

## The Probable Trend of Aeroplane Design\*

By R. F. Mann

DURING the last few months I have spent some of the time reviewing the present stage in the development of aeroplane design with the view of determining what changes are likely to occur in the immediate future.

The system of strutting and bracing biplane wings has undergone fewer large modifications than any other part of an aeroplane, but nevertheless signs are not wanting that considerable changes are likely to occur in the near future with the object of reducing resistance. Since any considerable improvement in streamline sections is very remote, this reduction of resistance can only be obtained by reducing the number of struts and wires hitherto used. Two interesting machines in which attempts had been made to achieve this were the S.E. 4 and the Sopwith triplane. In the former machine use had been made of the I strut, the flying wires being taken from the front of the rear spar. The chord of the wings was large, and in consequence of the travel of the C.P. the stresses in the strut were high. In the Sopwith, however, these stresses were kept within reasonable limits by employing wings of small chord and obtaining the necessary area by adding a third wing. Unfortunately, this method is only applicable to small machines, so it cannot be regarded as a complete solution of the problem. Two other forms of built-up strut have been suggested—the V and K. The latter has been employed on a few machines turned out by the Curtiss Company, but they both have disadvantages which are not shared by the K type.

(1) Owing to their great side area the range of vision of the crew is greatly impaired.

(2) This side area is unnecessary for stability and liable to make the machine uncomfortable to fly in a gusty wind. Also it is quite possible that the resistance and skin friction of such a strut would be equal to that of two plain struts and the necessary incidence wires.

All things being considered, the I strut would appear to offer the best solution, but how are the high stresses in it, caused by the travel of the C.P., to be overcome? It is possible to design such a strut with sufficient F.S., but a large percentage of the gain due to lessened resistance may be lost through added weight. Failing the advent of an exceptionally light but strong alloy, the only other course is to produce a wing section which, without a greatly impaired value for  $K_y$  and  $L/D$ , has a considerably smaller travel of the C.P. Naturally, a section with a stationary C.P. would be ideal for this purpose, but I fear that the loss in efficiency would nullify any other advantage.

What is required is a satisfactory compromise, and it should be attainable if as much research is expended on it as there has been in getting the present highly efficient sections.

Similar large changes in the bracing of the wings are in sight; in fact, already there is at least one machine in existence—the product of an allied country—in which the usual cables or streamline wires have been dispensed with and the wireless truss system used instead. See Fig. 1. The advantage of this system is that there being no flexible tension members, vibration, and the consequent increase in resistance is overcome.

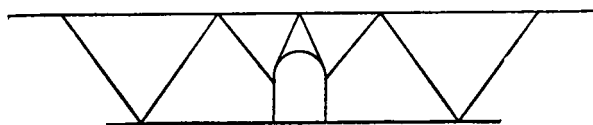
This vibration, while not of much importance in small machines where the length of the bays is small, assumes rather unpleasantly large proportions in the long bays of, say, a bomber. As in the case of the I strut this construction comes out heavier, but as the saving in resistance is considerable it is more than likely that in the end there is a distinct gain—in fact, the performances of the machine mentioned show that this is indeed the case. With a satisfactory I strut on the one hand and a thoroughly tried out wireless truss system on the other, the next step is a combination of the two—i. e., a wireless truss constructed with I struts. Probably there are people who would contend that this is looking too far ahead, and that as really large machines are in existence which use the, so to speak, old-fashioned system of strutting and bracing with satisfactory results there is no need to consider anything else.

The obvious retort is that there would not be the convenient and speedy car of today if our ancestors had been satisfied with the pony trap and stage coach.

### FUSELAGE, OR BODY.

As the shape and general lay-out of the body are to a certain extent governed by the type of engine employed, it will be as well to devote a few lines to a general survey of engines. When looking back over the past three years, one is immediately struck by

three facts, which are: (1) the great and continued increase in h.p., (2) the growing favor of water cooling, and (3) that although the Allies employ engines of all types—i. e., the vertical Vee, "broad arrow Vee," rotary, &c.—the German designers continue to employ the 6-cylinder vertical to the almost entire exclusion of any other. Admittedly an 8-cylinder vertical



has been in use recently, but this has now been deleted in favor of a 6-cylinder of the same power approximately, and although using the number of cylinders which are common in Vee type engines the German designers still stuck to the vertical type. What is the reason for this great—almost universal—employment by them of the vertical type engine?

Have considerations of engine or aeroplane design weighed most in their decision? Personally, I think the latter. A better entry of the body can be obtained by using a vertical engine than with any other type, and the almost universal employment of "propeller pots" by German designers seems to show that they have realised and make the utmost use of this fact. Although using a narrow engine, their bodies are often of quite generous proportions, but performance does not appear to suffer. Is it not possible that the shape of the nose is of as much importance to resistance as the cross sectional area of a body? Again, can such an excellent entry be conveniently obtained when using an engine of the Vee type? Isn't the answer to the first question—in the words of the politician—in the affirmative, and the second in the negative? A further point. When "propeller pots" are a feature of body design the distance between the rear of the airscrew and the front of the first cylinder can be reduced; a lighter crankshaft and crankcase resulting. When, however, a flat radiator forms the nose of the fuselage it is necessary—in the interests of airscrew efficiency—to keep this dimension as large as practicable, which, of course, entails added weight.

It might be argued that if this design is so usual among German-designed single-engined machines, why is it not so often employed for the engine nacelles of their twin-engined bombers?

