The 1928 Baby Bullet looked fast on the ground . . . in the air nothing in the air could touch it. Ed Heath in the cockpit.

PLANS FOR BUILDING THE
"BABY BULLET"

By Stewart Rouse

Faster than anything that flies, horsepower for horsepower, Ed Heath's "Baby Bullet" has won over $5,000 in prizes at recent air meets. For the first time in the history of American publishing, Modern Mechanics presents herewith complete how-to-build for a successful racing airplane — one which you can build yourself!

PART I

"Ed" Heath, that unassuming fellow whom we like to think of as the dean of American lightplane designers and pilots, is a very energetic man.

The Bristol Cherub motor, of his "Spokane Super-Parasol", had hardly cooled from the work of winning the light and sport plane races of the 1927 National Air Races at Spokane, with the $1,000 he had won in prize money still making his purse heavy, when he began to plan a light race plane which would show its tail skid to the field at the 1928 National Air Races at Los Angeles.

As he made the long trip back across half the continent to Chicago, his mind was not occupied with the races he had just won, or those he had won in the past. He was concerned with the earnest contemplation of a new racer to embody the best of engineering, the latest knowledge of aerodynamics, and the counsel of experience gained in 20 years of practical aircraft building — a race plane which should be the smallest practical airplane in the world, should carry a man and 75 pounds of ballast in addition to fuel, should do this at the speed of 2 1/2 miles per minute, and use only 32 hp!

The plane was finally built and ready for flight trials. It had been seen and much admired by the flying men of Chicago, for Ed is never secretive and visitors are often seen in his factory. Unfortunately, just at this point, in the spring of 1928, a disastrous fire burned the main factory, the
oldest airplane factory and supply house in America, and all that was in it. Thus the first "Baby Bullet", known as the "Wee-Mite", was destroyed.

Another factory was secured and construction began on another racing airplane identical to the "Wee-Mite", to be known as the "Baby-Bullet". It was put through very gratifying trials August 23, 1928, the day after its completion. The author of this article saw these trials, helping a newspaper man in securing a head-on view of the "Bullet" about 15 ft. from the ground, just after it had flattened out of a dive. The speed may have been 200 or 250 mph — at any rate, it was indescribably fast, and it is rather bewildering to see a man in a plane that looks about as large as two side-cars hurl at one like that, and then zoom with squealing wires back up to 1,000 ft., before one's brain begins to wonder if the picture just taken is any good. Well, we got the picture, and it is in this article. It is not to be supposed that Ed is a reckless pilot; the maneuver described was made merely to get a sensational photo.

The "Baby-Bullet" was shipped to Los Angeles in two beautifully made crates. The wing crate was about 1 ft. by 4 ft. by 9 ft., and the fuselage crate was 2½ ft. by 3½ ft. by 13½ ft. On arrival at Mines Field the little racer was unofficially timed around the five-mile triangular course at an average speed of 142 mph, and during this test it easily passed an army plane which was also flying the course and has an official top speed of 145 mph. The propeller used was 4 ft. 4 in. long with 3 ft. 6 in. pitch, Heath-made of walnut. It turned 3450 rpm at top speed, 2700 rpm in a steep climb, and 2800 rpm on the ground.

On September 14 Heath won the 300 cu. in. race for light planes and sport planes, defeating among seven other contestants a D. H. Moth flown by Mr. Carbury of Toronto. The race was for 50 miles around the five-mile triangular course at Mines Field, from a standing start, and Heath, carrying a load of 75 lbs. of iron, with the motor turning 3150 rpm averaged 112 mph. Even at this rather slow speed the "Baby-Bullet" lapped most of the field three times, and the D. H. Moth twice. The purse was $1,500. This purse made Heath's total winnings from three years of racing the same motor, $5,000. The motor's original cost was $1,270.

The "Baby-Bullet" is a success.
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.

Design your short struts so that two or more are alike. This can easily be done without sacrificing any strength, and by so doing you will save considerable time in getting your struts ready. Blocks of wood 1/4 in. thick are put in to show where the spars pass through the ribs, and these furnish a guide for the vertical rib struts which fit tightly against the sides of the spars when the wing is assembled. The cap strips and all brace struts for the ribs are made from spruce, 1/4 in. by 7/16 in., and long enough to give a few inches extra over the length required by the rib jig, say 5 ft. 3 in. There is danger of breaking the cap strips, especially the upper, when putting them in the jig, unless special precautions are taken.

The best method is to steam the cap strips in a long container, holding at least 6 in. of water for about two hours. A newspaper is wrapped around the top of the container to hold in the steam. At the end of this time, the cap strips will be in a pliable condition and can be bent easily without danger of breaking. The next thing is to put the cap strips in some sort of device for holding them in position until they cool and take on a permanent set. The figure shows such a device.

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. 1/8 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
What a joy to the heart of the amateur pilot is the instrument board and the cockpit layout of the little racer! She is virtually, in this regard, a miniature pursuit ship. Particularly interesting is the lap counter, installed to avoid improper running of races.

planes and their construction by building a duplicate of the record-breaking “Baby-Bullet” race plane, which requires a good field but which has real speed. And if one is a careful pilot and uses a good field, there is no reason why it cannot be used safely for what it was designed — intelligent speed.

Construction of the Fuselage

In writing this article the author will recommend several departures from the original construction of the “Baby-Bullet” race plane that are regarded as advisable either from the standpoint of structural strength, economy, or simplicity of construction. In each case the method used in the construction of the original racer will be described, the recommended change will be described, and the reasons for the change given.

In the original “Baby-Bullet”, shown complete but minus fabric in Fig. 1 of this installment, the fuselage tubing is of two kinds, namely 1025 mild carbon seamless steel, and duralumin. In the front portion of the fuselage, where stresses are great, struts and longerons are of steel tubing with welded gusset joints, while the rear part, from the pilot’s seat back, has struts and longerons of duralumin tubing joined with welded steel sleeve fittings riveted to the longerons and bolted to the struts.

These steel sleeve fittings consist of a sleeve of steel tubing which has a slip fit on the longeron to which it is riveted. But before it is slipped on the longeron, three steel gussets are welded to it, two for the vertical and horizontal strut ends, and one a good deal smaller than the others takes the end of one of the brace wires which cross inside the fuselage. The strut ends are split far enough with a hacksaw to hold the strut gussets and at the same time seat well against the longerons; and finally a 3/16 in. machine screw is passed through the strut end and gusset, the nut is tightened, and the strut end clamps firmly on the gusset. The entire fuselage structure is diagonally braced with hard-plated aircraft wire, with the exception of three bays. One of these is where the pilot’s head and shoulders protrude, and the top wire bracing is tied together through this bay with wires lying against the longerons to take tension fore and aft, just as this was done in the old J.N.-4 training plane. The other two bays without diagonal wire bracing are the two cross sections shown in Fig. 4 of this installment. Fig. 4, however, shows not the original but the improved method of building the bay CDed, which is vastly stronger, as the original has only triangular corner gussets for bracing. The brace wires were left out originally to provide more leg room, but with the improved CDed bay, as drawn, the strength of the ship is improved without sacrificing leg room by merely introducing an inverted “V” of steel tubing as shown.

