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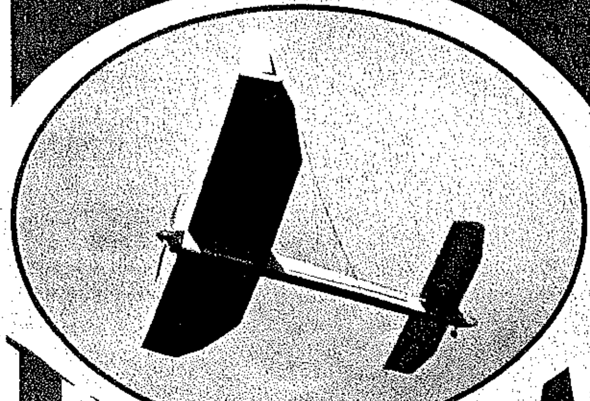


KANARDEZE

With a nod to Burt Rutan, the author continues his comparative-flying experiments with this look at "tail-firsters."

Hal deBolt

Is there any red-blooded aviation enthusiast who has not wondered at, then admired what Burt Rutan and his followers have been doing with canard aircraft over the past decade or so? Their success should be enough to entice a serious modeler to give the arrangement some attention. To say I was tempted more than once would be an understatement!

If you listen to all the canard hoopla, two major points are always made:

1) A canard is stallproof, which is far more important to full-scale than it is to models.
2) A canard produces *more lift* and *less drag* compared to normal configurations. With the foreplane lifting, you can add its lift to that of the wing. With a pusher propeller the airframe flies in cleaner air (no prop slipstream), thus less drag. The latter two factors are

tempting for any endurance model. So it was the mystic and hope for something superior that led us into this Electric-powered Enduro.

My initiation into "tail-firsters" came with my first successful rubber-powered duration model—a single pusher whose flight is still a vivid memory. I probably would have done well to continue that theme! Then there was fellow Flying Bison Doug Joyce, who demonstrated nearly 40 years ago how well a free flight canard could perform. Never forgot that! So it was not without some positive expectations that we launched into the Kanardeze.

In many ways, this design was most frustrating in the first flight stages; yet the end result is a most delightful and exhilarating model to fly. It took two designs to accomplish it: I learned what the score was with the first and did it right with the second!

A major obstacle was the lack of pertinent design data—no decent references. Burt Rutan was kind enough to furnish details of his VariEze, which was to interpret into the style of model I envisioned, but did provide some basics. Andy Lennon's report on canard design in *RCM* had some clues, especially with a formula to locate the mean center of lift.

With basic aerodynamics to lean on, the design became quite mechanical in nature; a simple layout that allowed equipment weights to locate the center of gravity (CG) correctly plus the mean center of lift. That is, until the first flights were made!

After the first launch we were very happy with the powered flight. The canard stepped right out into solid flight, handling very similar to a normal model. A few passes around the field, then a good climb angle was established that brought it to altitude for glide tests. When the motor cut, it dropped into a steady glide that looked pretty fast and sinking, so some up trim was applied, which bled off the speed and lowered the sink rate. However, a low-speed point was reached where, without warning, the nose dropped into a steep dive—very scary!

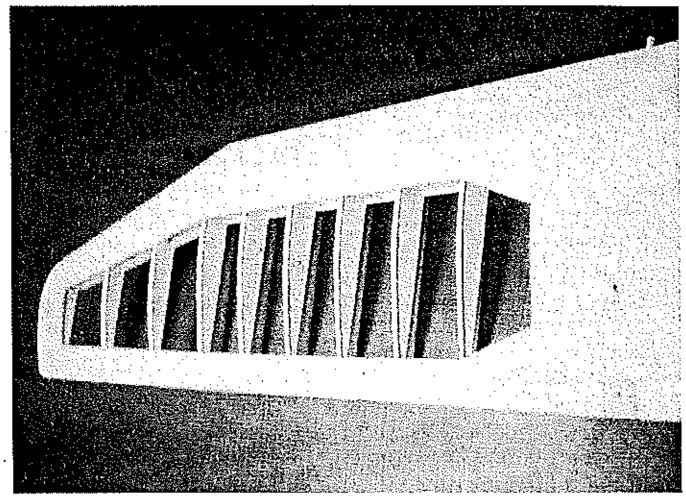
The second scare was when full up had no effect for several seconds, then "grabbed" to produce a stall! Everything was fine until the courage was gained to slow down again, which created a repeat. This was something that I had never seen before; it was difficult to comprehend. With reserve power it went back up to altitude and created the same action several times. It was quickly obvious that the problem was for sure and that there was no indication of a stall. It appeared that the foreplane simply quit lifting, which allowed the nose to drop. The life-saver was that as long as speed was maintained everything was fine, so a landing was uneventful.

