No. 64 OCTOBER 1991

T.W.I.T.T. NEWSLETTER

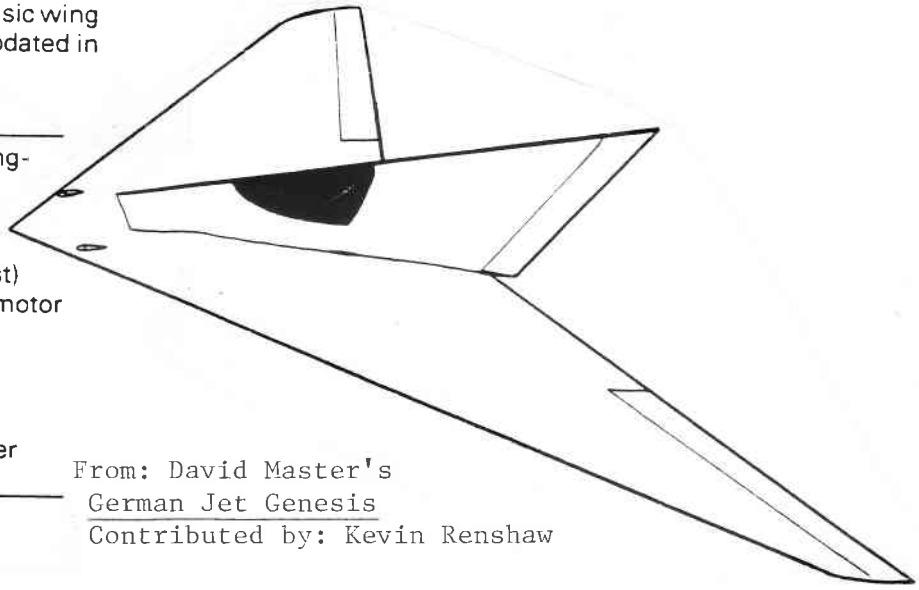
Horten Ho XIIIB

The Horten Ho XIII glider was built as a flying testbed to investigate flying-wing control problems. It combined Ho III glider wings with 60° sweepback and a new centre section, and the pilot was to be carried in an underslung nacelle.

Developed from this was a design for a supersonic flying-wing fighter, designated Ho XIIIB. The basic wing shape was retained but the pilot was accommodated in a flush faired cockpit at the base of the large, sharply swept fin. The wings were swept back at 60° and power was to be supplied by a single BMW 003R rocket/turbo-jet combination. This unit could deliver a total thrust of over 3,000lb (1,360kg) for short periods of emergency high-speed action.

Horten Ho XIIIB data

Role	Single-seat supersonic flying-wing mixed-power fighter
Ultimate status	Design
Powerplant	One BMW 003R combined turbojet (2,205lb, 1,000kg st) and BMW 109-718 rocket motor (882lb, 400kg thrust)
Maximum speed	1,120mph (1,800km/hr)
Span	39ft 4½in (12.0m)
Length	39ft 4½in (12.0m)
Armament	Two MG 213 30mm revolver cannon



From: David Master's
German Jet Genesis
Contributed by: Kevin Renshaw

T.W.I.T.T.
(The Wing Is The Thing)
P. O. Box 20430
El Cajon, CA 92021

The number to the right of your name indicates the last issue of your current subscription, e.g., **9110** means this is your last issue unless renewed.

Next TWITT meeting: Saturday, October 19, 1991 beginning at 1330 hrs at hanger A-4, Gillespie Field, El Cajon, Calif. (First hanger row on Joe Crosson Drive - East side of Gillespie.)

THE WING IS THE THING
(T.W.I.T.T.)

T.W.I.T.T. is a non-profit organization whose membership seeks to promote the research and development of flying wings and other types of tailless aircraft by providing a forum for the exchange of ideas and experiences on an international basis. T.W.I.T.T. is an affiliate of The Hunsaker Foundation which is dedicated to furthering education and research in a variety of disciplines.

T.W.I.T.T. Officers:

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Vice Pres.,	Dave Pio	(619) 789-1650
Secretary,	Phillip Burgers	(619) 563-5465
Treasurer,	Bob Fronius	(619) 224-1497

Editor (Acting), Andy Kecskes

The T.W.I.T.T. office is located at Hanger A-4, Gillespie Field, El Cajon, California.

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Wt/#Issues	FRG	AUSTRALIA	AFRICA
1oz/1	1.00	1.00	1.00
12oz/12	5.00	6.75	5.00
24oz/24	9.00	12.25	9.00
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48oz/48	16.75	23.00	16.75
60oz/60	21.75	30.25	21.75

Meetings are held on the third Saturday of each month, at 1:30 PM, at Hanger A-4, Gillespie Field, El Cajon, California (first row of hangers on the south end of Joe Crosson Drive, east side of Gillespie).

PRESIDENT'S CORNER

I can't believe another month has gone by already and the newsletter is due to the printers next week. I guess being sick for a week really through my internal clock off.

Not much has been happening this past month, just business as usual. I am happy to note that a number of members have requested copies of the tapes from Don Mitchell's talk at the Tehachapi meeting. For those of you interested in the historical aspects of his flying wing development process, the tapes are the best way to go, since you can hear all the details rather than having me try to translate the best parts. The set of tapes is $4 delivered to you, postage paid.

Unfortunately, I missed last month's meeting due to a 104.9 temperature that sort of sapped all my energy (can't understand why?). From what I heard on the tapes, it sounds as if those present were treated to a very interesting program between Jerry Blumenthal and Phillip Burgers. It is very refreshing to know that one of our members has come up with what appears to be a very workable concept even though it has never been tried before. I hope Jerry's scale models prove to be successful, and that we may see some video tape of his creation in actual flight.

I noticed the letters to the editor was rather sparse this month, although we got a lot of mail with renewals and tape requests. We are glad to see the renewals, since it means you are still enjoying what you get from TWITT. But don't forget, this is your organization and it includes sharing your ideas and dreams with your fellow members. So let's hear from all you designers and builders on what is in the works.

I find I must apologize to Jim Loyd for not getting his design into the forefront and analyzed as we have Jerry's. I have not forgotten it, and I will attempt to get the members interest again during the October meeting. I am a little disappointed that there has been no response from the membership at-large with any comments on either of these designs, and that everything is coming from those attending the meetings. If any of you have any thoughts, please let us hear from you. Without the interchange of information everyone will continue to work as a single entity rather than build on the collective efforts of the entire group.

That's about it for this month.

Andy

OCTOBER PROGRAM

The program this month should prove to be an interesting one. Bob has arranged to have Carl Gwartney talk about the Waco CG-4A troop glider from the prospective of a combat pilot. Then Lee Klaus will describe his experiences in towing troop gliders with C-47s, He was part of a test program to prove twice the load could be delivered by C-47s if each towed a glider. Temporary duty to Missoula, Montana to try the idea out provided results that were, to say the least, interesting. If he is available, Doug Fronius may also give us an overview of the troop glider convention he attended in Tucson recently, and his latest project of rebuilding a CG-4A glider in consortium with several other enthusiasts. Although this program is not directly related to flying wings, it sounds as if it should be very interesting.

