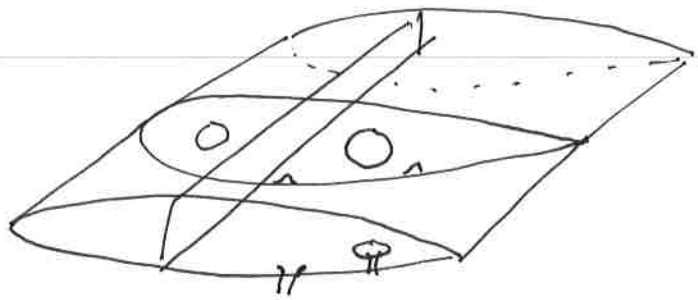
AEM 617
Lesson 6

C-182   2 issues with water in fuel

- Bladder tanks with wrinkles

- Rib construction with stamped holes rather than reliefs.
  issue with 172s and 182s in a range of years



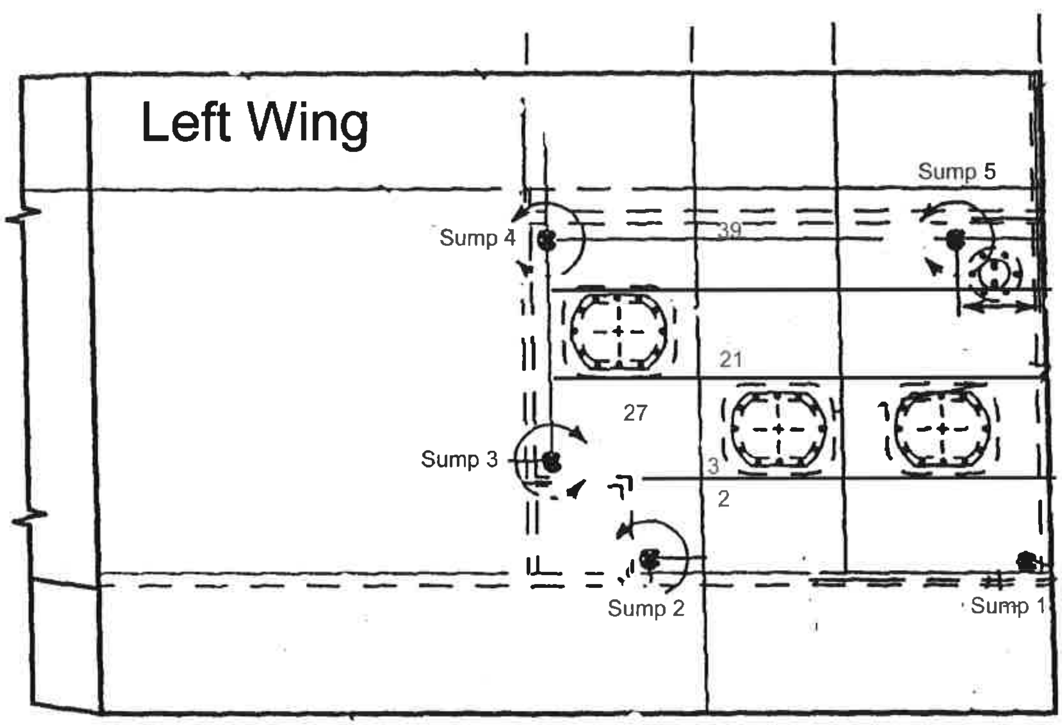


Figure 1

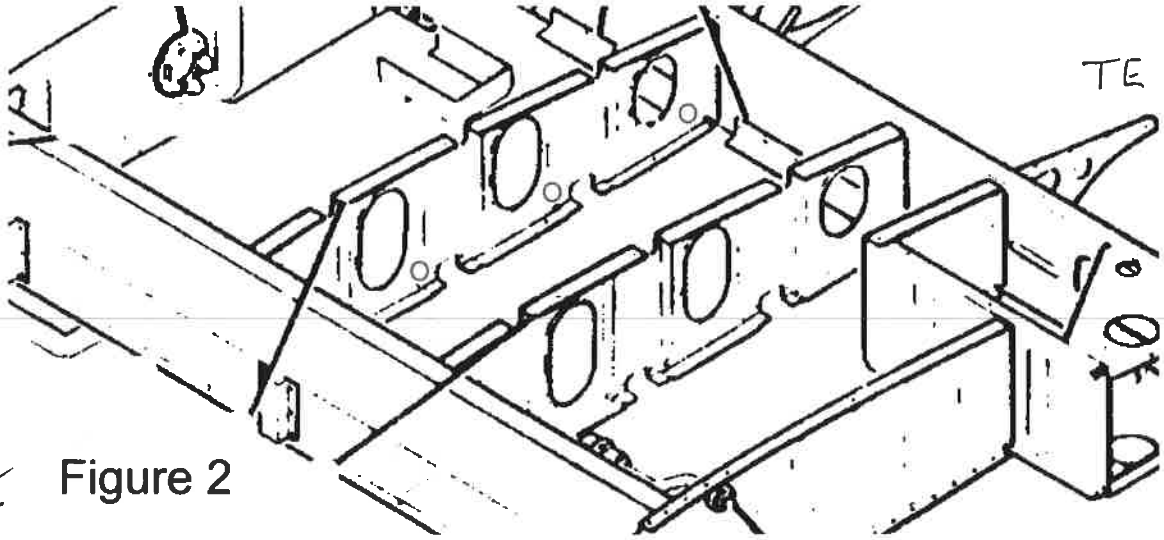


Figure 2

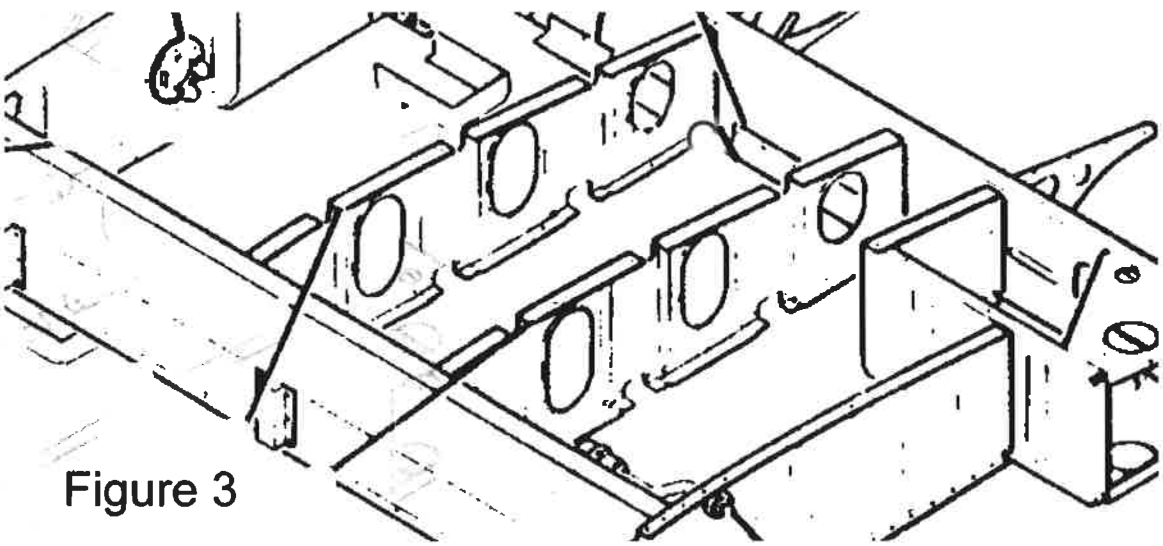
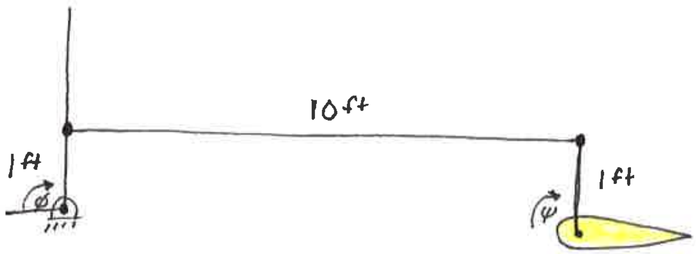