You can imagine what the subject of our lunchtime bull session was! We quickly labeled the problem The Canard Syndrome. All sorts of causes and possible cures were discussed at length, with no logical answer. Having no positive data for canard balancing and foreplane angles of attack, it was decided to experiment in those areas.

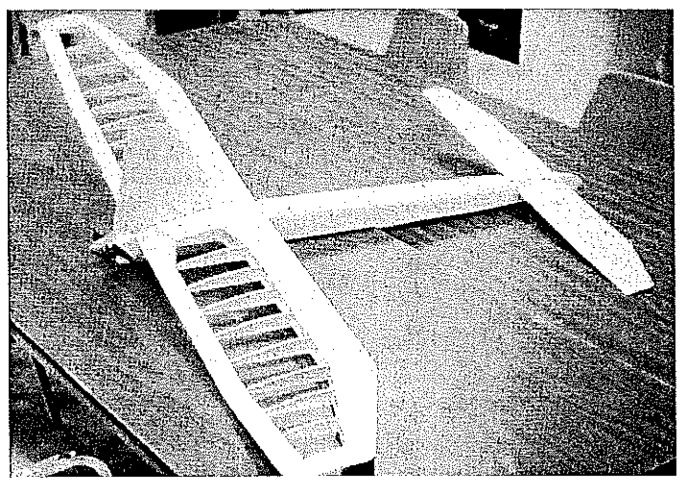
The CG was moved forward 1/2 inch; all that did was increase the glide speed and rate of sink. No change in the syndrome. Moving the CG as much as 3/4 inch rearward was no help either. With the CG back to its original location, more foreplane incidence was tried to no avail. It was obvious that the problem was beyond incidental aerodynamics.

Reviewing our research data on canards, we noted minor mentions of flight characteristics similar to our syndrome. However, the only cure mentioned was just to not fly too slowly!

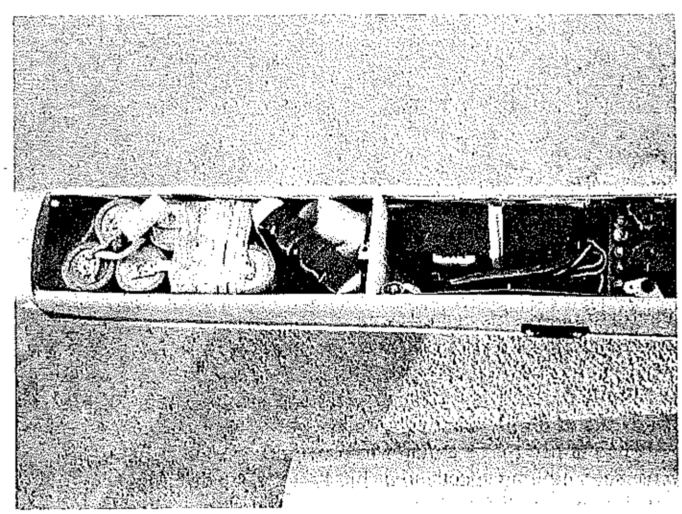
The bull session after this outing centered on the thought that the foreplane appeared to lose all lift—quit flying, so to speak. We know that a wing must have *some* forward speed to create lift. There will be a low speed where lift no longer exists. We also know (due to the Reynolds effect) that the wider the chord is, the lower will be the zero-lift speed.



Left wing detail shows capstripped ribs, 1/16 top sheeting. Stressed-skin structure is light yet strong.



Completed framework less winglets. Geared Astro 05 FAI on seven 900-mAh cells is more than adequate power.



Radio installation. Airtronics system on the original model weighs only five ounces, handles loads with no problem.

From those factors it can be assumed that if two surfaces are flying at the same speed, the one with the lesser chord will reach its zero lift speed sooner than will the wider-chord surface. Or you can assume (in the case of the canard) a low speed will be reached where the lift proportion between the wing and foreplane will disintegrate.

In the end, these factors made the cause of the Canard Syndrome clear. As originally designed, the wing/foreplane lift proportion did not hold over a wide enough speed range—a range that probably would only be seen with a powered endurance type model, FF or Electric Enduro.

The cure for the Canard Syndrome proved to be relatively simple once the proper analogy was made. We simply "patched" some more chord onto the foreplane, made no other changes, and repeated attempts did not create the Canard Syndrome.

We saw some areas that could stand improvement, so with the lessons learned, a second design was produced. Among other things, we increased the chord of the foreplane and switched to an airfoil with better lift characteristics at lower speeds. (For models, it appears that a foreplane chord should be at least 50% of the wing chord.) This version is the completely successful, fine-flying Kanardeze.

