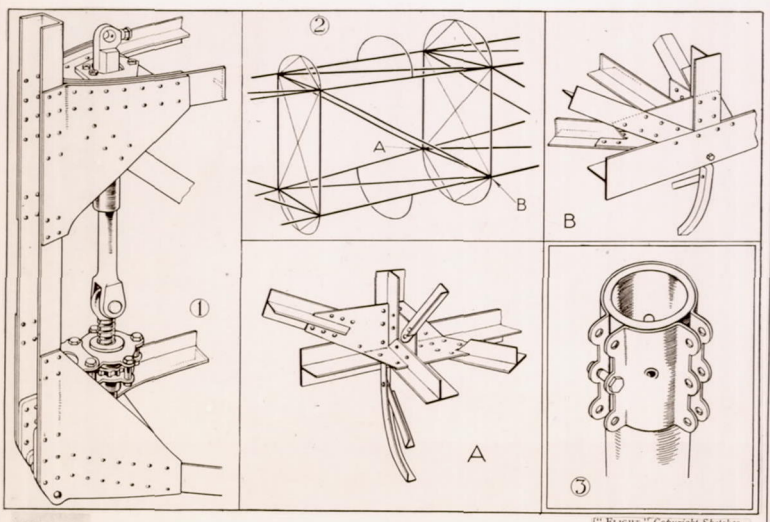


Fig.4

["Flight" Copyright Sketches.

Details of fuselage members. (1) Shows the construction at the stern post. (2) Illustrates in diagram the arrangement of struts and longerons, with details at A and B. The sketch in (3) illustrates a fuselage fitting for use with tubular longerons.

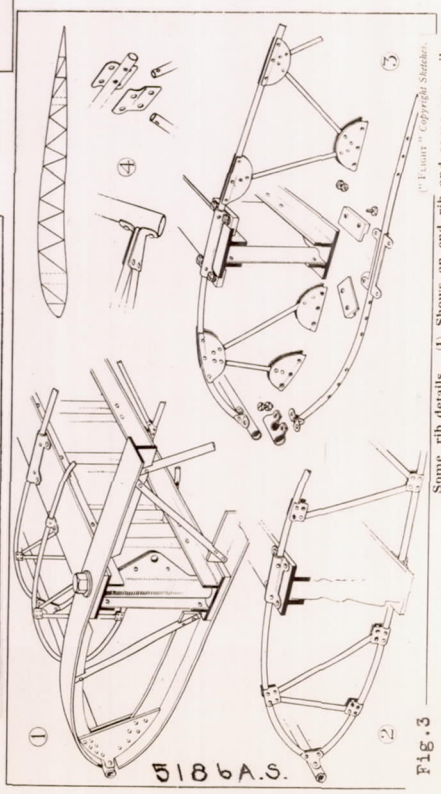


Fig.3

["Flight" Copyright Sketches.

Some rib details. (1) Shows an end rib and some nose ribs, while (2 shows a normal rib attached. The type of rib used for replacements is illustrated in (3. It will be noted that no riveting is required. The general lay-out of a rib is shown in (4, with details of brackets, etc.