Complete ALCO SPORTPLANE Plans

By John M. Allison, A.E.

For the last nine years, or since 1920, the Allison Airplane Co., at Lawrence, Kans., has been marketing plans and blueprints, and selling knockdown parts for a small sport monoplane carrying one or two people with less than 65 hp.

Hundreds of amateur builders have made and flown the little ship successfully, using the most ordinary tools for doing the work. These ambitious young men, with typical Yankee ingenuity, have set up their workshop in the parlor, cellar, or barn, and there they have built their rib jigs, made ribs, and the many other items involved before the assembly of the complete plane. Later the complete plane was test flown from some pasture or other small field, by the owner-pilot, who designed the plane.

The Alco is a true “flivver” plane, designed especially for the man who wants to fly a plane of his own without investing several thousand dollars in a commercial plane that he would probably “crack up” and damage before he was scarcely capable of handling a plane with any degree of confidence in the air.

The Alco costs only $100.00 to build, without the motor. He saves himself hundreds of dollars by using his plane to pile up flying time that is required by the United States Department of Commerce before issuing a pilot's license. Some of the more daring men have actually taught themselves to fly by the time-honored method used by the pioneers in this country about 1910; this system consists of first “taxiing” around on the field until they could handle the plane nicely on the ground; then short straight-away flights of a few feet while the plane is just barely off the ground; then making longer flights at a higher altitude, as skill and confidence are required, until finally they found themselves banking, zooming, and performing all the other feats that are commonplace in the lives of experienced aviators.

Perhaps after the beginner has built his plane with a motorcycle motor, and successfully flown it, he will feel the urge for more power and range. He will then replace his motorcycle engine which he probably obtained at a junk yard or motorcycle shop for about $15.00, with a slightly more powerful and expensive engine, say the Lawrence two cylinder opposed 28 hp air cooled engine which sells new for about $100.00 at the present time. The new engine makes the plane capable of greater range and better performance.

So it goes, until the young pilot is absolutely at home in the air, and can fly any type of plane without difficulty.

The history, as given above, is in fact the history of the designer of this plane. The writer taught himself to fly in 1922 in a small plane of his own design. While a student in mechanical engineering at the University of Kansas, he wrote several papers on aeronautical subjects, which are frequent-
ly referred to by those interested in aviation. Since his graduation from college, the writer has been associated with his brother in manufacturing high lift replacement wings for war production ships, and small sportplanes which are sold for the most part in knockdown form; that is, without motor, and covering. The knockdown plane consists of all parts such as ribs, spars, fuselage struts, etc., ready to assemble into the complete sportplane. By buying these parts, instead of the complete plane, ready to fly away, the purchaser saves himself a good percentage of the first cost of his plane. Some customers prefer to build their plane up from the raw material, (spruce, cloth, dope, sheet metal, etc.), using the blueprints as a guide for getting the correct proportions and dimensions.

The writer estimates that he has sold over 3,000 sets of plans in the last few years, and he has yet to hear of anyone who built one of the planes which failed to fly. For the benefit of readers of Flying Manual, the writer will start telling in simple language how to construct the Alco Sport Monoplane.

Below are the specifications, (Motorcycle engine):
Length overall .................. 18 ft. 3 in.
Weight empty .................. 375 lbs.
High speed .................. 75 mph
Low speed .................. 30 mph
Landing speed .................. 30 mph
Wing span .................. 26 ft.
Wing chord .................. 5 ft.
Gas consumption .................. 1 1/4 gal. per hr.
Cruising range (with 10 gal. tank) .................. 400 miles

The first installment of this article will take up the building of the wing. The Gottingen 365 airfoil is used. This section has proved very successful on several transoceanic flights; the blueprints show a half size drawing. However, if you want to lay out the rib directly without double the scale shown in the drawing, the following table of ordinates will be found useful:

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The first column is percent of the wing chord and the chord in this case may be measured along the lower side of the aerofoil since it is perfectly flat except at the nose. The other two columns are plotted against the chord to get the aerofoil drawing for unity chord. For five foot chord plottings all you would have to do would be to multiply the upper and lower aerofoil readings by .60. Five feet is equal to 60 in., and unity chord may be called 100 in. 60/1000 is equal to .60. The above figures are taken from Report No. 124, published by the National Advisory Committee for Aeronautics, and may be obtained free from the Washington, D.C., headquarters by anyone interested in designing.
The figures are not needed in building the Alco Sport Plane, since the figures for the half size rib may be doubled to get the full size curve; they are given merely to show the young designer the line of attack in designing and making a rib jig.

