#247

JUST about everyone has at least one relative who is more than 75 years old. Someone who was alive when the Wright Brothers made that historic first flight of a fully controlled heavier-than-air flying machine. The flight that led directly to enormous changes in transportation, warfare and, for many of us, sport and recreation.

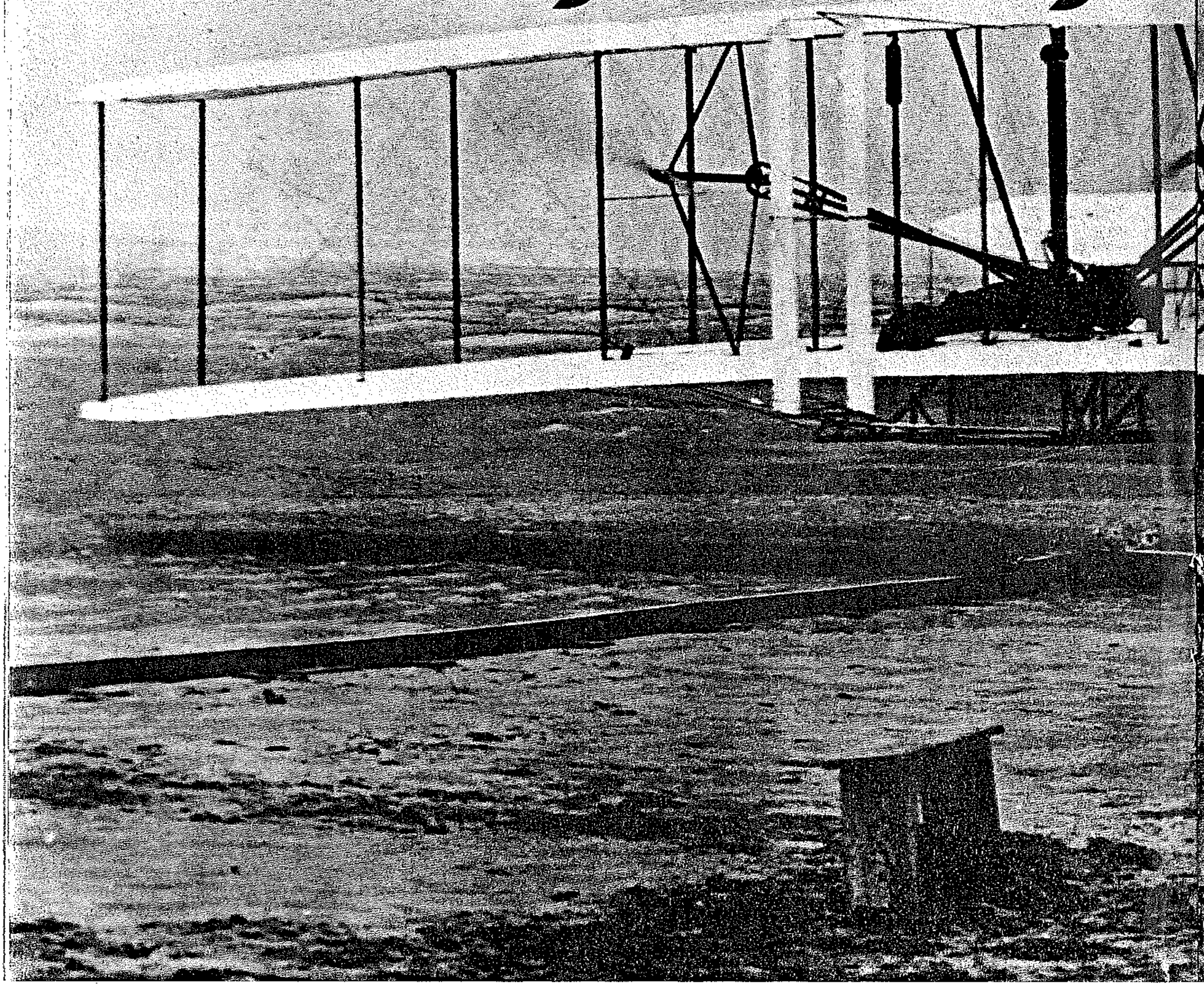
Three-quarters of a century seems like several lifetimes to a teenager. In terms of getting from one place to another, it is more like several lifetimes of progress. Yet is has all happened in just over the normal life span of the average person. Because of two men who were very far from average.

It wasn't just that the Wright Brothers wanted to fly. A lot of men had been trying for years to invent the airplane. Most of them failed for reasons which today are painfully obvious. In most cases, they didn't bother to think the problems through. They sketched out something that looked like it ought to be able to fly, and went out and built it from whatever materials were handy.

One after the other, these early attempts fell flat. Most of them showed no sign of even trying to get off the ground. And those that lifted their wheels or skids into the air quickly crashed because their designers hadn't bothered to develop flight controls that stood any chance of working.

All but alone on the windswept beach on the Outer Banks that December 17 morning in 1903, the brothers, Wilbur and Orville Wright, would test the frail end-product of what is now recognized as aeronautical history's most remarkable research and development project. Even now, on the 75th Anniversary of man's first powered flight, that story is all but obscured by the fame that came afterwards. ■ Don Berliner

Destiny at Kitty



Once something started to go wrong, there was no way to correct it, short of picking up the pieces and starting all over again.

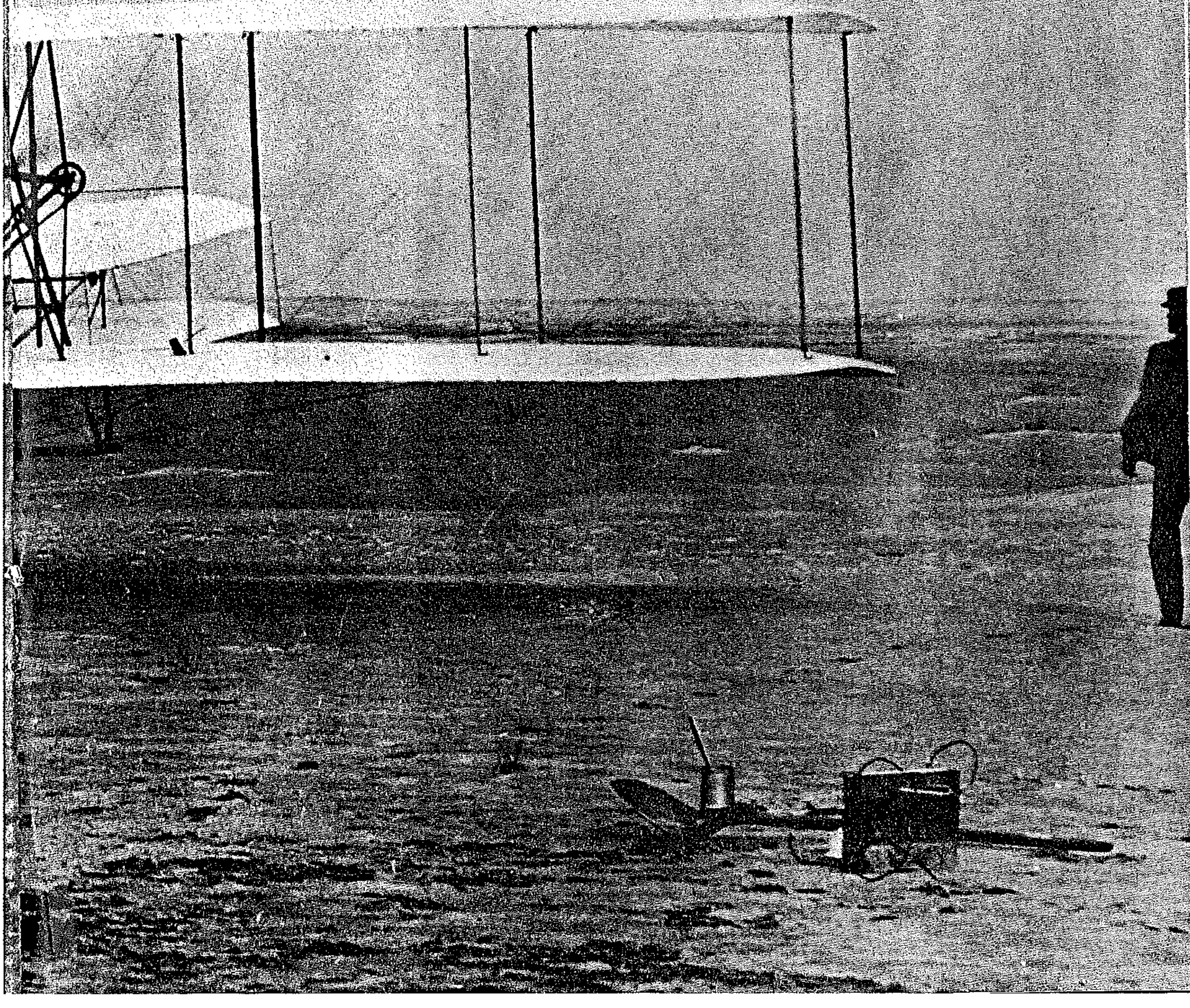
What made Orville and Wilbur so historically different from all the others was their methodical way of going about the search for practical answers to ancient questions. They were not interested in building something that would struggle off the ground for reasons unknown to them or anyone else. They wanted to work the whole problem out, step by step, so they would know exactly why things were going as they were.