In view of the sturdy reliability of 1025 mild carbon seamless steel tubing, it would simplify matters to make the entire fuse-
ilage of that material. It works easily and is easily obtained. Shelby seamless steel tubing is also satisfactory, but 1025 is generally preferred nowadays.

The design is for the 32 hp English Bristol “Cherub” motor and the three-view drawing of the fuselage, Fig. 2, shows a front end suitable for the attachment of a four-tube motor mount adapted to this power plant. It may need some shortening to hold a 4-in-line motor.

One thing which must be clearly realized in building this ship for personal use is that Mr. Heath is only 5 ft. 1 in. in height and, as the plane is quite snug for him, in case one is much taller than he, it will be necessary to move the cross section of struts GHgh several inches to the rear and to move the motor a few inches forward in compensation to regain balance. Change the ship as little as possible to get room enough.

To obtain the angle in the top longeron at C, the tubing must be sawed off at this point, the ends fitted to give the required angle, then butted together and welded all around. Carefully study Fig. 3, the full page of fuselage constructional details, noting especially Fig. 3, G, a typical welded gusset joint. Note the 12 ga. steel gusset of trapezoidal shape welded to the longeron. Make up a supply of these gussets and weld them at their proper locations upon the top in. 20 ga. longerons. Make up the left side of the fuselage first in a panel including AB. Now prepare the necessary side struts AB, CD, and EF. It is not yet necessary to make struts GH and IJ, as their ends go into unwelded clamp fittings wrapped around the longeron. As seen in Fig. 3, G, the preparation of a strut is simple. It is only a matter of filing the ends of a piece of tubing of right size to fit the longerons’ surfaces, splitting the ends with a hacksaw far enough to allow the strut ends to slide over the gussets far enough to seat properly against the longerons. Install the struts in their proper places. No jig is necessary for welding the struts to the gussets and longerons. Just brace the bays with a temporary bracing of stove pipe wire fastened through the clevis pin holes in the gussets, see that the vertical struts are square with the top longeron, and then weld the edges of the split strut ends to the gussets and longerons. The front end of each longeron is allowed to extend about one inch beyond the strut AB, a piece of 9/16 in. 20 ga. tubing 4 in. long is slipped into the longeron flush with its end, and then the end of the longeron is heated cherry red and flattened vertically in a vise.

This flattened portion is then drilled for a 1/4 in. bolt of the motor mount. The right side of the fuselage is prepared in the same way. Now weld the horizontal strut gussets on the top and bottom longerons of both right and left sides of the fuselage, checking their angle with the “vertical” struts of the side panels, and noting that this angle is always an acute angle if it is a top longeron gusset and an obtuse angle if it is a bottom longeron gusset.

This is because the top horizontal struts are longer than their corresponding horizontal bottom
struts, making the cross section of the fuselage at any point a trapezoid, wider at the top. Now install the top horizontal struts Aa, Cc, Ee and their corresponding bottom struts. Now, true up with the aid of stove pipe wire, making both diagonal wires in each horizontal bay of equal length, then weld the horizontal strut ends to their gussets and longerons as this was done in the side panels. Now, returning to the study of Fig. 3, G, observe the triangular gusset with its edges welded to both “vertical” and horizontal struts in the angle they make with each other, and over which the end of a diagonal brace strut of cross section CDₑdₑ, see Fig. 4, has been slipped and welded in place. Put one of these gussets in each angle formed by vertical and horizontal struts with each other. In the cross section ABab they carry a pair of No. 10 hard-plated diagonal brace wires with No. 324 turnbuckles. Next install the diagonal tubes of the two sections shown in Fig. 4, working with greatest care, and fitting the gussets and tubes with all possible accuracy. Note that the large gussets in the centers of horizontal struts Cc and Ee are one-piece 12 ga. steel and must be made as large as shown to take bending stresses.

The cabane struts, though they scale 1 ft. 4 in. in length on the drawing, Fig. 2, are really 1 ft. 7 in. in length. This is because the drawing only shows a side elevation of the pyramid formed by the four struts. Their lower ends are fastened to the top longerons by means of the usual welded gusset joint of Fig. 3, G, while their top ends join in a weld, one pair to each side of a flat steel crown plate \( \frac{1}{4} \) in. by \( \frac{1}{2} \) in. by 2 in., at the apex of the four-tube pyramid. Along a line running about \( \frac{3}{8} \) in. below the upper edge of the crown plate are spaced at equal distances, four holes to take the threaded ends of the 10-32 threads to the inch, streamline, landing wires. These holes must be drilled through the crown plate at the same angle as that of the landing wires, so two must slant to the left and two to the right. To distribute the landing stresses, the front and rear holes should take the right hand, and the two center holes the left hand landing wires. An irregular washer must be cut for each hole in the plate and welded or brazed to it, in order to provide a good flat bearing for the nuts screwed on the ends of the landing wires.

**Landing Gear Lugs**

Note in Fig. 3, G, and Fig. 4, that the landing gear lugs are made two-ply by welded two \( \frac{5}{8} \) in. 12 ga. straps, one to the vertical strut and the longeron, the other to the horizontal strut and longeron. Finally they are welded together and the two-ply lug resulting is drilled with a \( \frac{1}{4} \) in. hole for the landing gear strut bolt.

**Wing Beam End Fittings**

In Fig. 4 the design of the wing beam end fittings is shown with very accurate measurements. Make two pairs, one right and one left hand pair, of 16 ga. sheet steel, locate them very carefully on their vertical struts and weld them to the strut as stoutly as possible. Now cut \( \frac{1}{2} \) in. 16 ga. steel strips and weld them by their edges to the long, unsupported edges of the fittings, and to the vertical struts. This will stiffen up the whole bearing for the wing beam ends so that the maximum strength of the wood may be developed.

**Cross Section at EeFF**

In Fig. 4 this section is shown with accuracy. Note the location of control stick and pulleys. The next installment will carry a full description of the controls. Curved pieces of \( \frac{5}{8} \) in. 20 ga. steel tubing are welded into the lower corners as shown for reinforcement. These corners are further strengthened by welding a gusset of 16 ga. sheet steel to this tubing, the bottom strut, and the vertical struts as shown.

**The Unwelded Rear Part of Fuselage**

Beginning with the strut GH and ending with the stern post, we find only these few cases of welding; one welded joint at the top of the stern post, the welded or brazed longeron splices at I and J, and a few welded on lugs at the extreme rear of fuselage.