Figure 3

Example



$L = 10\,ft$
$c = 10\,ft$
$b = 1\,ft$
$d = 1\,ft$

$$R_1 = \frac{L}{d} = 10$$

$$R_2 = \frac{L}{b} = 10$$

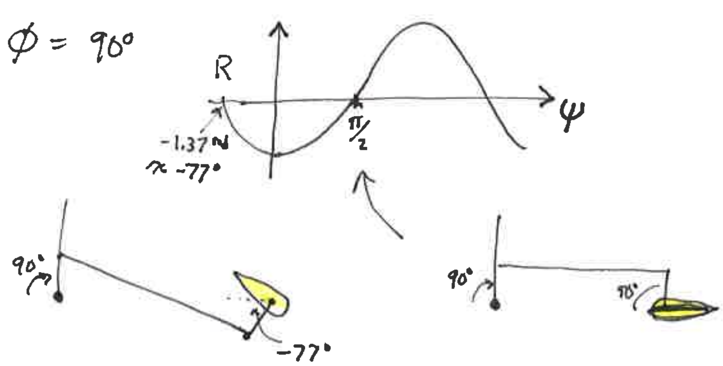
$$R_3 = \frac{100 + 1 - 100 + 1}{2} = 1$$

Freudenstein

$$10\cos\phi - 10\cos\psi + 1 = \cos(\phi - \psi)$$

$$\text{Residual} \equiv 10\cos\phi - 10\cos\psi + 1 - \cos(\phi-\psi) \rightarrow 0$$

when $\phi = 90°$



What about the gearing ratio? $\frac{d\psi}{d\phi}$

Take $\frac{d}{d\phi}$ of Freudenstein while remembering that $\psi \doteq f(\phi)$

$$\frac{d}{d\phi}\left(R_1\cos\phi - R_2\cos\psi + R_3 - \cos(\phi-\psi)\right)$$

$$= -R_1\sin\phi \underbrace{\frac{d\phi}{d\phi}}_{1} + R_2\sin\psi\frac{d\psi}{d\phi} + 0 + \sin(\phi-\psi)\underbrace{\frac{d}{d\phi}(\phi-\psi)}_{1-\frac{d\psi}{d\phi}}$$

Solve for $\frac{d\psi}{d\phi}$

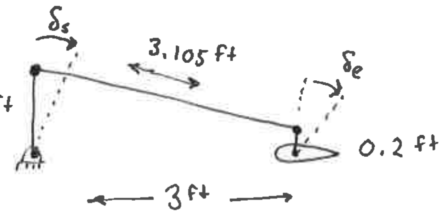
$$\frac{d\psi}{d\phi} = \frac{-\sin(\phi-\psi) + R_1\sin\phi}{R_2\sin\psi - \sin(\phi-\psi)}$$

For the above,

$$\frac{d\psi}{d\theta}(\theta=90, \psi=90) = 1.0 \checkmark$$

$$\frac{d\psi}{d\theta}(\theta=90, \psi=-77) \approx -0.98$$

Example (shorter pushrod)



$L = 3$
$b = 1$
$c = 3.105$
$d = 0.2$

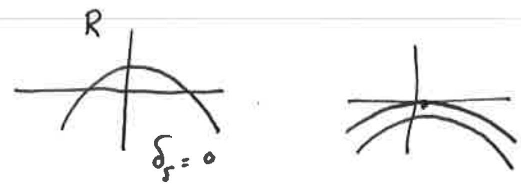
$R_1 = 15 \quad R_2 = 3 \quad R_3 = 0.9974$

At $\delta_s = 0$ We expect a gearing ratio of 5, since $\frac{b}{d} = 5$

What are the limits of stick travel?

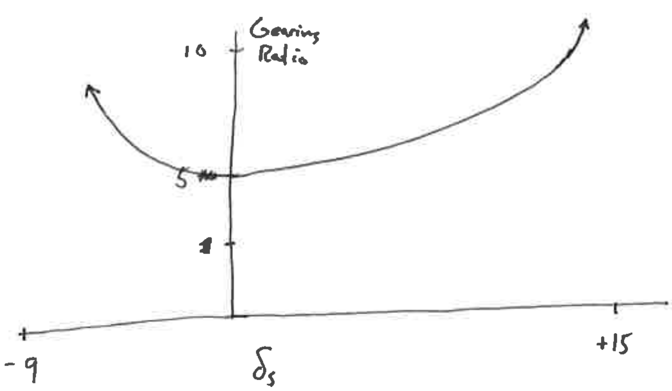
$\delta_s \approx 15° \Rightarrow \delta_e = 108°$

$\delta_s \approx -9° \Rightarrow \delta_e = -70°$



What is the gearing ratio at $\delta_s = 15°$? $G \approx 216$

" at $\delta_s = -9°$ $G \approx 380$



Case Study

Gossamer Condor

\+

Gossamer Albatross

(human powered aircraft)