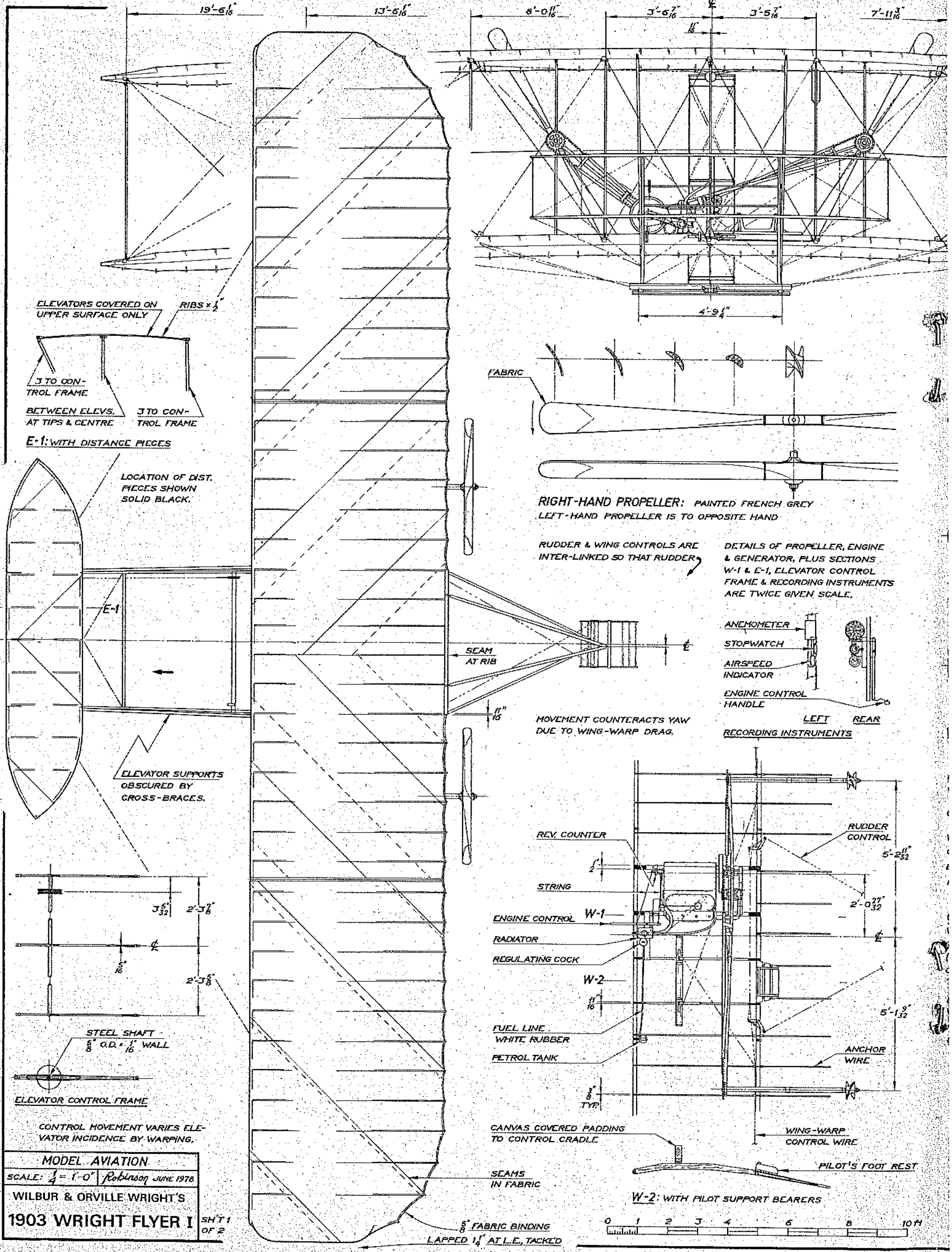
The basic theory had been known since the beginning of the 19th Century, when an Englishman, Sir George Cayley, determined that the best route to follow was a fixed-wing craft in which thrust was completely separate from lift. Until then