**The Longeron Splice**

From JJ back to the stern post, top and bottom longerons are of...
9/16 in. 22 ga. steel tubing. A splice is made at L1 by telescoping the 9/16 in. 22 ga. rear longeron into the 5/16 in. 20 ga. front longeron for about 6 in. and splicing as shown in Fig. 3, A. Three two-penny shingle nails are passed through each longeron splice as shown and riveted. The longeron are brazed or welded together at the end of the larger tube.

Sheet Steel Fuselage Joint Fittings

The sleeve fuselage joint fittings used in the rear part of the fuselage of the original "Baby-Bullet" are hard to make and in no way superior to the old easy-to-make "Super-Parasol" sheet steel clamp, fuselage joint fitting, so the latter is here described. In Fig. 3, C, its construction is clearly shown. It is made of a piece of 18 or 20 ga. sheet steel of rectangular shape, which is bent around a short length of longeron tube and clamped in a vise as shown, until it clamps the longeron tightly and emerges a sleeve clamp fitting. It is installed on the longeron at a proper point for a strut end by passing one or two two-penny shingle nails through it and the longeron and riveting them. In Fig. 3, B, the method of preparing strut ends to make this joint is shown. A 2¼ in. piece of smaller tube is telescoped flush into the strut end, the end is heated red hot with a gas plate, clamped in a vise to flatten it, and drilled for the 3/16 in. fitting bolt. The end must be shaped to seat on the longeron when the strut is installed in the clamp fitting. Install all the vertical and horizontal struts. Note from Figs. 2, 5, that some of the horizontal strut clamp fittings are installed in front of the vertical strut fittings and some to the rear of them. A ½ in. space must be left between each pair of sleeve fittings on the longeron. The purpose of this space is to form a groove to hold the inside brace wires of the fuselage, whose ends wrap around the longeron, Fig. 5.

The stern post, see Fig. 5, is welded to the ends of the top longeron and is also held to them by two triangular gussets of 12 ga. sheet steel. Its lower end is reinforced and flattened to take the flattened and reinforced ends of the bottom longeron which are attached to it by a ½ in. bolt passing through all three flattened ends.

Near the bottom of the stern post and on its rear face is welded, as shown, a bracket lug of 10 ga. sheet steel, which acts as a hinge lug for the lower end of the rudder.

The Tail Skid

The tail skid is composed of three leaves of 3/16 in. by 1 in. spring steel shaped as shown. A ½ in. bolt passes through their forward ends securing them to an 18 ga. steel plate riveted to the tops of the extreme rear ends of the bottom longeron. The skid is secured to the bottom of the stern post by a ¼ in. 16 ga. wrap-around clip fitting held by the ½ in. bolt in the bottom of the

The Heath Baby Bullet as it appeared in 1928.
stern post, and the upper ends of this strap fitting form lugs for attaching the stabilizer brace wires.

**Stabilizer Clip Fittings on Longerons**

Stabilizer clip fittings as shown in Fig. 5 must be either welded or riveted to the top longerons. These clips are made of \( \frac{5}{8} \) in. 18 ga. strap steel, two-ply, welded to the strut fittings in front, and are \( \frac{3}{8} \) in. 14 ga. steel wrap-around fittings in the rear.

**Application of Wire Bracing**

The front half of the fuselage back to strut IJ is braced with No. 10 hard-plated aircraft wire, with No. 324 turnbuckles installed at the wire ends and with clevis. The rear portion of the fuselage is braced with No. 12 hard-plated aircraft wire, with No. 324 double-eye turnbuckles installed near the centers of the wires with loop wire ends held fast in the clamp fittings by means of 3/16 in. bolts. Fig. 3, D, shows the correct method of making wire end loops. The main points to observe are never to bend the wire twice in the same place, and never to use a scratched, split, or defaced piece. Every turnbuckle should be safety-wired as shown in Fig. 3, E, to prevent disastrous loosening. Every bolt in the plane must be secured against loosening, either with a cotter pin or by a slight riveting. Solid anchor at the stern must be provided for the top and bottom wires of the fuselage. Figs. 5 and 6 show how lugs riveted to the top and bottom longerons serve this purpose.

**Truing the Fuselage**

Make both diagonals in each horizontal top and bottom bay of equal length. Make all side struts square with their top longerons. In each bay of diagonal brace wires inside the fuselage, make both brace wires equal in length. It will take several hours to do a good job. When it is right, the fuselage will be true; all the wires will be in equal tension, taut but not tight, and they should hum a low note when plucked. When this is accomplished, safety-wire all the turnbuckles.

Still another inquiry which it is the purpose of the writer to forestall is in regard to the use of the wiring on this machine. Some have written to the editors of the parent magazine of the FLYING MANUAL, MODERN MECHANICS, and have asked whether piano wire, which is cheaper than aircraft wire, could not be substituted for the aircraft wire specified. The answer is no. Piano wire is of a type of steel which will crystallize rapidly under low vibrations.

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**COMPLETING THE FUSELAGE OF THE "BABY BULLET"**

How the controls are built, how to make the seat, firewall, fairing, and other parts which go to make the "Babe" a midget sportplane are further elaborated in this second part on the construction of the plane.

**PART II**

As to the arrangement of the cockpit: the pilot sits flat on the bottom of the fuselage with his legs extended to the front of the fuselage where his feet rest upon the rudder bar or rudder pedals, as the case may be. The control stick's lower end is situated between the knees of the pilot's extended legs, and its upper end is just forward of and below the lower edge of the instrument board. Fig. 7 shows the control stick to be of \( \frac{3}{4} \) in. 18 ga. steel tubing, with a turned spruce knob inserted into its upper end and held by a rivet passed clear through the tube from side to side. Two 18 ga. steel plates formed as shown are welded to the lower end of the control stick to form a fork which embraces the torque tube, and is held to it by a \( \frac{1}{4} \) in. — 28 threaded taper pin and two nuts. This taper pin is passed through the torque tube from side to side and is held in place by brazing. Its protruding ends are tapered for a short distance and then threaded at the ends.

The holes in the fork at the lower end of the control stick are reinforced by \( \frac{1}{8} \) in. steel washers brazed on. The holes must be tapered to conform with the taper of the ends of the taper pin. The control stick fork is attached by means of two \( \frac{1}{2} \) in. castellated nuts and washers, the nuts being drawn up just enough to prevent any lost motion between the pin ends and the fork holes. The taper pin effect is used merely to make it possible to take up wear by tightening the nuts slightly from time to time. The castellated nuts must be locked on with cotter pins. The ends of the torque tube are carried in bearings attached to the horizontal struts "D" and "F." These bearings are made as shown in the small detail drawing of such a bearing in Fig. 7, which is self-explanatory. The torque tube runs in a fore-and-aft
direction, as shown, and in order to prevent undue fore-and-aft movement, due to the pull of the elevator cables, it will be necessary to place collars of steel tubing, held by rivets as shown, upon it to act as thrust bearings against the end bearings.

