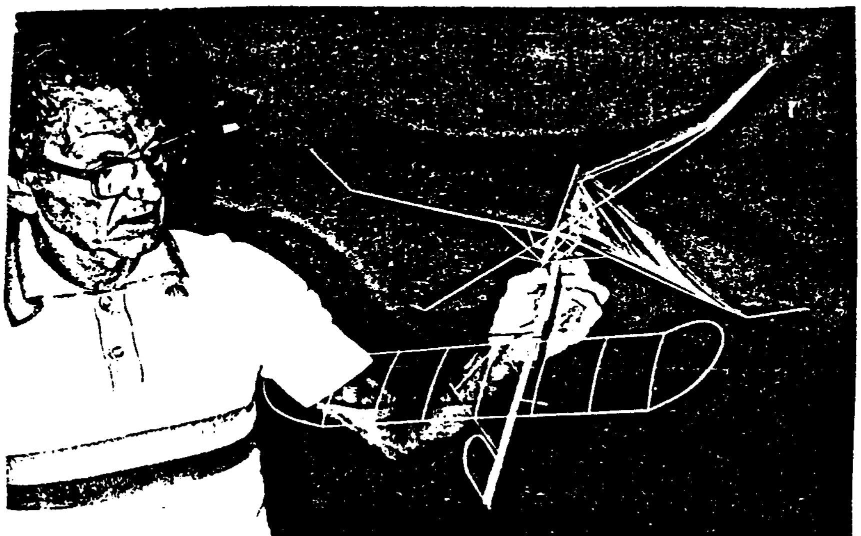
Ornithopter Modeler Society Newsletter

AUTUMN 1987

flapper facts

Volume 5 Number 4 — Roy White, Editor



First twelve minite flight July 5 1987

F. Kieser Cat. II
10 Min. 00 Sec.
Lincoln Nats.
F. Kieser Cat. III
11 Min. 32 Sec.
West Baden In.
Scott Robbins Cat. IV
2 Min. 07 Sec.
Santa Ana Ca.
R. White Cat. IV
12 Min. 20 Sec,
Akron Ohio

Frank Kieser and Myself had a chance to fly at West Baden IN. 29&30 of august had a good time flying, with Frank comeing out on top. My best flight was 10 Min. 10 Sec. Frank did a fantastic 11 Min. 32 Sec.

He started out with a 9 Min. 51 Sec. flight, I came back with a 9 Min. 55 Sec. later in the day Frank put up a flight of 10 Min. 30 Sec., so we call it quit Sat. 29.

Sun 30, My best flight was 10 Min. 10 Sec. and Frank did 11 Min. 32 Sec.

Frank had one flight that hit the mushroom and lost about 30 feet altitude, I think it would have done close to 12 Min. His model has a average flap rate of 1.7 to 1.8 FPS. model weight is 1.2 grams. I had built one under a gram, but on my first flight the linkage failed. so I had to fly my 1.1 gram model. (Watch Frank model fly is sheer delight)

We VCR some flight for the movie were been making for over a year, hopefully we will have enough footage for a ½ hour program soon.

Frank did a fantastic flying job at the NFFS unofficial Ornithopter contest at the Lincoln Nats. Cat. II. His 10 Min. 00 Sec. flight was fantastic for a new record. My best was 7 Min. 51 Sec.

The outdoor Ornithopter contest, I won, becouse my model was blowen further then Franks.

Dan Garfinkel had the best design Ornithopter. The workmenship was great and the battery operated motor made the wings flap.

Dont forget to get the 87 Symposium. Frank Kieser has a great article on Ornithopter wing design. Also hats off to Scott Robbins on his new Cat. IV record. 2 Min. 07 Sec. flying Warren Williams model.

NFFS publication
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4858 Moorpark Ave. $13.00 per copy
San Jose, CA 95129

Roy

Dan Garfinkel Lincoln Nats. 1987

BUTTERFLY II

Butterfly II is an evolution of Butterfly I as shown in the 1986 winter issue of Flapper Facts. It differs in the following;

1. Larger wing area with kevlar trailing edges.
2. Forty degree flapping angle as opposed to thirty.
3. Flat section on lower wing to bring upper and lower wings closer together at minimum point.

