



Hamburg Branch

The story of UK jet VSTOL



by John Farley



Royal Aircraft
Establishment

The story of UK jet VSTOL

a story enabled by
RAE scientists
since 1951



Royal Aircraft
Establishment
Apprentice

1950

1951

The power of jet engines was steadily increasing and it became clear that before long it would be possible to design an aircraft with a thrust greater than its weight

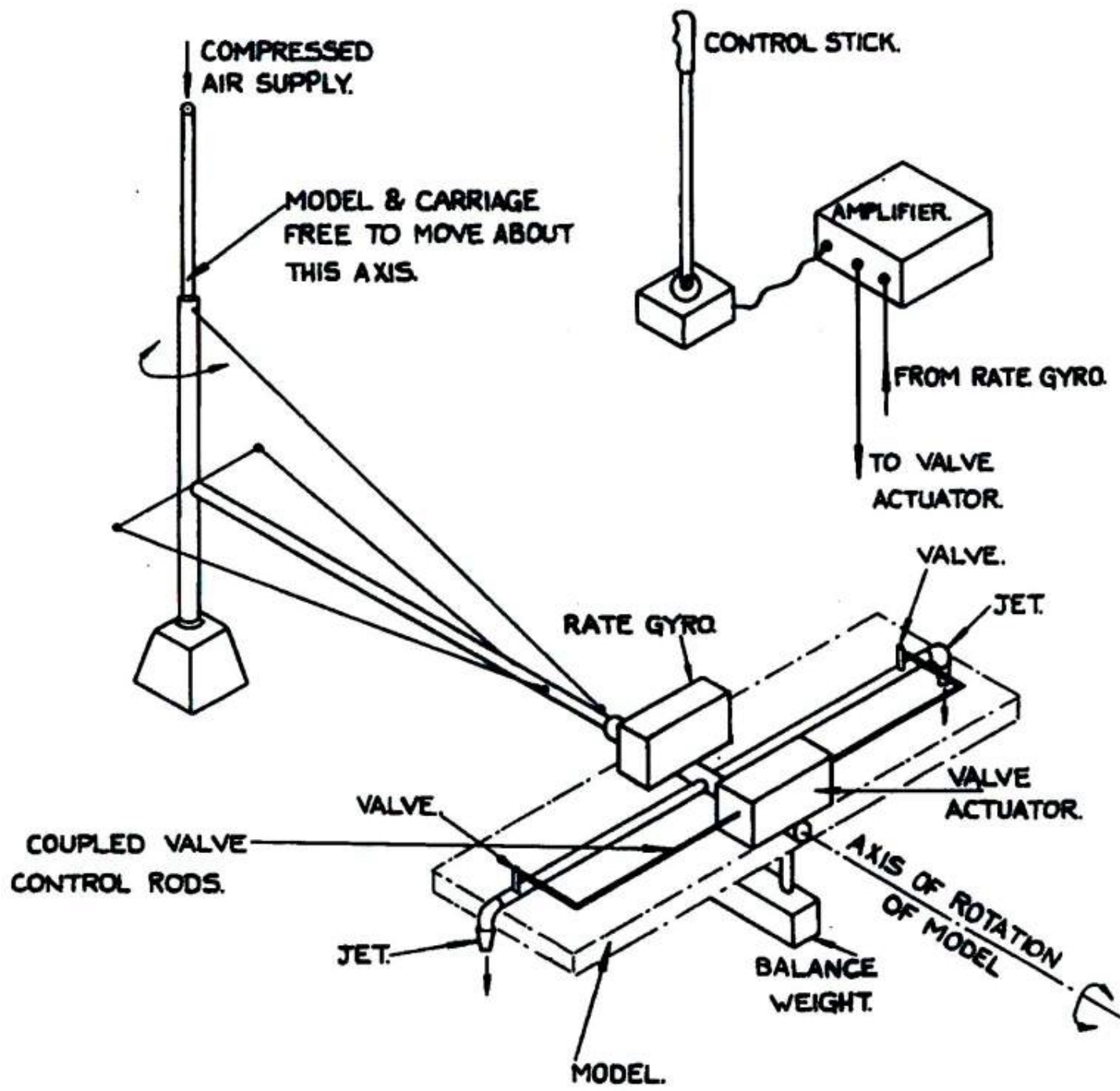
But how could such an aircraft be controlled in the hover?

Dennis Higton

A former RAE Apprentice then working on the

Aerodynamics Research Flight at RAE Farnborough

devised a rig to prove the feasibility of controlling the attitude of a hovering vehicle by means of jets



NATIC

~~SECRET~~

UNCLASSIFIED

A 001740

NATIONAL AERONAUTICAL ESTABLISHMENT

LIBRARY



Technical Memo. No. Aero.268

April, 1952

CHECKED 17 APR 1983

ROYAL AIRCRAFT ESTABLISHMENT, FARNBOROUGH

Note on a simple model experiment to investigate the controllability of an aircraft supported by its jets

by

D. J. Higton

R.A.E. Ref: Aero F/468/88



It has been proposed¹ that model tests should be made to obtain preliminary information on the control of an aircraft supported by its jets². This note describes briefly the preparations being made at the R.A.E. for a very simple model experiment with a model supplied with compressed air and with only a limited freedom of motion. In the initial experiments the model will be free to rotate about a horizontal axis through its C.G. and will be free to move in a horizontal direction at right angles to this axis. The model can be regarded as representing either pitching and fore and aft motion or rolling and sideways motion. It is recognised that the experiment will not give the pilot a true representation of the motion of the full scale aircraft, but it is hoped that useful qualitative information will be obtained. In order to simplify the mechanism supporting the model and to reduce the number of bearings and friction to a minimum, the horizontal path will be part of a circle instead of a straight line. This misrepresentation is considered to be of minor importance compared with the obvious limitations of the experiment.

A diagrammatic sketch of the model is shown in Fig.1. The model itself is a simple platform with two jets equally spaced each side of the horizontal axis. The model is carried on an arm which is coincident with the model axis and is about 8 feet long. This arm is mounted on a column which is free to rotate about a vertical axis.