With its pin 4½ in. forward of the control stick taper pin a 1½ in. aircraft control cable pulley is let into a slot in the top of the torque tube where it is supported, as shown in Fig. 7, by a ½ in. 16 ga. steel strap bent around the torque tube and brazed or welded in place, so that its drilled upper ends hold the pulley by means of a 3/16 in. bolt passing through them and the pulley.

The control stick has an 18 ga. steel double-ended control cable lug passing clear through it from front to back, and welded in place with its clevis pin holes 3 in. above the center of the taper pin of the torque tube.

The control cable for the bottom horn of the elevators is attached by means of a cable end, shown in Fig. 3, Part I, to the eye of a 324 turnbuckle, which in turn is fastened by its forked end and a clevis pin to the rear control cable lug of the control stick. The control cable for the top horn of the elevators is fastened by a cable end and clevis to the front lug of the control stick, from whence it passes forward over the torque tube pulley and back inside the torque tube, and thence back through the fuselage to the top horn of the elevators.

At the extreme rear end of the torque tube the downward pointing aileron control horn will be noted. Control cables run to right and left from the lower end of this horn, or lever, to transmit its movements to the upper horns of the ailerons to effect lateral balance of the plane. The pulleys used to guide these aileron cables from the aileron control horn on the torque tube, into the wing butts, are well shown in Fig. 4.

The horn itself consists of two pieces of 18 ga. sheet steel, one of which is wrapped about the end of the torque tube and riveted and welded in place as

Fig. 7. Note the sturdy, simple assembly of control stick and rudder.
shown in Fig. 7 of this installment, while the other, a flat piece, is welded to its front edges as a stiffener, and to the rear face of this stiffener's lower end is welded a 1/8 in. by 3/8 in. washer, with a 3/16 in. hole drilled through it, and the stiffening piece, to provide attachment for the aileron control cable fitting.

The original "Baby-Bullet" was equipped with rudder pedals or stirrups as shown in Part I. This worked well enough, but the common rudder bar, as used so successfully in most of the "Super-Parasols" and shown in Fig. 7 of this installment, will prove easy to make and highly satisfactory. As shown, it consists of a foot bar pivoted at the center, in the same manner as the foot bar of a steerable sled, with the rudder cables attached to its ends and actuated by the movements of the bar produced by the pilot's feet. As these cables are also attached to the horns of the rudder, they communicate the movements of the rudder bar directly to the rudder, producing changes in direction of flight.

The rudder bar consists of a piece of 3/8 in. 18 ga. steel tubing reinforced, slotted and flattened horizontally at the ends, and drilled to receive 3/16 in. bolts which hold short steel straps, to which are attached the 324 turnbuckles of the rudder cables. At its center the rudder bar is reinforced at top and bottom by means of 1/16 in. by 1 in. washers welded on to form a better bearing for the 1/4 in. bolt which attaches it to the 14 ga. steel crown plate of a tripod of 1/8 in. 20 ga. steel tubes, each of which tube is reinforced and flattened at the ends. The legs of this tripod are attached to the crown plate by riveting and welding, and to the horizontal bottom struts of the fuselage "B" and "D" by means of 20 ga. steel clips wrapped around the struts and clamped on the flattened ends of the tripod legs by 3/16 in. bolts passing through both

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**Fig. 10.** Landing gear of the Baby Bullet, with adjacent fuselage details. Center—Fig. 12. Closeup of the left wheel with stub axle end plate removed to show details. Right—Fig. 13. Left stub axle with wheel removed to show parts.

**Fig. 11.** Drawing showing structural details of the landing gear and cross tie rod axle.
clip ends and tripod leg ends. The clips are secured against slippage by rivets passed through clip and strut. Wheneve a tube is flattened, reinforce it by telescoping a smaller tube inside it at the point to be flattened, and flatten only while red hot. Note that when the pilot’s right foot is pushed forward the plane turns to the right and vice versa, which is exactly opposite the result obtained with a sled’s foot bar.

The Instruments

The instrument board is made in this way. A piece of 3/32 in. plywood is cut to the exact size and shape of the completed instrument board. This is to be the face. Holes are next cut in it of presence of several plywood rings for instruments to be installed in. This 3/16 in. piece must now be matched up with the reverse side of the 3/32 in. face piece and glued in place with airplane glue. The finished instrument board will thus be well reinforced around the edge and edges of the instrument holes. For a nice finish, sandpaper it, stain as desired, apply two coats of shellac and one coat of spar varnish. The instrument board is attached to the top longerons and rear cabane struts with small steel clip fittings. The magneto switch is installed on the left side of the panel, the choke handle at the bottom center, the tachometer at the center, while the oil pressure gauge is at the right. Incidentally on the instrument board are the gasoline filler neck at the top of the panel and the lap counter just above the oil gauge. This last is a strip of 18 ga. soft sheet aluminum about 1 1/2 in. by 6 in. mounted crosswise on the panel (see photo, last part). It has nine saw cuts to make ten 1 1/2 in. by 3/4 in. vertical tongues. After completing the first lap of the race the pilot bends the first tongue toward him, and so on until all ten laps are run. The idea being to prevent mistakes in counting laps on the part of the pilot in the excitement of competition.

The hand throttle for the carburetor is installed on the left top longeron 5 in. ahead of the instrument board. It is of conventional design and can be made or purchased cheaply from the designer.

The Seat

The seat bottom is made of a piece of 18 ga. half hard sheet aluminum wrapped around the bottom longerons and horizontal strut "F." After being wrapped around the tubes it is bolted back to itself, as shown, with 1/8 in. bolts. Its front edge is rolled over like the edge of a bucket to prevent cracking. The seat back is made of a piece of 20 ga. half hard aluminum sheet. It is fastened to horizontal struts "G" and "H" by having its ends rolled over them and fastened back to itself with 1/8 in. bolts. Its edges are rolled over to prevent cracking; see Part I. In the center of the front edge of the seat will be seen a half conical guard, the purpose of which is to keep the greasy elevator control cables from rubbing the pilot’s trousers. It is riveted on.

The safety belt is a standard 2 1/2 in. web belt, fastened to the
fuselage joints at the ends of horizontal strut "H" with triangular hard wire loops fastened to the longeron fittings with clevis in the conventional manner.

Heel plates of 18 ga. half hard sheet aluminum fastened by the same means as the seat bottom run from "B" to "F" on each side of the torque tube, forming a sort of skeleton floor.

The Fire Wall

The fire wall is made of a piece of 18 ga. aluminum fastened to the vertical struts at "AB" and the horizontal strut at "B." It is fastened to horizontal strut "A" with several clip fittings. Its upper portion extends above horizontal strut "A" and is cut to form a bulkhead to support the top and motor cowl. The edge of this bulkhead has a ½ in. flange.

