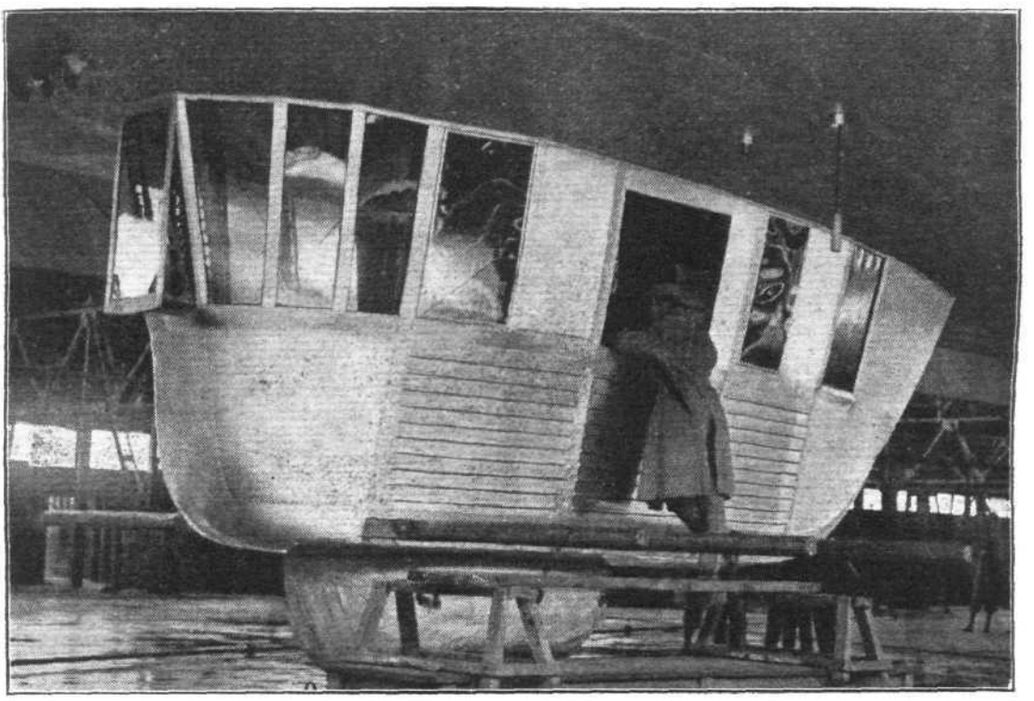
mentioned that a somewhat unusual procedure was followed. Although R.101 is actually a Cardington-designed airship, this applies to the general "scheme" only. The firm of Boulton and Paul, Ltd., of Norwich, which had had many years' experience of metal construction of heavier-than-air craft, was entrusted not only with the construction of the girder work for R.101, but actually with the design of the



The Control Car of R.101 is quite a small affair, but the Captain's Control Room is immediately above it, inside the main hull.
("FLIGHT" *Photo.*)

The vertical and horizontal Fins of R.101 are cantilever beams, except for a steadying wire connecting them.
("FLIGHT" *Photo.*)

girders. The design staff at Cardington supplied to Boulton and Paul the "single-line" diagram of the structure, and specified the loads which each individual member was to carry. The Boulton and Paul design staff was then left free to evolve the particular type of girder, and the particular type of joint which seemed best to meet the requirements. Thus, a large proportion of the credit for the very wonderful structure of R.101 is due to the Boulton and Paul technical staff, and in particular to Mr. J. D. North, chief engineer of Boulton and Paul, Ltd. The very closest co-operation between Cardington and Norwich was maintained, and Mr. North was appointed to act as consultant in metal construction to the Director of Airship Development.

The system of design was not concerned merely with the problems of the finished structure but also, and very largely, with those of erecting the component parts at Cardington after their arrival from Norwich. The system finally adopted was one which permitted of erection and assembly in a minimum of time, and with but very few workmen. Whereas, with the Zeppelin type of construction much of the assembly has to be done *in situ*, and by riveting at that, in R.101 the component units are assembled by bolting. This method, apart from the advantages which "pin jointed" frames have in being statically determinate and therefore amenable to stress calculation, greatly reduces the work of erecting, but calls for working to very close limits if the parts are to "go together" without any difficulty. It speaks well for the accuracy of Boulton and Paul workmanship that very little trouble was experienced in this respect.

Structure of R.101

Space does not permit of anything approaching a detailed description of the structure of R.101. Readers who wish to study this subject more intimately are referred to an illustrated article entitled "Building the Structure of R.101," which appeared in THE AIRCRAFT ENGINEER (Monthly Technical Supplement to FLIGHT) of November 29, 1928, and to the various papers on the airship read by Col. Richmond (the designer of R.101), and Col. Cave-Browne-Cave before the Royal Aeronautical Society from time to time, and published in the *Journal* of the Society.

The transverse "rings" or frames are, in a way, the keynote of the design of R.101. In previous airships of Zeppelin type, these frames were not in themselves stable structurally, but relied upon radial bracing wires in their own plane. The transverse frames of R.101 are self-sufficient structures in that they are "rings," or polygons, composed of outer and inner ridge girders with radial struts, forming triangles in section, with the apices inwards toward the centre of the hull and the bases outward towards the envelope. Permanently attached to, and forming part of, the outer ridge girders are short lengths of longitudinals known as frame longitudinals. In length, these frame longitudinals are

equal to the width of the "ring," and the main longitudinals are fastened to the ends of the frame longitudinals by bolting.

It will be realised that whereas the older type of "ring," stabilised by its radial wires, was somewhat in the nature of a bicycle wheel, the "rings" of R.101 are without such bracing, and the inner and outer ridge girders, with their radial struts and bracing wires, must be made strong enough