We would also like to have the members go over Jim Loyd's three view published several months ago (a reduced version is reprinted in this issue) and give him any positive or negative feedback on the concept. Those of you who are aerodynamicists, please take a look at it and bring your ideas and comments.

MINUTES OF THE SEPTEMBER 21, 1991 MEETING

Bob opened the meeting since Andy was unable to be there due to illness. He then covered a few items from the Tehachapi meeting, including that we will have a version of the slide show used by Don Mitchell during that meeting. Bob went on to talk a little about the good flying that was available on Sunday and Monday, to include a cross country run from Tehachapi to Rosemond reaching altitudes of over 10,000'.

Bruce Carmichael reported that the Sailplane Homebuilders design contest was won, unfortunately, won by a conventional style aircraft. However, Ed Lockhart's and Harald Buettner's designs did place, Ed's being a flying wing and Harald's Flying Surfboard. We are sure they will be trying again next year, and we wish them good luck in that endeavor.

The raffle prize was announced as a ride in a PT-19, which would be very welcome since it is an open cockpit and the temperature is in the high nineties. Harald Buettner went on to win this prize later in the meeting, and I know he enjoyed the ride.

Now the technical bugs began to rear their ugly head. Even after making a test run to make sure the tape recorder would work properly, for some reason it decided not to record the opening remarks and Jerry Blumenthal's part of the meeting. The tapes didn't start working until well into Phillip's portion of the program. Then as luck would have it, the tape decided to malfunction while trying to translate it into the minutes, so a little more was lost to crinkled tape. All this means that most of what is presented below has come from Phillip and Jerry's recollections of the meeting.

Jerry Blumenthal had presented his latest project at the August meeting and this was covered in the minutes, along with the beautiful cover drawing he prepared for us. At this meeting Jerry wanted the members who were present to act as the devil's advocate and offer whatever comments and/or criticism of the design. Prior to the meeting, Jerry had the opportunity to demonstrate a beautiful small free flying model of the RATTLER which performed flawlessly when launched. Jerry indicated the design work on a 1/8 scale model (54" span) was well under way.

Bruce Carmichael opened the discussion asking about the directional stability of the model. Jerry indicated he was confident there was enough vertical area behind the center of gravity of the aircraft to have positive stability even when confronted with adverse yaw upon deflecting the ailerons. The stability & control model was being flown without the central canopy and fairing, and showed no signs of spinning (which is what happens with insufficient or improperly placed side area). This convinced him that the wing dihedral <u>was</u> acting as directionally stabilizing side area.

Bruce also asked about the reason for so much washout at the tips (4 degrees), and suggested that there was no need for any at all. Jerry was pleased to hear that comment and said that he would indeed build his radio control model as Bruce suggested (besides it would be easier). The Horten wings had none.

Ralph Wilcox, along with Bruce, also was wondering about the effect of the stall of the wing planform, which is a mix of a very low aspect ratio wing portion near the root, and a relatively high aspect ratio at the tip. There has been some recent news mentioning the phenomena of "deep stall" in similar types of wings, like the one in the homebuilt aircraft

"Velocity." Even though it is a canard, there can be a stall pattern of the main wing that only affects the outside panels, or high aspect ratio portion, and some vortex lift at the low aspect ratio portion of the wing, or the strakes at the root of the wing. The fact that low aspect ratio planforms tend to stall at higher angles of attack than the larger aspect ratio wings can make these "compound wings" have a peculiar stall which is not desired.

Phillip Burgers mentioned that the small flying model which was being tested before the meeting, was flying in the realm of VERY small Reynolds numbers. Even though it demonstrated good natured flight characteristics, it would not be wise to extrapolate to higher Reynolds numbers and expect the same flight characteristics. Phillip also praised the aesthetic appearance of the RATTLER, and the efforts of Jerry to go to a more realistic scale to find out more about the aerodynamic characteristics of this unique design.

Bob Chase mentioned that he had been working on a similar design and asked if there was any incidence change in the forward section (wash in). Jerry said that he planned to construct the wings on a flat M.C.P. (Manufacturing Chord Plane) with no decalage or twist.

Harald Buettner said that he felt the directional stability of the model was due largely to the fact that the greatest portion of the drag of the design was behind the CG, like an arrow.

Bob asked Bruce to introduce Phillip Burgers, who was the main speaker for this meeting. Bruce commented on Phillips arrival in San Diego from Argentina about six years ago, when he went to work for Ryan as an aeronautical engineer. Bruce went on to explain a little of the Horten brothers history in Germany during WW II, and how some of Horten's gliders ended up in the U.S. for testing and evaluation after the war. With that background complete, Phillip took the floor to tell us about his visit with Dr. Reimar Horten in Argentina about five months ago.

One of the things that Phillip wanted to discuss with Dr. Horten was the evolution of a computer wind tunnel simulation program he has been working on for a long time. Phillip had gotten the idea from Dr. Katz, of San Diego State University, after Dr. Katz invited him to attend a course on computational fluid dynamics. Hernan Posnansky, an original founder of TWITT, also aided Phillip in developing some of the matrix programming. According to Phillip the program is just about finished.

Dr. Horten had done a lot of work with the Argentinean Air Force, during which time he produced a number of design drawings of aircraft that are not very well known. Phillip was given a large amount of paperwork to bring back, and within this were drawings of these aircraft. The originals of these drawings were destroyed in a fire, so the importance of these copies has been greatly increased. Phillip noted that many of the drawings were done by Karl Sanders while he worked for Dr. Horten in Argentina. Karl is a long time TWITT member and has spoken to the group on several occasions.

Unfortunately, some of the drawings that Phillip used for the presentation were large blueprints which could not be reduced for publication or as view graphs. He did try to point out the most interesting items on each blueprint. Some of the designs were conventional in the context of flying wings, while others were of rather unconventional thoughts. Most of what he showed were just design concepts and had never been constructed or flown.

One transport type design using winglets, and another having discontinuity in the leading edge. Dr. Horten, while still in Germany, had become aware of the phenomena of vortex lift, therefore, some of his designs used this theory as early as 1943, but it was not discovered by U.S. designers until development of the F-5.

Dr. Horten had used some very sophisticated equipment, a stethoscope, to find out why one of his flying wings was not stalling at the estimated speed. This highly refined, aerodynamic measuring device was used during flight to listen for changes in sound, which helped Dr. Horten determine where and how the vortex lift was affecting his aircraft.

One of the items Dr. Horten included in the paperwork given to Phillip was the notebooks he had used when he was a teacher at an Argentinean university between 1948 and 1955. Within these notes were drawings and calculations for supersonic flow across the longitudinal axis of an airframe. Apparently, Dr. Horten had also been looking at supersonic flow as far back as the 193Ø's while still in Germany.

Some of Dr. Horten's more conventional designs were using reflex airfoils as early as 1959. One drawing included the use of a high speed T-tail design. However, Phillip said he didn't have any data to show the deep

stall characteristics of this particular design.