You will see some unusual engineering detail in the Kanardeze:

Full-flying rudder: With tip plates (as first used) or winglets (final version) it would seem logical to incorporate rudders. However, the need to keep weight out of the aft section for balance purposes led me to the central rudder, which works just fine.

On landing, the tip plates tended to catch in the grass and make the model ground-loop. The foreplane tip would also catch, often breaking its mount. The cure was adding some dihedral to the foreplane and installing the "bumper wheel" which serves no other purpose. (When the change was made to winglets, the problem disappeared.)

With elevators on the dihedraled foreplane, a simple method was needed to connect the two control horns to the single pushrod. The answer came from very early RC experience: a wide bent end on the pushrod serves both horns. A spring keeper holds them in place and allows them to be disconnected.

Power: While the Kanardeze was developed with Electric power, there is no reason why engine power could not be substituted. A sport .15 and its fuel tank would weigh about the same as the motor used; some weight would be required to achieve the proper CG (to compensate for the batteries used on the Electric version).

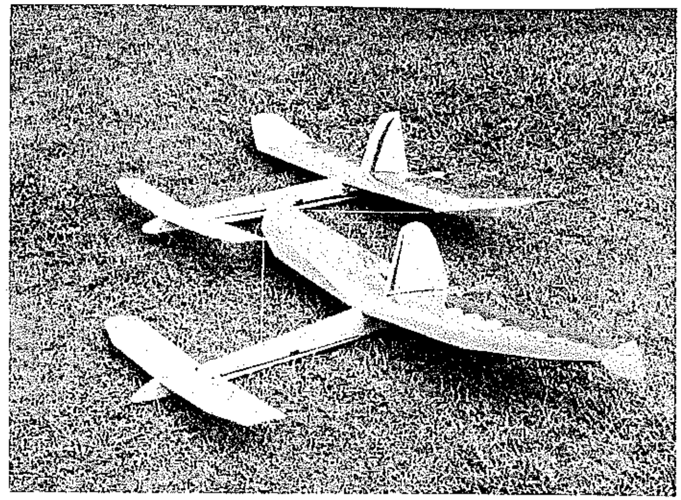
I cannot say enough about the Electric power used: a geared Astro 05 FAI, fed by seven 900mAh SCR cells. Propeller is a Master Airscrew 12 x 8 folder. This combination takes the 42-ounce Kanardeze nearly OOS in 30-40 seconds—it moves!

Radio: The mini Airtronics airborne system used is an asset to any Electric model. With a gross weight of only five ounces, it helps to keep the power loading reasonable. The tiny servos handle the air loads with no problem. A neat system!

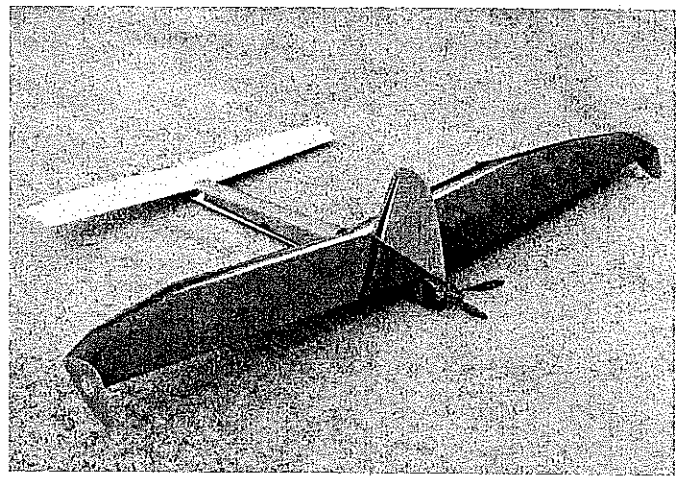
Performance: This canard handles no differently from a normal configuration. It's very stable and responsive; it simply goes where you point it. Compared to a similar "tail after" it is definitely quicker in all respects. Less drag is apparent. With less drag, rate of climb is above normal.

I had hoped to see a major improvement in rate of sink, but have seen nothing spectacular, but there was a definite improvement in thermal response.

For sport flying instead of endurance, the flight mode compares to an advanced trainer.



Two versions of Kanardeze. Tip plates on model in foreground were replaced by winglets as shown on the plan.



Red and white Black Baron film covering is light and gives needed contrast. Full-flying rudder also saves weight.