The full weight of the model will not be supported by the jets. As pointed out in Ref.1 the model thrust/weight ratio determines the linear scale of the experiment and initially this will probably be about $1/10$. Control of the model is obtained by differential control of thrust between the two jets obtained by throttle valves situated near the nozzles. These valves will be remotely operated from a standard pilot's control column by small electric actuators.

The mass and moment of inertia of the model and the jet thrust and jet moments will be variable over fairly wide ranges so that the linear scale of the experiment can be easily changed and the effects of changes in inertia can be easily investigated.

In the first instance the model will be tried in its simplest form as outlined above, with the object of seeing how well it can be manually controlled. The pilot will probably be seated near the central

UNCLASSIFIED

~~SECRET~~ 1/6/72



2-12-52
3 am
[Rearing scrapers, for Keno found

F86 film analysis

H. Martin as jumper.

12-3-52

Jet controlled model.

- ①. A. Keeles.
 - ②. See Thrane.
 - ③. Pyestak.
 - ④. Requirements.
 - ⑤. Controls.
 - ⑥. Situation.
 - ⑦. Hingeage etc.
- ⑧. File

Kennings note on tabs rate.

MANCUS ✓ / S case camera.

These early experiments enabled RAE
scientists

Dennis Higton and Arthur Keeler
and later Roger Duddy

to outline the specification for a full size
piloted rig that became the

Rolls-Royce Flying Bedstead

1953

The year piloted jet powered vertical flight experiments started with the first tethered flights at Hucknall of the

Rolls-Royce Flying Bedstead

or Thrust Measuring Rig

3 August 1954

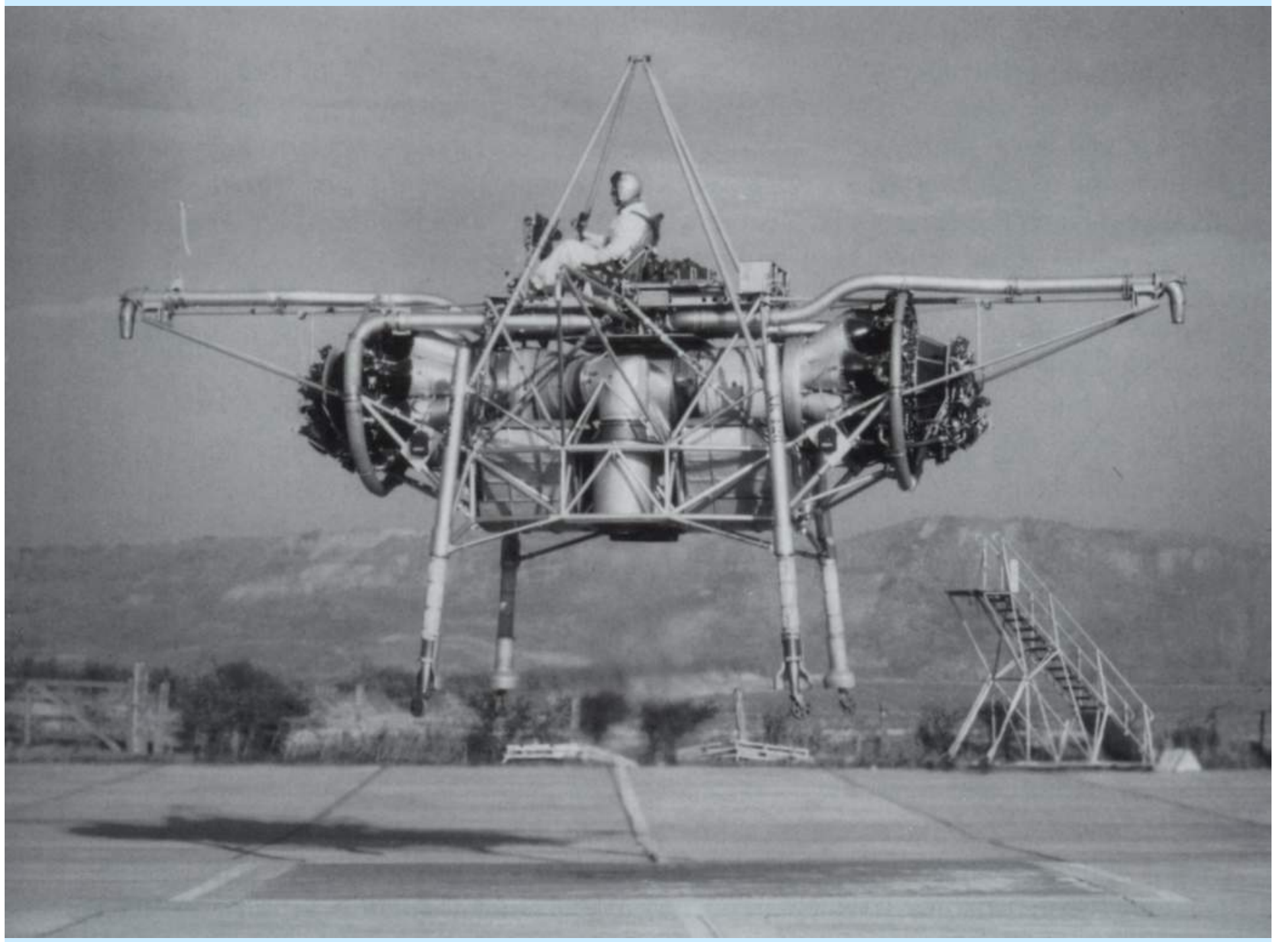
The date when

Rolls Royce Chief Test Pilot
Capt R T Shepherd RN

flew the first free hover in the Bedstead
and jet powered vertical flight became a reality