The probable explanation is that some of their large bombers are twin pushers, in which case the use of a flat radiator in the nose does not detract from the airscrews' efficiency. Also the conditions governing the design of a fuselage and an engine nacelle are not the same. A fuselage carries the crew, fuel, oil, tail unit, &c., and has, in consequence, to be of fairly generous proportions at the largest point, but as this can be conveniently situated a little to the rear of the engine easy "lines" will suffice to merge this with a reasonable size of "pot" on the nose. On the contrary, the engine nacelles of multi-engined bombers generally have only to cover in the engine, so their cross sectional area and length are reduced to the extreme, and the prospect of saving any resistance by making the section round or oval with a "propeller pot" in front is extremely remote.

The success the German designers have achieved with semi-monocoque bodies is of as much interest and warrants as much attention as the subject just dealt with—viz., the actual shape of the nose considered in conjunction with the type of engine employed. The true monocoque body was introduced with success on special racing machines about five years ago, but the high manufacturing costs prevented it coming into general use, although its good aerodynamical qualities were fully realised. Another advantage this system of body construction has over the more common wire braced body is that it is less vulnerable to the effects of bullets, owing to there being no vital parts—such as wires and struts—liable to damage. Also there is no risk of a strip of the fabric covering the body being ripped up by a bullet and wrapping itself round the control cables.

Some of these objections were overcome by substituting the wire bracing by sheets of plywood screwed to the struts and longerons, thereby combining a strong bracing with an unrippable covering. This type of body construction has been very popular with German designers for some years past, and was only modified when higher speeds demanded a body of less resistance than that offered by one of rectangular section, so while retaining the old system of construction, but replacing the flat sides with curved ones resulted in the formation of the low resistance, oval section, semi-monocoque body employed on Albatros scouts and two-seaters, during the past year. While on the subject of bodies it will be well to consider the requirements in

this direction of a new type of machine which has come into prominence lately—i. e., the Flying Tank.

The duties of this machine are to co-operate with the attacking infantry by harassing with machine gun fire all enemy troops in the neighborhood. As this entails flying at a low altitude armoring is essential to protect the vital parts, such as the engine, tanks, crew, &c., from the heavy and concentrated fire of the enemy with rifles and machine guns. During 1914 a French firm produced a very interesting armored monocoque body, in which the fore part was of sheet steel as far as the rear of the gunner's cockpit, thus protecting the vital parts already mentioned. From this point to the tail the pure monocoque type of construction was employed. Although this body fulfilled all requirements of strength, low resistance, lessened risk of fire and protection of the vital parts, it was not adopted owing to the reduction of climbing speed due to the extra weight. This objection does not apply to a Flying Tank, because excessive rate of climb is not required.

The employment of a circular section body for this type of machine where low resistance is not of primary importance may appear to be unnecessary, but as it is quite probable that a round section body would deflect bullets which could easily penetrate a flat sided one, it will be seen that its employment with this type of machine is of as much value as in the case of ordinary scouts and two-seaters.

### CONTROLLING SURFACES.

There are points in the design of controlling surfaces which it will be of interest to deal with, and one of these is the rapidly-growing practice of balancing—or, more correctly, partially balancing—not only the rudder, but also the ailerons and elevators on small, as well as on large machines. There can be little doubt that this practice has come to stay, in fact the wonder is that it has been so long coming, for by its adoption the stress on the pilot and controls is greatly reduced. A small point, but one of certain importance, is the placing of all control cables inside the body, where the risk of damage by flying splinters of shell is considerably reduced. Also by not being exposed to the elements there is less risk of rust and consequent deterioration. Admittedly these cables are kept greased, but is it not possible for some of this to be accidentally rubbed off and the machine make a long flight in the rain before this can be replaced? Once damp has penetrated to the core of a cable grease will not fetch it out. Except for the protection from shell splinters, the same arguments apply to running the aileron controls through the wings, and in both cases there is a small, but not negligible, saving of resistance.

There are many more interesting points to consider, but as space is limited it will be necessary to deal with the most important very briefly. Undercarriages have undergone many extensive changes in the past, and the number of types produced during the last ten years must be legion. Although some were very ingenious, those of low resistance, simplicity and lightness have been most popular. The type which satisfies these requirements best is that composed of two Vees of wood or steel tube with the axle slung from the apex by rubber cord, and its use has been almost universal during the last year or two on all except large machines. It is difficult to see how the low resistance, simplicity and lightness of this type can be improved upon, so one is forced to the conclusion that any further improvement lies in the direction of an undercarriage capable of being drawn into the fuselage when the machine is flying.

### Eradicating the Barberry

THE campaign to eradicate the common barberry, which was started by the United States Department of Agriculture last spring, has already met with gratifying results. The common barberry harbors the black rust of wheat, oats, barley and rye, a disease which causes enormous losses in this country. In certain European countries it has been demonstrated that the eradication of the barberry has resulted in a marked decrease in the amount of damage caused by this disease. In central and northwestern states where the campaign is being conducted, public sentiment has been aroused. Nurserymen for the most part have agreed to discontinue distributing common barberry bushes. Park boards in many cities have eradicated them. State nursery inspectors and state entomologists are destroying the bushes wherever stem rust infection is found. Several state councils of defense have issued appeals for the eradication of this barberry, and the public safety commission of Minnesota has issued an order providing for compulsory eradication in that state. The Japanese barberry does not come under the ban, as it does not harbor the rust.—*Jour. N. Y. Botanical Garden.*

\*From Flight.