Kanardeze

Type: RC Electric Sport

Wingspan: 60 inches

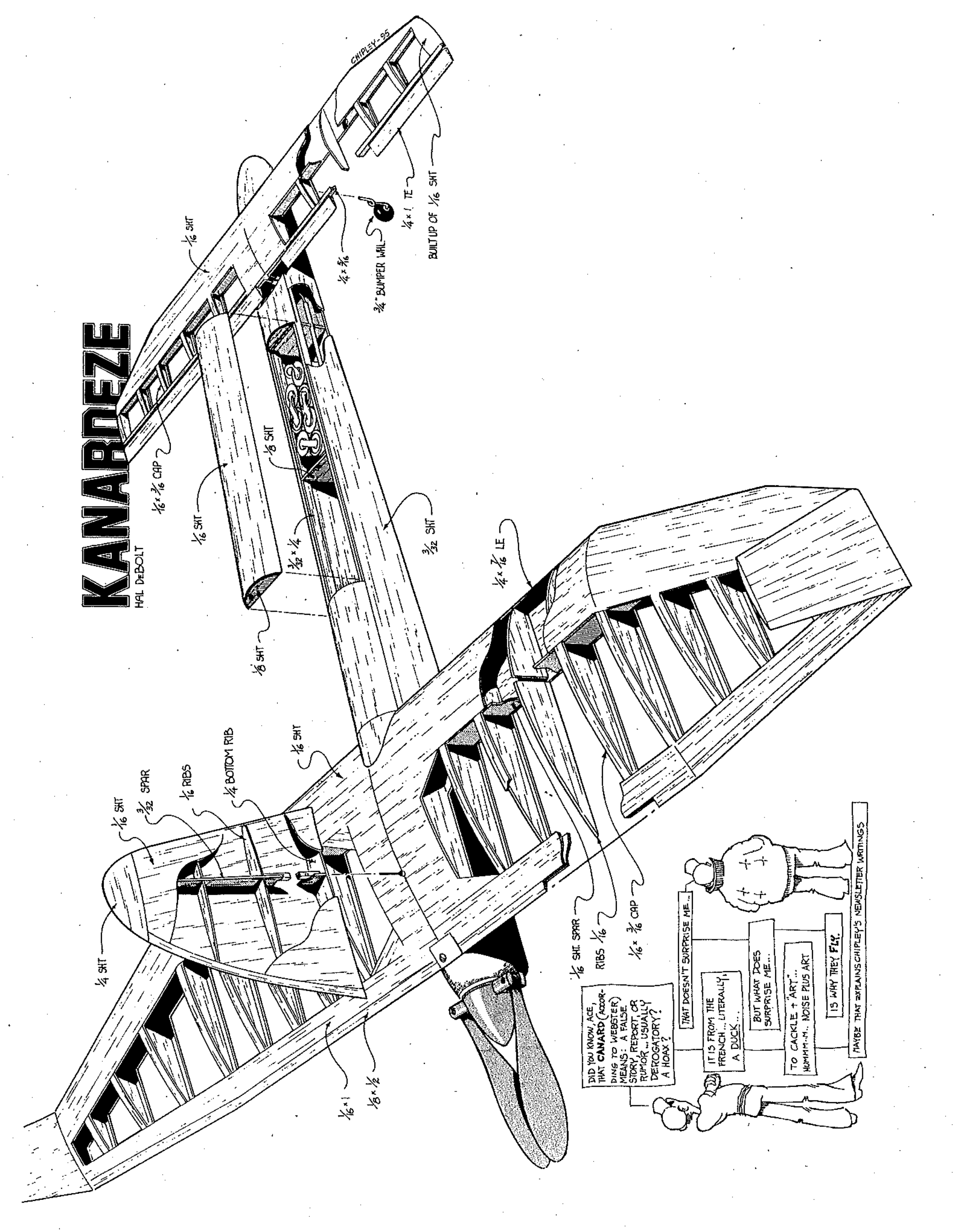
Motor size/type: Geared Astro 05

Number of channels: Three

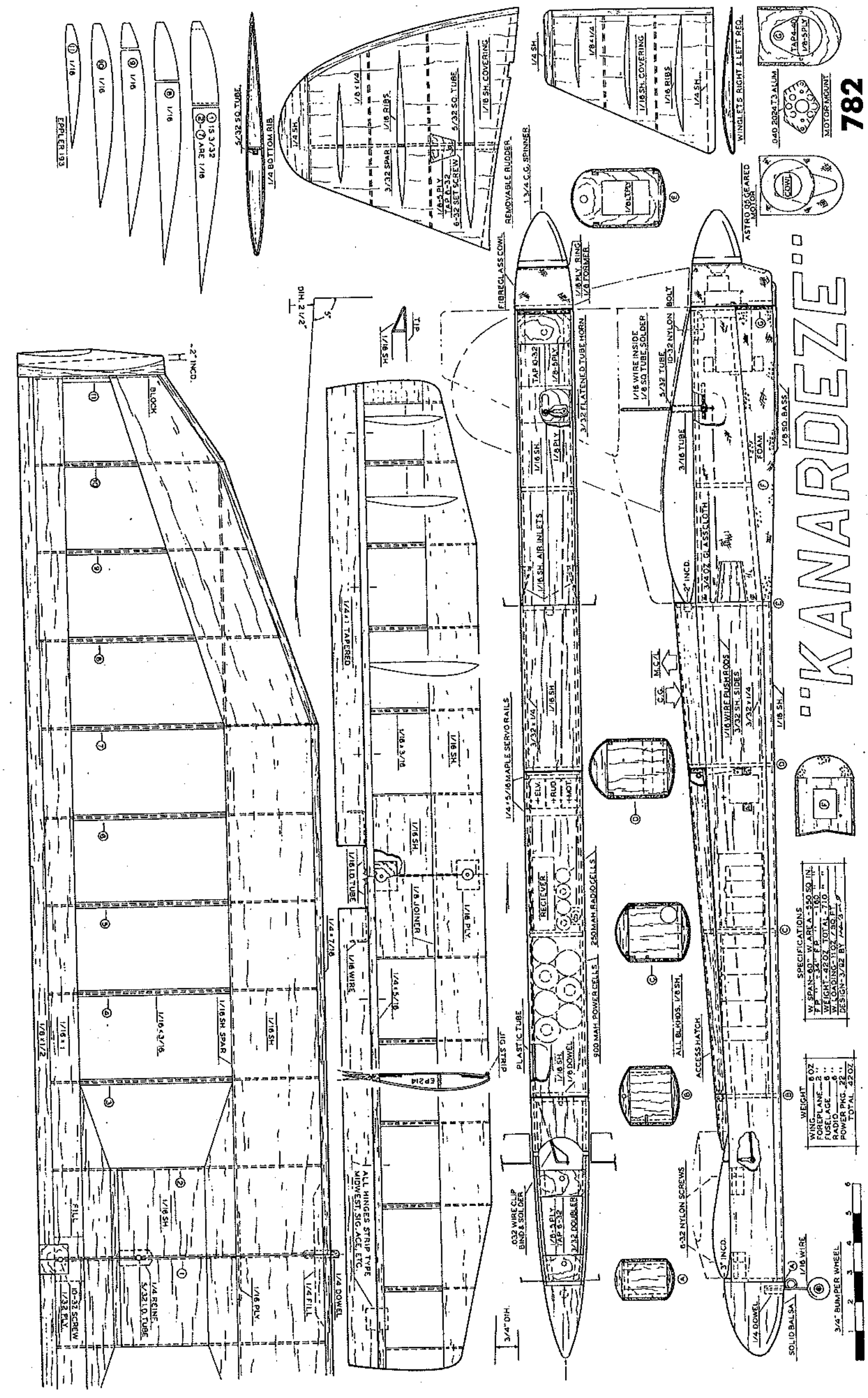
Flying Weight: 42 ounces

Construction: Built-up

Covering/finish: Black Baron film



KANARDEZE
HAL DeBOLT
CHIPLEY-95
1/16 SHT
1/4 x 1 TE
BUILT UP OF 1/16 SHT
1/4 x 5/16
3/4" BUMPER WHL
1/8 SHT
1/16 x 3/16 CAP
1/16 SHT
3/32 x 1/4
3/32 SHT
1/4 x 7/16 LE
1/8 SHT
1/16 SHT
1/4 BOTTOM RIB
1/16 RIBS
3/32 SPAR
1/16 SHT
1/4 SHT
1/16 x 1
1/8 x 1/2
1/16 SHT. SPAR
RIBS 1/16
1/16 x 3/16 CAP
DID YOU KNOW, ACE, THAT CANARD (ACCORDING TO WEBSTER) MEANS: A FALSE STORY, REPORT, OR RUMOR... USUALLY DEROGATORY? A HOAX?
THAT DOESN'T SURPRISE ME...
IT IS FROM THE FRENCH... LITERALLY, A DUCK.
BUT WHAT DOES SURPRISE ME...
TO CACKLE + "ART"... HUMMM-M... NOISE PLUS ART
IS WHY THEY FLY.
MAYBE THAT EXPLAINS CHIPLEY'S NEWSLETTER WRITINGS