This is therefore the story of over
half a century of V/STOL flight
development

and the engineers behind it all



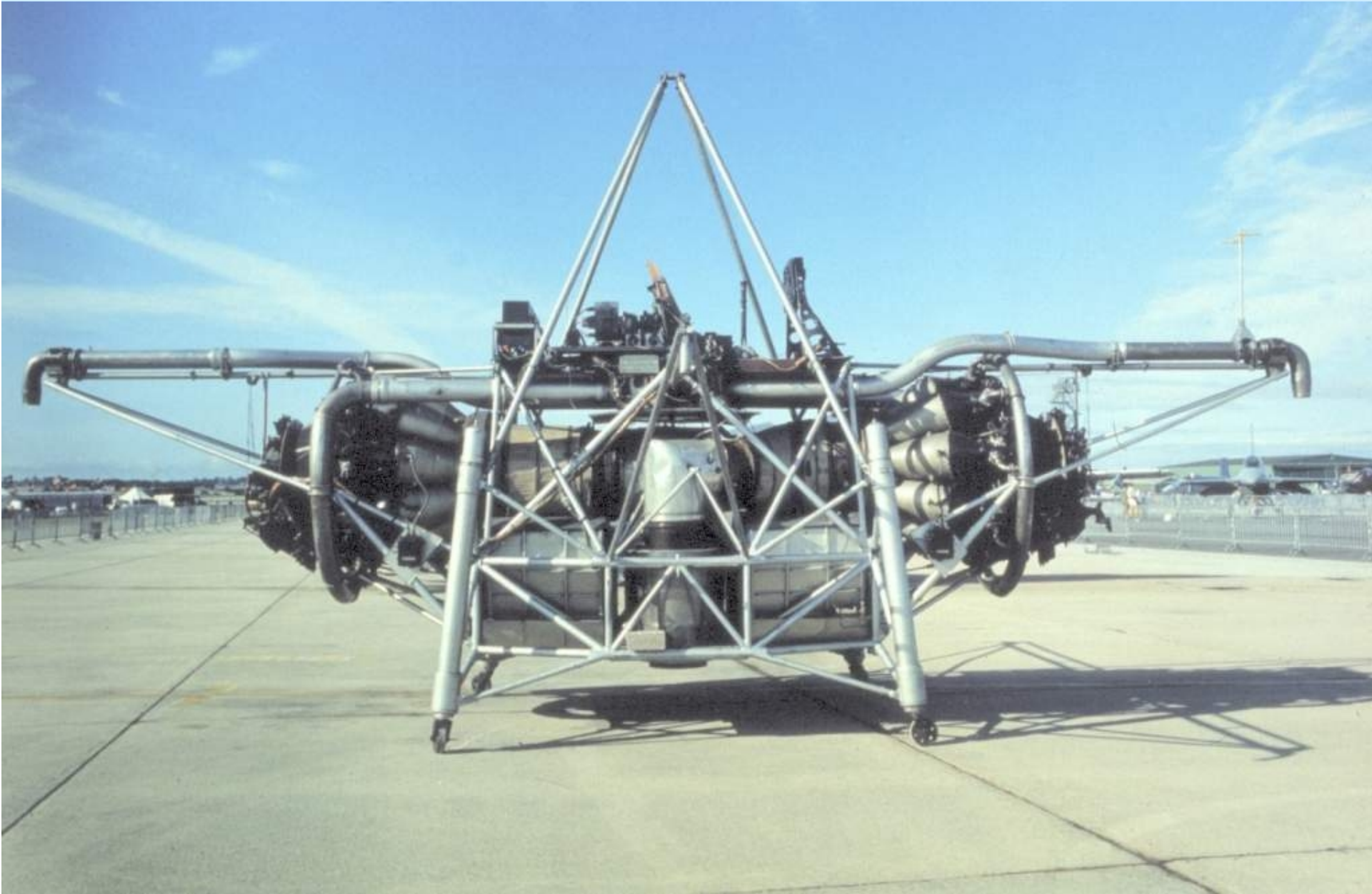
Following these early flights an
RAE Aerodynamics Research Flight
test pilot