Hawk

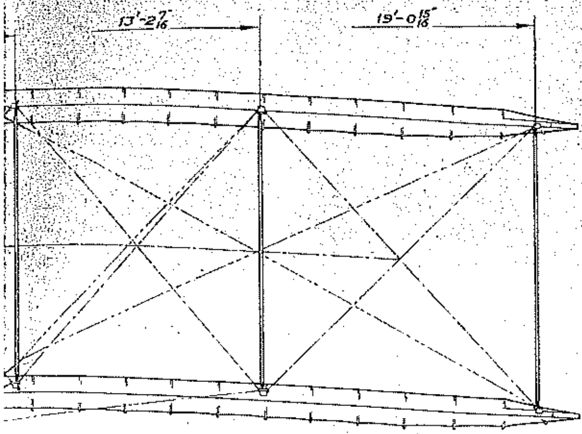
ORVILLE WRIGHT

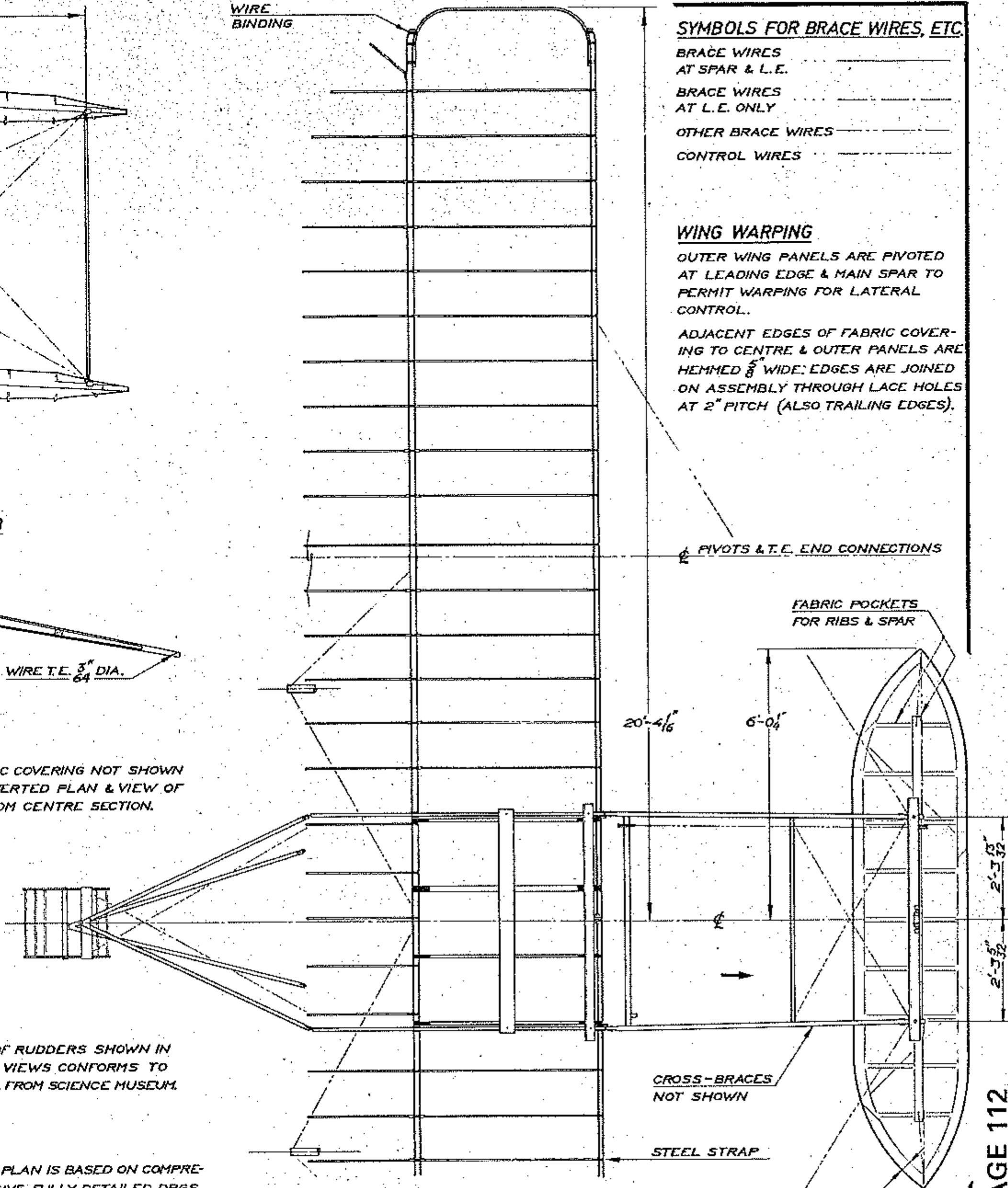
WILBUR WRIGHT





19'-6 1/16"
13'-6 1/16"
8'-0 11/16"
3'-6 7/16"
3'-5 7/16"
7'-11 3/16"
4'-9 1/4"
ELEVATORS COVERED ON UPPER SURFACE ONLY
RIBS × 1/2"
3 TO CONTROL FRAME
BETWEEN ELEVS. AT TIPS & CENTRE
3 TO CONTROL FRAME
E-1: WITH DISTANCE PIECES
LOCATION OF DIST. PIECES SHOWN SOLID BLACK.
E-1
ELEVATOR SUPPORTS OBSCURED BY CROSS-BRACES.
SEAM AT RIB
FABRIC
RIGHT-HAND PROPELLER: PAINTED FRENCH GREY
LEFT-HAND PROPELLER IS TO OPPOSITE HAND
RUDDER & WING CONTROLS ARE INTER-LINKED SO THAT RUDDER
MOVEMENT COUNTERACTS YAW DUE TO WING-WARP DRAG.
DETAILS OF PROPELLER, ENGINE & GENERATOR, PLUS SECTIONS W-1 & E-1, ELEVATOR CONTROL FRAME & RECORDING INSTRUMENTS ARE TWICE GIVEN SCALE.
ANEMOMETER
STOPWATCH
AIRSPEED INDICATOR
ENGINE CONTROL HANDLE
LEFT
REAR
RECORDING INSTRUMENTS
3 5/32"
2'-3 7/8"
2'-3 5/8"
5/16"
STEEL SHAFT 5/8" O.D. × 1/16" WALL
ELEVATOR CONTROL FRAME
CONTROL MOVEMENT VARIES ELEVATOR INCIDENCE BY WARPING.
REV. COUNTER
STRING
ENGINE CONTROL
W-1
RADIATOR
REGULATING COCK
W-2
FUEL LINE WHITE RUBBER
PETROL TANK
RUDDER CONTROL
5'-2 11/32"
2'-0 27/32"
5'-1 9/32"
ANCHOR WIRE
3/8" TYP.
CANVAS COVERED PADDING TO CONTROL CRADLE
WING-WARP CONTROL WIRE
PILOT'S FOOT REST
W-2: WITH PILOT SUPPORT BEARERS
SEAMS IN FABRIC
5/8" FABRIC BINDING LAPPED 1 1/4" AT L.E., TACKED
0 1 2 3 4 6 8 10 ft
MODEL AVIATION
SCALE: 1/4" = 1'-0"
Robinson JUNE 1978
WILBUR & ORVILLE WRIGHT'S
1903 WRIGHT FLYER I
SH'T 1 OF 2





SYMBOLS FOR BRACE WIRES, ETC.

BRACE WIRES AT SPAR & L.E.

BRACE WIRES AT L.E. ONLY

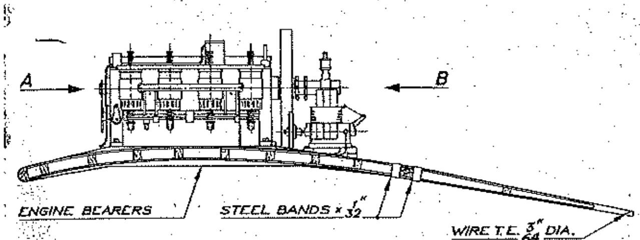
OTHER BRACE WIRES

CONTROL WIRES

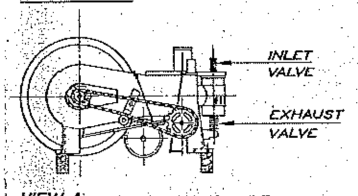
WING WARPING

OUTER WING PANELS ARE PIVOTED AT LEADING EDGE & MAIN SPAR TO PERMIT WARPING FOR LATERAL CONTROL.

ADJACENT EDGES OF FABRIC COVERING TO CENTRE & OUTER PANELS ARE HEMMED 5/8" WIDE; EDGES ARE JOINED ON ASSEMBLY THROUGH LACE HOLES AT 2" PITCH (ALSO TRAILING EDGES).