Making the rib jig: The sketch of the rib jig shows how the jig for turning out the 24 ribs required, is made.

The jig is mounted on a large plank about 2 in. thick, so that there will be plenty of weight to support the hammer blows when the gusset plates are tacked on the ribs. As shown in the figure, the lower surface of the rib is flat except at the nose, and it will be very easy to saw out the lower half of the jig, using a paper pattern made from the full size wing curve as a guide. Half inch pine is good enough for the purpose.

Since the camber of the upper half of the jig is great, it will probably call for two boards sawed to shape and joined as shown. The half inch material is nailed securely to the planking using inch and a half nails with big heads.

Use the half size rib drawing to determine approximately where the beam centers should lie with respect to the chord, and also where the diagonal struts join the upper and lower cap strips.

Another way of fixing the cap strips so that they will bend easily is to saw a slot about 6 or 8 in. long in the end of the cap strip where the bend is the sharpest.

Cut a strip of 1/16 in. fiber to fit the slot; apply plenty of glue to the fiber before inserting in the slot. Before the glue starts to set, place the cap strip in the jig, (the upper one first, then the lower one). Next put all vertical and diagonal struts in the proper places, and start nailing on the pieces of fiber or plywood which act as gusset plates to hold the different members firmly together. 1/2 in. by 20 gauge, is the proper sized nail to use for this work.

As shown on the drawing of the rib jig, small cams are used to hold the cap strip firmly against the sides of the jig. Without these, the cap strips would tend to sag away. These cams pivot around a screw in the plank. The cap strips do not go clear forward on the jig, since a little space must be left for fitting the nose; the nose is a hollowed
In this photo are shown the plywood firewall or bulkhead, the method of taping struts to prevent splitting. Note N framing.

out and rounded piece of spruce as shown on the wing curve drawing, and attaches to the ribs by means of screws about 1½ in. long.

These screws go through the almost vertical front strut between the two cap strips, as shown.

The nose piece or leading edge, as it is called, fills out the front part of the wing curve. It is not attached until after ribs are slid on the spars and fixed in position. After the gusset plates have been nailed on one side, the rib is removed from the jig, and the gusset plates are nailed on the other side. Design your gusset plates so that they are as strong as possible without being large. If fiber is used, tin snips make a convenient tool for cutting the gusset plates to shape. If plywood is used, it will be necessary to use a saw. When both sides of the rib are nailed, the patches may be trimmed with a pocket knife and the end of the rib cut off to the right length. The ribs may now be given a heavy coat of spar varnish and set aside until you are ready for the wing assembly.

In addition to the 12 long ribs required, 12 short ribs are needed; also one special short rib in the center of the wing extending from the rear beam to the trailing edge; the gas tank will rest in the space between the front and rear beams in the wing on the left side of the fuselage, and the wing will be cut out from the front beam or spar forward in order to afford the pilot a better view.

The short ribs are made exactly like the long ones except that shorter cap strips are used and an extra vertical strut is placed at the rear. The false beam for taking the control hinges is attached to these struts by means of nails when the wing is ready for assembly. The sketch below shows method of placing the vertical strut at the proper place.

The aileron ribs are built up separately, using the same jig as before. The width overall of the ailerons is 12 in. and this includes the small beam at the front which is ½ in. spruce and is attached

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The ribs are sawn for the fiber and are glued, so that the gusset plates may be fastened at the ends of the wing ribs.

Here is a photo of the completed skeleton wing panel for one side of the ship. The fiber side gusset plates are plainly shown. Note the adequate spar depth and sturdy appearance.
Good tail areas make for ease of control.