Best time to date was 7:02 at the USIC 1987 contest. A 15 in. X 1.23 gm Pirelli motor with 1540 turns was used. The average flapping rate was 173 flaps/minute. Two points about this design:

1. The LE of the canard must be stiff and the TE must be fairly flexible or the model will be unstable.
2. To increase left turn: Hold model by the bearing and crankshaft with crankshaft in the lowest possible position. Looking down from the top , bend the end of the crankshaft slightly in a CCW direction.

The most negative aspect of this design is that the aerodynamic loads vary greatly during each cycle of the crankshaft. For this reason the above time is probably close to maximum performance. I am working on a new mechanism that should remedy this fault.

Present state of the art has evolved the biplane canard configuration as optimal. Frank Kieser's Fancy Girl III is without a doubt the best available design. Two factors critically affecting future improvements are:

1. The aerodynamic loading of the crankshaft during each cycle. This determines the efficiency with which motor power is transferred into useful aerodynamic work. (see papers by Frank Kieser)

2. The angles of attack of the flapping surfaces are EXTREMELY critical for the efficient production of lift and thrust. To date, all designs control pitch distributions via spar twisting and aerodynamic loads. This is neither very reliable or controlable.

An engineering study of ornithopters concerns kinematics, aerodynamics, and energetics. After some library research I've found the problems of ornithopter flight are fairly well understood. The following article gives a good overview:

Weis-Fogh, T. & Jensen, M. "Biology and Physics of Locust Flight. I. Basic Principles in Insect Flight. A Critical Review" 1956, Royal Society of London. Philosophical Transactions. 415-457.

July 13, 1987

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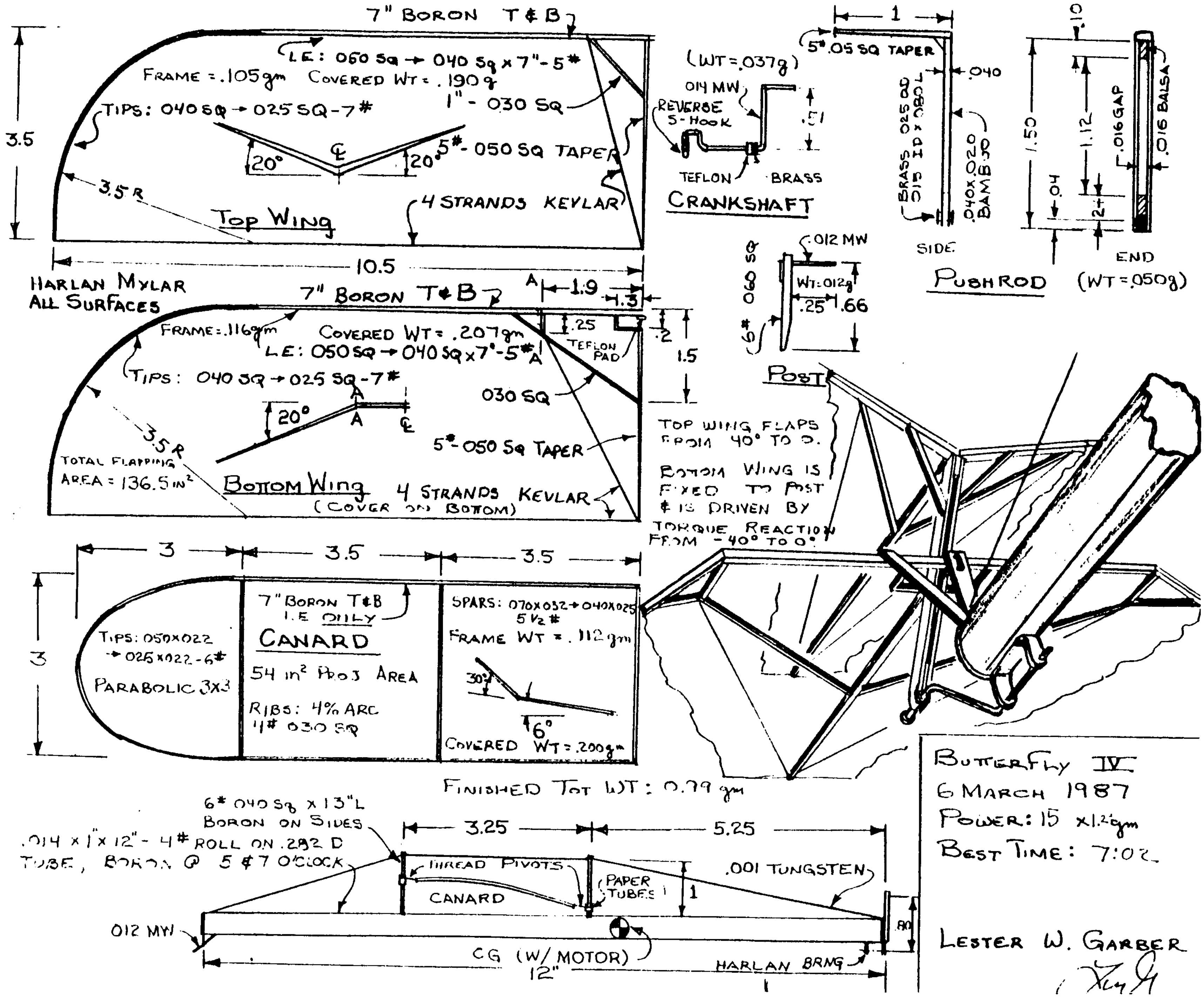