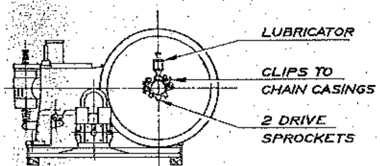


W-1: TYPICAL: WITH ENGINE & GENERATOR



VIEW A: ON CAM SHAFT DRIVE

FABRIC COVERING NOT SHOWN IN INVERTED PLAN & VIEW OF BOTTOM CENTRE SECTION.



VIEW B: ON GENERATOR & DRIVE SHAFT

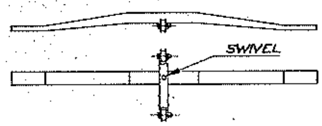
TILT OF RUDDERS SHOWN IN PLAN VIEWS CONFORMS TO DRGS. FROM SCIENCE MUSEUM.

DATA

WINGSPAN	40'-4"
CHORD { TO END OF RIB	6'-6 7/8"
CHORD { TO WIRE T.E.	6'-6 3/8"
WING AREA	510 ft²
OVERALL LENGTH	Approx. 21'-0 7/16"
ELEVATOR SPAN	12'-0"
PROPELLER DIAMETER	8'-6"

THIS PLAN IS BASED ON COMPREHENSIVE, FULLY DETAILED DRGS. PREPARED FROM THE ORIGINAL (REBUILT) FLYER IN 1928 BY THE SCIENCE MUSEUM, LONDON. ADJUSTMENTS HAVE BEEN MADE TO CONFORM TO PHOTOGRAPHS TAKEN IN 1903.

GRATEFUL THANKS FOR HISTORICAL ADVICE & MANY RECENT PHOTOS FROM GEORGE HARDIE JR.



1906 TROLLEY BAR
DETAILS OF 1903 TYPE NOT AVAILABLE

RUDDERS COVERED ON OUTSIDE ONLY: DOTTED LINES SHOW SEAMS IN FABRIC OF RIGHT-HAND SURFACE.

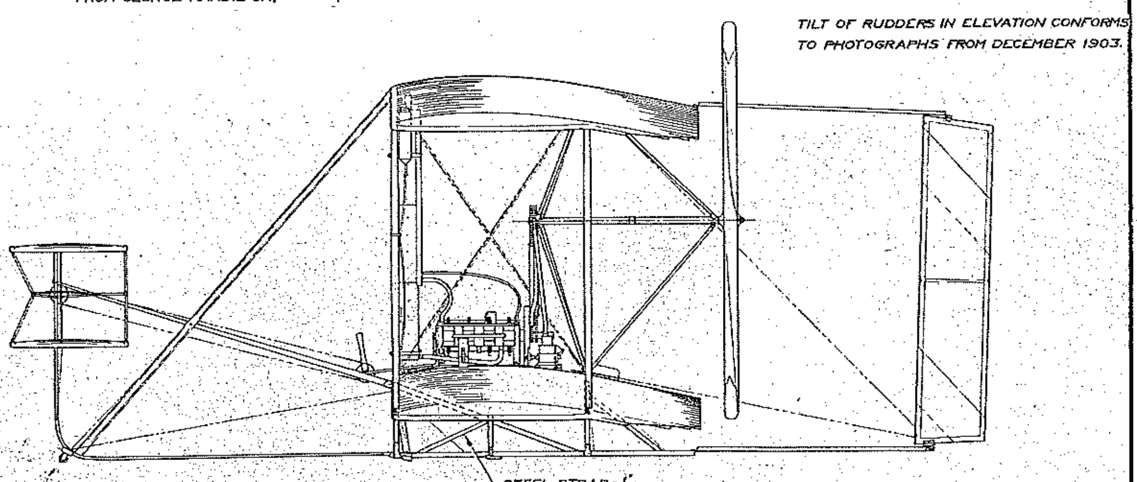
TILT OF RUDDERS IN ELEVATION CONFORMS TO PHOTOGRAPHS FROM DECEMBER 1903.

COLOURS

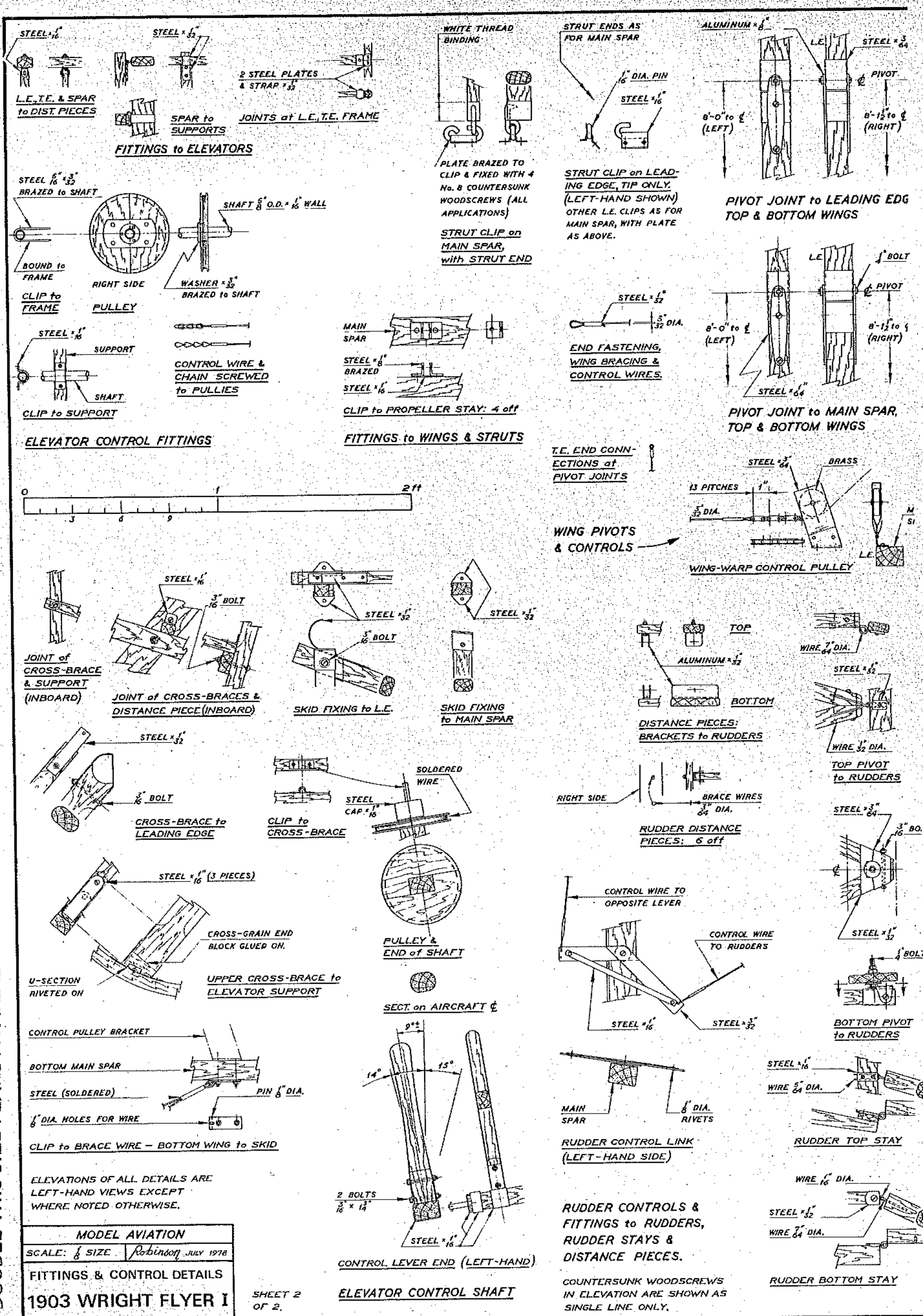
WINGS, ELEVATORS & RUDDERS COVERED WITH CREAMY-WHITE (UNBLEACHED & UNDOPED) COTTON FABRIC KNOWN AS "PRIDE OF THE WEST" MUSLIN.