tiny.cc / AEM 617 Albatross

2:00

3:52

835

tiny.cc / AEM 617 Daedalus

19:40

21 45

Greek myth

Daedalus and Icarus

↖ labyrinth creator ↖ son

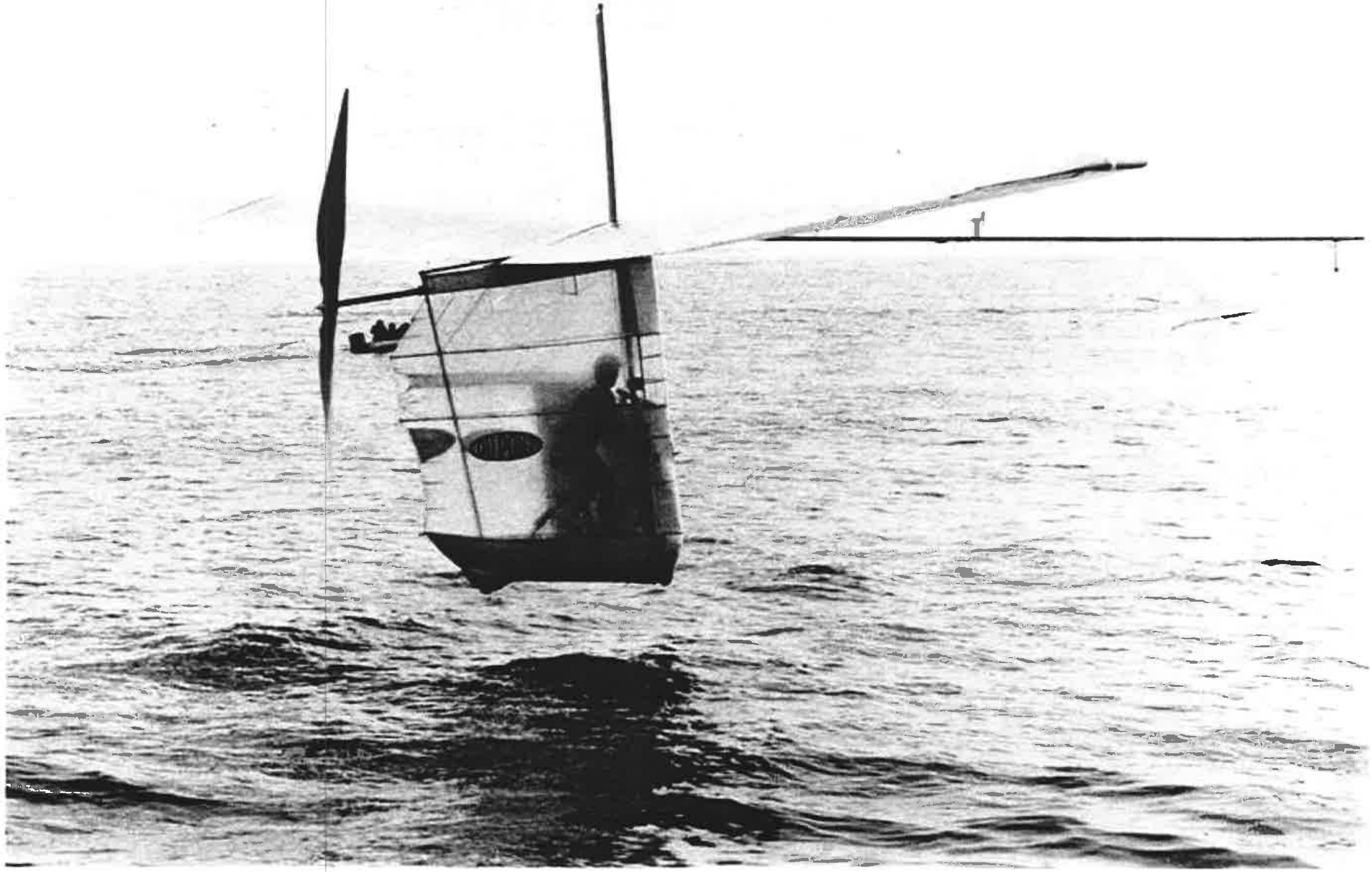


FIGURE 2. Gossamer Albatross in mid-Channel. Photograph by Don Monroe.

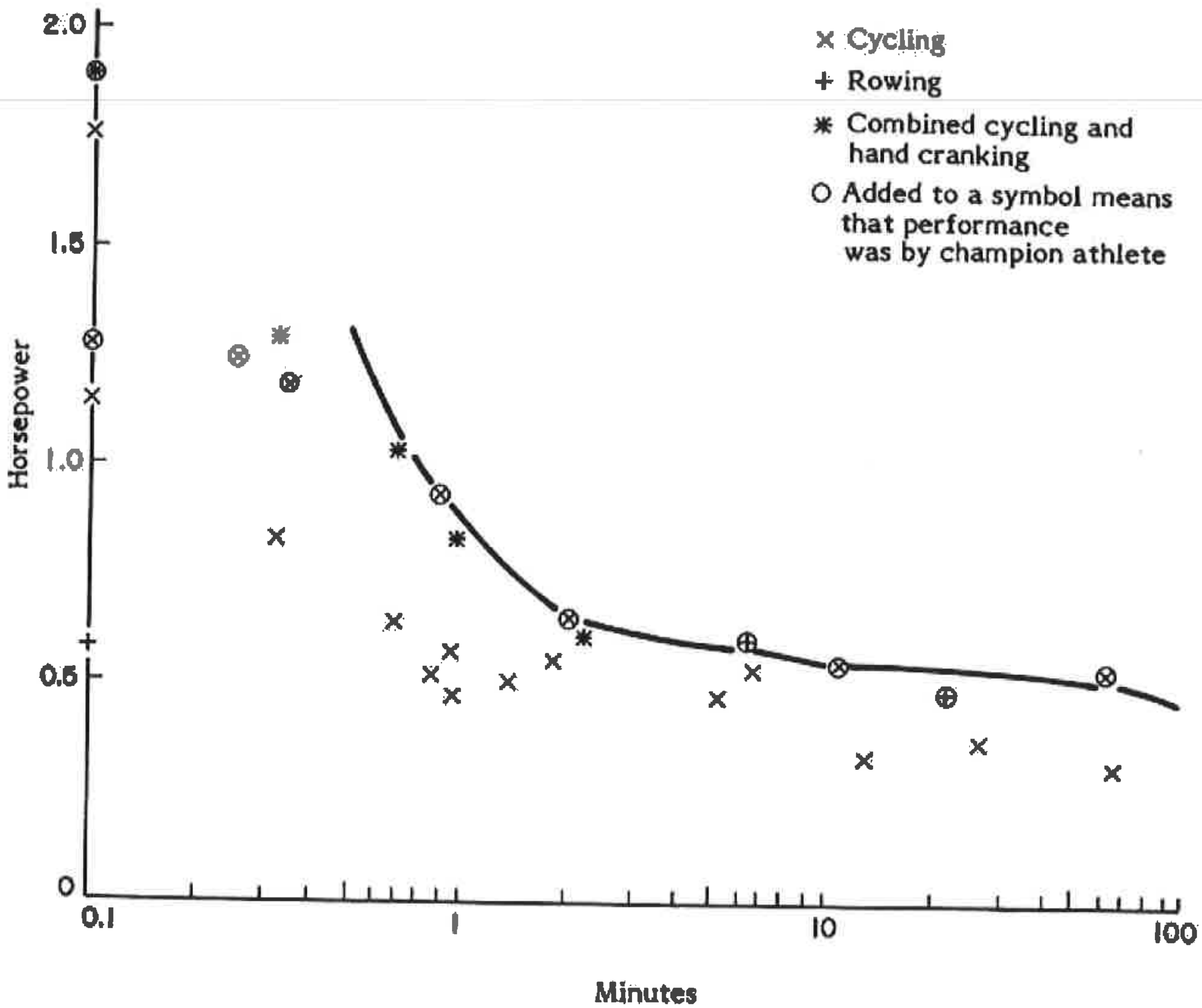


FIGURE 10. Human power output versus time.

Power Required for steady level flight

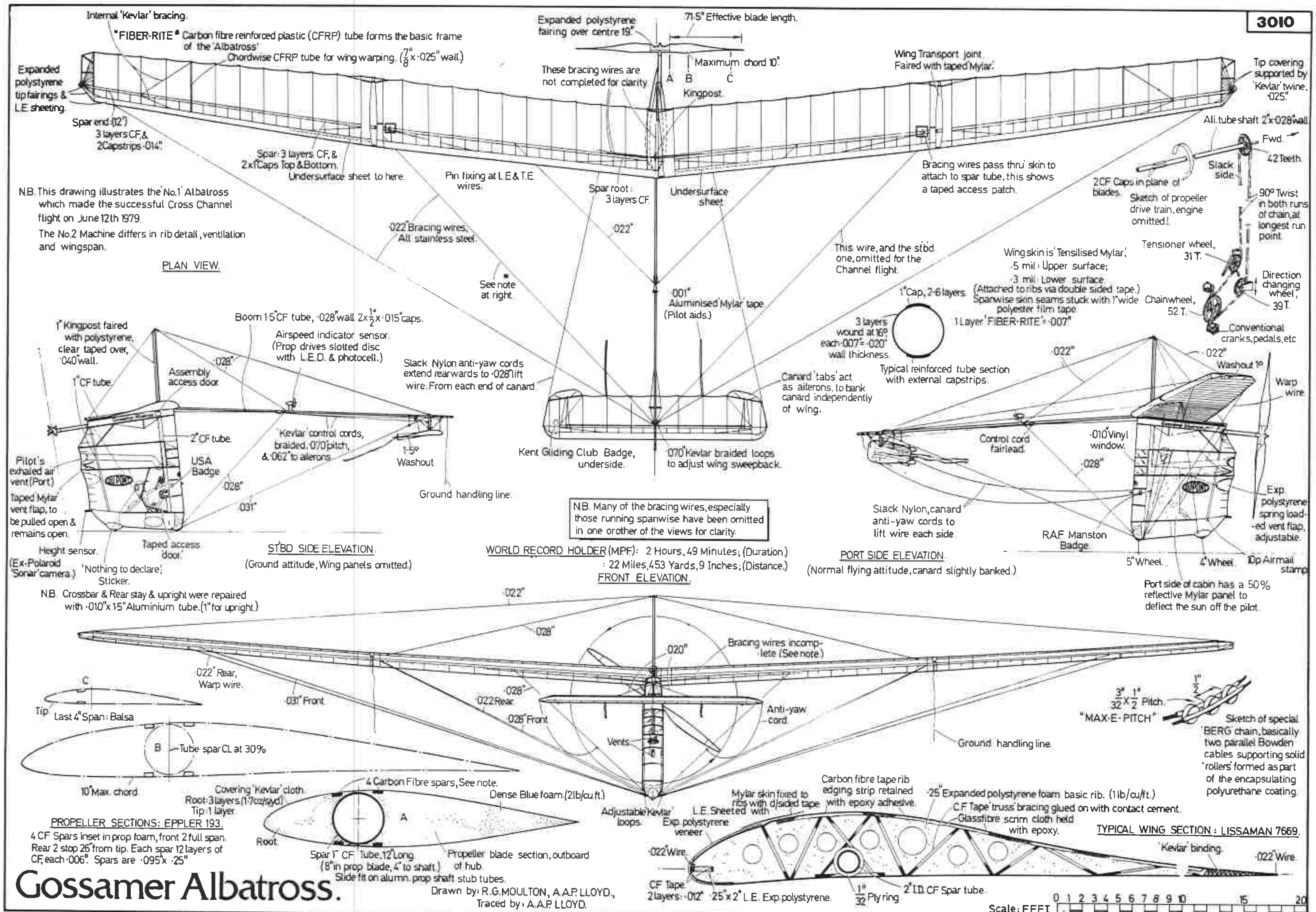
$$P = \frac{2W^2K}{\rho \pi e b^2 U} + \frac{1}{2}\rho U^3 A_1$$