The Fairing

The turtleback fairing consists of five transverse bulkheads, and at its large end 14 longitudinal stringers and 8 longitudinal nailer strips for tacking on the fabric cover. Fig. 9 shows patterns for the five bulkheads and a drawing of the "T" bulkhead which is typical. These bulkheads must be carefully drawn up as shown on 3/16 in. plywood, and then cut out with a scroll saw leaving large holes, as indicated, for lightness. Part I gives a good conception of the complete turtleback fairing. Notches are cut at appropriate points in the outlines for reception of the nailers and stringers which are glued and nailed in them. To attach the complete turtleback to the top of the fuselage, either small sheet metal clips attaching the bulkheads to the horizontal struts, or wrappings of linen rib cord saturated with wing dope applied as shown in Fig. 9 may be used. The best way to build the turtleback is to attach the bulkheads in their places on the fuselage and then attach the nailers and stringers. A head pad made of curled hair and automobile upholstery material is applied to the front of the front bulkhead after the turtleback has been covered with fabric.

The bottom fairing is made in the same way as the turtleback. However, it is very shallow. Its patterns are given in Fig. 9.

The side fairing only requires one shallow nailer bulkhead at "AB." It is of 3/16 in. plywood. Its notches carry the two side fairing strips, the upper of which is ½ in. by ⅛ in. and the lower ⅛ in. by ½ in. They are attached to the vertical struts by wrappings of linen rib cord saturated with wing dope as shown in Fig. 9. These side fairing strips run the entire length of the fuselage.

The Landing Gear

The landing gear is at once the heart of this little ship and the hardest part to build. It must be built well, for the greatest strains both in flying and landing center in it in this ship.

Fig. 10 shows its appearance and general layout. The wheels, as shown, are cloth covered, to reduce air resistance, and both 14 in. by 3 in. and 18 in. by 3 in. rims have been used, with special hubs which will be presently described. Fig. 10 clearly shows the 5/16 in. 24 streamline spreader wire of the landing gear and the wheel retaining end plate of the left hand stub axle, with the ends of the clevis of the 10-32 streamline flying wires seen protruding slightly through their
holes in the end plate.

Fig. 12 is a closeup of the left hand wheel with the stub axle end plate removed to show the interior of the left stub axle, the location of the end of the front strut of the landing gear, the end of the 5/16 in. spreader tie rod, and the double lug welded to the floor of the stub axle which takes the clevis of the left hand wing's flying wires. Fig. 13 is a closeup of the left hand stub axle with the wheel removed. In this note the interior of the wheel hub showing the turned bushings which are integral with the hub flanges which are drilled for the wheel spoke ends.

These photos give an excellent idea of the landing gear and its details, but turn to the drawing, Fig. 11, for the niceties of detail. The left hand view of the landing gear it will be seen has struts of 7/8 in. 16 ga. steel tubing. Both front and rear struts are reinforced at their upper ends in the usual way, flattened, slotted, and drilled with 1/4 in. holes to receive their respective lug fittings on the fuselage. The lower end of the front strut has an outside reinforcement in the shape of a 1 in. by 6 1/4 ft. 16 ga. tube, slightly reamed, slumped over it and fastened with 1/8 in. rivets passed clear through both tubes. Its lower end is cut at the angle shown in Fig. 11, and its length from the center of the bolt hole in its upper end to its extreme lower end is 1 ft. 5 in. The lower end of the rear strut is later welded to the back of the lower end of the front strut, as close to the 12 ga. steel stub axle diaphragm as possible.

It has a 4 in. inside reinforcing tube at its lower end held in place by four 1/8 in. rivets. Its length from the center of the bolt hole in its upper end to its extreme lower end is approximately 1 ft. 9 3/4 in. These landing gear struts have streamline section fairings, as shown, of balsa wood taped on with a neat wrapping of 2 in. tape and five coats of wing dope. This fairing, however, should not be applied until the landing gear is otherwise complete. Now make the flying wire end lugs shown in Fig. 11, one right and one left hand. Next make the two 12 ga. circular diaphragms that must be welded to the inner ends of the stub axles. It takes clever welding to put one of these stub axles together. Slip the diaphragm up on the front strut for about one foot to have it out of the way. Weld the flying wire lug to the front strut end as shown. Weld the steel boss that the nut of the 5/16 in. spreader tie rod seats against in place. Now weld the flying wire end lug to the floor of the stub axle, which is made of a length of 3 in. 14 ga. steel tubing. Now slip the dia-

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**Fig. 11. Sections through "baby bullet" fuselage, at C D and E F, looking toward front end.**

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Department of Agriculture: The improved method of constructing the cross bays of the fuselage as described by Mr. Rouse are here shown in full detail and depicts the new bracing which has been lately adopted.
phragm into place and weld it to the end of the stub axle all around, and to the front strut.

Weld the steel boss that the 5/16 in. spreader tie rod passes through to the small end of the flying wire lug, and the dia-

phragm, as shown, and then drill an oversize 5/16 in. hole through both bosses for the 5/16 in. spreader tie rod. Two wheel retaining end plates must now be turned from aluminum. They are held on by two 1/4 in. machine screws screwed into threaded holes in small brackets welded inside the end of the stub axles, see Fig. 13. The wheel hubs are made from 12 ga. steel tubing with turned bronze bushings in each end which have integral flanges, which serve as spoke hole flanges. This is a reliable type of hub and is sometimes used in full-size ships.

The Motor Mounting

In the original “Baby-Bullet” the motor mounting, see Fig. 14, was made integral with the fuselage and had the usual disadvantages of such an arrangement, and furthermore it did not develop the full strength of the material used in its construction. An improved motor mounting similar to that now used in the 32 hp Bristol “Cherub” motorized “Super-Parasol” Sportplane is shown in Fig. 15. As indicated, it is made entirely of 18 ga. steel tubing reinforced heavily and flattened at the ends. The bracing is accomplished with 10-32 aircraft tie rods. If the “Heath Henderson” or the new Heath “Bee 4” 40 hp motor is used instead of a Bristol “Cherub”, a modified “Super-Parasol” type, “Heath Henderson” motor mount may be used, see plans of the “Super-Parasol.” It is best to leave the motor mounting and motor cowling until the very last, as the only practical method of gaining perfect balance fore-and-aft is to move the motor itself an inch or so forward or backward as found necessary.

The Tanks

Unless one is quite experienced in tank making, it is best to have a tank maker construct the gasoline and oil tanks. Part I gives a good view of the installation of the 3 gal. gasoline tank on the longerons under the cabane, and Fig. 14 gives a good view of the two quart oil tank mounted on top of the motor mounting. 20 ga. sheet steel is all right for these tanks. The gasoline tanks should have two transverse baffle plates. Note that the gasoline filler neck protrudes through the top of the instrument board. A sight gasoline gauge may be installed in the filler neck. It would be wise to install a reliable airplane gasoline filter in the gasoline line and a shut-off cock, with a long handle in reach of the pilot, should be installed beneath the tank for emergency use. The tanks must be insulated from their supports with heavy felt pads to absorb vibration which might cause damage.