EXPOSED WOODEN MEMBERS VARNISHED.

METAL PARTS, EXCEPT BOLTS ETC. & CHAINS, PAINTED BLACK.

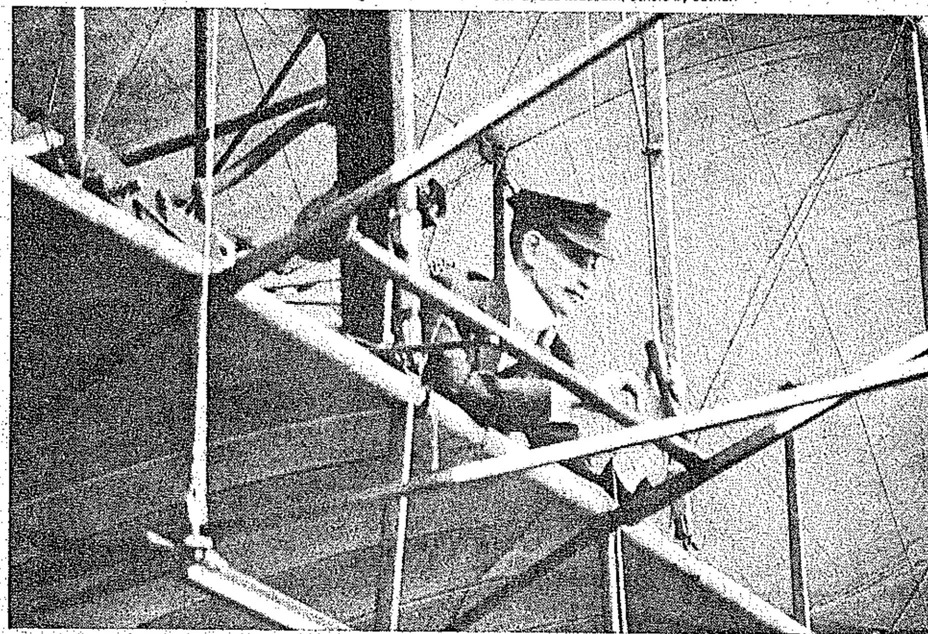


DOUBLE THIS SIZE PLANS AVAILABLE . . . SEE PAGE 112



DOUBLE THIS SIZE PLANS AVAILABLE . . . SEE PAGE 112

Credits: Pictures of Wright Brothers; U.S. Air Force; flight, Smithsonian Air and Space Museum; others by author.



When he made the simple flight that changed the history of the world, Orville peered ahead over wind-swept sands; his effigy at the National Air & Space Museum peers over endless visitors who make the hallowed hall the most popular tourists' site in the nation's capital. Left: Prone figure rests upon cradle which slides side to side to control the wing warp (in lieu of ailerons), coordinated with box rudder, in foreground, making controlled flight possible.

(and afterwards, as well), inventors had seemed convinced that an airplane would have to resemble a bird if it was to stand any chance of flying like one. Flapping wings were all the rage, at least until Cayley came along with the first truly scientific outlook.

In 1799, just after George Washington had stepped down as the first American President, George Cayley produced his first airplane design. It had a fuselage of sorts, with a monoplane wing. The rear-mounted tail had both elevator and rudder. There were two paddle-like propellers. And the wing had a curved, or cambered, cross-section to produce what we now call "lift."

Cayley never built this airplane design, but in 1804 he constructed a small glider model which flew successfully. By 1809, he had done research on cambered wings using a whirling-arm test rig, and had studied longitudinal stability, streamlining and the movement of the center of pressure. Had there been a light-weight engine of reasonable power available at the time, it is entirely possible that the first airplane would have flown not in America but in England. And not in 1903, but by 1815. The course of world history would surely have been very different.

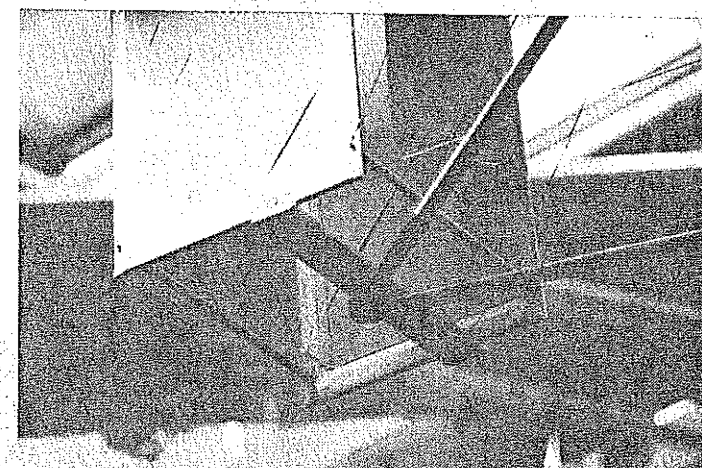
But there was no small, light engine. And so there was no Cayley airplane to make history. Even worse, Cayley's brilliant work was largely forgotten, as inventor after inventor charged off along strange paths that could lead to nothing but failure.

Some people did try, of course. Two more Englishmen, Henson and Stringfellow, worked through the first part of the 19th Century on monoplane designs based on Cayley's work. One of these, the "Aerial Steam Carriage" was publicized out of all proportion to its worth. One of Stringfellow's models, powered by a little steam engine, may have flown along an overhead wire, but nothing of permanent value came from any of this effort.

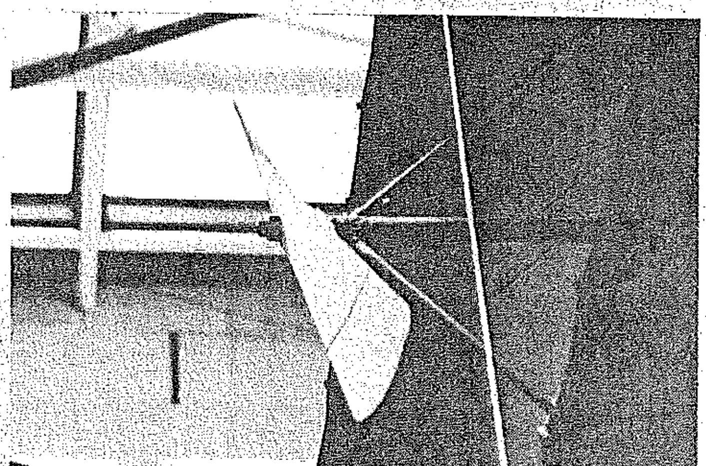
In 1874, Felix du Temple, in France, probably made a takeoff down a ramp in his tractor monoplane, but it was unable to sustain itself in the air. Today, only the most nationalistic of Frenchmen will claim this is a true first flight. Ten years later, a Russian named Alexander Mozhaisky made a takeoff from a ski-jump ramp, but was airborne for only a second or two in his steam-powered monoplane.