One transport that was actually built and flown in Argentina was a four engine flying wing with a 64' wingspan. Horten used a triangular loading scheme to control the center of gravity problems, and the aircraft flew very well. This was sort of a test bed for another design Dr. Horten wanted to build (but never did) that would have been a flying wind tunnel. (A drawing of this can be seen elsewhere in this issue.) Scale models could be mounted inside the tunnel portion and then the aircraft flown to produce the desired airflows and angles of attack tests.

The next drawing Phillip showed was of a delta shaped aircraft which was going to be built, but never materialized. When asked why he had mounted the ailerons a little bit inboard of the tips, Dr. Horten explained that at high angles of attack and low speeds there would be a vortex going over the ailerons, producing tremendous roll response at these low speeds. This was around the 1957 era.

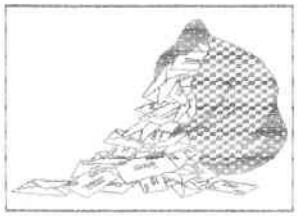
Some of the materials Phillip received were secret (at the time) reports on analysis' of the P-51s laminar flow wing design. Horten used some of this information during design of the Horten IV, but found that laminar flow airfoils were not necessarily the best for a flying wing design. (See the airfoil layouts for the IVB elsewhere in this issue.)

Phillip went on to talk a little bit about his computer program. It has the capability to analyze flying wings, but it also can take a second surface so conventional, tandem wing, or canard designs can be analyzed. The program will work with high angles of attack, up to about 1Ø degrees, depending on sweep and be comparable to the NACA results (within 2-3%) for the same configurations. Once he has some good sample runs and their comparisons with NACA data, he will make a presentation to TWITT. The program is somewhat limited in its scope, focusing primarily on low speed aerodynamics.

He said what it will do is find the optimized lift distribution and have the program show him where the highest load is in the section. With this information he can guess-t-mate at what station the stall will occur. However, he cannot tell what the induced drag will be for the section.

After the conclusion of Phillip's presentation, Bob wanted to clarify an item from the last newsletter about the T-shirts presented to Bruce and Georgie Carmichael at the Tehachapi meeting. Bruce's shirt was donated by Bob from his raffle winnings of the previous meeting, and he and June went together to purchase the shirt for Georgie. Bob did this to recognize the many contributions Bruce had made to TWITT, and we apologize for the misunderstanding. With that, Bob concluded the meeting.

LETTERS TO THE EDITOR



9/23/91

TWITT

Enclosed is my check for subscription renewal. I will try to be more timely next time, but with our move to Arizona and many projects we have been really busy trying to accomplish things.

If you see Don Mitchell, tell him my B-1ØM is out in my garage and from time to time gets my attention. The modifications we discussed in Gardnerville some time ago will be accomplished in time and then I will try to contact him for some final adjustments before attempting any serious flying with it.

Sierra Vista is a nice area, and the weather is as good as one could expect anywhere. The most frequent comment heard here from the people who have moved here from near everywhere is that the weather is the best they have experienced, and so it is with us.

According to the Summer 1991 issue of Bungee Cord, Reimar Horten has designed a small ultra light flying wing with a pusher engine, and apparently it has been built and flown. I hope we will soon see some photos and data on what sounds like an interesting aircraft.

I do not do much sailplane flying these days, but my interest in ultra lights continues strong - especially in soarable ultra lights. In my travels, including those overseas, I am finding many that are going the same way - including former sailplane pilots.

Best Regards,

Gil Metcalf
2648 Canyon View Drive
Sierra Vista, AZ 85635

(Ed. Note: Thanks for the renewal and the update on your B-1ØM project. Don will get

your message since he is a TWITT member and I am sure reads the newsletter from cover to cover. We will have to get Phillip Burgers busy and correspond with Dr. Horten to see if we can come up with any more information on the ultra light flying wing. Thanks for the information.)

9/16/91

TWITT

Here's some bucks, please extend me 2 years. I wished to attend the August meeting to hear Danny Howell - we seem to be inventing the wheel each independently. However, due to buying a house and doing slave duty on wallpaper stripping, no could do.

Perhaps the September meeting.

See You Sooner,
Randy Bergum

(Ed. Note: Randy, if your interested in all of what Danny had to say, simply send us $4 and we will copy the minutes for you. Or, you can borrow the tapes next time you can break away from your "chores" and make it to the meeting.)

TWITT

Great September issue! I was especially interested in the talks by Danny Howell and Don Mitchell, and delighted to hear someone has taped these so non-local members can hear the talks too. Please find enclosed $8 for the two tapes you mentioned in the newsletter.

Yours sincerely,
Stewart Midwinter
Calgary, Alberta

(Ed. Note: I will get the tapes reproduced and sent off to you just as soon as possible. We have had quite a few requests for Don's talk, and now it seems Danny Howell's talk was of interest to several people too.)

9/4/91

TWITT

I sent my application yesterday but forgot to ask for a list of back issues.

I was thinking of a logo for TWITT. I'll send my idea soon.

Charles Hildebrand
323 Colonel Ledyard Hwy
Ledyard CT Ø6339

(Ed. Note: We don't have an actual list of back issues that tells you what is in each one. That is a project, like a bibliography of the library, we haven't been having much success at getting done. There are 63 back issues of the newsletter, and the vary in style and material based on who was the editor at the time. I believe that there is no duplication of information in any of the newsletters, each having something of value to most people interested in flying wings. See the first page for purchase and mailing prices.)

AVAILABLE PLANS/REFERENCE MATERIAL

Tailless Aircraft Bibliography
by Serge Krauss
Cost: $2Ø
Order from: Serge Krauss
3114 Edgehill Road
Cleveland Hts., OH 44118

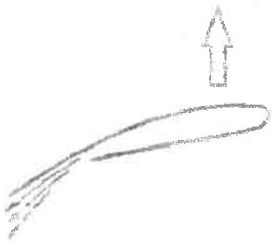
Horten H1c construction drawings with full size airfoil layout. 3Ø sheets 24" x 36" with specification manual. Price: $115.

Horten Newsletter
Cost: $5 per year for US/$7.5Ø foreign
Order from:
Flight Engineering and Developments
2453 Liberty Church Road
Temple, GA 3Ø179
(4Ø4) 562-3512

FLYING WING SAILPLANE PLANS AND KITS: Two time-proven, 13m homebuilt designs suitable for the novice pilot. Build either the MONARCH "F" ULTRALIGHT (19 to 1), or the PIONEER II-D (35 to 1) sailplane.

Info packs $8 each, or $15 for both.