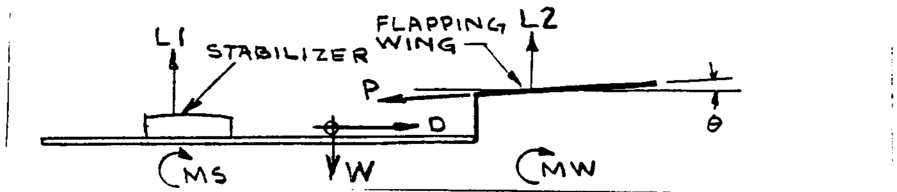
7" BORON T&B
LE: 060 SQ → 040 SQ x 7"-5#
FRAME = .105gm COVERED WT = .190g
1" - 030 SQ
TIPS: 040 SQ → 025 SQ-7#
20°
℄
20°
5#- 050 SQ TAPER
3.5
3.5R
TOP WING
4 STRANDS KEVLAR
10.5
HARLAN MYLAR ALL SURFACES
7" BORON T&B
A
1.9
.3
FRAME: .116gm
COVERED WT = .207gm
LE: 050 SQ → 040 SQ x 7"-5#
A
.25
TEFLON PAD
.2
1.5
TIPS: 040 SQ → 025 SQ-7#
030 SQ
20°
A
℄
3.5R
5#-050 SQ TAPER
TOTAL FLAPPING AREA = 136.5 in²
BOTTOM WING
(COVER ON BOTTOM)
4 STRANDS KEVLAR
3
3.5
3.5
3
TIPS: 050x022 → 025x022-6#
PARABOLIC 3x3
7" BORON T&B LE ONLY
CANARD
54 in² PROJ AREA
RIBS: 4% ARC 1# 030 SQ
SPARS: 070x032 → 040x025 5½#
FRAME WT = .112gm
30°
6°
COVERED WT = .200gm
FINISHED TOT WT: 0.79 gm
6# 040 SQ x 13"L BORON ON SIDES
.014 x 1" x 12" - 4# ROLL ON .282 D TUBE, BORON @ 5 & 7 O'CLOCK
3.25
5.25
THREAD PIVOTS
PAPER TUBES
1
.001 TUNGSTEN
CANARD
012 MW
.80
CG (W/ MOTOR)
12"
HARLAN BRNG
(WT = .037g)
014 MW
REVERSE S-HOOK
.51
TEFLON
BRASS
CRANKSHAFT
1
5# .05 SQ TAPER
.040
BRASS 025 OD 015 ID x 080 L
.040 x .020 BAMBOO
SIDE
.10
1.50
1.12
.04
.2
.016 GAP
.016 BALSA
END
PUSHROD (WT = .050g)
.012 MW
WT: .012g
.25
.66
6# 060 SQ
POST
TOP WING FLAPS FROM 40° TO 0.
BOTTOM WING IS FIXED TO POST & IS DRIVEN BY TORQUE REACTION FROM -40° TO 0°
BUTTERFLY IV
6 MARCH 1987
POWER: 15 x 1.2gm
BEST TIME: 7:02
LESTER W. GARBER

