Plans for Building the Driggs Dart

Driggs Dart competed in 1926 National Air Races at Philadelphia.

By Ivan Driggs

The Dart I whose construction is illustrated and described in this article is one of the most successful and practical of American single seaters. This airplane with the Henderson motorcycle engine won the greatest proportion of the prize money at the 1924 Air Races. The same design with the Wright Morehouse two-cylinder engine took part in the Ford Tour of 1926 and subsequently flew over the mountains from Moundsville, W. Va., to Washington, D.C., and from there to Philadelphia to compete in the races there. In making this flight the Dart I left a great many larger planes behind due to bad weather.

The only light plane at present owned by the U.S. Air Corps is a Dart I. It is used by the Engineering Division at Wright Field in the development of wing slots. This design was made under contract to the Air Corps and the stress analysis has been checked by the Engineering Division. No one need fear that this airplane, if properly constructed, will be structurally unsafe.

To build the Dart I a good knowledge of cabinet making and welding is necessary. No one should attempt it unless he possesses that knowledge or is able to engage the cooperation of one who does.

In building anything, it is usually best to begin by building the most difficult item first. Consequently we will first start the construction of the fuselage, though the wing might at first seem to offer greater difficulties. Such however is not the case, and there really is nothing tremendously difficult in the construction of the whole plane. Take two long beams that will later be used as cauls in building the wing beams, and make of them a base for the fuselage jig. This is made by supporting the beams on four saw horses, and leveling them up about two feet apart. They should be firmly nailed to the horses. Starting from the front of the fuselage, each station should be laid out with a sharp pencil on these beams, using a carpenter's square to insure that the lines are absolutely square with the center line. Then lay out the various lower cross tubes at each station. Erect at each station
on both sides just at the rear edge of each bottom cross tube line a series of 2 by 4 yellow pine members, about 4 ft. long at the rear and 6 ft. long at the front. These members will support the fuselage jig proper. Thirty inches from the surface of the beams mark a line on each of these uprights. This may easiest be done by the use of a piece of wire after laying out the front and rear uprights. By stretching the wire tightly a straight center line along the sides of the uprights is insured. This line so obtained on the outside of each corresponds to the thrust line marked on the drawing. Be sure that all uprights are square with the surface before nailing.

Next obtain some 3/4 by 4 Yellow Pine for cross members. Measure down and up on each upright to
Fuselage details are in drawing above, and the design of the Driggs Dart I is now quite a few months old, and has been tried by time. Below is shown the granddaddy of split undercarriages, and is simple to make, and efficient.

The very clever Driggs Dart I trolley makes use of rubber rings to absorb shock. There is little recoil in such an arrangement. Note the compression figures under load.
This view shows the enormously refined lines of the Dart I, with parasite pared to the "irreducible limit." The full cantilever wing is the modern thing, and is highly efficient and ruggedly strong.

the center line of the longeron plus one-half the diameter of the cross tube as given and securely nail these cross members on the front of the uprights. Bottom cross members at every station should be placed below the longeron and tangent to its lower surface, top cross members above. For the attachment of motor mount and wing fittings make up dummy motor bearers and wing spars and support from cross pieces. Make up fittings and properly locate on these dummy members.

We now have a frame into which we can lay our tubing for welding. Referring to the plan view of the fuselage, lay out on the lower cross members the center line and both sides of the longeron clear back. Do the same for the single upper longeron. You are now in position to cut and fit the tubes previous to welding. Obtain sufficient of the specified sizes. Specification 1025 will be satisfactory. First fit the upper longeron and fasten in place by a piece of wood with a hole in it the size of the longeron. This piece is nailed to front of top cross member in such a way that the longeron is held exactly on the lines previously laid out. Next fit in the two bottom longerons in a similar manner. When the longerons are in place and the work has been thoroughly checked, the uprights and cross members are next fitted. It is not necessary to file out the tubes to fit the longerons exactly in such small sizes. Simply cut them off square and allow about 1/32 clearance for expansion when heated. When these tubes have been all fitted, an experienced welder should tack them lightly into place. Next make up the corner gussets. These pieces can best be made by coiling the tubing around a large steel bar in a lathe, similar to the way a spring is coiled. After this coil is made it is sawed into four pieces lengthwise. Next the welder tack in these gussets. Go over the fuselage and set in all fittings not already mentioned, having them lightly tacked into place. When all parts are in, a thorough check

The tiny Driggs Dart draws an admiring crowd under the wing of the huge three-engined, all-metal Ford during the 1926 Ford "Airplane Reliability Tour."