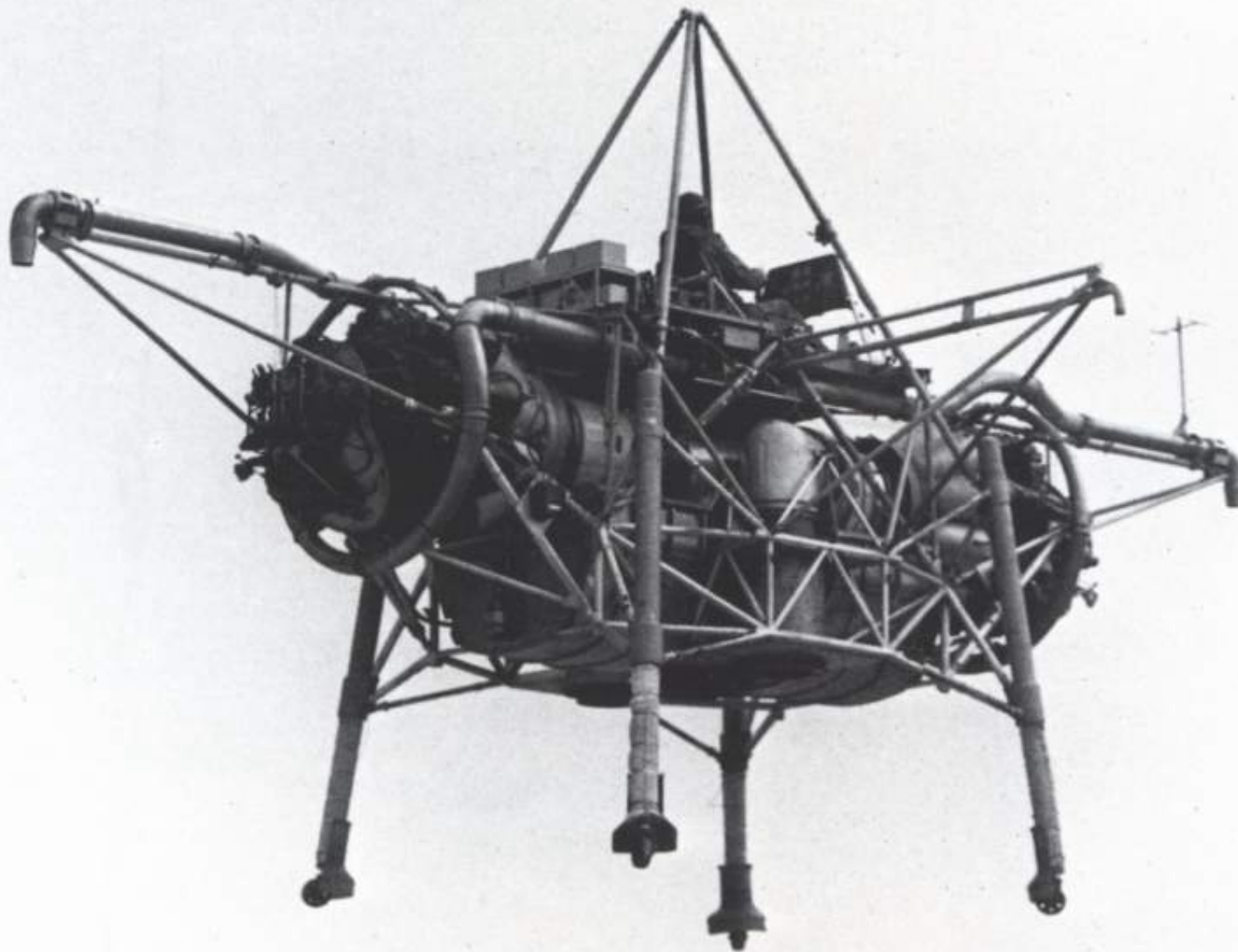
Sqn Ldr R A Harvey AFC

took over the development flying
at Hucknall



Jock
Harvey





“ I felt insecure.....
.....since this was the first aircraft designed by Rolls-Royce”



Short SC1 on Bedford pit



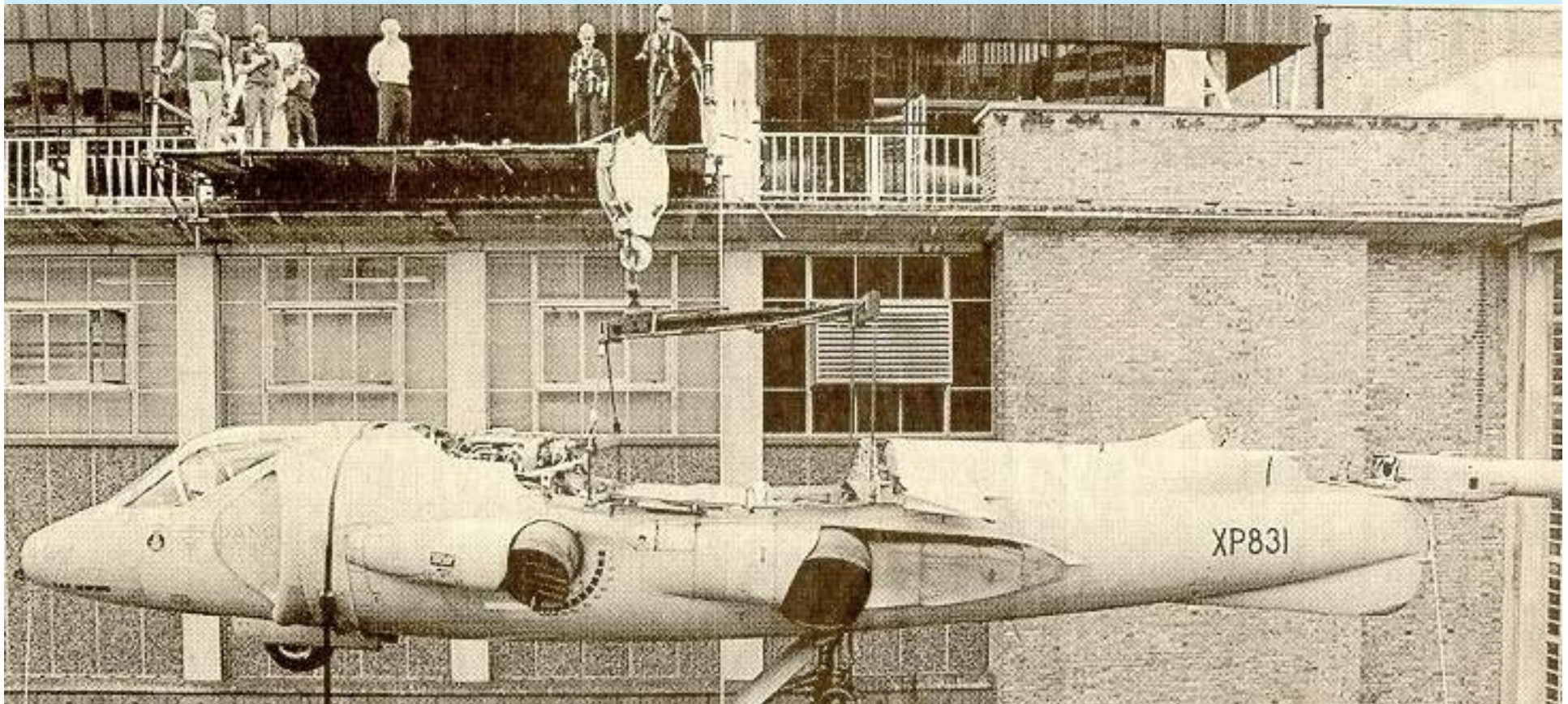
Short SC1 airborne

then in APRIL 1960

In October the same year the Hawker P1127 prototype XP831 first hovered and started what was to become the Harrier family of V/STOL aircraft



Following a distinguished career of research and development XP831 retired to the Science Museum in South Kensington





**The P1127 owed its origins to
one
man who in 1956 had an
idea.....**

Vectored thrust

- He was a French Engineer ***Michel Wibault*** and suggested using rotating nozzles to vector thrust back in 1956
- He failed to interest ***Marcel Dassault***
- So he went to a USAF Colonel ***Johnnie Driscoll*** in the Paris office of the NATO Mutual Weapons