Others achieved even less. In August and November of 1903, the German, Karl Jatho, built a tiny machine with a 9-hp gasoline engine. He made at least two "running jumps," one of which may have carried him as far as 200 feet; neither is seen as a flight in the sense of a controlled journey in which the airplane carries the full weight of itself and its pilot to a point at least as high as the take off.

In at least one way, it may have been a good thing that none of these machines

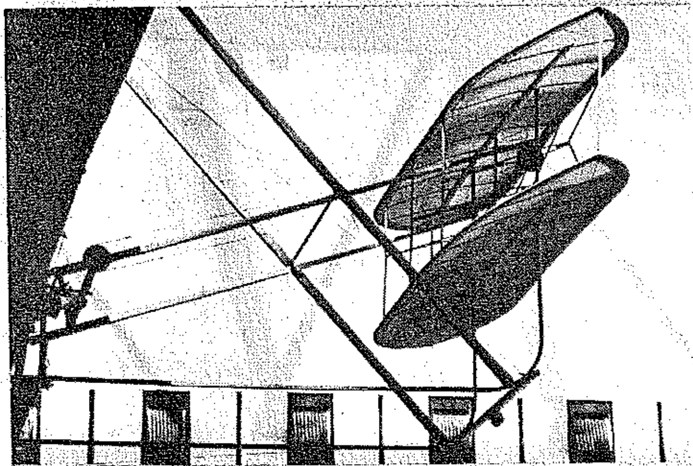


The arrangement of the moveable rudder was both simple and practical.

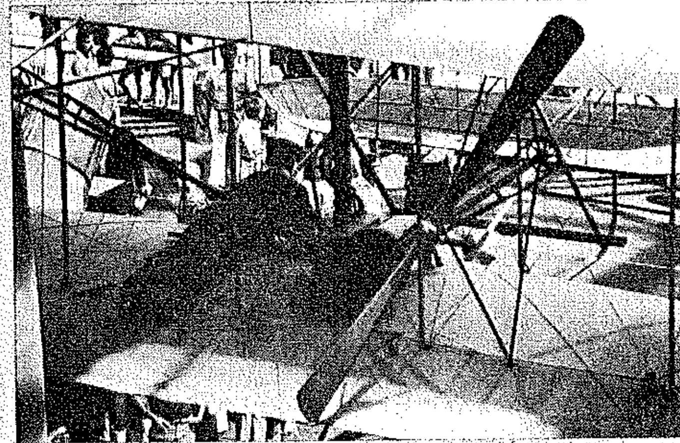


One of the two chain-driven propellers. In everything—engine, system, controls, stability, airfoil, the prop—success crowned intensive research, experimentation, and flight testing with a series of gliders. Simultaneously, they had to teach themselves to fly.

Drawings by Harry Robinson



And you can't make a canard model fly? The Wright Flyer was a canard. The hinged biplane forward surfaces were also aerodynamically balanced to minimize the control forces—note the location of the hinge line.



This closeup gives a singular feel for the way things were: Orville, stretched out to the left of the ingenious engine—which they designed and built, the chain-driven propellers (note chains and sprockets), another view of the canard surfaces, and the forward edge of the rudder.

really achieved much speed or altitude, for their pilots (or "chauffeurs," as British historian Charles Gibbs-Smith prefers to call them) would have been unable to keep them going in a straight line, once things began to go wrong. Some of them had limited flight controls, others depended on body-English, while a few had no known means of steering or correcting in roll, pitch or yaw.

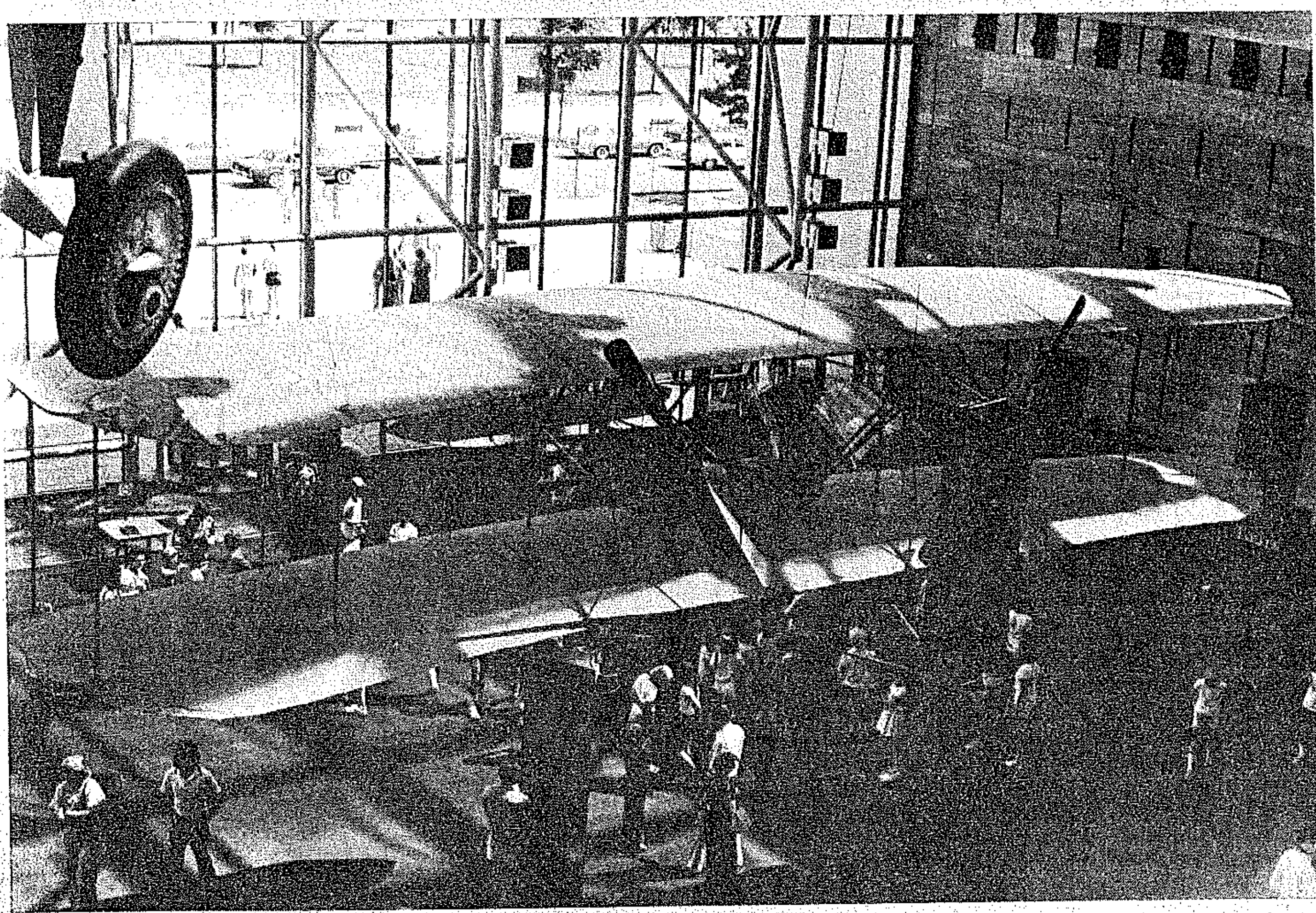
It was here that the Brothers Wright showed their enormous superiority over their competitors. They realized they would have to learn to fly, before trying to invent and perfect the airplane. For the very first time, man would be travelling in three dimensions, and this had to require some new skills.