Here are the side view details—all that are necessary—to build the cabin seat of the Dart. Note the beautiful engineering that has gone into this design, and how easy the parts can be made. The seat is cushioned.
should be made to insure that all parts are properly located, especially the wing attachment fittings and the motor mount. When you are sure that everything is O.K., complete the welding at each joint as far as possible so as to insure that the members will not shift after removing from the jig. The splices in the rear longeron should not be welded until the last operation. When this is complete remove from the jig by sawing off the cross members. Place on horses and complete the welds at every joint. Next wire up and line up the rear part of the fuselage, using small buckles and the wire called for.

The next operation is to varnish the fuselage and to cover it. After varnishing, bolt in the spruce stick at station three, and wrap the members around the door with tape to which you can sew the cover. When covered dope with three coats of good nitrate dope and paint.

The next part to make is the landing gear. The average man has a great amount of trouble in building a gear so it is true. The whole secret is in having a good jig, and the best one is the fuselage that has been completed. Support the fuselage on two horses so that the lower longeron at the gear attachment is about 12 in. from the floor. Level the fuselage fore and aft, and crosswise. Plumb down to the floor from the center of the front fuselage fitting and lay out the wheel centers on the floor. Support small pieces of axle tubes on blocks from the floor in the exact location given on the drawing. Set up the upper ends of the main axle and brace tube and bolt into fuselage fittings. By sawing at the proper angle the main axle and the stub for the wheel are made to meet properly where dimensioned. When the three tubes fit properly they should be tacked together and the fittings made up and applied. The welding on the axle should be completed as far as possible before removing from the fuselage and floor blocks. When completed each vee should be heat treated by a competent man to the specifications given. The S.A.E. number of the steel is 4130 which the heat treater will have to know. The shock tube is too simple to make to warrant any explanation. Next the tail surfaces and ailerons should be made. Obtain some ¾ by 6 yellow pine lumber and make jig boards sufficiently large for each surface. On these boards lay out each surface and all of its members. Make up some blocks about 3 in. high, with holes in them on center, the sizes of the various spars and leading edges. Split these blocks and nail to layout boards at suitable intervals to support spars. Be sure they all line up perfectly level. Cut spar tubes and clamp in jig to the above blocks. Then bend up rib tubes and weld them where shown. Tack as far as possible in the jig and complete welding after removal. Thoroughly varnish, then cover and dope. Be sure that all hinges properly line up on adjacent surfaces before completion.

The tail skid, motor controls, seats, flooring and plane controls can now be made and installed. No jigs are necessary for these parts which can easily be made by a good welder and mechanic. No description of their construction will be given.

In the next part we will describe the making of the cowling, and the installation of the motor fuel system.

This ship has been flown in all kinds of weather, and has made long cross country hops successfully. It has a high speed, with a Henderson motor, of around 84 mph, and a ceiling of about 12,000 ft. It will climb better than 300 fpm and is very sturdy and rugged. The ship built for the Army to these specifications is shown in a photo on page 31. We have built another, powered with a Henderson, and it is from this ship these figures are taken. The ship shown above is powered with a Bristol Cherub and performed in every way like its bigger sisters. Full illustrations for building the wing will appear in the second part of this article.

Here are the complete details for the beautifully engineered design of the wing tank. All dimensions are given. It would be wisest for the amateur-builder to take this job to his local tinsmith, who will build it for him.