Marske Aircraft Corp.
13Ø Crestwood Drive
Michigan City, IN 4636Ø



THE HIAM AIRPLANE
NEEDS YOUR HELP

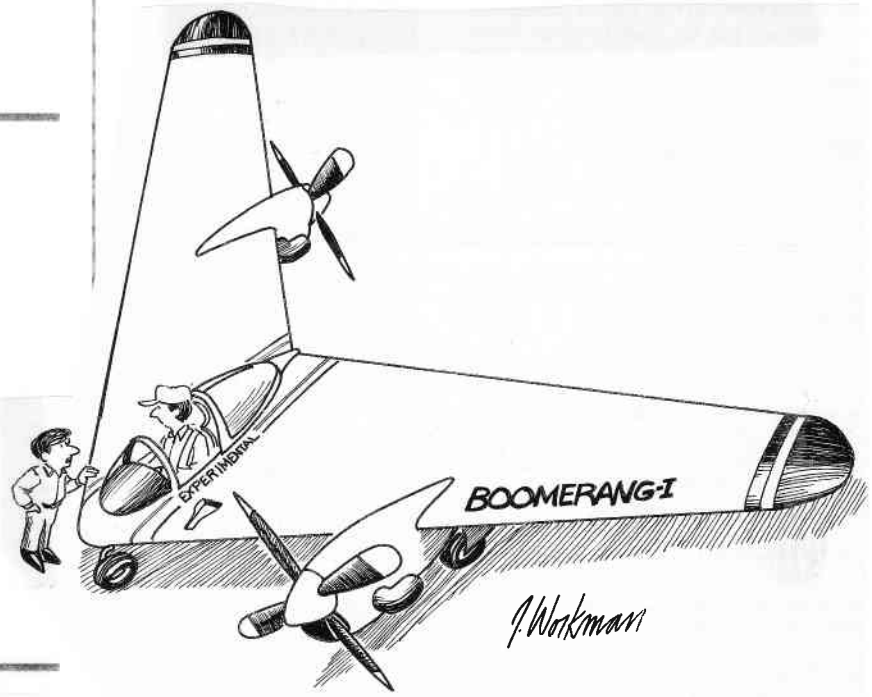
For those of you who would be interested in assisting Budd Love with some aspect of his High Internal Air Mass (HIAM) project, he would be glad to hear from you. This concept has great potential for the future of air transportation.

Contact: AIRLOVE, LTD.
6423 Campina Place
La Jolla CA 92037
(619) 459-1489

MODEL WINGS

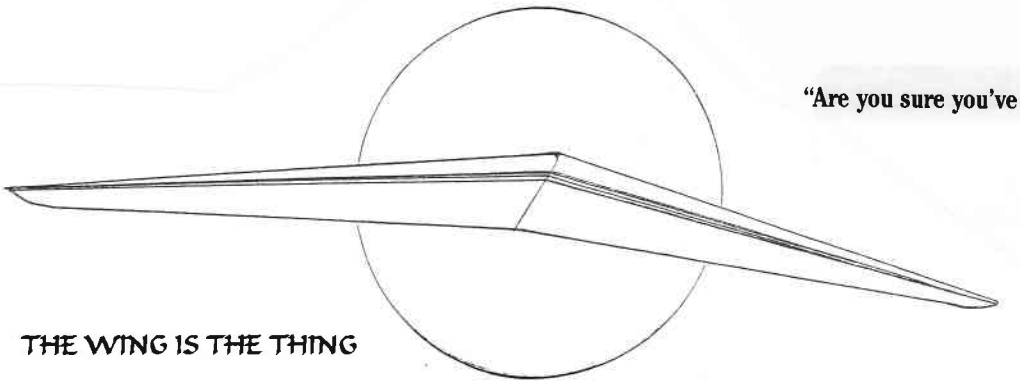
The cover of the July 1991 issue of RCModeler features a flying wing called the "Stealthbat" offered by Wing Manufacturer. There was no price listed, but they can be contacted at:
306 E. Simmons
Galesburg IL 61401
(309) 342-3009 Catalog: $4.00

Omni Models carries the Future Flight Klingberg Wing kit for $39.99 (item #FTF4000). They can be contacted at: P.O. Box 1601
Bloomington IL 61702
1-800-747-6664 or (309) 663-5798
Shipping: $5.00



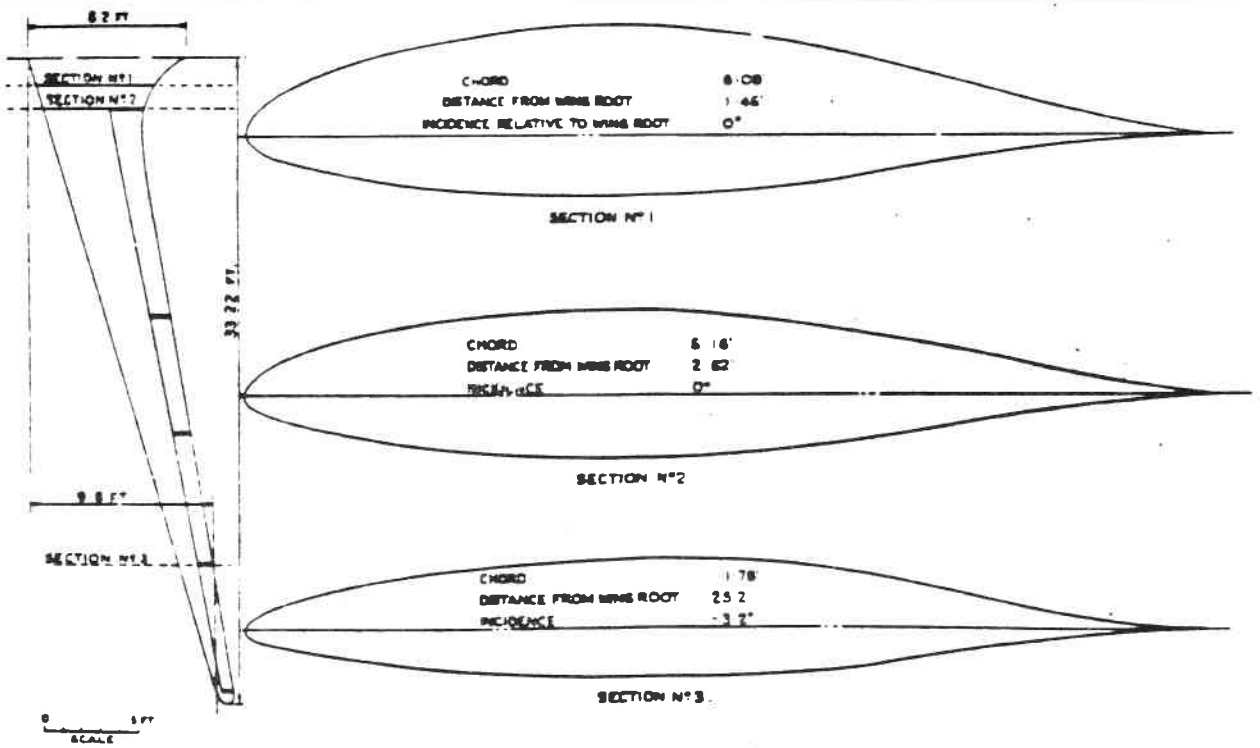
"Are you sure you've thought this through?"