The first step involved figuring out what was needed, and then trying it initially with a small glider flown like a kite. This was done with a 5-foot span biplane in August 1899, and proved to the Wrights the value of wing-warping for lateral control. The glider/kite also had a form of elevator.

Next came a 17-foot man-carrying glider which was flown at Kitty Hawk, NC, in 1900, first with ground controls via a tether line, and then freely by the pilot. It had an elevator in front, but neither horizontal stabilizer nor any kind of vertical tail surface. Dihedral was tried, but was found to cause problems in gusty conditions. This machine made an unknown number of tethered flights, followed by 12 with one of the Wrights lying on the lower wing.

With their rapidly increasing knowledge

Continued on page 108



Piece de resistance of the fabulous Museum is the Flyer, positioned to be the first thing you see. Appropriately, the Spirit of St. Louis hangs near by; you can see its wheel jutting into this picture. They don't speak of craftsmanship, but it leaves a profound impression.

placement (which is rather firmly fixed when the wing sockets are mounted on the motor stick), and angular difference (incidence) between the wing and horizontal stabilizer. Most fliers move wing posts up or down in the sockets to set wing incidence, which works quite well. However, there are a few disadvantages to moving the wing posts, not the least being the quandry of where to set the posts for the first test flight. Many fliers have found that their models have much more repeatable performance if the wing posts are cut to the proper length to "bottom out" in the bottom of the sockets.

How do I work that? Note in Fig. 1 that the bottom of each socket has a plug of balsa which is glued firmly to the bottom of the motor stick. Actually, this plug is sharpened so that it can extend out the bottom of the motor stick, where it is glued and then trimmed flush. It is very important that the bottom end of the socket be anchored, so that the motor stick's natural torsion resistance helps to stabilize the wing's tendency to twist under flight loads. If the post is not fully inserted in the socket, part of the available torsional leverage is not being used, and there is a possibility that the post can slip out of the socket under load. So, instead of making tiny marks on the post during test flying (how do you remember which is the right mark?), cut off a tiny bit of the longer post (finger nail clippers are ideal for this) and fully insert the post again. After flight trim is finished, the wing posts automatically set up an almost perfect flight adjustment at the next session.

What if I need to change? There are at least two ways to change the incidence after cutting the posts to length. Obviously, minor trimming can be done at the next session. However, if too many changes are needed, the wing post's growth will appear to be stunted! Stan Chilton uses variable incidence in the stabilizer of his models, which allows for very fine tuning of flight trim. Stan's setup is doubly useful, as can be seen in the photo. Although the stabilizer bracing wires do not show in the photo, the leading edge of his rudder extends through the stab for about 1½ inches, and serves as a bracing post also. A very close study of the photo shows a tiny paper socket at the end of the tail boom, with the post/leading edge going through the socket. Not only is the tail boom shorter (and therefore lighter), but the stabilizer incidence is easily adjustable.

Take a Close Look! Even if your eyesight is 20-20 with or without glasses, poor light at many indoor sites makes it hard to see tiny details of our models. One way to improve your vision is to use a magnifier, such as that worn by Erv Rodemsky in the photo. Like many other fliers, Erv uses rubber O-rings on his motors to allow easier handling and better torque control (see section on O-rings in a previous column—p. 55, July '78 *MA*). Sometimes the O-rings are hard to see for proper hookup.

More Flying Planned: The Aug. '78 *MA* reported on indoor activity throughout the Midwest, but several other areas hold regular indoor sessions and contests during the Fall and Winter months. The longest stretch of activity occurs in Miami, Florida, using the Goodyear hangar at Opa Locka Airport, in Miami. Contact Dr. John Martin, 3227 Darwin St., Miami, FL 33133 for more details. Also, Ron Williams, 1364 Lexington Ave., New York, NY 10028 has managed to establish regular flying sessions in the Low Library Rotunda at Columbia University in New York City. Another regular activity area is Glastonbury, Connecticut, where George Armstead ramrods monthly sessions. Contact George at 89 Harvest Lane, Glastonbury CT 06037 for specific information. Visit these groups if you are in the area, or fly with them regularly if you live close enough—they are nice, friendly people!

Bud Tenny, P.O. Box 545, Richardson, TX 75080.

FF Sport/Scale/Warner

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tains all of the Smithsonian's aeroplanes in 3-view form, for only $2.75! Title: *Aircraft of the National Air and Space Museum.* Check or money orders can be made out to the above museum, c/o the Smithsonian Institution, Washington, D.C. 20566.

The nine-inch Peanut controversy has drawn fire from all sides, many of the combatants sending in remote 3-views of planes, which if built with a nine-inch fuselage would qualify for Jumbo. Nothing daunted, I dug up a weirdo which qualifies under the present 13" wing span rule, with about a 22" length and around 250 sq. in. A descendant of the boxkite, as is John Martin's "Boxmoth," it proves nothing except that wing span alone doth not make a Peanut. It's the spirit that counts. Frank Scott of the Dayton "Buzzin' Buzzards" says, "Let's leave the rules alone." Ed Hopkins of Fillmore, CA suggests a uniform 1/24" scale. Flightmaster James Dean thinks an area rule would do.

How about this idea, which is called "Mooney Judging" after its originator: Planes are ranked from best to worst, 1 point for best, 2 points for next best, etc. This score added to their flight placing makes for a "low-score wins" situation, with CD and contestants agreeing beforehand whether ties are to be broken with scale or flying scores. The judge(s) is not bound by a set of ridiculous constricting rules, and can place that Fike, Lacey, or Forbes-Arnold right on down the line. An interesting alternative, which takes some time to tabulate, is having every contestant rate all the planes, giving his or hers the top score possible. Add 'em up and average 'em. No complaints. Most people have a pretty good idea of what a Peanut is. Let the rest fly AMA rubber scale or Manhattan Cabin!

Bill Warner, 423-C San Vicente Blvd., Santa Monica, CA 90402.

Wright Flight/Berliner

continued from page 60

of the basics of flight and control, they moved on to Biplane Glider 2, flown in July and August, 1901, at Kitty Hawk. With a span of 22 feet and wing area of 290 sq. ft., it was fully capable of carrying a man under a variety of wind conditions. It made some 60 flights, the longest of which was almost 400 feet. Like the Biplane Glider 1, it had a front elevator and no vertical rudder or fixed surface. Wing warping was now controlled by a hip cradle, and although it flew better than its predecessor, a lot of changes would obviously have to be made before they could consider themselves to be flying.

In the late summer of 1902, they brought out their Biplane Glider 3, built as a result of extensive research into means of control. This machine had grown to a wingspan of 32, an area of 305 sq. ft., and a much greater aspect ratio for reduced span-loading. At first, it had twin rear-mounted vertical fins for directional stability, which were supposed to counteract the disturbing tendency of the downwarped wing to lag behind and increase the bank and turn it was supposed to correct.

What was happening was this: When

the right wing dropped because of a sudden gust of wind, its trailing edge would then be warped down by the pilot. This would increase the lift of that wing and supposedly bring it back up to level. But the warped right wing's trailing edge had so much more drag than the unwarped left, that the right wing would lag behind and start to drop. This would swing the airplane around to the right and sometimes into the beginning of a spin.