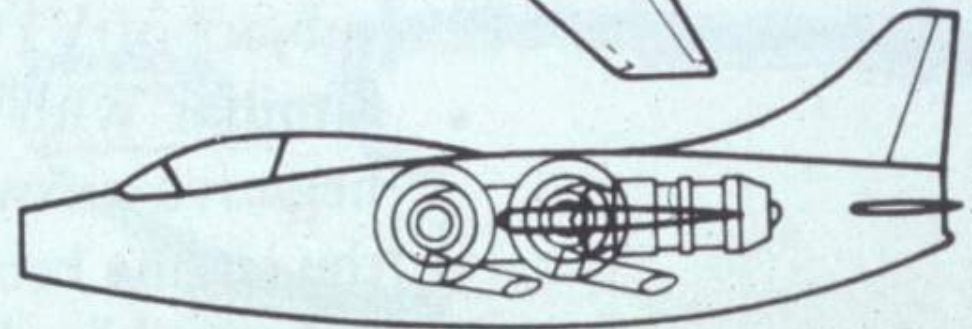
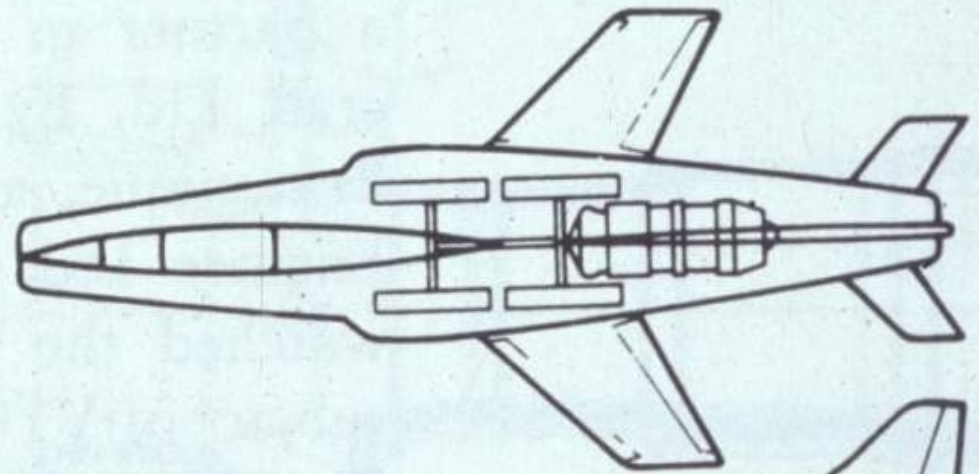
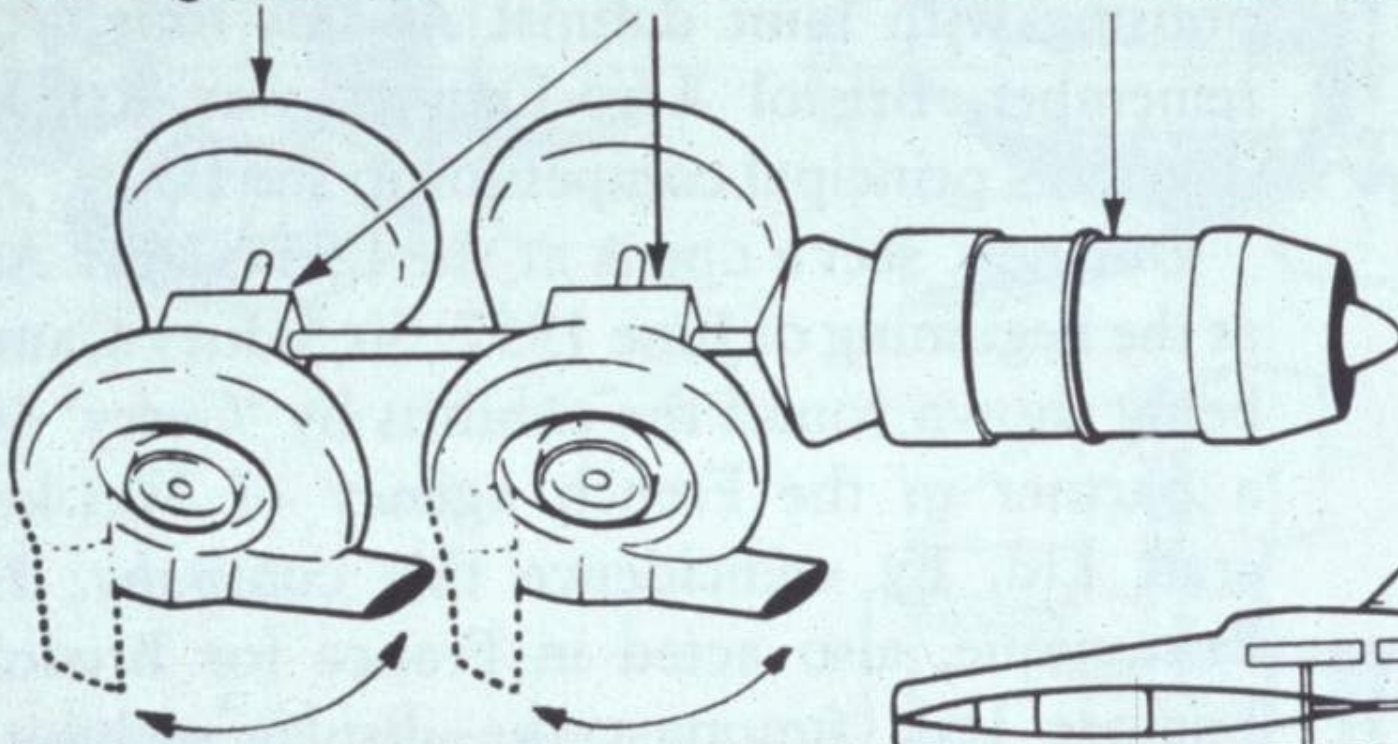
the UK became involved.....