W = weight
U = speed
A_1 = drag (profile) = C_{D_p}
b = wing span
K: ground effect ($\neq 1$ when height low)
e : span efficiency ($=1$ for elliptical)
ρ = air density

$$P = \underbrace{\left(\frac{W}{b}\right)^2}_{\text{span loading squared}} \underbrace{\frac{2K}{\rho \pi e}}_{\text{geometry + atmosphere constants}} \underbrace{\frac{1}{U}}_{\text{vel}} + \frac{1}{2}\rho U^3 \underbrace{C_{D_p}}_{\text{drag}} \cdot \text{Area}$$

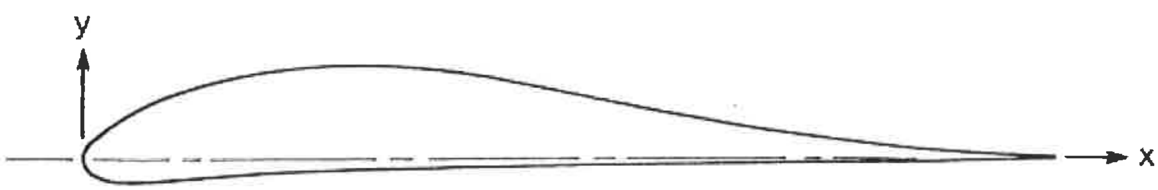
What strategy should we use to minimize power?

- low span loading ⇒ light weight w/ large span
- Efficient geometry ⇒ $e \to 1$
- Slow to keep U^3 low, but not too slow to keep $\frac{1}{U}$ low
- U^3 implies profile drag is ok if speed is low