CONTRIBUTED BY:
KARL SANDERS
FROM: KITPLANES
JULY 1991

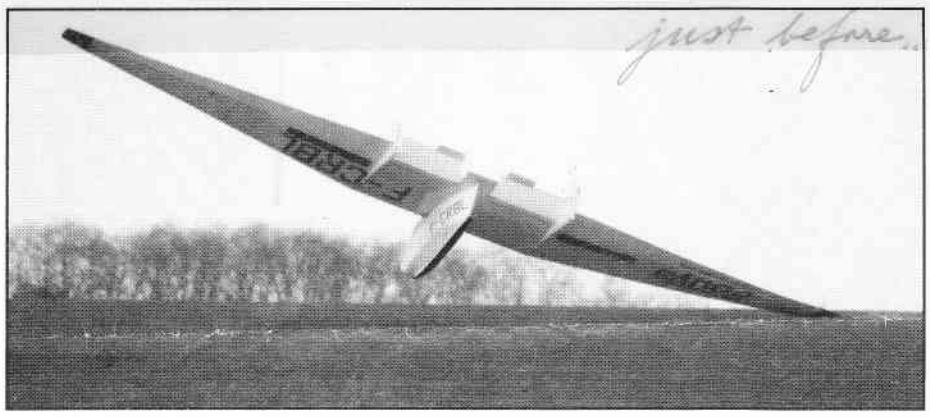


THE WING IS THE THING

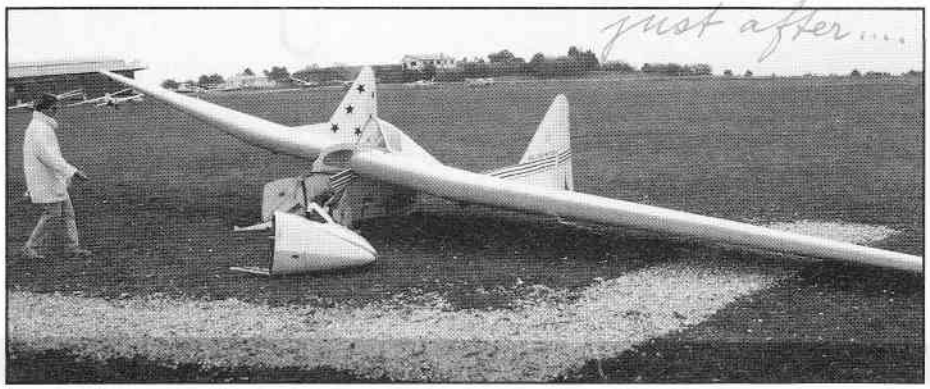
LOGO SUBMITTED BY: RICHARD AVALON
SAN BRUNO, CALIFORNIA



HORTEN IV B.
SECTIONS.



Viel Glück hatte Pilot Lucien Bocciarelli beim Flugzeugschleppstart mit der Fauvel AV 36. Nach Bodenberührung mit der Tragfläche schlug die Rumpfspitze auf.



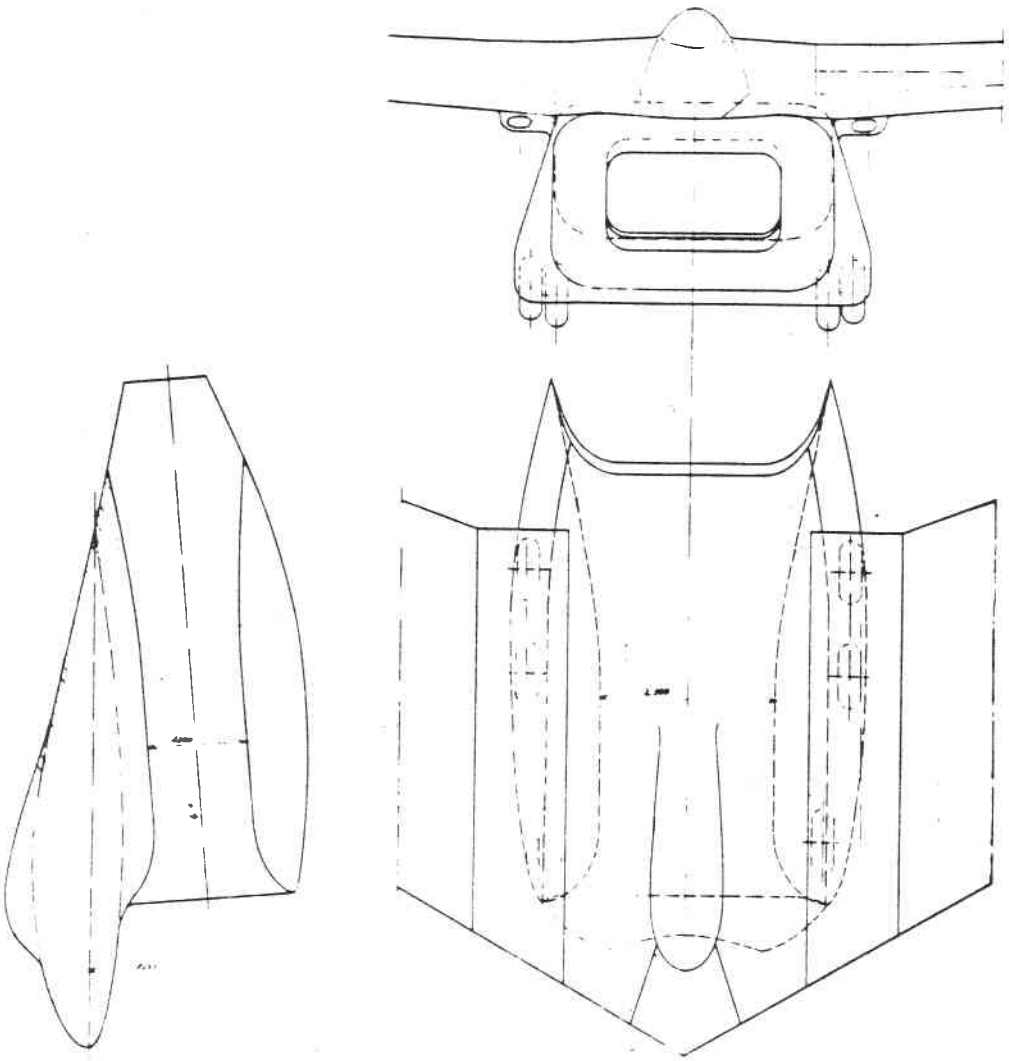
CONTIBUTED BY:
KARL SANDERS

FROM: GERMAN AVIATION MAGAZINE FLUGWELT MAY 1991

Article was titled:
"Oldtimer: Nurflugel segler"

with a subtitle that read:
Rarely did one see so many flying wing sail-planes as during this year's "Oldtimer Glider" meeting at Pont St. Vincent in France.

Karl commented on the picture: "No harm done; he just stepped out from his seat. It flies again!!"