- Driscoll and his successor ***Colonel Bill Chapman*** approached ***Stanley Hooker*** of the Bristol Aero Engine Company with whom they were working on other projects
- Hooker agreed to look at **Wibault's** design called the

Centrifugal blower

Gearboxes

8000 HP Bristol Orion turboprop



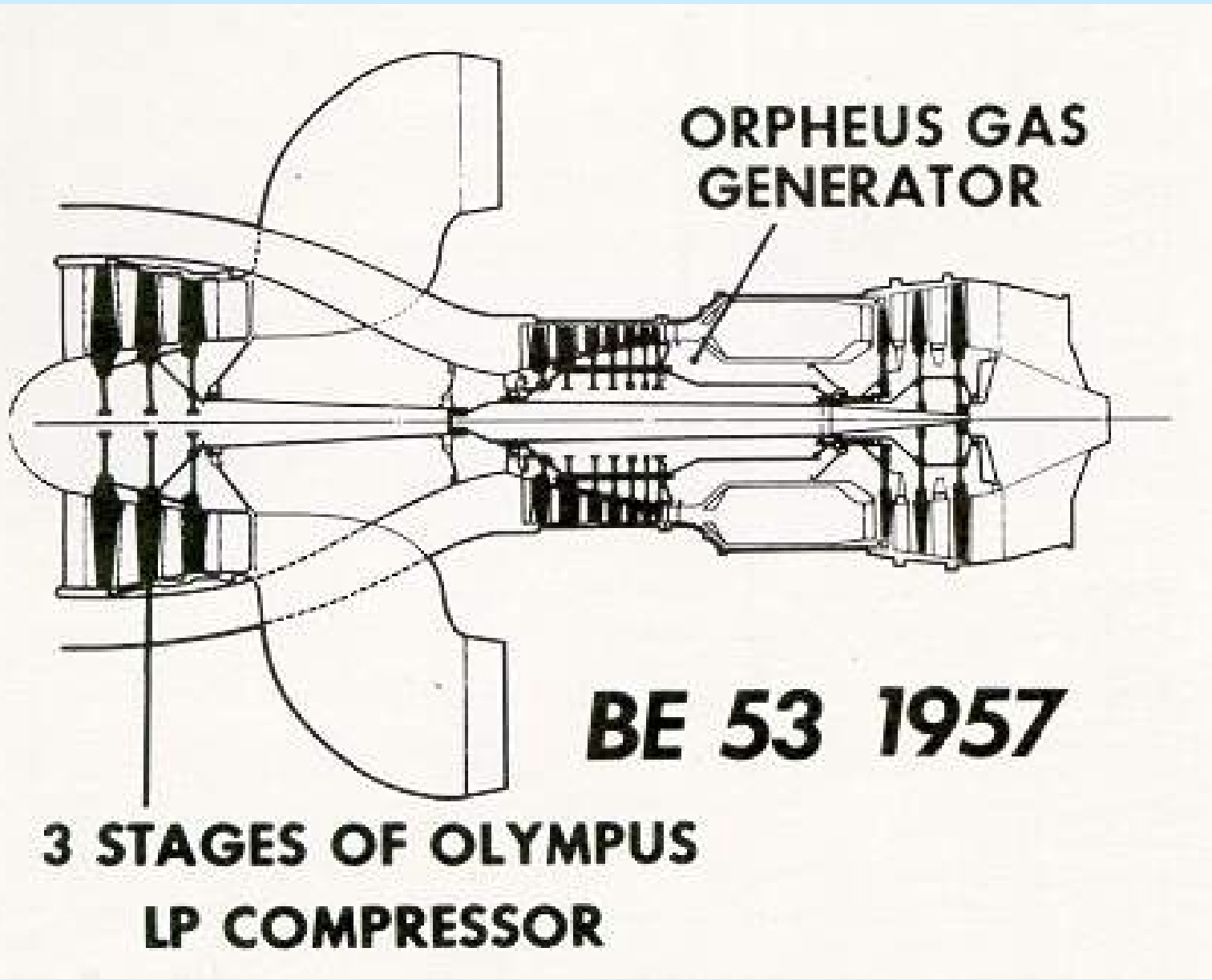
The GYROPTER

Stanley Hooker's view

- He was unhappy with the mechanical complexity used by Wibault ***but he did like the vectoring notion***
- So he gave the job of coming up with a better way to use this idea to one of his young engine designers ***Gordon Lewis***

The Lewis/Wibault engine

- **Gordon Lewis felt the airflow from a turbine driven fan could be vectored directly**
- **So he and Wibault worked together on the improved idea and jointly took out a provisional patent for such an engine in *January 1957***



**ORPHEUS GAS
GENERATOR**

BE 53 1957

**3 STAGES OF OLYMPUS
LP COMPRESSOR**

Enter Hawker Aircraft

- At the same time Hawkers legendary fighter designer ***Sydney Camm*** was also considering V/STOL
- But Camm did not like the ***multiple lift engines*** that Rolls Royce were providing for the Short SC1 and other research aircraft

CONTRACTORS TO H.M. AND FOREIGN GOVERNMENTS

**HAWKER AIRCRAFT LIMITED**CANBURY PARK ROAD
KINGSTON-UPON-THAMES
SURREYDIRECTORS
SIR FRANK SPENCER SPROGS, K.B.E., HON. F.R.A.S.
(CHAIRMAN)
SIR THOMAS SOPWITH, C.B.E., HON. F.R.A.S.
A.N. SPROGS, O.B.E., M.I.P.E. (MANAGING DIRECTOR)DIRECTORS
J. T. LIDBURY, J.P. (GENERAL MANAGER)
SIR SYDNEY CAMM, C.B.E., F.R.A.S.
E. H. JEFFERSON
J. D. STRANKS, A.F.R.A.S. (WORKS DIRECTOR)

OUR REF. Design Dept. SC/PM REF.

17th May, 1957. S.G.H.

Dr. S.G. Hooker,
The Bristol Aeroplane Co. Ltd.,
Filton House,
Filton,
Bristol.

Dear Dr. Hooker,

I saw recently a film on the Ryan V.T.O. aircraft and it started me wondering whether we ought to give more attention to this possible development. I have also heard that you have given some consideration to it and I should like very much to have your views. My own view is that before we can go very far we would have to have in mind the practical application of the aircraft in other words it could not be merely a research aircraft.

There are many aspects, of course, of this development. Up to the present I have thought that the arrangement in which engines are carried merely for take-off and landing would be bad for the over all efficiency but Rolls, on the other hand, have suggested that this is probably the best arrangement.