All spacings here shown to above scale.

Front view shows clean design with parasite resistance cut to bone.

Goettingen wing firmly braced is easy to build, and very stout.

Ordinates for this Goettingen wing curve (somewhat similar to the Clark Y wing section) will be found in the text. Lay the rib jig out according to this plan.

Plywood deck

$\frac{1}{2}$" Plywood deck

$\frac{3}{4}$" steel strap

Plywood brackets.

Plywood sides on cabin

Longeron - $\frac{1}{4}$" x $\frac{1}{16}$" tapering to $\frac{1}{8}$" x $\frac{1}{8}$" at rear.
to the foremost vertical struts of the aileron ribs by means of 3/4 in. nails.

As shown in the drawing, the wing tips and aileron tips are made of 3/4 in. steel tubing. Bend it to about the shape shown in the blueprints, cut it to length, and attach at the aileron beam, (tapered at the end). To get a good joint at the points of attaching, cut away half of the steel tubing at those places, flatten it with a hammer, and drill it in two places to take a good sized nail which will be driven into the beam in front and the junction of the last rib and the trailing edge in the rear.

The aileron beam extends 4 in. beyond the last rib; seven aileron ribs are needed for each aileron. The one in the middle of the aileron should have a special block in it near the beam so that the aileron horn may be firmly attached. All control hinges are made as shown.

Making the drift or compression struts: These are the members holding the spacing of the spars against the pull of the wing brace wires. They are 28 1/16 in. long, 4 3/4 in. deep, and 1/2 in. wide, and made of spruce. They are notched at each end, so that they will straddle the fitting where the brace wires are attached. In a future installment they are shown fastened to the inside of the wing spars.

Building up the spars: The wing rib for the Alco Sport Monoplane is so designed that the two spars are of equal depth. Make the rear spar 25 ft. 10 in. long and the front spar 25 ft. 4 in. long. The difference in length is explained by the fact that steel tube wing tip is curved and it must be fastened against the end of the tapered beams. Some of our builders who are somewhat cramped for room prefer to build the wing in two parts, a right and left panel, then join the panels to the center section 24 in. wide which makes the total span 26 ft., the same as if the wing were made all in one piece. In either case, the under side of the 24 in. section of the wing is not covered, in order to allow more head room for the aviator. The spars used are of the box type, using stringers of spruce 1 in. wide and 3/4 in. deep. Of course, these will have to be spliced once or more if the wing is made in one piece. However, this is not very hard to do; simply join the butt ends, and nail to a heavy block placed at that point. Do not splice the plywood and the stringers at the same place or else the spar will be weakened. Splice the spar beyond the point of fastening with the external brace struts, if possible.

Use 1/8 in., two ply mahogany plywood for the sides of the box spar. Be sure to have spruce blocks about 3 in. wide at all points in the spars where wing fittings and drift struts attach; also where the aileron control pulleys fasten.

According to this system, wire No. 1 is entirely concealed, except where it emerges from the wing a short distance in front of the rear beam, on its way back to the elevator horns. The pulleys shown in the sketch are fastened to the back side of the front beam one above the other, using a simple sheet steel fitting. From the pulley A the simplest method is to bring the wire out of the wing on a direct line to the control stick; this way is open to the objection that it causes considerable head resistance. By the use of two additional pulleys, wire No. 2 may be kept entirely concealed.

In assembling the wing, the two spars are placed on two horses, and the ribs are slid on to the proper place and nailed there. A carpenter's square is used to get the right angle between the rib and the spar. Next make up the brace wires, and put them in; you will notice that there are two bays on each side of the fuselage; the two drift wires and the anti-drift wire are led as shown above, from their anchorages and are safetied.

PART 2

ALCOR SPORTPLANE FITTING DETAILS

You are now ready to start the real work of assembling the fuselage. There are several ways of going at it, but probably the easiest way is to build the sides up first. Placing the upper longeron on a wide work bench, line it up until it is perfectly straight, then hold it in that position with spikes driven into the bench on each side. Then starting at what will be the stern post of the fuselage, put in your vertical strut, nail on the 3/8 in. plywood gusset plates. Then go on to the next vertical strut, already cut to length and ready to put in place, insert it and the diagonal, bring the lower longeron into place and hold it there by nailing the lower gusset plates on.

