How to Build the

CHAPTER VI

By ORVILLE HICKMAN

The editors of MODERN MECHANICS AND INVENTIONS and the annual FLYING MANUAL have consistently endeavored to present plans of light planes which were easy to build and within the price range of the average amateur. Here, however, is a one-place sport plane, designed especially for the builder who is willing to spend more money for greater speed and higher ceiling.

LIGHT plane designers and manufacturers have adhered so consistently to the high-wing monoplane that many persons have come to believe that light plane and monoplane are synonymous. There are some fans, however, who have so insistently demanded a one-place biplane of steel fuselage construction that their plea could not be ignored.

In the Powell “P.H.” Racer these fans will find a ship that will require skill in building and flying, a knowledge of welding, strict adherence to the plans as given, and a real honest-to-goodness aero engine. For one who can exercise enough self-control to follow plans to the letter, and who has the price of a good light plane motor, this article will present something that will get out and step with the best of them. A high speed of 95 miles an hour and an absolute ceiling of 14,000 feet can be attained with this little biplane if the builder will give the job the time and money needed on a ship such as this. Those who want to use a two-cylinder motorcycle engine, and who can’t do a good job of welding, had better leave the “P.H.” alone.

Before we tackle the actual building of the plane, let us look around and see what we can use for the power plant. Only one model of this racer has been built, and it was powered with a Bristol-Cherub motor. This is an excellent little engine for a racing job such as this, as it develops plenty of horsepower for its weight.

The “Cherub” is a British motor, and is distributed by the Aero Engines of Canada, Ltd., of Montreal. Two American motors have recently been developed which are just suited to such a job as this. These are the Aeromotive motor, manufactured by the Aeromotive Corporation of America of Cincinnati, and the Continental A-40 made by the Continental Aircraft Engine Company of Detroit, Michigan. You will find the Heath Henderson motor a very fine little power plant if economy is what you are after, but the above mentioned higher priced engines will give you top performance.

SPECIFICATIONS OF THE POWELL “P.H.” RACER

<table>
<thead>
<tr>
<th>Specification</th>
<th>Measurement</th>
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<tbody>
<tr>
<td>Length Overall</td>
<td>14 ft. ½ in.</td>
</tr>
<tr>
<td>Height Overall</td>
<td>5 ft. 3 in.</td>
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<tr>
<td>Span, Upper Wing</td>
<td>15 ft. 9 in.</td>
</tr>
<tr>
<td>Span, Lower Wing</td>
<td>15 ft. 9 in.</td>
</tr>
<tr>
<td>Chord, Upper and Lower Wing</td>
<td>32 in.</td>
</tr>
<tr>
<td>Gap</td>
<td>30 in.</td>
</tr>
<tr>
<td>Stagger</td>
<td>9½ in.</td>
</tr>
<tr>
<td>Airfoil</td>
<td>R. A. F. 15</td>
</tr>
<tr>
<td>Angle of Incidence, Upper and Lower</td>
<td>0</td>
</tr>
<tr>
<td>Dihedral, Upper and Lower</td>
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</tr>
<tr>
<td>Span of Stabilizer</td>
<td>6 ft.</td>
</tr>
<tr>
<td>Maximum Speed (With Bristol-Cherub Motor)</td>
<td>95 m. p. h.</td>
</tr>
<tr>
<td>Cruising Speed</td>
<td>80 m. p. h.</td>
</tr>
<tr>
<td>Landing Speed</td>
<td>32 m. p. h.</td>
</tr>
<tr>
<td>Ceiling</td>
<td>14,000 ft.</td>
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POWELL "P. H." RACER

THE BEAUTIFUL LINES OF THE TINY POWELL RACER ARE HERE SHOWN IN COMPARISON WITH THOSE OF THE 300 HORSE POWER LAIRD SPECIAL SPEEDWING RACING PLANE, WINNER OF THE 1930 THOMPSON TROPHY.
These Scale Drawings Give Dimensions for Laying Out the Fuselage

Figure 1. The lines for your fuselage should be laid out on a level surface from these drawings.
You will notice that nothing has been said of converted automobile or twin motorcycle engines. Such motors are absolutely unfitted for powering the "P.H." Racer, the former having too much weight and the latter not enough horses.

Now that I have scared off those who hoped to build something cheap from a few odds and ends picked up here and there, we fellows who have the price and want to build a real racer will step over to the corner of the hangar and take up the matter of construction. Let us start with the fuselage.