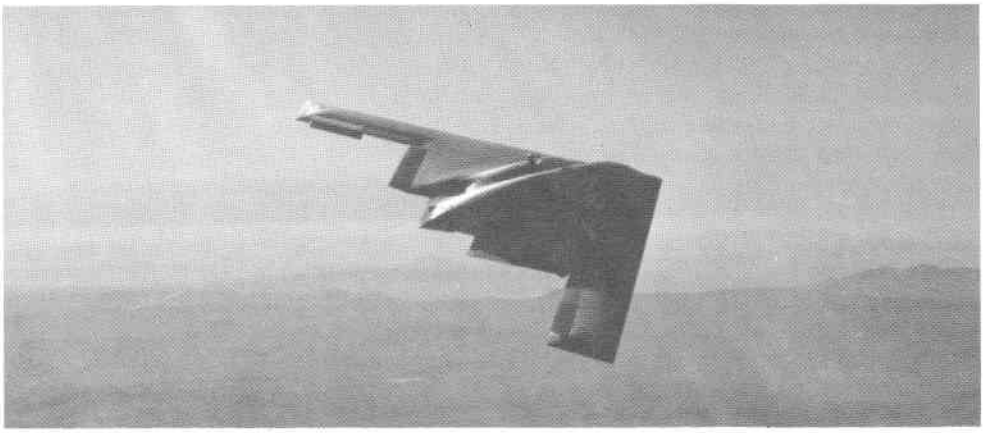


HORTEN'S PROPOSED WIND TUNNEL FLYING WING

B-2 takes part in stealth week

FROM: NORTHROP NEWS
June 14, 1991

CONTIBUTED BY:
KARL SANDERS



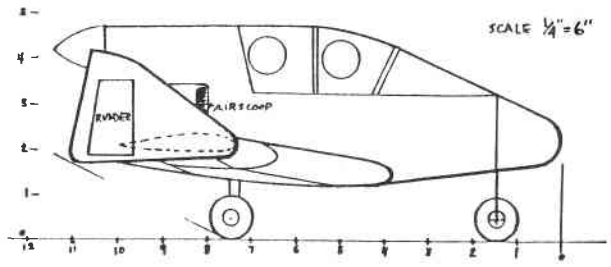
USAF file photo

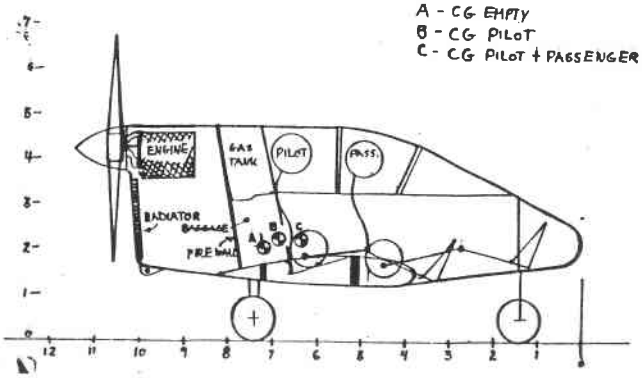
THE B-2, seen here during an earlier flight, flew to Andrews Air Force Base recently to take part in the Air Force-sponsored Stealth Week activities. Congressional representatives and government officials were invited to view static displays of the Air Force's stealth weaponry, including the B-2, F-22 Advanced Tactical Fighter, F-117 Stealth Fighter and the Advanced Cruise Missile. The B-2 mission team for the flight from Edwards AFB to Andrews AFB included Col. Frank Birk, Combined Test Force director and Eric Hansen, Northrop test pilot.

SPECIFICATIONS - BOOMERANG

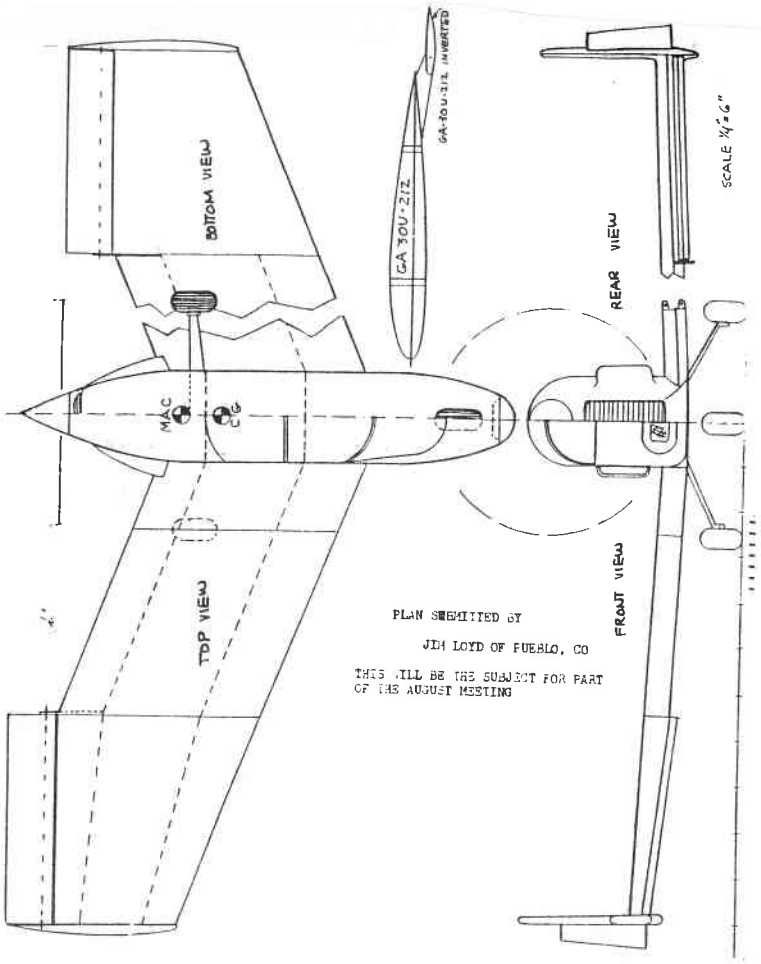
LENGTH - 12'
WING SPN - 22'
WING AREA - 81.6 SQ FT
ELEVONS AREA - 9 SQ. FT
EMPTY WT - 414 LBS
GROSS WT - 854 LBS
WING LOAD G.W. - 10.2 LBS/SQ FT

POWER=90 HP SUZUKI 3 H. ENG
POWER LOAD - 9.2 LBS/HP





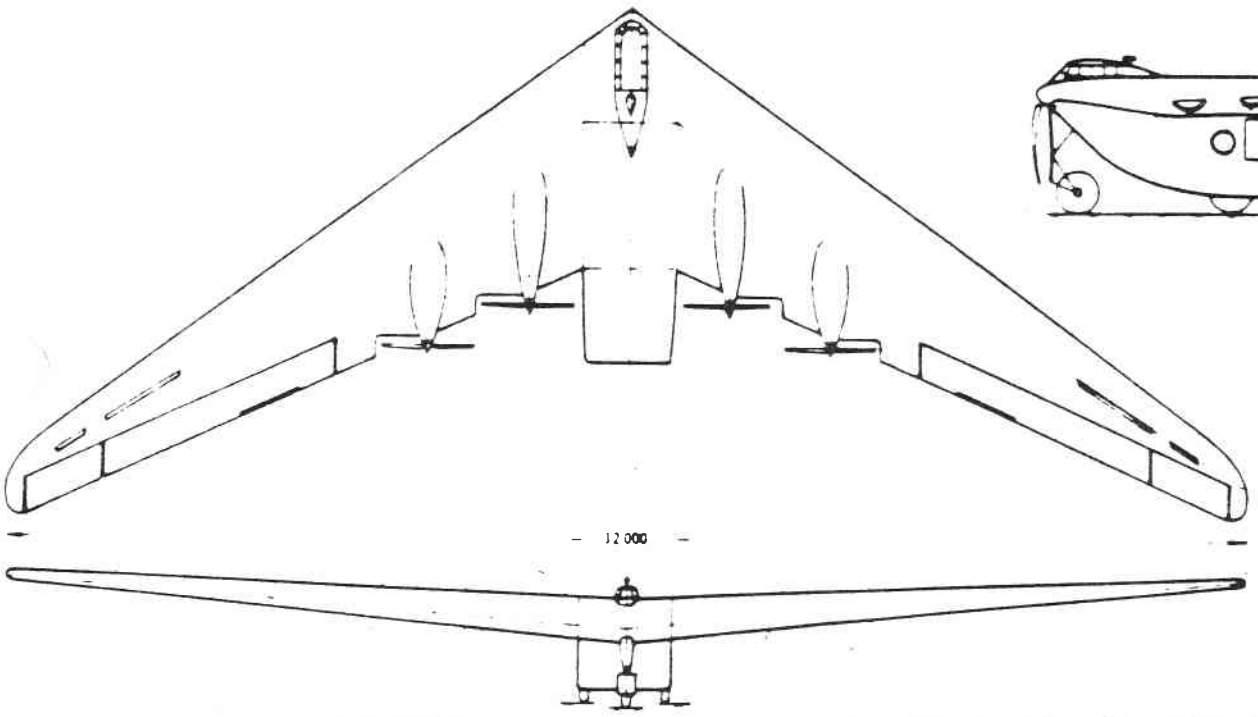
A - CG EMPTY
B - CG PILOT
C - CG PILOT + PASSENGER