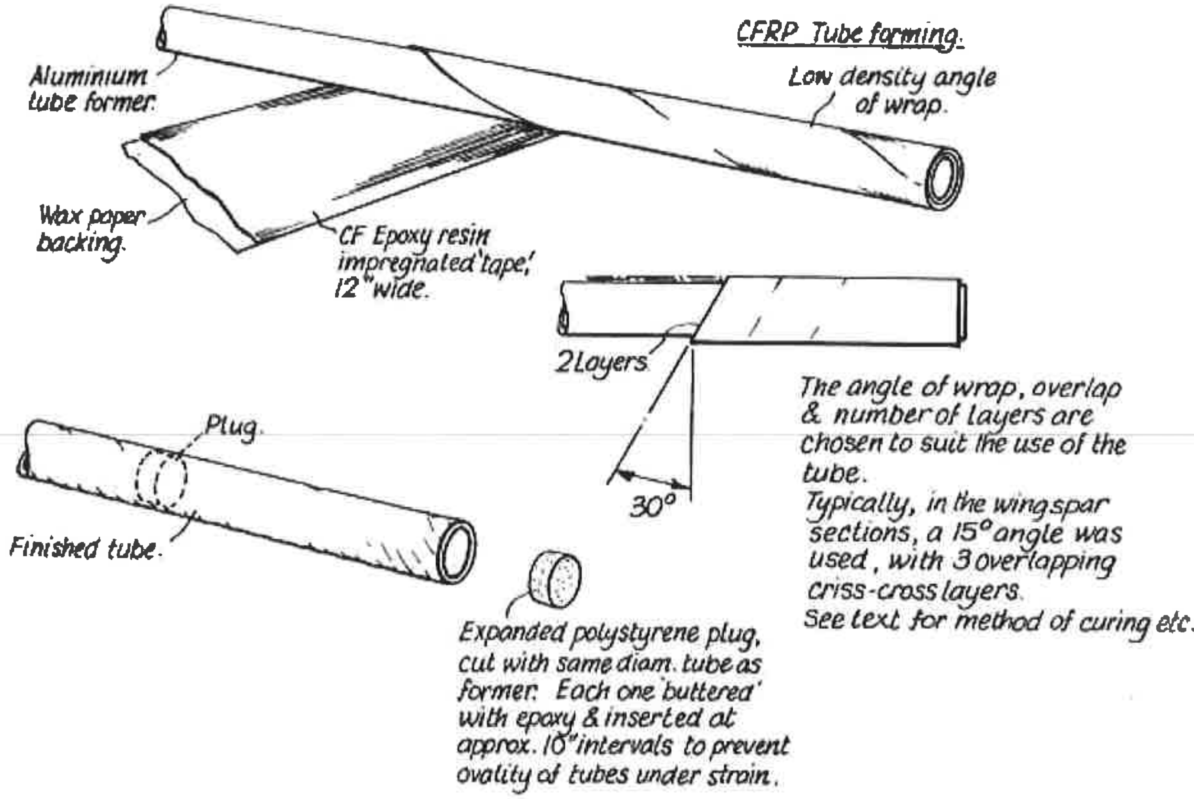
Empty weight = 55 lb

Gross weight = 215 lb

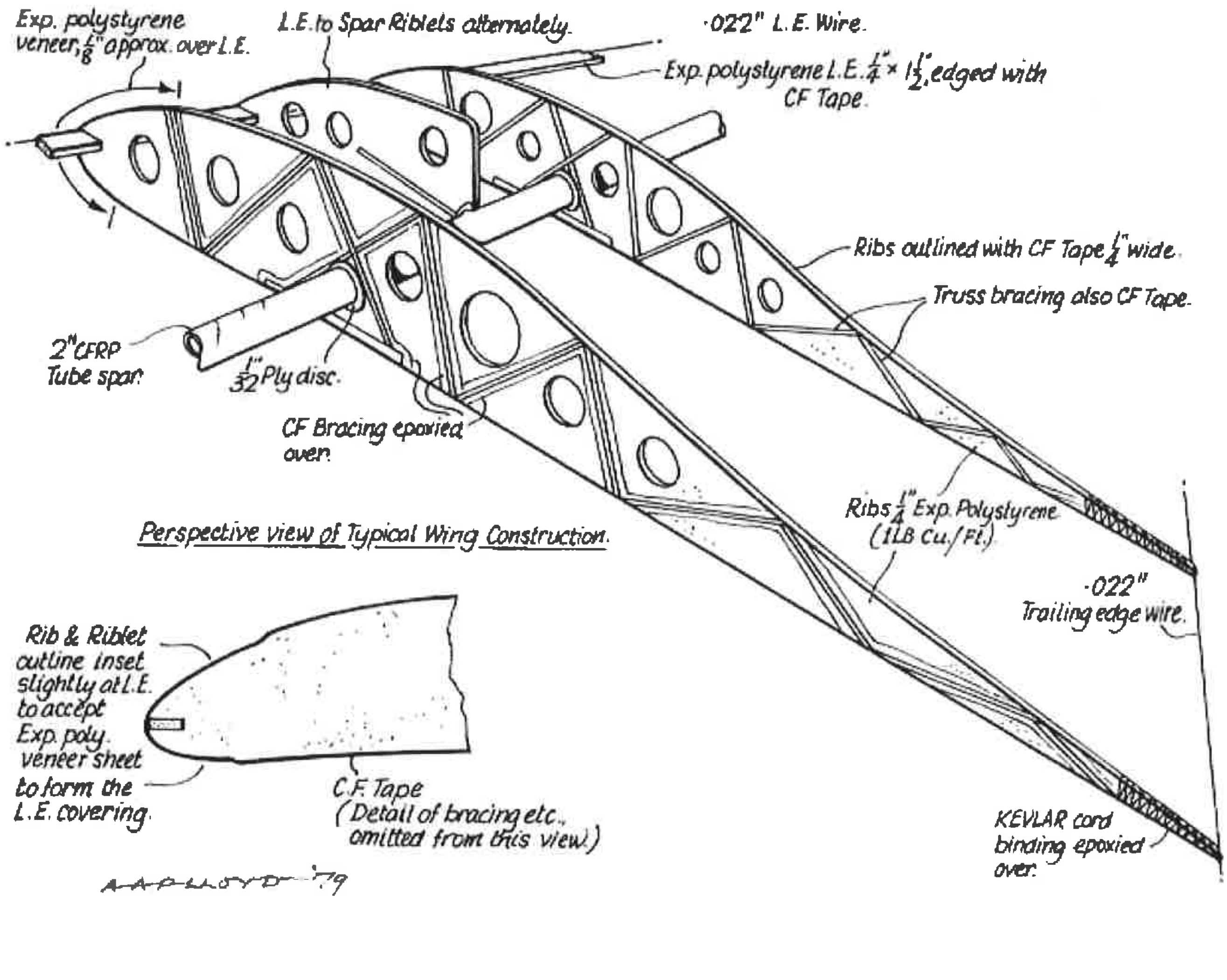


Lissaman 7769

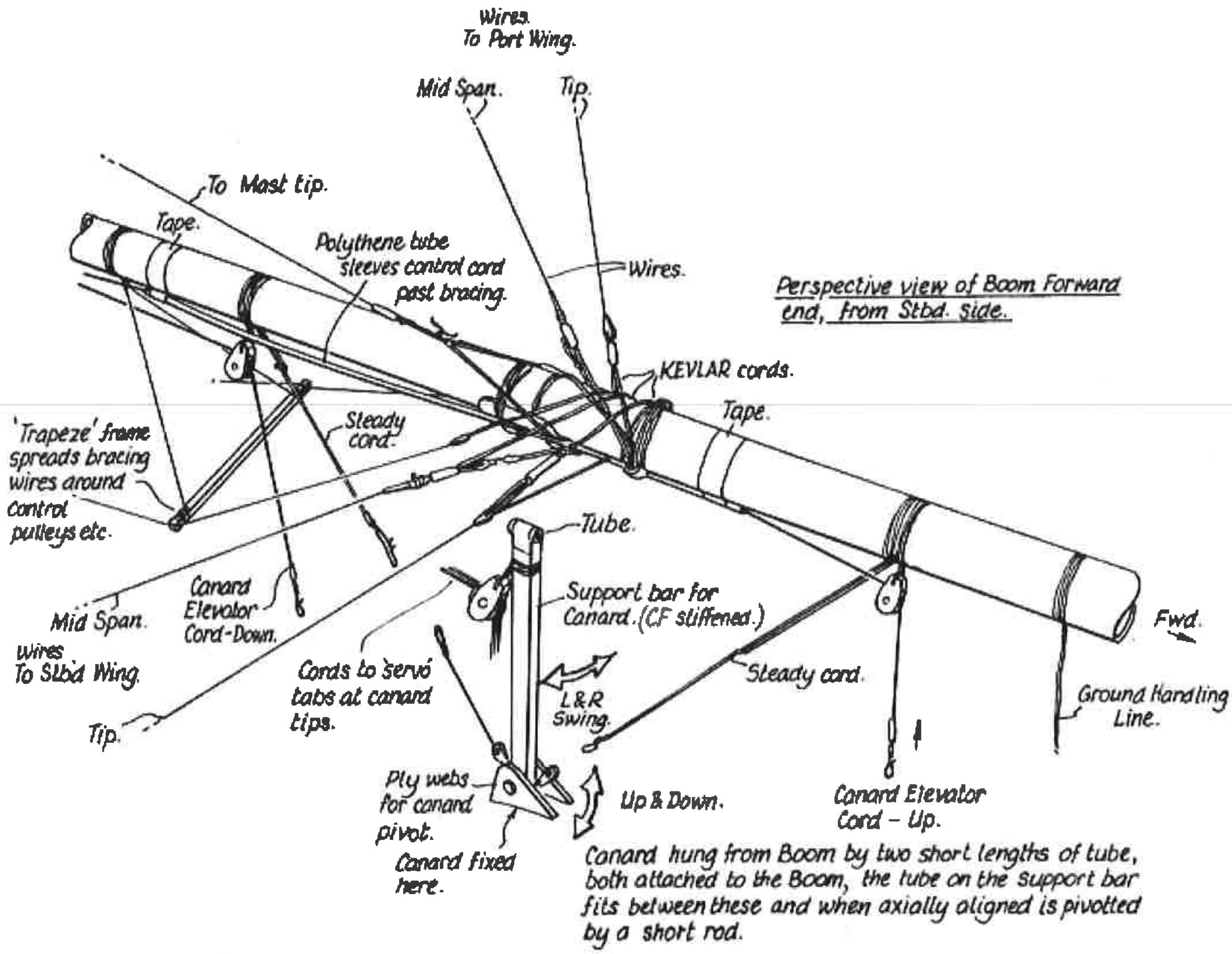
11% thick

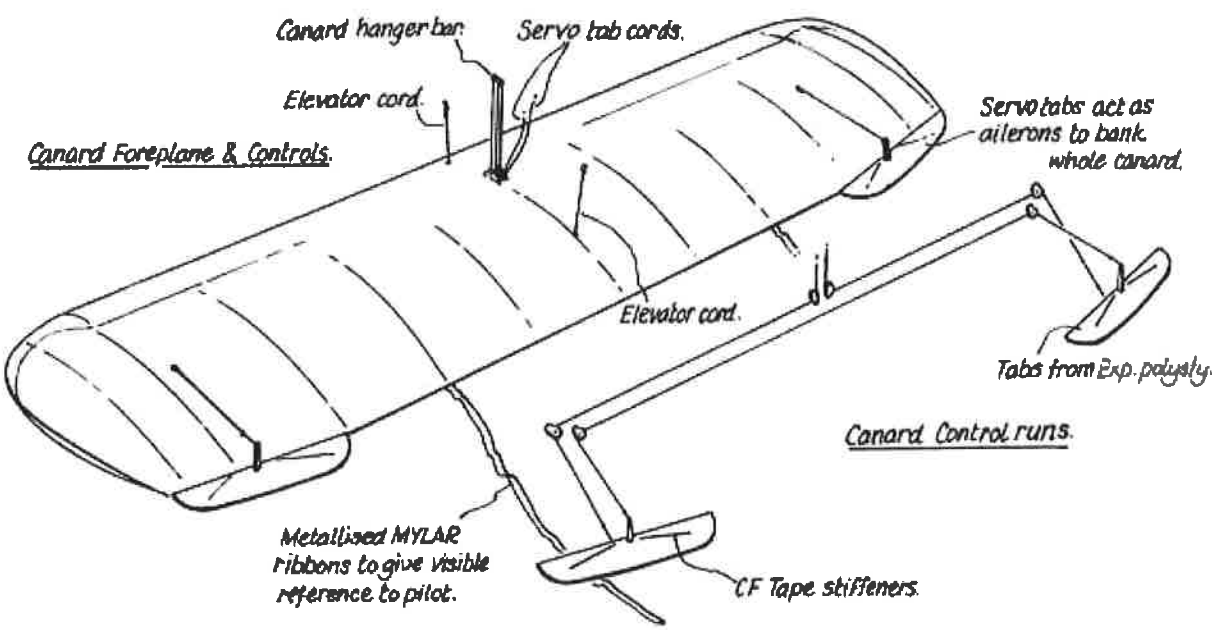


CFRP Tube forming.