QUESTION & ANSWER by Frank Kieser

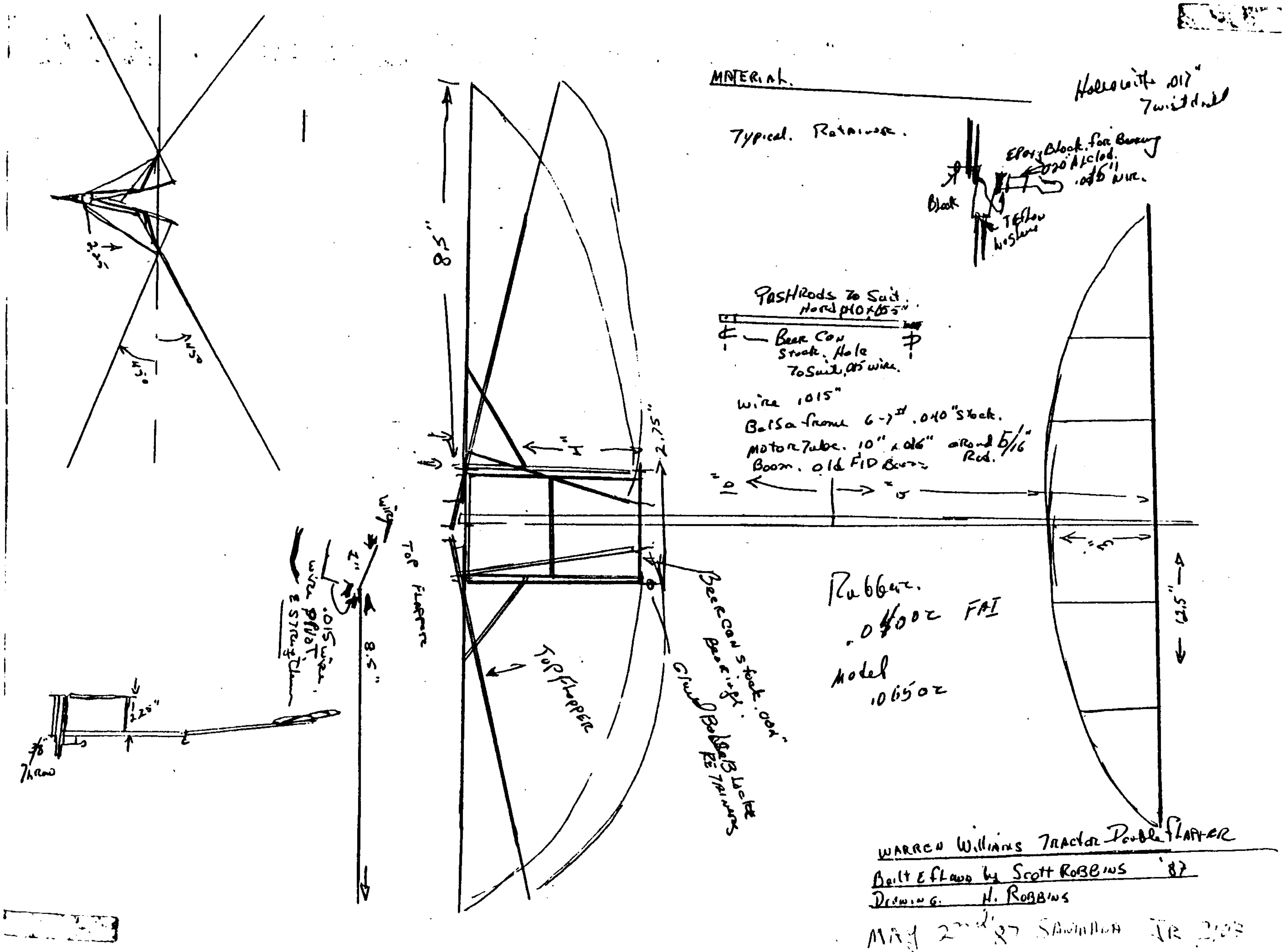
Recently, I had a letter from Jim Woolnough who has built a canard flapper and has had trouble getting good pitch trim. The following is a description of how I go about trimming for pitch.