This structure is all steel and is of conventional design. Twenty-gauge steel tubing, commonly listed as .035 thickness is used throughout, the longerons being ½" material, while all other members are of ½" diameter except where otherwise specified on the plans.

The first thing to do is to layout your plan on some absolutely level surface such as a wooden floor or a long table. When you are sure that everything is right to the fraction of an inch, take two pieces of tubing that are long enough for the entire length of the fuselage and outline them over your layout with nails so that they are right over the lines for the longerons.

Now you are ready for the vertical members and diagonals. The tubes should be cut with a hacksaw so that all are in place right to the dot. When this is done, spot weld all of the fuselage side together. Now make the other side just like the first and spot weld it too.

We are now ready for the most particular job of the entire fuselage construction. Having satisfied yourself that your floor or table is perfectly level, lay out the top plan of the fuselage and cut these pieces to the proper size. Then using nails or some other sort of jig to hold the members in their proper places, place one side of the fuselage, with the top longeron down, in its proper place, forming it around the lines you have already laid down, using a square to get the side absolutely perpendicular to the floor or table. Now do the same with the other side and spot weld the cross pieces and diagonals in place. The jigs will hold the work while you are welding it.

Now lay out your bottom plan, invert the fuselage and square it up as before, cut your diagonals and cross pieces and spot weld them. After making sure that your structure is still square you can cut and spot weld the internal diagonals, and will then be ready to weld the fuselage together.

This welding must be done by a man who thoroughly knows his job. If you don't feel competent to tackle this most important task you can hire a welder to come to your shop. An experienced man should be able to do all of the cutting and welding in two days at the most. Of course this will cost you more than if you did the job yourself, but if you have to make a forced landing...
The landing gear is one of the most important parts of your plane and one of the hardest to build. Full details are shown here. (and who doesn’t at one time or another?) It’s a great satisfaction to know that your fuselage isn’t going to come apart at some critical point. Welders demand good money for their labor, but it seems paltry beside what a doctor or undertaker can charge.

Start welding from the front end and go around the fuselage, working toward the tail. In this way you chase out all the kinks and warps that would develop if you went at the job in a hit and miss manner.

Now that you have the structure completed let us put on the lugs for the landing gear, center section struts, flying wires, and the tail group. These are all made of 13 gauge steel 3/4” wide and 1” long. They are put in their respective places and welded on (see Figure 2). After all of these fittings are in place, the entire fuselage should be treated to a good coat of lionoil.

The motor mount is not given in detail, but is merely suggested in Figure 9. The reason for this is that a mount suited for one motor will not fit another, and besides this, all of the boys have their own pet ideas as to just what a motor mount should be. The main thing is to get the weight of the motor in the right place. It is best
Figure 3. This three-view drawing of the Powell "P.H." Racer gives you some important dimensions.

Glider Manual
METHOD or ATTACHING STABILIZER TO THE Rudder Assembly with the Tail Skid.

VERTICAL FIN AND RUDDER ASSEMBLY WITH THE TAIL SKID.

WELD TO BOLT HEAD STABILIZER LONGERON BOLT SPREADER TUBE DETAILS OF THE HINGE BACK BEARING FOR HINGE 6-REQ'D 16 GA.

Rudder Torque Tube DRILL HOLES 16 FLEXIBLE CONTROL CABLE.

DRILLING HOLES.

DETAILS OF THE RUDDER HORN 1-REQUIRED.
OF 16 GA. CAR. STL.

Hinge Strap 6-REQ'D 16 GA.

COMPLETE DETAILS OF THE ASSEMBLY OF TAIL GROUP FOR THE "P-H" RACEPLANE.
to leave the motor mounting and cowling to the last, as the only practical way to attain perfect balance is move the motor an inch or so forward or backward as found necessary.

**Empennage**

Little difficulty will be experienced with the tail assembly after having built the fuselage, for the same procedure is followed. This job will also require welding, so if you have called in a welder you might just as well let him go ahead with these details, which are fully given on Figure 5. If you are tackling this job yourself, lay out the fin, rudder, stabilizer and elevators on a flat table and outline in nails. Then cut the pieces to fit the forms and weld. Be sure to make the hinges and put them on the torque tube as you go along, for they are rather hard to put on afterwards. After all of the tail group is finished, check and see that it fits the fuselage, for you may have to make a few minor alterations, and it will be found much easier to have them done now than later when the parts are covered.