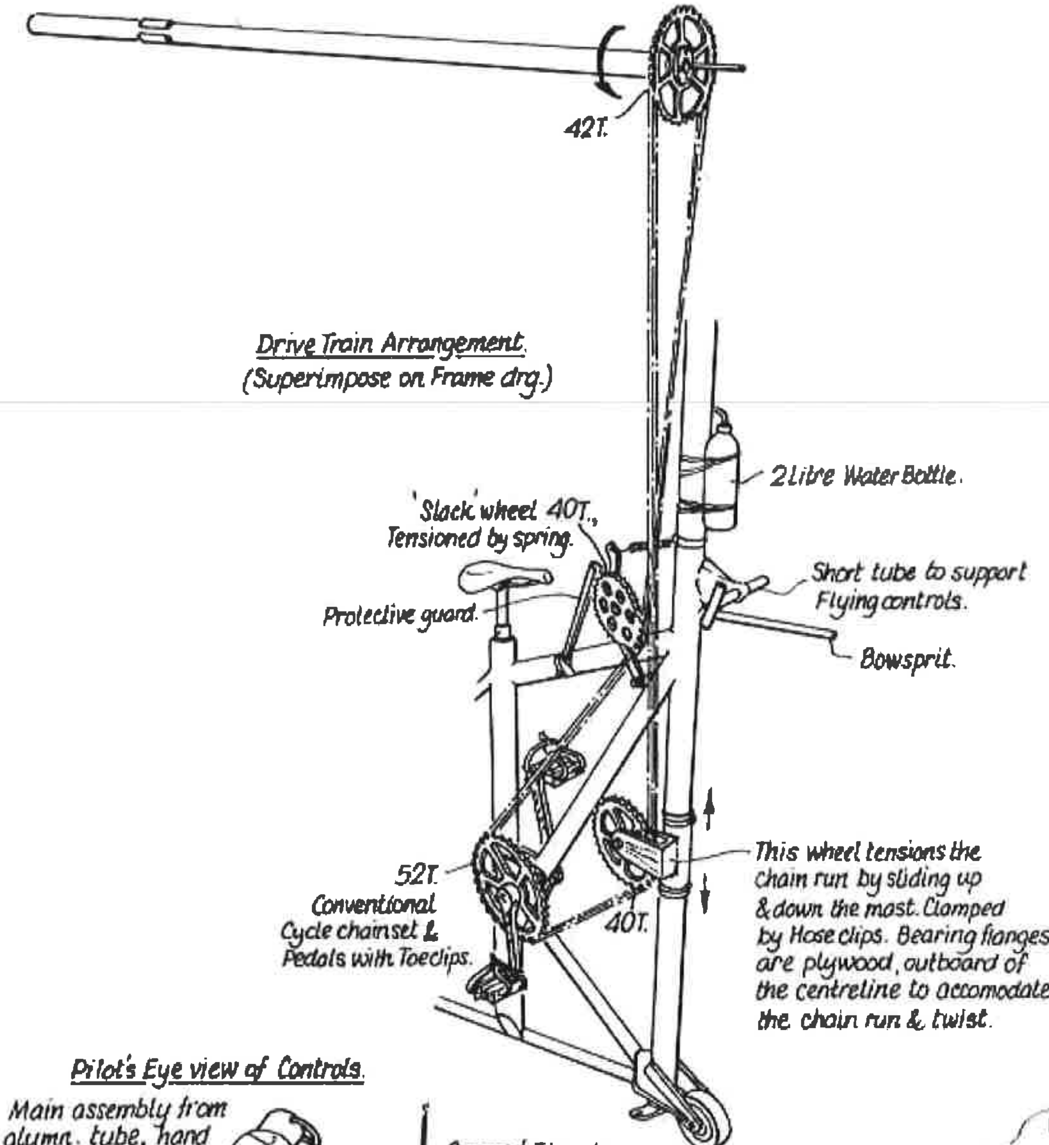


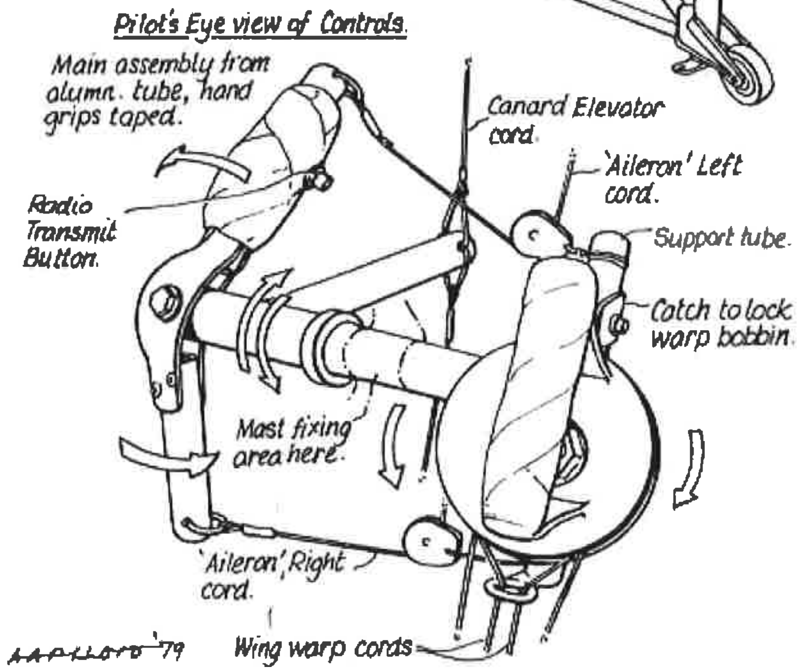
Perspective view of Typical Wing Construction.