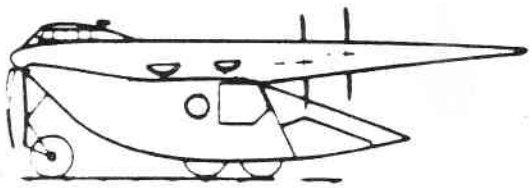


PLAN SUBMITTED BY

JIM LOYD OF PUEBLO, CO

THIS WILL BE THE SUBJECT FOR PART OF THE AUGUST MEETING

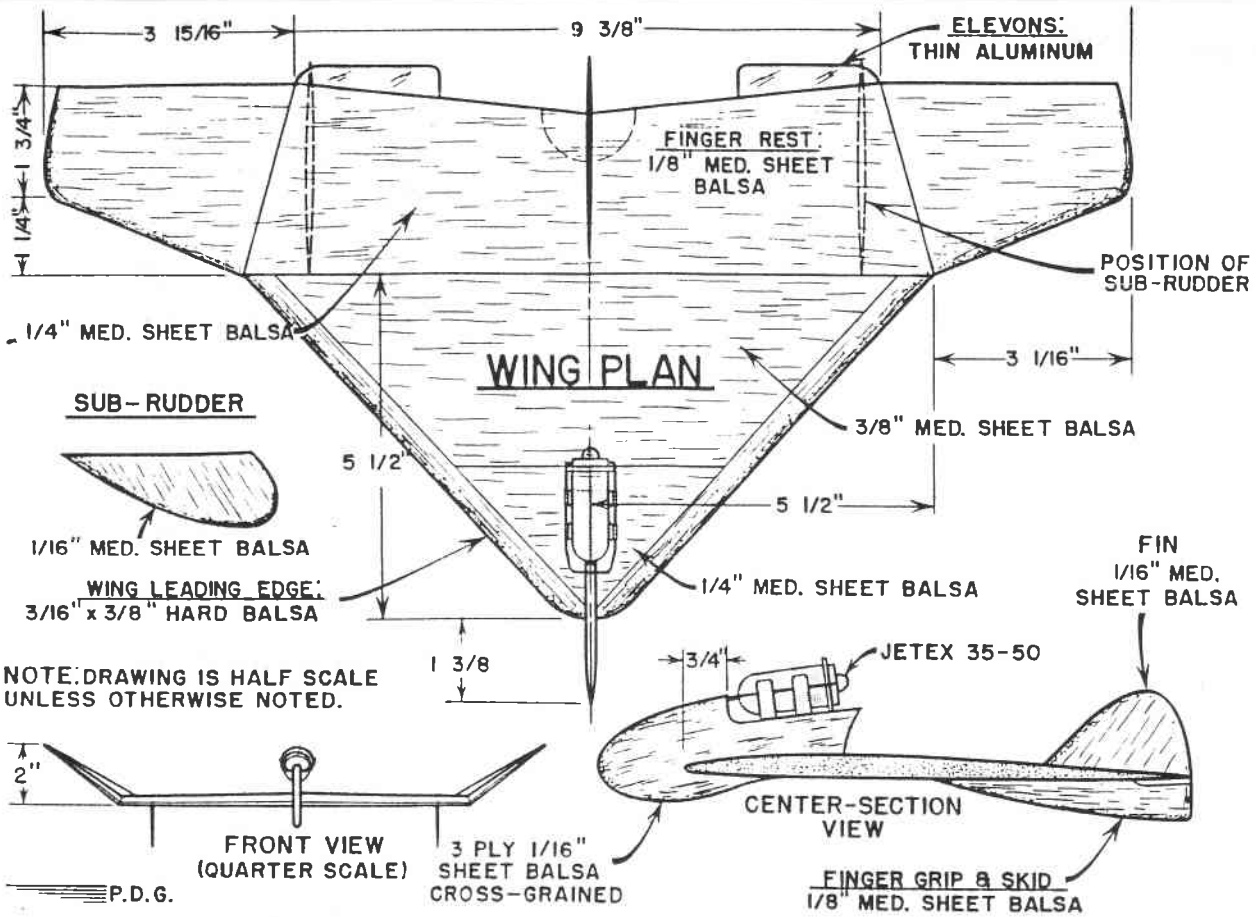




I. Ae. 38

HORTEN TRANSPORT

CONTRIBUTED BY: PHILLIP BURGERS



MODEL AIRPLANE NEWS • April, 1957

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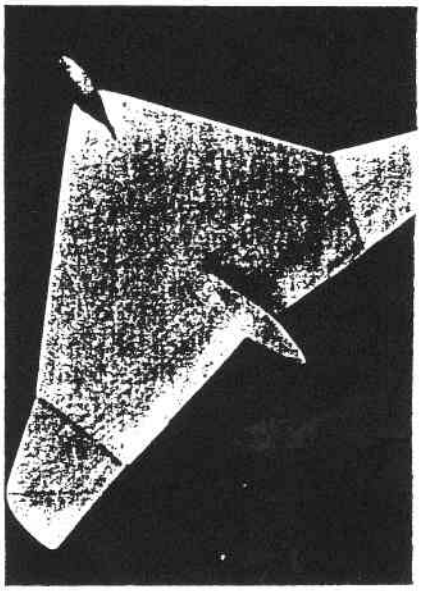
Jetex Delta

by PAUL Del GATTO

Nike? What's that? This simple machine will leave your breathless with 300-foot climbs.



This was the delta hand-launched glider which flew so well. A bigger blob of clay was weighi

▶ Originally, this model started out as a hand-launch experimental design over three years ago and, since that time, it has undergone many changes. As a hand-launch design it proved successful from its inception and, after modification of the rudder and fin area and the dihedral angle, its performance was comparable with good contest hand-launch designs.