I am sorry I omitted to discuss this with you when I was down at Bristol. Perhaps you could drop me a line about it.

Best wishes,

Yours sincerely,

S.G.H.

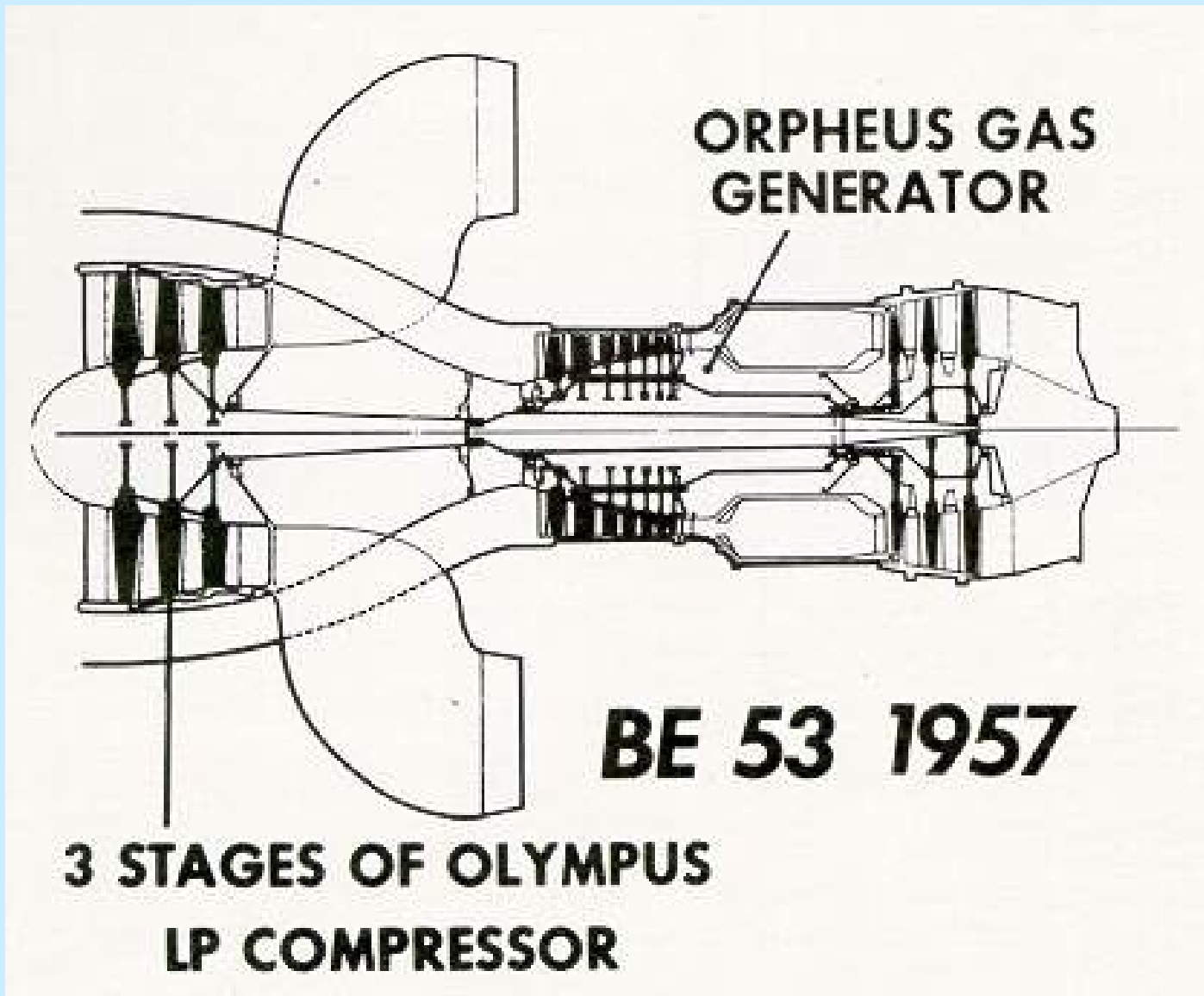
21 MAY 1957

2477. S.

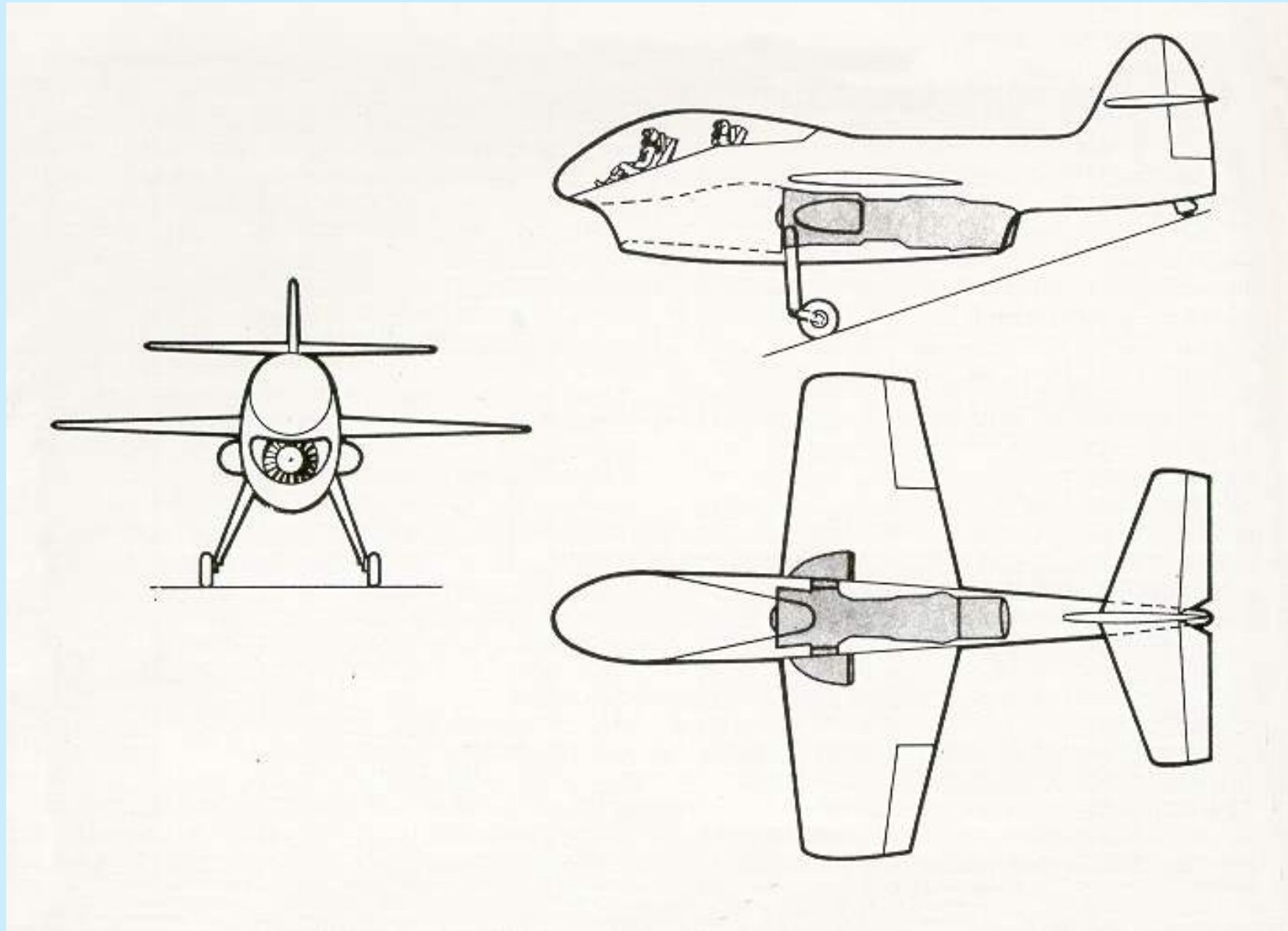