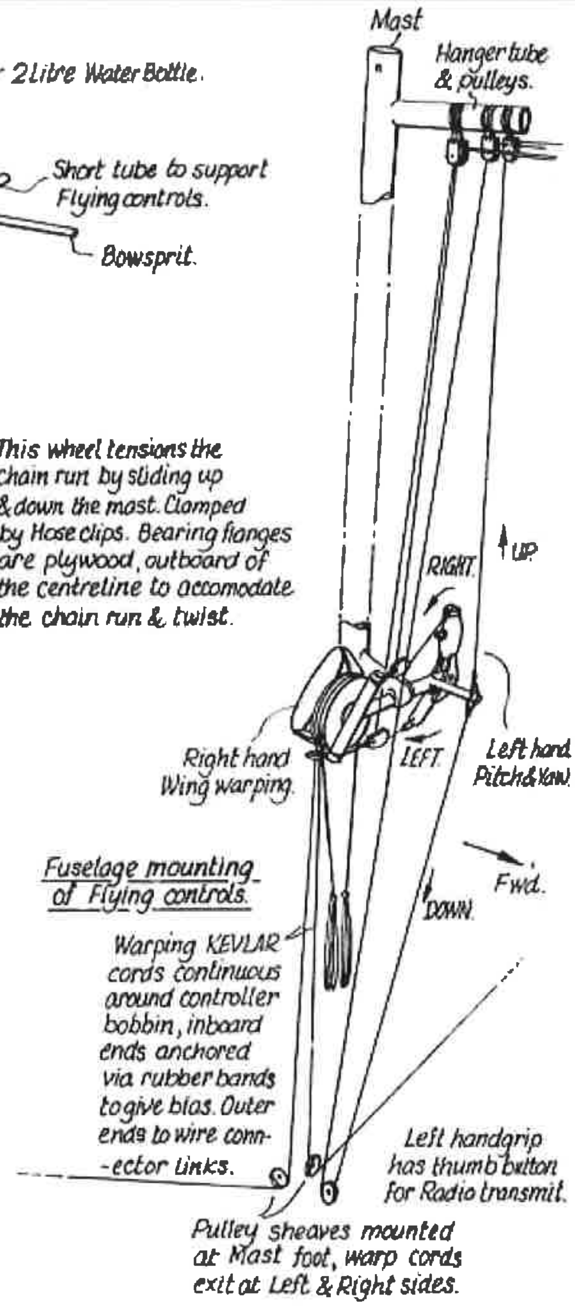

Wires.
To Port Wing.
Mid Span.
Tip.
To Mast tip.
Tape.
Polythene tube sleeves control cord past bracing.
Wires.
Perspective view of Boom Forward end, from Stbd. side.
KEVLAR cords.
Tape.
'Trapeze' frame spreads bracing wires around control pulleys etc.
Steady cord.
Tube.
Mid Span.
Canard Elevator Cord-Down.
Wires
To Stbd Wing.
Support bar for Canard. (CF stiffened.)
Fwd.
Cords to servo tabs at canard tips.
L&R Swing.
Steady cord.
Ground Handling Line.
Tip.
Ply webs for canard pivot.
Up & Down.
Canard Elevator Cord – Up.
Canard fixed here.
Canard hung from Boom by two short lengths of tube, both attached to the Boom, the tube on the support bar fits between these and when axially aligned is pivotted by a short rod.

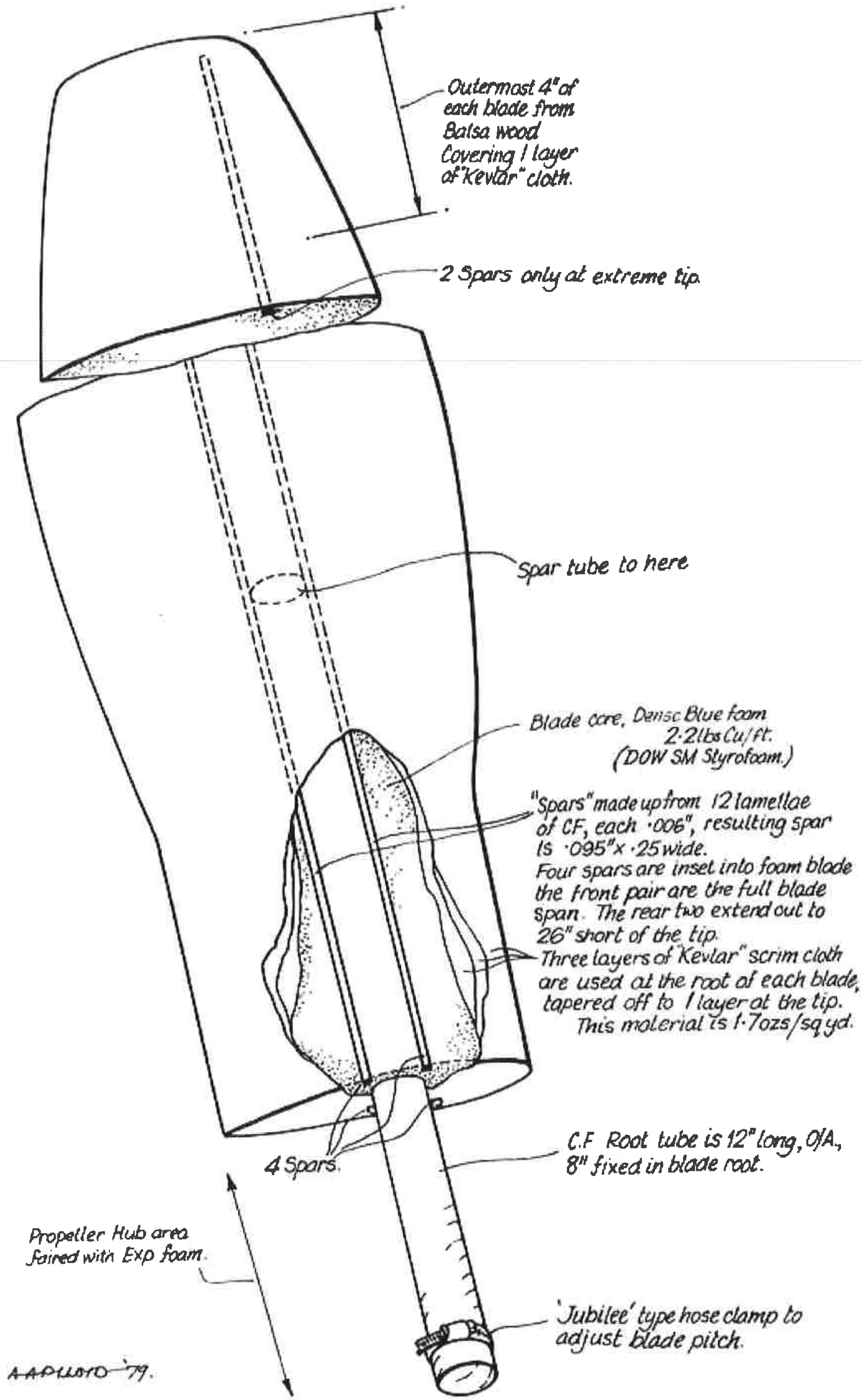

Canard hanger bar.
Servo tab cords.
Elevator cord.
Canard Foreplane & Controls.
Servo tabs act as ailerons to bank whole canard.
Elevator cord.
Tabs from Exp. polysty.
Canard Control runs.
Metallised MYLAR ribbons to give visible reference to pilot.
CF Tape stiffeners.

AAP LLOYD '79.