Some of its characteristics, surprisingly enough, make it particularly suitable for a model builder who doesn't have the strength of a Hercules in his arm, for it will attain altitudes of 75 to 100 ft. with little effort, and we have been able to trim it for much higher altitudes. The design can be adjusted to do a roll at the top of the climb after which it dips slightly and quickly into a tight turn, thus it is ideally suited for thermal conditions.

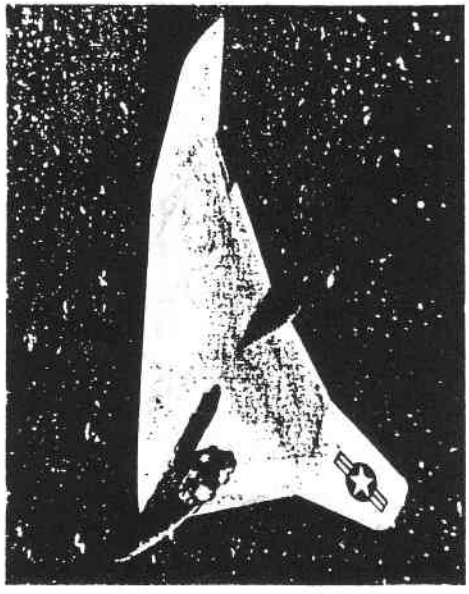
Bringing the design up to date, the latest edition features jetex installation, and all we can say about it is, "there just ain't enough room around no how!" Properly adjusted and launched as soon as the fuse is ignited, the jetex takes over at just about the time that the model is approaching the peak of the hand-launch climb and the upward trajectory is sometimes continued to what we estimate to be an altitude of better than 300 ft.

The construction of the model differs slightly from the standard type of glider construction because of its Delta configuration. However, the type of construction used is nonetheless quite simple to duplicate and exceptionally strong and very difficult to damage even under the most adverse conditions.

When constructing the model, exercise proper care to obtain a suitable airfoil section similar to that which is indicated on the plan. Use cement quite liberally, but not excessively. Apply three to four coats of dope and sand surfaces with fine sandpaper between coats and, for added luster and smoothness, apply a light coat of wax after the last coat and rub it gently into the dope finish.

The original model weighed less than two ounces ready to fly, with the grades of wood as specified on the plans. If you plan to use it just for testing the combination, however stock can be employed throughout. From the amount of wing area the design contains, it could weigh three or more ounces and still perform satisfactorily.

We haven't tried it yet but we are of the opinion that, with the addition of a small engine nacelle at the nose, an infant-powered free flight or duration powered controline version would also prove to be very successful. Whichever arrangement you try, you're bound for hours of flying fun with little expense and effort.



The rocket-powered sky-hook conversion. Slanted tips for stability; tabs for any adjustments

MODEL AIRPLANE NEWS • April, 1957

700-seat flying giant set to shrink jumbo

by Christy Campbell
Defence Correspondent

AIRBUS Industrie, makers of the successful Airbus airliners, is planning to beat its US rival Boeing by building a flying-wing aircraft capable of carrying 700 passengers.

It would carry half as many people again as the world's current biggest airliner, the Boeing 747-400.

The Toulouse-based European consortium last week revealed its concept for the airliner, to enter service in 2001. Conventional fuselage, wings, engines and tail are blended into a single structure, controlled in flight by fly-by-wire computers.

The giant would be aimed at the Far East where airline economists predict a boom in traffic.

World airlines are currently retrenching after the Gulf war, but builders and operators predict that the underlying trend of air travel growth will continue, with the Pacific overtaking the Atlantic as the key market.

The bigger the plane, the more efficient the use of runway space should be, which in theory means cheaper air travel.

Airbus is determined to compete with Boeing. The consortium, in which British Aerospace is a partner, is working on the prototype of the A340, a very long-range aircraft carrying up to 300 passengers, which is due to fly this year.

But for all its technical sophistication, the A340 is conventional-looking, with four jets underneath its swept wings in the familiar layout pioneered by the Boeing 707 in the early 1950s.

A flying-wing design for an airliner would be a radical departure. Flying-wing planes were pioneered in Edwardian Britain and have regularly appeared on drawing boards.

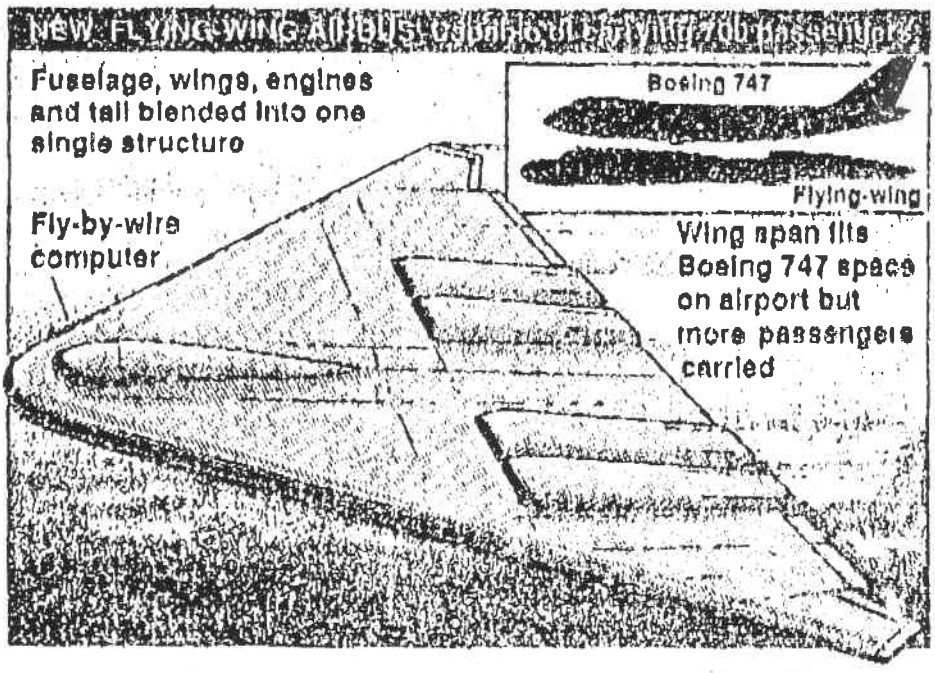
The Nazis built experimental flying-wing jet fighters. The Americans built a huge flying-wing bomber in the 1940s and revived the concept for the B-2 Stealth Bomber.

But a flying-wing design has an immediate and more down-to-earth aim. With the increase in air travel, airports will have to park more and more airliners on their crowded taxiways. A wedge-shaped flying-wing represents a compact solution.

However efficient in use of space, the concept will not solve the problem of 700 people rushing for passport control and the luggage carousel.

The British Airport Authority's new terminal at Stansted, Essex, was "planned from the beginning to take the largest conceivable airliners on its taxiways, bigger even than today's jumbos" said a BAA spokesman.

But he admitted that the prospect of mass passenger departures and arrivals would simply swamp many world airports.



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CONTRIBUTED BY: HOWARD ALLMON