"KANARDEZE"
782
ASTRO 05 GEARED MOTOR
MOTOR MOUNT
WINGLETS RIGHT & LEFT REQ.
1/16 SH. COVERING
1/16 RIBS
REMOVABLE RUDDER
1 3/4 C.G. SPINNER
FIBREGLASS COWL
1/16 PLY RING
1/8 FORMER
EPPLER 193
1/4 BOTTOM RIB
5/32 SQ. TUBE
3/32 SPAR
6-32 SET SCREW
BLOCK
TIP
1/16 SH.
3/32 FLATENED TUBE HORN
1/16 WIRE INSIDE 1/8 SQ. TUBE, SOLDER
5/32 TUBE
10-32 NYLON BOLT
1/8 SQ. BASS
FOAM
3/16 TUBE
3/4 OZ. GLASSCLOTH
1/16 SH. AIR INLETS
1/4 x 1 TAPERED
M.A.C.
C.G.
1/16 WIRE PUSHRODS
3/32 SH. SIDES
3/32 x 1/4
1/4 x 5/16 MAPLE SERVO RAILS
RECEIVER
250 MAH. RADIO CELLS
900 MAH. POWER CELLS
ALL BLKHDS. 1/8 SH.
ACCESS HATCH
PLASTIC TUBE
1/8 DOWEL
EP214
JIG STRIP
1/16 SH. SPAR
1/16 I.D. TUBE
1/8 JOINER
1/16 PLY
1/16 WIRE
ALL HINGES STRIP TYPE MIDWEST, SIG, ACE, ETC.
1/16 PLY.
1/4 REINF.
5/32 I.D. TUBE
10-32 SCREW
1/32 PLY.
1/4 FILL
1/4 DOWEL
.032 WIRE CLIP BIND & SOLDER
3/32 DOUBLER
6-32 NYLON SCREWS
3/4" O.D.
3/4" BUMPER WHEEL
SOLID BALSA
SPECIFICATIONS
WEIGHT
WING
FOREPLANE
FUSELAGE
RADIO
POWER PKG.
TOTAL

CONSTRUCTION

Wing: The Schuemann planform is advantageous for a canard, as it moves the center of lift rearward. The winglets definitely improved performance over the tip plates, though they are more tricky to install. A brass tube bearing for the rudder linkage is required so it can be removable.

The stressed-skin structure has more than ample strength and does not depend on internal structure, so there is a minimum number of parts. Result: a very light and strong assembly.

The two panels are partially assembled, then joined. The center LE sheeting is a straight piece of 1/16 x 3. Join the required tapered tip portion to it with cyanoacrylate (CyA) glue.Note that a "jig strip" is required at the LE to curve the sheeting so it will conform to the lower airfoil shape. Use the forward ribs as a guide to locate the 1/16 sheet spar on the LE sheeting. Spot-glue it with CyA. Add all forward ribs except the center one. Using the aft ribs as a guide, locate the TE sheeting and install the aft ribs except for the center one. Leave the excess spar material in the tip area in place until the top sheeting is installed. Add the LE strip.

Next the opposite panel is assembled to the same point. Use the first panel as a guide for the chord width of the second panel.

Now the two panels can be joined at the center. A piece of 2 x 4 or similar is used chordwise to establish the dihedral and assure that the raised panel is true to the building board. The dowel reinforcement at the LE and the 1/16 plywood spar joiner are now installed. Follow this with the 3/32 center rib. Add the 1/4 sheet used to support the rudder bearing to the center rib and the "fill" at the TE that supports the attachment bolt.

With one panel still on the building board, all top sheeting and capstrips are installed. We use aliphatic-type glue for this to allow enough time to locate and pin the sheeting down properly.

Repeat this procedure with the opposite panel. The TE strips are then added, and the structure is carved and block-sanded to complete the basic assembly.

Winglets: These are simple sheet-balsa structures; note that a right and a left are required, and one side of the airfoil is flat.The outline is fabricated from 1/16 sheet. With this on the board, the ribs are installed, and the other side sheeting is added. With these simple structures, no LE is required; the joined sheeting is sufficient. Block-sand the winglets to contour.

Install the winglets on the tips with balsa spacer blocks. Before the blocks are shaped to the tip airfoil, establish the 2° winglet incidence angle on them. Then carve the winglet airfoil into them, being sure to maintain the 2° angle. Follow this by altering the winglet airfoil saddle so that when the winglet is on the wing it will be vertical when the wing dihedral is equal on both sides. Cement the spacer blocks to the tips and shape to suit the tip airfoil.