The fixed vertical tails on Biplane Glider 3 were supposed to act like a weathervane and keep the airplane straight. Instead, they acted like a lever when the airplane began to sideslip, and actually increased the problem. To correct this, the Wrights swapped the two fixed fins for one moveable rudder which was connected to the warping cradle and automatically turned toward the warp direction. Thus was created the first coordinated turn, which opened the door to controlled flight.

During September and October of 1902, the Wrights flew their modified Biplane Glider 3 something like 1,000 times! They built up about four hours of flying time, which was more than everyone else in the history of aviation, combined!

Even more than hours, they built up experience and knowledge. They, in fact, became the first humans to *learn to fly*. No longer would a little puff of wind from the side mean the end of a flight. If a wing dropped, it was quickly brought back up to level by means of the cradle-operated linked controls. Moreover, smoothly banked turns could be made as the glider skimmed down the sandy Kill Devil Hills.

Mastery of the air was still far in the future. But the Biplane Glider 3, as modified, had controls over roll, pitch, and yaw. And Orville and Wilbur had control over Biplane Glider 3. It was history's first solid combination of man and airplane into one functioning unit.

The next step was obvious: Power. In those days, however, a little more was involved than driving down to the neighborhood airplane engine store and picking out the powerplant you needed. There were no airplane engines for sale, nor were there any that could be built from plans. The only way out of this bind was to design and build one to fit an airplane that was being designed and built at the same time. Not the ideal way to do things, but what choice did they have?

While the Wrights were investing the profits from their bicycle business in flying machines, a well-financed scientist was doing everything he could to beat them to the historic first. Samuel Langley, secretary of the Smithsonian Institution, had built and flown several impressive tandem-winged models, and was encouraged by this to build a full-size, man-carrying machine by simply scaling up his largest model.

His mechanic, Charles Manly, produced an amazing 52-hp radial engine which had been designed by Stephen Balzer, and this put Langley far ahead of the Wrights as far as power was concerned. But the emminent professor paid entirely too little attention to the problems of structure and control. His "Aerodrome" had terribly weak wing spars, and flight controls that could not possibly have moved the huge contraption enough to do any good.

With a tiny elevator, a rudder close to the center of gravity, and absolutely no roll control at all, there was not much chance that it could have flown very far even in a dead calm. As it turned out, the two attempts by pilot Manly in October and early December of 1903 failed when the Aerodrome fouled its launching catapult and pitched poor Manly into the icy Potomac River.

A week after the second and final watery crash of Langley's misguided dream, the Wrights were ready. They had polished their flying skills with 60 more flights in the Biplane Glider 3, to which had been added a second rudder for even greater control. And they had built an entirely new craft which they called the "Flyer I." It was not, as had often been written, one of their gliders with an engine attached.

The 1903 Flyer I was the largest Wright aircraft yet, with a span of 40' 4", wing area of 510 sq. ft., and empty weight around 600 lbs. Like the Biplane Glider 3B, it had twin rudders, but the low aspect ratio monoplane elevator had been replaced with a slim biplane device a few feet in front nose of the prone pilot.

Sitting next to the pilot was another symbol of the Wright genius: their engine. It may not have been the equal of the Manly radial, but the four-cylinder in-line was good for about 13 hp at 1,750 rpm. By means of chains, it drove a pair of counter-rotating propellers which had been designed and built by the Wrights in yet another display of their superior skill, craftsmanship, and thinking.

On Monday, Dec. 14, 1903, everything seemed ready. The wind blew steadily across the bleak North Carolina shore, as Orville and Wilbur dragged their new machine from its crude hangar. Wilbur won the toss of the coin and prepared himself to become the world's first airplane pilot. The engine was fired up and allowed to warm. With enough power being developed, the restraint was loosed and the Flyer I started foward and into the air.

Its nose came up quickly and Wilbur reacted with the application of down-elevator. Too much down-elevator, for it had to be counteracted with up-elevator to prevent an immediate landing. A few more oscillations and the nose dug into the sand after about 2½ seconds. To the Wrights, this was not enough to qualify as a flight, for the airplane had never really been under control.

Three days later, they tried again, this time with Orville as pilot, and there can't be many people in the world who don't know what happened. They flew! Four times! Their longest flight was 59 seconds, covering 852 feet over the ground and an estimated half mile through the air, as the wind was blowing better than 20 mph.

The Flyer 1 never flew again, having been wrecked by the wind shortly after its fourth landing on that historic day. It was eventually shipped to England for display in the Science Museum in London because the Smithsonian insisted that Langley had been the inventor of the airplane. In 1948, it was finally placed on display in Washington, after the stuffy Museum people admitted that the Wrights, and not Langley, had been the first.

And so today the Flyer 1 hangs in all its glory just inside the entrance of the National Air & Space Museum, where 20 million people have seen it in just the first two years since the new museum opened. Yet the true superiority of the Wrights is still not fully appreciated by the world. It isn't merely that they were the first to fly a fully controlled heavier-than-air machine. No, their accomplishments span the whole spectrum of aeronautics: Aerodynamics, structures, control, engines, propellers, flight training.

The race to be the first to fly really wasn't much of a race. The 59-second flight of Dec. 17, 1903, wasn't bettered by anyone else for almost four years! And by then, Wilbur had to his credit a 38-minute flight which covered 24 miles! They were so far ahead it was like no one else was even trying.

And if you still think that 75 years is such a long time, consider the case of Steve Wittman, undisputed king of pylon air racing and record holder in the new Formula Vee Class. Steve was born just 3½ months after the Wrights' first flight, and he's still as active as any pilot. If you ever run into Steve, ask to see his FAI Sporting License...it's signed by "O. Wright".

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Wing: Begin by cutting out all of the ribs from the materials called out on the plan. There are many methods of cutting out wing ribs; but the one preferred by this builder is to pin the blanks together in stacks about one inch high, trace the pattern onto the top of the stack and sand them to shape on a disc sander. The table must be set at exactly 90 degrees to the sanding disc or the ribs will vary from the top of the stack to the bottom. The notches for the spars can be cut with a band, jig or razor saw before the ribs are split apart. An alternate method would be to cut a template from light sheet metal, pin it down on the sheet balsa and cut around the edges, making one rib at a time. More time consuming perhaps, but the results are the same.

Pin the spars, leading and trailing edges down over the plan and, after carefully checking each rib for proper fit, cement it in place. Next, add the wing tips which are cut from ⅛" sheet balsa. Finally, add the upper spars. Join the two outer panels to the center section, using the plywood dihedral braces for reinforcement. Next, cover the leading edges and center section with 1/16" sheet, top only. Sand and shape as necessary in preparation for covering.

Covering and Finish: With the many types of coverings and finishes available today, it is sometimes difficult to decide which method to use. This builder has more or less standardized on MonoKote, or other plastic covering material, for the wing and tail surfaces and doped Silkspan-covered surfaces for the fuselage.

Sand the fuselage thoroughly with #400 grit sandpaper, dust off and apply a coat of clear dope. At this point, simulate the longerons by applying 1/32" wide strips of masking tape or thread at the appropriate places shown on the plan. Next, the entire fuselage is covered with one layer of lightweight Silkspan, followed by two coats of a 20% cornstarch and 80% clear dope mixture. After another sanding with #400 grit sandpaper, the structure is ready for color doping. Two or three coats of your favorite color, preferably sprayed, will usually give a satisfactory finish.

The windows and numbers are cut from white and black MonoKote trim sheets.

RC Gear Installation: The location of the