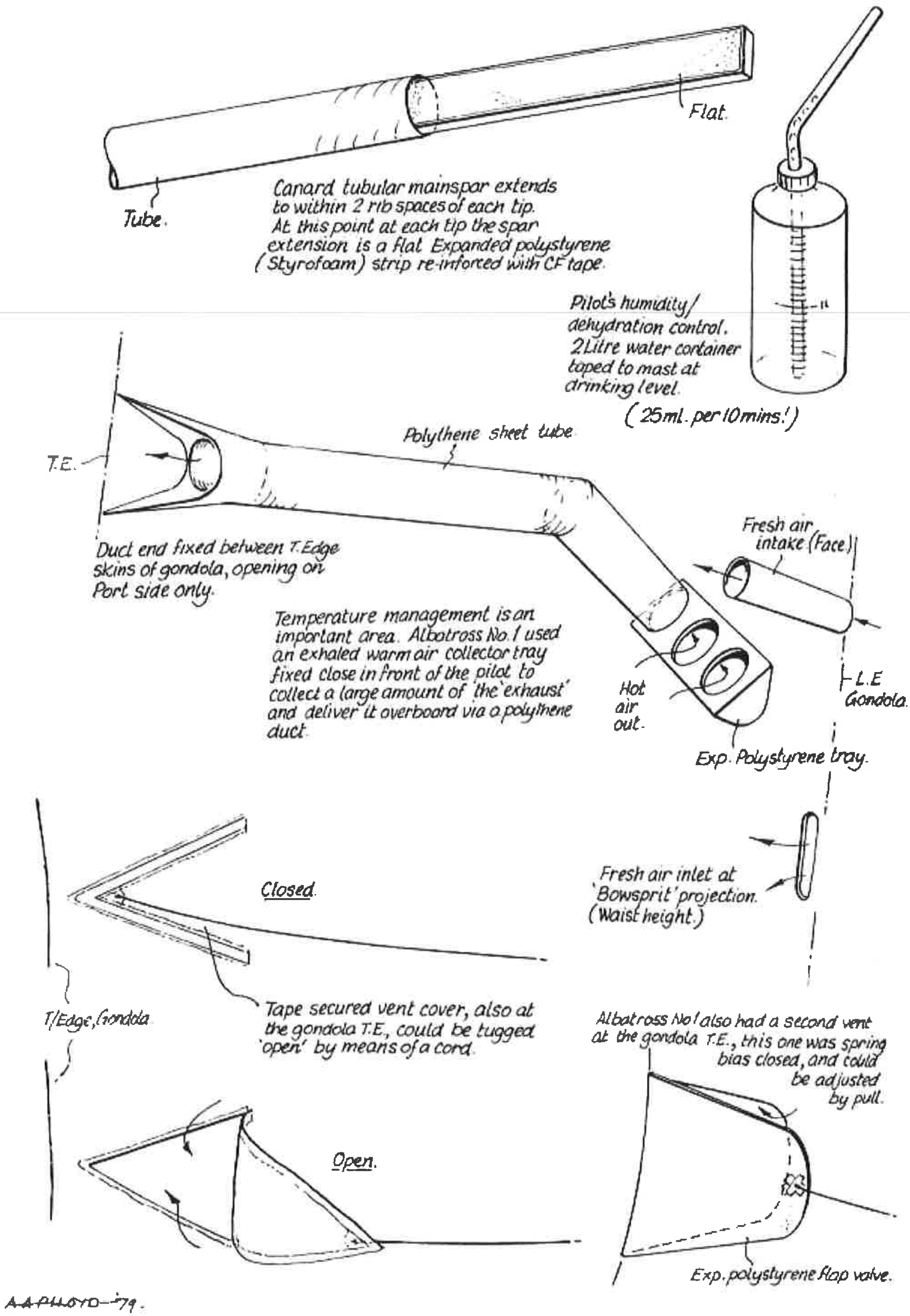

42T.
Drive Train Arrangement.
(Superimpose on Frame drg.)
2 Litre Water Bottle.
'Slack' wheel 40T., Tensioned by spring.
Short tube to support Flying controls.
Protective guard.
Bowsprit.
52T.
Conventional Cycle chainset & Pedals with Toeclips.
40T.
This wheel tensions the chain run by sliding up & down the mast. Clamped by Hose clips. Bearing flanges are plywood, outboard of the centreline to accomodate the chain run & twist.


Pilot's Eye view of Controls.
Main assembly from alumn. tube, hand grips taped.
Canard Elevator cord.
'Aileron' Left cord.
Radio Transmit Button.
Support tube.
Catch to lock warp bobbin.
Mast fixing area here.
'Aileron' Right cord.
Wing warp cords
A.A.PILLORD '79

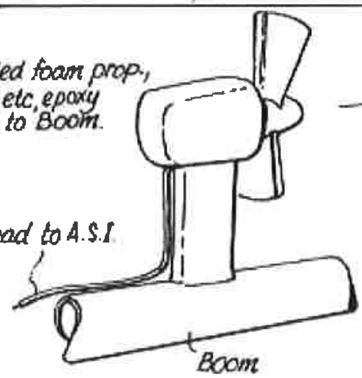

Mast
Hanger tube & pulleys.
RIGHT.
UP
Right hand Wing warping.
LEFT.
Left hand Pitch & Yaw.
Fuselage mounting of Flying controls.
Fwd.
DOWN.
Warping KEVLAR cords continuous around controller bobbin, inboard ends anchored via rubber bands to give bias. Outer ends to wire connector links.
Left handgrip has thumb button for Radio transmit.
Pulley sheaves mounted at Mast foot, warp cords exit at Left & Right sides.


Outermost 4" of each blade from Balsa wood Covering 1 layer of "Kevlar" cloth.
2 Spars only at extreme tip.
Spar tube to here
Blade core, Dense Blue foam 2·2lbs Cu/ft. (DOW SM Styrofoam.)
"Spars" made up from 12 lamellae of CF, each ·006", resulting spar is ·095" x ·25 wide.
Four spars are inset into foam blade the front pair are the full blade span. The rear two extend out to 26" short of the tip.
Three layers of "Kevlar" scrim cloth are used at the root of each blade, tapered off to 1 layer at the tip. This molerial is 1·7ozs/sq yd.
4 Spars.
C.F Root tube is 12" long, O/A., 8" fixed in blade root.
Propeller Hub area faired with Exp foam.
'Jubilee' type hose clamp to adjust blade pitch.
A A P LLOYD '79.

Pilots rejected heat ≈ 1000 watts to generate 0.4 Hp

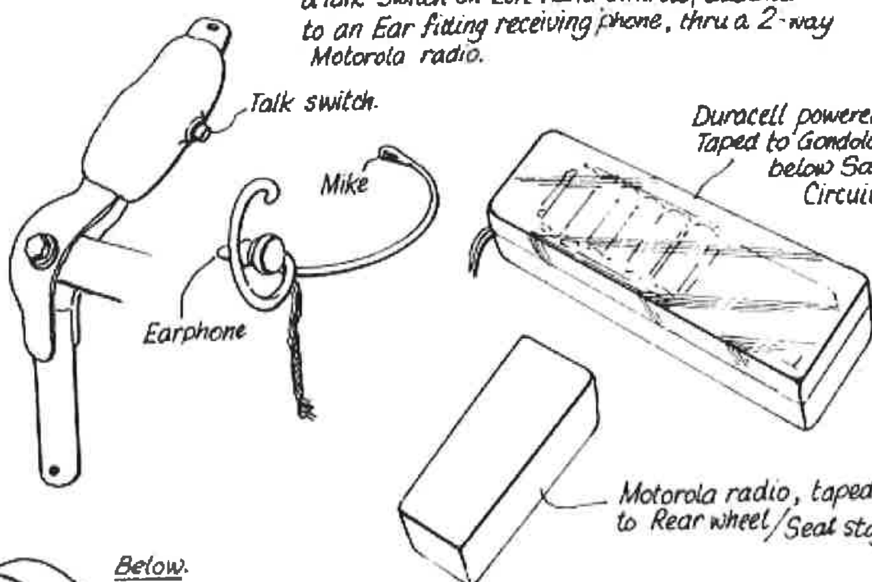


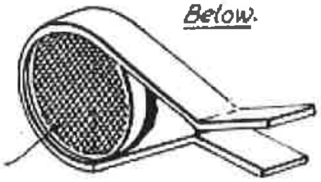
Instrumentation, Radio & Electronics Equipment.



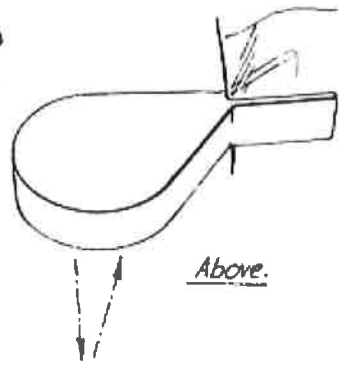
Propeller, driven by Airflow, in turn drives slotted disc, which interrupts an L.E.D. display to a photocell sensor thus producing countable impulses.

Radio contact via a Boom Microphone, with a "Talk" switch on Left hand controls, attached to an Ear fitting receiving phone, thru a 2-way Motorola radio.





Vertical distance measured with this "Sonar" rangefinder cell, from a POLAROID camera. Cell window faces down.



[illegible] '79.