Install the 5/32 I.D. brass rudder bearing tube. Locate the position at wing center. Drilling is best done with a drill press to assure alignment. The hole needs to be a tight fit for the tube, so use a pilot drill first and follow with the full-size drill. The tube length should be flush with the lower surface and protrude slightly from the top to act as a stop when the rudder is in place. Lock in place with CyA.

Foreplane: Except for size, the foreplane assembly procedure is the same as for the wing until it is ready for elevators. There are mounting plates at the center, which are installed before the top sheeting is applied.

The elevators are fitted to the foreplane as strip ailerons would be to a wing. I used homemade brass tube control horns rather than something commercial; these seemed superior because of the close spacing required and their compact size. Otherwise the surfaces are covered before permanently installing the elevators. Because the elevators can affect directional control, *be sure to seal them with film.*

Rudder: Another simple sheet-balsa structure, but with a symmetrical airfoil that complicates assembly a bit. You will need some simple "strip jigs" to raise the sheeting from the bench so that it conforms to the airfoil shape as the ribs are installed. The spar is installed first, followed by the ribs, using the strip jigs. The 3/32 I.D. square brass connection tube is aligned to the spar and attached with thick CyA. Make sure it is centered properly.

After the top sheeting has been completed, the 1/8 plywood screw plate is inset flush with the sheeting. The plywood is drilled and tapped for a 6-32 set screw, used to hold the rudder in place. Drill this hole carefully so that the drill just pierces one side of the tube inside the rudder. To complete, the block tip and TE edge strip are added. Block-sand to contour.

Fuselage: This is a typical "box" to which some fairing has been added. Assembly is started by fabricating the sides and bulkheads. The sides should be precise—the lower edge is also the line of flight and reference point. Fortunately when the flat of the wing and foreplane airfoils are parallel to this lower edge, they are at their correct incidence angles, so no surface-mount angles are required.

I used the "centerline method" for fuselage assembly, which assures alignment. This calls for a centerline on the building board and each bulkhead. Bulkhead spacing is marked on the board centerline. In this case, because the motor mount bulkhead extends below the fuselage lower edge, the spacing is commenced at the board edge. Then the motor mount bulkhead can be temporarily nailed to the edge of the board, assuring true alignment.

Erect the bulkheads in their place on the centerlines and bow the sides around them. Spot-glue them to the board with CyA to hold the bulkheads during assembly. When removal from the board is required, I break the structure loose by forcing a thin razor blade between the board and the bulkheads.

The rest of the assembly is straightforward; just install the pieces called for. The upper fairing sheeting does have a sharp curve, but it bends to shape easily when wetted with Windex.

The rudder operating linkage is one-of-a-kind so that both rudder and wing are removable. The basis of the linkage is a piece of 1/16 music wire with a 90° bend at one end, to which the brass tube pushrod connector is soldered. As for the elevators, the 3/32 brass tube is flattened at one end and a 1/16 hole is drilled in the flat for the clevis connection. A suitable length of 1/8 square brass tube is slipped onto the long end of the wire and soldered. A short length of 5/32 round tube is needed to suit the wing tube bearing. This is slipped over the square tube and soldered. Sound complex? It really isn't, when you contemplate the need and have the pieces at hand.

Note that there is no bearing in the fuselage for the linkage, but there is a slotted plywood mount. A washer soldered to the linkage on each side of the mount slot holds the linkage vertically. The slot is required so that you can get the LE dowel out of its hole for wing removal.

There is some fairing needed at the aft lower fuselage, and a cowl. Blue Styrofoam is used for this, as it carves and sands neatly. For the fuselage fairing a foam block is glued in place. Note that the cowl has a balsa former at the rear edge and a plywood spinner ring at the front.

With the motor mounted the former is close-fitted around the gear box and the spinner ring is a press-fit onto the motor's prop drive. Stuff the space between the two and around the motor with pieces of foam. Carve and sand all the foam to fair into the spinner.

The cowl portion is covered with 1 1/2-ounce glass cloth and resin; from the wing LE position back, the entire aft fuselage and cowl are covered with 3/4-ounce glass cloth and resin. Once the resin has cured, sand with 80-grit paper and give a second coat of resin. To finish, the cowl is removed and all excess foam is removed.

Equipment Installation: When installing the elevator servo, remember that with a canard, *down* elevator produces *upward* flight—not downward as is usual. The radio and power batteries are shifted to locate the CG correctly.

Assembly Alignment: Slip the wing into its mount. Block the fuselage up on a smooth tabletop so that it is square. Measure from each wing tip to the table and adjust the wing saddle as required. Insert a straight pin atop the center line of the forward equipment compartment bulkhead. Measure from this pin to each wing panel TE at the tip. Adjust until the measurements are equal. Use the wing mounting screw hole as a guide to drill and tap the required hole in the fuselage mount. Do use a tap-size drill!