Highly streamlined Dart was ahead of its time. Engine was a 28 hp Henderson.
WINGS AND FUSELAGE
FOR THE DRIGGS DART

In the first section of this article full details for the fuselage parts and the method by which this most important part of the ship is constructed were treated. Herewith, in this, the second part of the Driggs Dart design story, details on the wings and further data on the fuel system will be added to make the story more complete. When you have completed the balance of the story given here you will have the complete design, just as I turned it over to the Army Air Corps for acceptance, only minus the voluminous stress analysts.

Here is the data on the construction of the wing:

By referring to the drawing on page 37 we see that the wing of the Driggs Dart is full cantilever, that is, without external bracing, and is plywood covered. Sufficient plywood 3/64 in. thick should be ordered to cover the wing as shown and to make the 21 ribs. Then obtain about 84 pieces of spruce 3/16 square and about four feet long for the rib cap strips. These ribs are made of one sheet of 3/64 plywood with the cap strip nailed and glued in each side. They may be laid out on one piece of plywood and that tacked to another and then both bandsawed together. This will insure that the corresponding ribs on each side are alike. With the rib contours sawed from the plywood each size is lightly tacked down on a smooth plank and about a dozen ½ by ½ by 1 in. blocks are nailed to the plank around the outer edge of the plywood, as closely to it as it is possible. After the blocks are nailed to the plank so as to form the rib jig the 3/16 square pieces are glued and nailed to the plywood. Use the best grade of casein glue. Force the cap strip out against the blocks with the fingers to insure that the proper contour is obtained. It will be necessary to soak the strips for the deeper ribs at the nose in hot water to make the bends without breaking the strips. When the strips are applied to one side of the plywood pry off the plank and apply the strips to the other side by constructing a similar jig, but of opposite hand. When the ribs are dry they should be cut out for the spars with a sharp knife and neatly trimmed and sanded. Do not varnish at this stage.

The next problem is to make the spars. This is where the services of a good cabinet maker will be
Above you will see the template measurements for the larger wing ribs in near the base of the wing. These are likewise made up of plywood with the web strips fastened outside.

Front and rear views of slots and flaps that were installed on Army Air Corps Dart.

High aspect ratio metal cantilever wing under construction by Air Corps Material Division.
necessary. From your local mill obtain some planks 1/8 in. by 7 in. by 12 ft., and some 1/8 by 4 by ½ from clear spruce. This material need not be especially the airplane quality, but should be free from knots and reasonably straight grained. Then obtain two 6 in. by 8 in. by 14 ft. beams and two planks 2 by 8 by 14 ft. for use as cauls. Spike these beams end to end onto about six saw horses. Be sure that they are perfectly level and without any twist. They should be perfectly straight. By referring to the wing drawings we see that the different laminations of the spars stop at different intervals from the center. Lay off these intervals on the beam and cut the outside lamination from the front spar, laying one of these pieces on the beams and securing it with a few small brads. Place two separate pieces outboard of this center lamination the remainder of the length of the beam. Also brad these pieces down.

Cut the next lamination and lay it on the first, using shorter filler pieces at the end. Continue until all of the spars laminations are cut. You will note that the center four laminations are continuous and that your material is not long enough to reach. Each lamination may be spliced taking care that no two pieces have a splice closer than about two feet. A good scarf splice should be made using a slope of about 1 in. for the ½ in. plank. When the laminations have all been cut and spliced they should be glued together by applying the glue to the shorter planks of any pair. That is, apply the glue to the first plank and lay down the next. Apply to the third and so on. Fill the ends on top with ½ planking cut-offs and firmly clamp on the two 2 in. planks above mentioned. Use about four dozen 12 in. C-clamps. Allow the spar to dry about 24 hours before removing from the caul. Be sure to use casein glue only. When the clamps are removed you have your front spar ready to work down.

The rear spar is made from the four inch planks in a similar manner except that the beams are raised up at the tips to take care of the bend in this spar as shown. This is accomplished by blocking up each successive saw horse until the beams make the proper included angle. Then a piece of soft wood should be screwed to both planks in the center and worked down by hand to form the proper radius for the bend of the spars. After the caul is thus made proceed exactly as for the front spar.