The lower longeron assumes almost a straight line between the two stations mentioned, making it easy to bring it up into place. Carry on in this way until the side of the fuselage is entirely built.
from the cabin forward to the motor mount. Use a heavy tack about 3/8 in. long for the work, and use plenty of casein glue in addition.

After the left side of the fuselage is done, start work on the right side.

The next thing to do is to make some sort of a jig to hold the sides of the fuselage upright at the proper distance apart at all stations while the horizontal members of the fuselage are fastened in place.

A long low bench comes in very handy; on this bench nail cross pieces about 1/2 in. by 3 in., with the narrow side down. There must be a cross member at each station of the fuselage. After these are nailed down, cut notches the exact size of the upper longeron at that point at each end of the cross member mentioned: starting at the stern post, which is the common vertical strut for each side of the fuselage at that position bend the sides into position, as fixed by the dimensions shown on the plan view of the fuselage, and push the upper longerons into their positions in the notches cut for them. See that they fit snug and that the distances across the fuselage check the blueprint dimensions at all points.

When everything is in alignment, put in the cross struts of the fuselage, which have already

up. Beginning from the fourth station from the rear, and continuing on forward, the lower longeron is curved pretty sharply, and care must be used to see that you get the proper bend. Check by measuring the bend at different points in the most curved part of the longeron. The left side of the fuselage will not be quite the same as that on the right, since it is cut down at the cabin to provide easy access for pilot and passenger. Put in all the struts and tack on 1/8 in. two ply plywood

The method of internal wing drift bracing is shown in the diagram above. Only one-half of the system is shown.

Up aloft, ready to go where you will! This drawing of the Alco Sportplane shows the ship equipped with a 2-cylinder opposed Lawrence engine. In adopting the Lawrence engine, which is no longer manufactured, a two-throw crankshaft is substituted to cut down vibration to a minimum.
been cut to length, and nail on the plywood gusset plates. After one or two of the cross members are in place, the work will commence to look like a real fuselage. The above instruction covers the work up to the bays nearest the nose. With the fuselage still in the jig, use temporary wires and turnbuckles to draw the lower longeron into the curve shown; then while it is held there, you can build up the front end, putting in the uptights and the short upper longerons running horizontal back to the heavy upright which also acts as center section strut to support the wing. (Only two such center section struts are needed, since the wing rests upon the top longerons of the fuselage itself back of the cabin). The heavy upright is 1 3/8 by 13/16 in. spruce. Great care should be taken to see that it is put in firmly. Finally nail the plywood bulkhead in place. During spare time or when your work elsewhere is held up temporarily, give the entire fuselage a couple of heavy coats of a good spar varnish.

Installing the seats and controls: The drawing above shows how the rudder bar, and control or "joystick" are made. A simple one-piece fitting cut out from 1/16 in. sheet metal and bent to shape makes a good universal joint, allowing the stick to be moved in all directions. A universal joint from a Ford car may be used as the socket for the stick if you have any trouble making the one shown in the sketch; however, it is a little heavy, so we do not recommend it. The stick itself may be either cut from a broomstick or made from 1 in. steel tubing. It is drilled to take the collar fitting upon which are fastened the elevator and aileron control cable ends. The lower part of the stick is also drilled for the bolt which holds it to the universal joint fitting, and upon which the stick turns when it is moved fore or aft by the aviator. The sideways motion which is necessary for the operation of the aileron in such maneuvers as banking, is obtained by the universal joint turning upon the U-bolt through the wooden base. The stick assembly is held to the floor of the fuselage by means of long finishing nails.