**The Landing Gear**

The landing gear is one of the most important parts of the ship and one of the hardest to build. It must be built well to stand the strains of landing.
Lay out the "V" struts on some flat surface, cut your 2"x17 gauge steel tubing to the proper size, spot weld as shown in Figure 2, then shape the tops of the struts and fit them to the fuselage lugs which are already in place, secure with 1/4" eyebolts, and weld according to the drawing.

Spreader bars of 3/4x20 gauge steel are then measured, slotted in the ends, welded up, and a hole bored for bolting to the spreader bar and brace wire lug which is welded to the struts as shown in the detail drawings on Figure 2. The 3/8" square tubing axle guides are then cut and welded in place.

Now for the axle. This should be a piece of 22 gauge chrome-molybdenum round steel tubing 1" in diameter and at least 54" long. This should be placed in the axle guides and the collars should be brazed at the points shown in the drawing. The axle should not be sawed to length until after you have the wheels on and the gear fitted to the fuselage, and then enough of the axle should be left to permit the placing of a hub cap. This can be made from a 1" inside diameter washer and a piece of 1 1/8"x16 gauge steel tubing about 3/4" long, with a 3/16" bolt put through the end.

The Wings

The wings are of conventional design with the same bracing as you will find in other wings. A glance at Figures 4 and 7 will reveal their simplicity. The spars are the acme of simplicity, as they are solid. But be sure and pick a very good piece of spruce for each spar, as they are the heart of the wings.
Inside of this place two more cap strips, pushing the middle one in place and nailing the inside strip. This middle one is the cap strip of your rib. Now you are ready to place the spar openings, which are illustrated on Figure 7, in their correct locations.

After these are located and their correct size determined, make a block of that size and put it in the spar place. Now cut the 1/16" plywood to the contour of the rib, place it over the cap strip, glue and nail with 1/8"x20 nails with a flat head. Then place the other cap strip on the opposite side and glue and nail it in place. After all the ribs are made, sand them up and fit to the spars.

A wing splice in the spar is not necessary if a piece of spruce can be obtained which is long enough, but in the event that you have to splice the top wing spar in the center, make it a diagonal splice 16" in length, wrap with rib cord and glue.

In rigging the wing it is easiest to measure out from the butt about three feet and make a mark on the spar. Then tighten and loosen the wires until it is the same distance diagonally from the wing butt to the mark on each spar. Give the wing a coat of good varnish before covering.

The Ailerons

The ailerons are of the semi-balanced type and are operated with a torque tube from the fuselage bell cranks. There are four hinges on each aileron, and these are made from 16 gauge steel 3/4" wide. Details for these hinges, as for all other parts of the aileron, are clearly shown on Figure 6. This type of hinge is the best if care is given in construction, but they must be assembled as the aileron is built if they are to be in line and operate smoothly.

The aileron ribs are the regular ribs with two inches cut out immediately behind the wing spar. The aileron spar depth is then gotten from the inside measurements of the cap strips. The trailing edge is made from a 1" wide strip of aluminum, bent in a "V" shape and secured by small strips of brass nailed around the aluminum and onto the rib cap strips. No other instructions are needed here, as the drawings are given in minute detail.

The Control Stick

This is another part of the ship which can be moved around to suit the pilot. There is not much room in which to play around, but the person who is to fly the ship should see that the stick and foot pedals are placed where they will permit the most comfort.
The tail skid may be made of either steel or wood, but for this size ship wood will probably be the best, although the drawing shows it constructed of steel. This is a matter of personal choice. If you decide upon wood, use ash, and follow the general size and shape as shown on Figure 9.

**Instruments**

The only instruments needed are the oil gauge, tachometer, altimeter and switch. Others are of course desirable, but you can buy what you want at the convenience of your purse.

**Struts**

The center section struts are of 1\(\times\)x20 gauge streamlined steel. They may be made adjustable if so desired. The front center strut is 15\(\frac{1}{2}\)" long and the rear one is 15". When these have been laid out and spot welded, the diagonal is cut to fit. They are then fitted to the fuselage and welded.

The front outer bay strut is 30\(\frac{3}{4}\)" long and the rear 30\(\frac{3}{4}\)". The diagonal is cut to the proper length before welding. The flying and landing wires are of \(\frac{1}{4}\)" streamline cable, although stranded cable may be used if preferred. Before ordering the streamline wire it is the best policy to set the plane up and block the wings to their proper positions; then measure the lengths.

**Covering**

Cover the ship with a good grade of airplane fabric and give six coats of dope. Tape the ribs and wings carefully, for that makes a lot of difference in the looks of the ship. Use pigmented dope for the last three coats, as the cloth will not stand sunlight otherwise.