The foreplane is installed by aligning the rear mounting screw hole with the centerline on the fuselage mount. Drill and tap the mount, and attach the foreplane with this screw. Similar to the wing procedure, insert a straight pin at the top center of the motor mount bulkhead. Adjust the measurements from the pin to each foreplane TE tip, and drill and tap the forward mounting plate. As with the wing, measure from the foreplane tips to the table, and adjust the saddle until the measurements are equal.

A secondary alignment check is made with both surfaces mounted securely. Stand back 10 to 20 feet and note how the foreplane relates to the wing spanwise. Should there be any apparent misalignment of the two, adjust the foreplane saddle to compensate.

Give a final double-check to the incidence angles. With both the wing and foreplane using the lower edge of the fuselage sides as reference, measure to the center of each leading edge and to the trailing edges. The difference between each LE and TE measurement should be the same as the drawing shows.

Balance: Check the CG location now; any major change that might be required would be easier to make before covering.

With all equipment in place, put a piece of 1/4 square on a riser on your table. Balance the fuselage on the 1/4 square and mark the location. The point shown on the plan is optimum, but surprisingly the canard will fly safely over or under the usual CG range. So if your model balances within 1/2 inch of the point shown, proceed to the covering stage. When all is completed a second balance check should be made.

Covering: You can use any covering you desire, aside from heavy fabric and/or paint. However, the proper choice will keep weight to a minimum, *and that is important.*

Black Baron Film is quick to apply and has presented no problem over a lengthy period of time. It comes with excellent instructions and is available in a wide variety of colors. Kanardeze will easily get sky high, where visibility can be a factor. I have found that red and white contrast best.

Preflight: There is not much to preflighting an Electric model beyond being sure that all systems are "go" and the batteries have been charged. Make sure that the elevator throw is within the range shown and the balance is correct. *Down* elevator is *up* stick on your transmitter, isn't it? Right and left correct? Motor operates correctly? You should have no excuse not to fly!

Flying: A word of caution if you are using a folding prop: be sure that the mechanism has a stop to prevent the blades from folding back past their hinge lines. With a tractor prop, the fuselage acts as a stop; not so with a pusher! With one blade folded and the other not, the vibration will quickly shake the bejibbers out of things!

For the first flights it is probably best to have a helper hand-launch while you stand by with the transmitter. With power *off,* simply launch flatly and briskly—*not* nose-up! Once launched, fly it to a landing, which will give you a feel for the procedure. If all went well—the glide looked correct—switch the motor *on* shortly after the next release. The Kanardeze will accelerate quickly, and you are off and flying.

Once you are comfortable with the method, you can launch the model yourself by having a finger ready to advance the motor stick on the transmitter.

At this point the Kanardeze will fly safely. However, fine tuning will bring out its best, and is done in two stages: first the power mode, then the glide mode. This brings any model to ultimate performance, and once done you will savor the difference every time!

The Kanardeze is neutrally stable, and it is quick. For a trim check, make a couple of laps around the field; get used to the "different" appearance, and note any drift and the climb angle. Trim if needed. Then bump it up to a 45° climb angle with the elevator; once established, the angle should hold with the elevator neutralized. Power-on trimming is done with foreplane incidence. The objective is to have little or no climb angle when launched flat and with the elevator in neutral. If there is a diving tendency, this is corrected by adding positive incidence to the foreplane (shim up the leading edge). If there is a distinct climb angle, reduce foreplane incidence by shimming under the trailing edge. You want to produce a condition where the Kanardeze flies flat until you establish climb angle, which should be as steep as possible without a drastic reduction in flying speed.

At a good altitude, flatten the climb angle with the elevator and cut the motor so the glide mode can be checked. With neutral elevator the glide should be flat and quick. All glide attitude fine-tuning is done with the balance.

Should the nose appear to be above the horizon or the model is "stally," the balance point is moved forward by shifting the batteries. If the glide angle is too steep, move the batteries rearward. You are moving a heavy weight so it does not require much movement to effect a change.

A word of caution about the landing: Remember that the glide angle is flat and there is some speed, so the approach should be long, with no extreme attempt to flare. You do not want to stall the model! Even though the landing is fast, the Kanardeze will slip easily through the grass to a stop.

The Kanardeze responds to thermals exceptionally well, rising vertically on entry. You will find it exhilarating to fly and an accomplishment which not everyone has. Good luck, and do have fun with your tail-firster!

It should be noted that performance evaluation of this canard configuration was done with comparative flying of it versus a similar high-performance model of "normal" configuration. Results were very encouraging. ✈