The seat used is made of wicker, and is very light. They do not cost very much and are more satisfactory than a home made one, although one of the latter can be made from plywood. The seat is nailed to the supporting bridge in the floor of the fuselage so that the center of gravity arrow will pass directly through the body of the aviator sitting upright in the aviator's seat. If the plane is to be built as a two-seater have the passenger's seat close behind that of the pilot; the passenger will have plenty of leg room around the sides of the seats ahead. The reason for arranging the seats this way is as follows: A plane with a narrow fuselage will always out-perform one with a wide fuselage, everything else being equal, on account of the smaller wind resistance. If a plane was built as a side by side job, the width of the fuselage at the seats would have to be about 35 in., whereas with the tandem seating arrangement, the fuselage is only 24 in. wide at the widest point.
The distances between the seat and the control stick and between the stick and the rudder bar should be adjusted before the stick and rudder bar assemblies are nailed to the floor of the fuselage. The distances most suitable depend upon the aviator’s individual requirements, and can be easily determined by sitting in the plane and moving the stick and rudder bar until they are in the most advantageous position.

The pulleys for the elevator controls are Micarta, 2 in. in diameter, and cost 34 cents each. For the amateur who wishes to build his plane cheap, we suggest that he use window sash pulleys which will cost only a few cents each. The pulleys may be mounted either above or under the floor board. If mounted under, a fairly large gap will have to be cut out of the floor to allow the cable to move when the stick is thrust sideways. The cable itself has one end fastening to the front hole in the collar fitting on the stick. A turnbuckle is used there as a means of adjusting the tension in the cable from time to time. From the stick the cable goes forward and down through the gap in the floor board to the single 2 in. pulley mounted on the under side. Passing around the front pulley it goes straight back to the guide pulley under the seat and back of the stick; thence back through the fuselage until in the fourth bay from the stern post, the single cable end is looped and two other cables joining on giving the split control effect. The two cables go to the upper elevator horns. Then coming back on the under side, two cables come from the lower elevator horns, join and make one cable, reversing the procedure, and thence go to the guide pulley under the floor boards and from there to the collar fitting on the stick again. A turnbuckle fitted near the stick serves as an adjustment of the tension in this cable.

The final step in getting the fuselage ready to cover is mounting the instrument board. This consists of nailing a piece of 1/8 in. plywood across from one center section strut to the other, and even with the pilot’s eyes; of course, it is not absolutely necessary that the pilot have any kind of instruments, but for up-to-date flying instruments we recommend an altimeter, an oil gauge, and a compass. A tachometer is needed, too, but the shaft is rather hard to attach properly to a motorcycle or other small engine. The instruments are mounted on the plywood dash board by sawing or drilling the right diameter for the body of the instrument.

The fuselage is now ready to varnish and cover, even though the motor mount has not been discussed; installing the motor mount will not interfere with the other work.

It is not necessary to buy high priced special airplane fabric such as used in our large aircraft factories. For about 30 cents a yard you can get a good grade of cotton muslin such as “Pequot” at your local dry goods store. Lay the bolt of cloth on the fuselage top and sides and measure the distance needed, from the cabin, where the plywood sides end, back to the tail. Cut out four rectangular strips, two for the top and bottom and two for the sides of the fuselage. Where the fuselage tapers there will be considerable waste but this can be used to advantage later, either made up into tape or used where small scrap pieces are needed, on the wing corners, etc. Nail one strip along one fuselage longeron, then pull tightly and nail the other side; use “berry box” tacks which can be purchased from your local hardware dealer. The row of tacks will be covered with a long piece of cloth tape after the first coat of dope has been applied. The fuselage covering will have to be cut out in various places; the skid will project through one cut out place, and small holes strengthened by leather sewed around the hole will allow the control cables to emerge.

Covering the wings and tail surfaces: The cover for the wing is made in the form of a long envelope or sack, with one end and one side sewed up before slipping on. It is made to fit fairly tight; the pulling on of the cover is facilitated by the use of rubber gloves made of a ring cut out of an old inner tube; one man stands at each side and both men pull together, keeping the cloth even until it is pulled on as far as the wing butt. The side of the envelope is not sewed along where the wing is cut out for the aileron.