After the spars are made and dried the next step is to lay out a center line on the spars and then lay out the heights of the spar at each rib point from the rib drawings. When this is done the spars may be sawed approximately to these points and worked down by hand so that the ribs will slip in place. These lines marked, horizontal plane on all ribs should be marked on the spars, especially on the rear since it is the same as the center line on the front. On the rear spar this line is somewhat above the center but is perfectly straight.
When the ribs have been properly fitted the whole assembly should be clamped to the saw horses in an inverted position and blocked at various points to insure that the two lines on the front and rear spars are perfectly level. Then glue and brad the ribs to the spars in the proper locations. Glue a strip of spruce 3/16 by 3/8 between each rib along the center line of the spar at top and bottom so that the cover will have an attachment to the spars. Shape the leading edges of all ribs to a straight edge and apply the spruce leading edge piece, gluing and nailing to each rib. Then apply the plywood cover to the bottom surface, gluing and nailing to each rib. It is well to cut each panel before applying and to work from the tips inward. Make all splices in the cover at the ribs by lapping about 4 inches. When the lower surface has been applied and the glue has had an opportunity to dry

turn the wing over and apply two coats of spar varnish to the inside, except to the tops of the spar strips and the ribs. Again block up the wing so that the base lines are level and apply the top cover. Make sure the blocks and the aileron hinges and aileron pulley brackets are glued in before the cover is applied. When the wing is thoroughly dry apply the balsa leading edge and form the contour by hand. Sand the wing and cover the trailing edge with cloth on which apply four coats of dope. The cloth is tacked to the rear spar and the joint covered with rib tape. Glue rib tape over the leading edge balsa and apply two coats of spar varnish over the whole wing.

Before the wing is sealed up the fuel tanks must be built and installed. Any good tinner can make up this tank when the filler caps, etc., have been machined up for him.

Air Corps Driggs Dart with a Wright-Morehouse engine. Air-
craft weighed 400 lbs. empty and had a useful load of 239 lbs.
method of making this tank is necessary since a person constructing this airplane would much better turn this job over to his local sheet metal shop.

Previously we have described the method of building all of the structural parts. Now we will describe the construction of the fuel system and of the cowling, together with a table of the source of supply of suitable material.

In installing the fuel system only ground union joints should be used, except between strainer and carburetor where we have shown a hose connection. Care must be taken so that the lines always have a downward slope so as to avoid any possibility of air pockets in the tubes. Bends should be very carefully made and not too sharp or the tubes will be considerably flattened and reduced in area at the bend. Thoroughly anneal all tubes with torch after bending and clean out all scale. The type of fuel level gauge shown is the most simple and reliable. Naturally one should be used for each tank. In making the union connections be sure to thoroughly sweat the ends of the tubing before trying to solder on the nipples. A line of solder around the tail of the nipple is not sufficient to hold the joint. If these instructions are carefully followed you should have no trouble with the fuel system.

The good appearance of your ship depends upon the care with which the cowling is made. A person sometimes gets too anxious at this stage and slightly the final finish. To properly make the cowl a form should be made to which the pieces are fitted while bumping. If this form is well made and the parts fitted to it carefully, you cannot help but get a good job. If the builder knows nothing about bumping or forming metal the services of an automobile body repair shop had best be enlisted.

With a power hammer a much smoother job can be done and in less time.

The cowl sections should be laid out on ¾ x 4 Yellow Pine boards and suitably held together by four longitudinal pieces notched into the section formers at the top and bottom and two sides. The angular section for the lower part of the firewall should also be set in. This form should be well screwed and glued together and properly braced so that it cannot be sprung out of shape when being worked upon.

You will note that the cowling is made in three parts, an upper and lower motor cowl and a fuselage cowl. By forming these pieces separately rather than the whole cowl in one piece will considerably simplify the work. The firewall is laid off the same way the cowl former bulkheads are made, and is screwed to ash bending around its outer circumference. These bendings serve to fasten the firewall and front fuselage cowl together.

We believe the drawings are sufficiently clear that this cowl can be made with but little trouble if the bumping form is properly made as above outlined.

The writer hopes that with these drawings and the above explanation any one with fair mechanical ability will be able to build the Dart I.