The Propeller

The propeller used when racing the “Baby-Bullet” was 4 ft. 4 in. in diameter with 3 ft. 6 in. pitch, of walnut, and Heath-built. This, the “Cherub” motor turned at 2800 rpm on the ground.

The Cowling

Cowling can enhance a plane’s beauty if rightly made, or hurt its appearance terribly if carelessly shaped. Fig. 8 and Fig. 16 show the cowling used on the “Baby-Bullet” pretty clearly. The propeller has a built up, large wooden hub, covered with the lower half of an 18 ga. spun aluminum cone, while the upper half of the same cone is attached in front by a row of small wood screws driven into the front edge of the big hub. The motor cowling has top and bottom halves, fastened together by 16 ga. steel hood fasteners which operate like automobile hood fasteners. The bottom half is made of two pieces riveted to an inside strap of aluminum with their edges just touching.

The double line of rivets runs fore-and-aft on the bottom center line of the nose. The sections of the motor cowling must be beaten into the shape shown by shaping 18 ga. soft aluminum sheet over a small leather pillow stuffed with lead shot, using a round faced wooden mallet for beating.

After beating for a short time, the aluminum will become hard and must be softened before further beating by heating it with a blow torch and plunging it in cold water.

If beaten hard, the aluminum will crack. When the motor cowling has been shaped, it is well to shape the pointed front part of the head streamline fairing, which must be riveted in place, as shown, on the stationary top cowling. The front of the motor cowling is supported by a large flanged aluminum disc attached to the front of the engine’s crank-case while the rear is supported by the front bulkheads of the side and bottom fairing, and the bulkheads formed by the extension of the top of the firewall.

Note that the air intake of the carburetor must protrude through a hole in the bottom half of the engine cowling.
BUILDING THE WINGS OF THE "BABY BULLET"

The "Babe" zooms off the ground like a pursuit ship and climbs 1,500 feet per minute. To the left is Ed Heath. These shots were taken at Mines Field, Los Angeles, at the recent air races.

Summing up the last of the details of the building of the Baby-Bullet Racing Plane, Stewart Rouse gives pointers on the wing construction.

PART III

Consulting Fig. 17 you will see that the ribs are made of 1/4 in. by 1/4 in. spruce fastened together with airplane glue, and 1/32 in. plywood gusset plates, with 3/8 in. 21 ga. flathead nails driven through them and clinched. The drawing, Fig. 17, shows the rib drawn accurately to scale, but separated into two halves by the vertical line at the 50 percent point; this must be taken into consideration when drawing the wing section on a smooth one-inch board in pencil, using double lines to show the top and bottom curves, and the bracing pieces. Now glue and nail small blocks of wood along these outlines at two and three-inch intervals to hold the rib pieces securely in their relative positions, while nailing and gluing the gussets to one side; then turn the rib over on a flat surface and nail and glue the gussets of the reverse side. The jig must be modified to hold the slightly different aileron ribs.

The Wing Beams

Fig. 18 gives a clear conception of the top view of the right wing, and also of wing beams and aileron beams. Use the finest aircraft spruce for the beams, ordering it from a reliable aircraft supply house. Fig. 17 gives a clear impression of the full sections of the beams as maintained at strut points. At points between struts the beams are channelled carefully, as shown in Fig. 18, to produce an "I" beam section. This "I" beam cross section is by no means constant, because certain points along the beams receive large bending stresses, while other points receive little but compressive stresses, from end to end such as a column undergoes. Follow the beam drawings carefully and remember that it is better to leave on too much wood than too little! Don't be a lightweight fan at the risk of structural failure. In cutting the channels in the beams, work with gauges small enough that a mallet is not necessary, as pounding may split the beams ever so little, which is dangerous. Cut the beams with sharp tools, leaving no splinters and no sharp corn-
ers—everything must be rounded in the channels. Cut the fuselage ends of the beams, as shown to fit the angle of the beam fittings on the fuselage. Cut the wing tip ends of the beams according to the drawings. Now drill the bolt holes in this manner: drill slowly through until the tip of the bit just shows on the far side; then drill from the far side to complete a smooth hole with no splintered edges.

The original "Baby-Bullet" had built-up three-piece wing beams, with solid flanges and plywood sides, but as the "I" beam solid beam is easier to construct and thoroughly reliable, it is described in this article. The Department of Commerce frowns somewhat upon homebuilt, built-up wing beams.

The aileron hinge beams of the wings and of the ailerons are made according to Figs. 17 and 18, and are not much different from wing beams excepting that they are smaller and not channeled, but left of full section.

At this point in the construction of the wings, the ribs should be slippered to their proper places on the wing beams and fastened in place with airplane glue and nails driven through the vertical strips, in front of and in rear of the beams, into the beams. The aileron beams should now be slippered through the aileron ribs and fastened in the same manner.

Note that the last two ribs of the wing tip are special ribs of shorter chord than common and regular aileron ribs. They must be drawn to the same wing section as the common ribs, only of shorter chord. This may be accomplished by reducing the measurements given in Fig. 17 by a simple arithmetical reduction. These tip ribs must be fitted with care that their angle of incidence is the same as that of the rest of the wing, namely 0 deg.

To fit them properly will require some cutting and shrinking of the wing beam tips.

**Metal Fittings of the Wings**

Fig. 19 illustrates the metal fittings of the wings and presents patterns for the flying and landing wire fittings of the beams. Make these anchor fittings with greatest care, for they are vital. Do not bend them more than once in a place. Make up two of the double, built-up, steel tube, drag bracing struts that connect these anchor fittings, and weld their ends to the fittings as shown. These steel struts and their fittings must be installed on the wing beams before the ribs are slid on.

The ordinary 3/4 in. by 3/4 in. drag bracing struts can be installed after the ribs are installed. Their ends are held in conventional strap fittings, as shown in Figs. 18 and 19.

The internal drag and anti-drag wire bracing is made of 10
ga. plated aircraft wire, with No. 324 turnbuckles. The forks of the turnbuckles are secured with clevis pins to the lugs on the front wing beam metal fittings, and the other ends of these wires are attached by means of clevis to the rear wing beam's metal fittings' lugs. Note that the wing tip drag strut's end metal fittings are modified to hold three bolts, making a secure end anchorage for the internal drag wire bracing. The drag strut end metal fittings of the wing butt are modified to wrap around the wing beam ends into which they are recessed a little to make smooth wing beam ends bearing against the fuselage wing fittings. Thus a good end-grain anchorage for the drag bracing wires is obtained. These combination strut and wire anchorage fittings are each attached by a 1/4 in. bolt passing through their respective wing beam ends, see Fig. 18.