PITCH TRIM OF A CANARD ORNITHOPTER by Frank Kieser

By definition, a canard ornithopter must be a pusher since the flapping wing is at the aft end. The diagram below shows the forces involved in pitch trim. Pitch equalibrium results when the equations X=0, Y=0 and M=0 are satisfied.



Some comments on the forces shown are appropriate.
1. Because of the poor aerfoil shape of the flapping wings and the airflow interference of the upper and lower wings, if it is a biplane, the lift coefficient of the flapper wings is low, possibly in the order of 1/3 that of a normal wing.
2. The center of gravity of the weight (W) is located between the two lifting surfaces with the distances X1 and X2 inversely proportional to the lift forces.
3. The propulsive force (P) is assumed to act along the flapper chord at the center and may be resolved into vertcal and horizontal components PY=(P)sinO and PX=(P)cosO.
4. The drag force (D) is the resultant drag of the entire craft and is parallel and opposite to the line of flight.
5. The AMA rules allow no part of the stabilizer to be closer to the flappers than 1/4 the span of the flappers. Also, the stabilizer area can be no more than 1/2 the flapper area. For indoor models, it is usually optimum to design to the limit of these rules. To minimize total weight no ballast should be used. It is usually beneficial to absolutely minimize the flapper and linkage weights so that the center of gravity is closer to the stabilizer since it is the more efficient lifting surface.
6. The wing and stabilizer moments are not predominant forces but are shown for completeness.
An accurate solution of the three equations of equilibrium is difficult because of the inexactness of the values of the individual parameters. The following experimental procedure is recommended to trim the craft.
1. Initially set the flapper and stabilizer incidence to zero. Check the center of gravity (with the rubber motor) to see that it is roughly midway between the stabilizer and flapper. Glide the craft. If it dives, add incidence to the stabilizer and if necessary move the stabilizer forward to increase the lift at the nose. If the craft stalls in the glide, reduce the stabilizer incidence. Don't be too concerned about gliding trim since in indoor flight, the motor should be sized so that there are turns left on landing.
2. Fly the craft, starting with a few turns and increasing gradually. If the craft stalls under high power with diminishing stalls as the power decreases, adjust the flappers for positive incidence. This causes an upward component of the flapper thrust, PV, at the aft end of the craft. It also increases the lift of the flapper surfaces. Both effects produce a moment to counteract the stall. If the climb is insufficient, put a negative incidence in the flappers to produce the opposite effect. This is much the same as adjusting the thrust line of a propellor craft. The flappers may be also be tilted left or right to control the turn.
To summarize, adjust the stabilizer incidence for low torque or gliding flight and the flapper incidence for high torque flight. The canard is a very forgiving configuration. It will never stall, but just dip the nose if the climb gets too steep. By flapper incidence adjustment, it is possible to suppress the climb at maximum power or even make the craft loop if there is sufficient power.



MATERIAL.
Typical. Retainer.
Hollow with .017" Twisted
Epoxy Block for Bearing .020 Alclad. .016" wire.
Block
Teflon washers
PushRods to Suit. Hard PLOX.055"
Beer Can Stock. Hole To Suit .05 wire.
wire .015"
Balsa frame 6-7# .040" stock.
Motor Tube. 10" x .016" around 5/16" Rod.
Boom. old FID Boom
10"
5"
3"
12.5"
Rubber. .0400z FAI
model .0650z
8.5"
1"
2.75"
Beer Can stock .004" Bearings.
Glued Bobbin Block Retainers
Top Flapper
TOP FLAPPER
wire
2"
.015 wire.
wire pivot.
8.5"
ESTring Clamp
2.25"
2.25"
Throw
45°
45°
WARREN Williams Tractor Double Flapper
Built & Flown by Scott Robbins '87
Drawing. H. Robbins
MAY 2nd '87 SAVANNAH TR 2103