The envelope is tacked along the false beam for the aileron, and also at the butt of the wing. All tacks are covered up by cloth tape which is applied after the first coat of dope. After the tacking
is done the wings are ready to sew. This is done with long needles with big eyes. Cotton warp is used. With the aid of a marking stick designed for the purpose, the cloth lying over each rib is marked with a pencil at 8 in. intervals, not sewing closer than 3 in. to the beams or within 6 in. of the trailing edge. Stand the covered wing up on its nose against a ladder or other support in such a way that each side of the wing is accessible to the sewers. The sewers on one side thrusts his needle thorough to the sewer on the other side, making sure that his needle point is close to the rib; the man on the other side draws the needle point through and passes it back through the cloth on the other side of the rib, at first sticking the point barely through the cloth, until told by his partner that he is on the pencil line. As soon as he gets it right, the man giving directions draws the needle through and knots it; the knot tied is not a full knot but just a sort of half hitch which is drawn tightly, then the needle is shoved through at the next lower point without cutting the string. The purpose of sewing the wing ribs is to make sure that the cloth will assume the shape of the wing section no matter how much wind stream there may be. This sewing is all to be covered with cloth tape about 1 1/2 in. wide.

After the cut out places in the wings and fuselage have been fixed, the whole plane is ready to dope, since all the covering is now done. Use big whitewash brushes for applying the dope; do not attempt to brush it into the cloth, like you would paint; use the brush just enough to spread the dope, and prevent it from piling up in one place. If you intend to use a finish of paint, sandpaper the surface after the first coat has been applied; with the second coat the tape is applied to all tacked and sewed places, etc. It will be found that not nearly as much dope will be required for the second coat, and the amount needed decreases with the number of coats applied. Two more coats are then put on after suitable drying intervals; these last two coats should contain the pigment if a pigmented surface is desired.

The last thing to do before assembling the plane is to install the motor. Two shelf-like brackets support the engine, which is held in its position by means of steel straps around the bases of the two horizontal opposed cylinders. The Lawrence engine is subject to a great deal of vibration, unless it is firmly mounted, but when installed properly makes a good engine for a small sport plane such as the Alco Sport Monoplane. Under favorable conditions it will carry the pilot and a passenger.

A Harley-Davidson 74 cu. in. motorcycle engine may also be used. The motorcycle engines can be bought for as low as $25.00 second hand, while the price of the Lawrence ranges around $100.00. A good Harley engine will develop between 12 and 16 hp. The chain sprocket on the crankshaft may be fitted with a thick metal plate held on with bolts, and the 5 ft. propeller may be bolted directly to this plate after it is suitably drilled for the propeller bolts. By using a reduction drive, by means of a jack shaft and chain, you can obtain considerably higher propeller efficiency, but the parts are somewhat more complicated. For a two to one ratio, use a propeller 61 1/2 ft. in diameter and 31 1/2 ft. pitch; these can be purchased for about $15.00. The direct drive propellers come somewhat higher, but they can be made at home by any handy man who will take the pains required.

All covering done and with the motor mounting accomplished, the plane is ready to be towed to the flying field where the final assembly is to take place. The easiest way to tow a complete plane to the field is as follows: With the landing gear in place, and tires pumped up, the plane's tail skid is placed on the back end of a truck or motor car and held there by means of ropes. 2 by 4 boards are then placed under the longerons of the fuselage, projecting out a little, to form a shelf for placing on the wing. Tie the 2 by 4s to the fuselage, set the wing up on the shelf formed, (nose down, trailing edge up), then tie the wing firmly by passing the rope clear over the top, then down under the fuselage where it is knotted. It is best that one of the workers should ride on the back end of the car and see how the load is doing. The car or truck should be driven at a conservative speed.

Upon reaching the flying field, unsling the wing, and start mounting it and the tail surfaces upon the fuselage; these should have been previously fitted, so that nothing remains but putting nuts on the bolts through the fittings for holding the tail surfaces, wing brace struts, and wings, and then safetying everything for the test flight.

After this is done, assuming that the motor is tuned up and ready to go, the test flight is ready to begin.

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