**Leading Edge**

Figs. 17 and 18 show the leading edge clearly. It is made from a long piece of 1 in. by 1 in. spruce attached with airplane glue and nails to each rib's front tip while in its square condition. Now install the 3/8 in. by 3/8 in. wooden brace strip shown in the upper left hand corner of the right wing, shown in Fig. 18, using small wooden blocks and plenty of nails and glue for end anchorage. With a small sharp plane carefully plane the leading edge to the cross section shown in Fig. 17. Now install the so-called false ribs which reach only to the rear of the front beam between the noses of the real ribs. Cover the front of the wing, top and bottom with 1/32 in. plywood back as far as the rear of the front beam. Use glue and 3/8 in. 21 ga. flathead nails to hold the plywood in place. 1/8 in. plywood must be applied with glue and 1/2 in. 21 ga. flathead nails to the face of the butt rib of each wing.

![Constructional Details of Wings and Ailerons of the Heath "Baby Bullet" Raceplane](image)
Trailing Edges

Fig. 20, C, shows how the 1 in. 20 ga. "Vee" section aluminum trailing edge is applied to the rear tips of the ribs with $\frac{3}{8}$ in. 21 ga. flathead nails. Fig. 20, A, illustrates how a $\frac{1}{4}$ in. 18 ga. steel trailing edge tube is applied to the rear tips of the aileron ribs by means of $\frac{1}{4}$ in. 20 ga. copper straps wrapped and soldered around the tube and fastened with $\frac{3}{8}$ in. 21 ga. flathead nails to the rib ends. The rib ends must be notched slightly to hold the tube firmly.

Wing Tips

The leading edge is bent back slightly to meet the tip of the front wing beam, where it is attached with small screws and airplane glue. Then the flattened end of the curved 5/16 in. 18 ga. steel tube wing tip is screwed to both the leading edge strip and the end of the front wing beam to form a neat splice which is covered with a strap of 20 ga. copper, which is first soldered to the steel tube and then nailed to the front wing beam. This wing tip tube is fastened in a similar way, shown in Fig. 20, A, to the tips of the rear wing beam and aileron hinge beam of the wing.

Ailerons

The ailerons of the original "Baby-Bullet" were of the oblique type shown by dotted outlines in Fig. 18. This type of aileron is extremely difficult to build and to hinge. The ailerons used in the original were welded up of small steel tubing and were very successful. The straight-type aileron shown in the drawings by the author, Fig. 18, will be found, however, much easier to construct and entirely satisfactory.

At this period of the construction of the plane it was only necessary to saw between the aileron hinge beam on the wing and the hinge beam of the aileron to entirely separate the aileron structure from the wing structure. Apply $\frac{1}{4}$ in. by 5/16 in. filler cap strips to the tops and bottoms of these beams, between ribs, to give an even edge, see Fig. 20, D. Brace the aileron internally with $\frac{3}{8}$ in. by $\frac{3}{8}$ in. spruce strips, as shown. Fig. 17 shows the construction of the aileron horn, which is made of 16 ga. sheet steel with 3/16 in. plywood applied to both sides and held by rivets passing clear through, as in a butcher knife handle. The 16...
The details for the horizontal stabilizer, the method of covering and the details of the control horns, flipper clips and rudder assembly are made clear in this drawing. Note the use of 3/16 in. 20 ga. shelfy steel tubing. Control horns are welded.

**Internal Wood Bracing of Wings**

3/8 in. by 3/8 in. wood braces are applied inside the wing as shown in Fig. 18. First, wooden blocks are nailed and glued to the members to be united by a brace, then the brace is nailed and glued both to blocks and the members to be joined together.

**Aileron Control Pulleys & Cables**

Two 1/4 in. aircraft control cable pulleys of the common type, having sheaves possessing an eye with an eyebolt attached, are attached, as shown in Fig. 18, one above the other, to the rear face of the rear beam in front of each aileron horn by passing the eyebolts through the beam, resulting in an entirely flexible mounting. The control cable used is 1/4 in. extra flexible control cable, with ends made as shown in Fig. 3, Part I, of this article.

**Flying and Landing Wires**

Flying and landing wires are 10-32 streamline tie rods which may be obtained from aircraft supply houses on short notice. Use the regular terminal clevis except at the crown plate of the cabane where the threaded ends are passed through the holes provided and castellated nuts run down to hold them.

**Tail Surfaces**

Fig. 21 will give a good idea of the external appearance of the empennage, or tail surfaces. Fig. 22 shows everything necessary to know to construct them. The entire empennage is welded up of steel tubing, and this work should go quickly. There is little difference between the horizontal stabilizer-elevators assembly and the vertical-fin-rudder assembly save size and position. The stabilizers have 5/8 in. 20 ga. steel tube hinge beams, while the elevators and rudder have 1/8 in. 18 ga. hinge beams reinforced, as shown, by telescoped pieces of 11/16 in. 22 ga. tubing at the horn positions. These reinforcements are welded and riveted in place. The control horns are simple two-piece affairs cut from...
sheet steel, welded to their hinge tubes and together at their tips. Their edges are flanged for stiffness, as shown in Fig. 22. The rudder control horn, being in the air stream, must be streamlined with balsa wood and fabric. The ribs are made with 3/16 in. 20 ga. steel tube cap strips. The leading edges are 1/4 in. 18 ga. steel tubes, while the trailing edges are of 3/16 in. solid steel rod. Internal diagonal bracing, as shown, is accomplished with 1/8 in. 20 ga. steel tubes. In Fig. 22, AA" detail of the horizontal stabilizer-elevators assembly shows the typical rib section of these surfaces. It is a streamline wing section set at 0 deg. incidence — that is, its center line is parallel to the top longeron. Note that instead of welding the cap strips of a rib to the leading or trailing edge at the same point, the strips are slightly separated and welded on side by side. At the trailing edge it will be necessary to flatten the tubes slightly for several inches to maintain the rib section. 3/16 in. 18 ga. lugs must be welded to the hinge tubes of the horizontal and vertical stabilizers to receive the ends of the 32 streamline tie-rods which brace the empennage. The hinges are made of 3/8 in. 18 ga. steel straps wrapped around the hinge tubes of the rudder and elevators and held to the hinge tubes of horizontal and vertical stabilizers by single 3/16 in. bolts passed through the tubes and straps, as shown in Fig. 22. Wherever a bolt passes through a tube, the hole must be reinforced by a piece of 16 ga. tubing inserted in the hole and welded in place, forming a "boss", see detail in Fig. 22. Small clips of 5/8 in. 18 ga. sheet steel are welded to the leading edge of the horizontal stabilizer as shown, to be held to angle brackets on the fuselage by 3/16 in. bolts. The hinge tube of the same stabilizer is held to the fuselage by two 3/16 in. bolts attaching it to clips on the fuselage near the stern post. The vertical fins' attachment to the fuselage is accomplished in this way: its hinge tube is telescoped into the stern post several inches, until stopped by a large washer welded to it, see Fig. 22; its front end is attached both to the small continuation of the fuselage turtleneck built integral with the horizontal stabilizer and to the clip welded on the leading edge tube of the horizontal stabilizer by a 3/16 in. bolt welded in the lower end of the fin's leading edge tubing. Note that the lowest rib of the fin is shaped to fit the small turtleneck and to have an inspection opening for the top horn of the elevators.

Control cables are of 1/8 in. extra flexible control cable. The right rudder control cable leads from the right horn of the rudder to the right end of the rudder bar. The elevator cables, however, are a different matter. The cable that leaves the rear of the torque tube goes to the top elevator horn, while the cable attached to the rear lug of the control stick goes to the bottom elevator horn.

Assembling

It is good practice to set the ship up complete before covering to make sure that everything is as near perfect as possible. Lock all nuts on with cotter pins, or by a slight riveting on the end.
with a small ball peen hammer. Do not rivet much, as it weakens the bolts. Just nick the bolts enough to hold the nuts. Cotter pins are preferred. Inspect with greatest care. Discard any hard wires that show any nicks, splits, or that have been bent more than once in a place. See that all wires are taut but not tight. See that control cables operate smoothly and drag nowhere. If they drag, try to remedy it, but in some places it may be necessary to install cable guides which can be obtained from aircraft supply houses. At this time determine just where each cable will pass through the fabric covering of the plane, and take measurements so that holes may be cut at proper places for the cables to pass through when the covering is on. Check everything for accuracy in every way possible. With the top longerons level, the bottom of the wing ribs should be level, too, and the horizontal stabilizer of streamline section should be set with the center lines of its ribs level. It is possible to make the ship more stable at low speeds by giving the wing a 2 deg. angle of incidence, but this will slow up its top speed about 15 mph. With the control stick exactly vertical, the ailerons should be continuations of the wing in front of them and the elevators should continue the streamline section of the stabilizer in front of them.

Give all metal parts three coats of high grade black auto enamel, and finish the woodwork with two coats of shellac and two coats of fine spar varnish. The control cables should be heavily greased with clear grease.

Covering the Fuselage

In covering the plane use only best Grade A airplane fabric. Wrap the longerons tightly from end to end with 1 in. binding tape. The method of wrapping should be the same as for a spiral bandage. Fasten the ends with a little wing dope brushed on. Wrap the stern post. Cut a panel of fabric to fit the bottom of the fuselage, with about ¼ in. overlap all around the edges. Sew it with heavy linen rib cord to the binding tape on the longerons and stern post, and tack to the small, front bottom fairing with ¼ in. copper tacks at B, see Fig. 2, Part I, of this article. The fabric sides of the fuselage are applied in the same manner. The fabric should be stretched snugly by hand while applying. It requires four strips of fabric to cover the turtleback fairing. Tack these strips to the nailer strips provided, letting them overlap each other about ¼ in., and sew, also, to the top longeron wrapings. When this is done, tape all the seams with 2 in. pinedged finishing tape saturated with wing dope and brushed out smoothly at the edges. Now make the control cable outlet holes in the fuselage and reinforce each hole with heavy imitation leather.
doped on each piece of leather having a cable hole in the center. Provide inspection holes as shown to inspect the lower elevator horn. The fuselage should now be given two coats of clear and two coats of pigmented wing dope.

The easiest method is to cut a piece of fabric large enough to cover the wing on both sides at once, then fold it over the trailing edge and tack it temporarily to the leading edge with 1/4 in. copper tacks. Tack it along the but rib and sew it together around the wing tip. Gradually tighten the cloth by re-tacking and re-sewing to remove all wrinkles and fullnesses. The cloth should be stretched quite tightly from end to end along the leading edge. It is unnecessary to stretch the rest of the cloth extremely tight as the wing dope does that. Trim away excess cloth. Cut away the cloth in the aileron opening of the wing, leaving about 2 in. overlap. Tack the cloth to the aileron hinge beam on the wing and to the plywood web of the last common rib. Space the tacks 3 in. apart. Have the edges of the cloth overlap each other along the leading edge, around the aileron opening, and across the but rib. Do neat, smooth job. Now cut 7 ft. 6 in. lengths of 1/2 in. rib binding tape and wrap one length around the wing over each rib, tacking the ends down at the leading edge. Thread an 8 in. steel needle with linen rib cord and, starting at the trailing edge, push the needle clear through the wing, touching one side of a rib, and then bring it back through on the other side of the rib. The result will be a loop of cord clear around the rib including and passing through both top and bottom binding tapes and the wing fabric beneath the tapes. Draw the loop snug and knot with a square knot on top of the rib. Sew forward in this fashion, looping and knotting at 4 in. intervals until the leading edge is reached, see Fig. 24. Now take 7 ft. 6 in. length of 1 1/2 in. pinked edged tape and wrap them on just as the binding tape was wrapped, with the ends overlapping at the leading edge. This tape must be heavily saturated with wing dope and stuck down with a brush to strengthen the sewing and to give the seams a finished, smooth appearance. Run a 2 in. pinked edged tape across the leading edge, around the wing tip across the trailing edge, as a reinforcement and to hide the rows of tacks and stitches. Cut out large strips of cloth to tape the but rib and the faces of the aileron opening. The edges of these pieces should be fray-ed by removing a few ravel-

Fig. 24. In covering the wings of the Baby Bullet, a piece of linen large enough to go from trailing edge around the leading edge and back to the trailing edge again is stitched on as shown.

ings from them, should overlap on the upper and lower surfaces of the wing about 1 in., and should be doped down neatly.

The entire wing should now be given two coats of clear and two coats of pigmented wing dope. Do not use more dope than this, or the ribs may be distorted by tension. The ailerons are covered in the same way as the wings.

Covering the Empennage

The tail surfaces are covered in the same way as the wings. However, the leading edges, trailing edges, and hinge tubes must be wrapped to permit sewing the fabric to them.

Balancing the Raceplane

Note that in Fig. 17 the location of the vertical center of gravity of the plane is located at 26% percent of the chord from the leading edge. This is where it has to be if the ship is to fly well and be stable. Otherwise the plane will be unnecessarily dangerous. Make sure that this condition is fulfilled in this way: Make a light, stiff, wooden frame or cradle of 2 in. by 4 in. lumber to go under the fuselage and support the weight of the plane only at the struts points of the landing gear. Now balance the ship on this cradle on a wooden knife edge made of a 2 in. by 4 in. piece of wood on strong supports. It takes several men to perform this operation without injuring the airplane. Then your Bullet is ready to fly.