Sydney Camm's method

Camm passed the brochure to his project office and one of his young engineers ***Ralph Hooper*** decided to draw an aircraft round this BE 53 engine

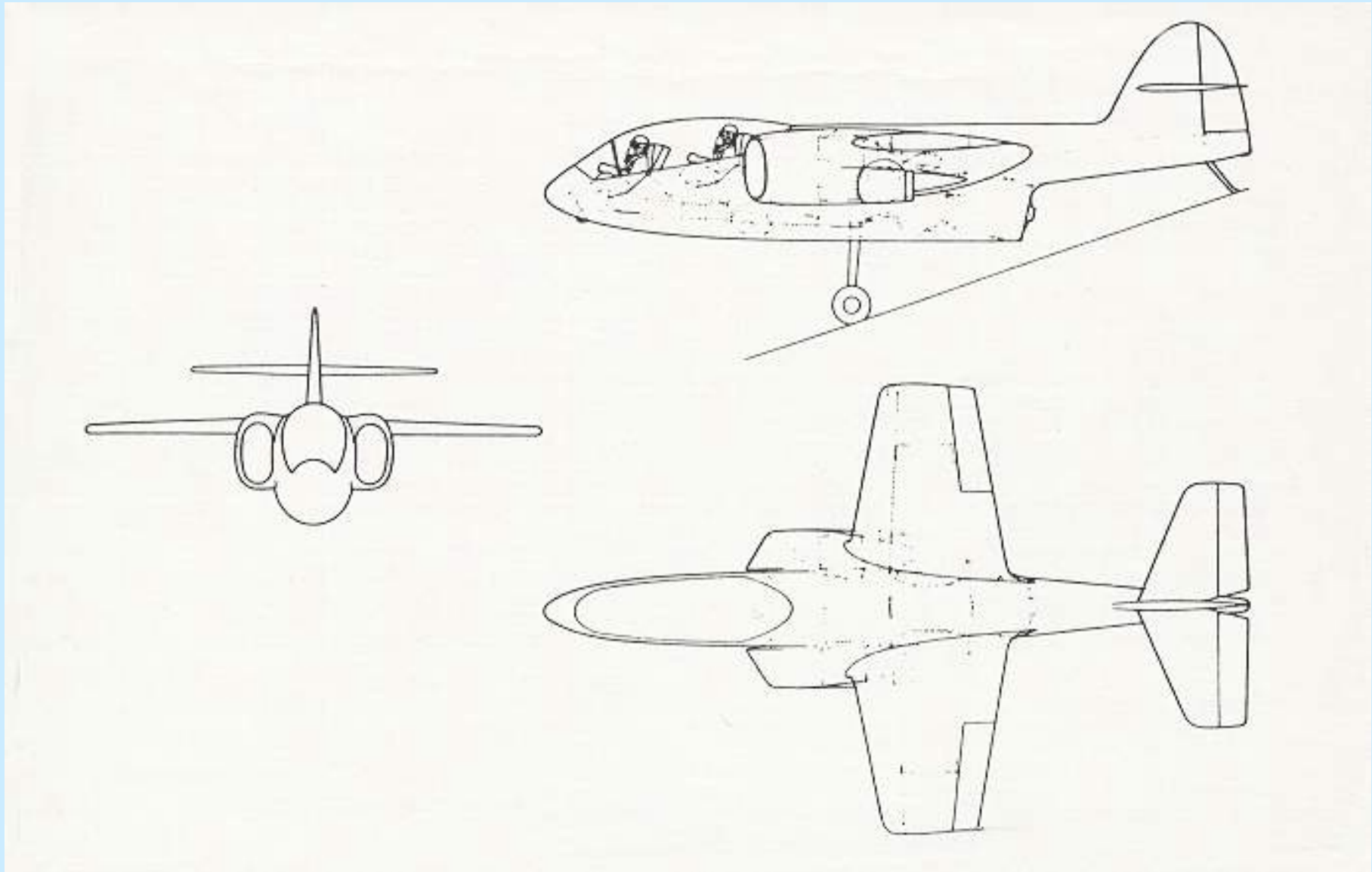
Ralph Hooper's problem – the rear exhaust



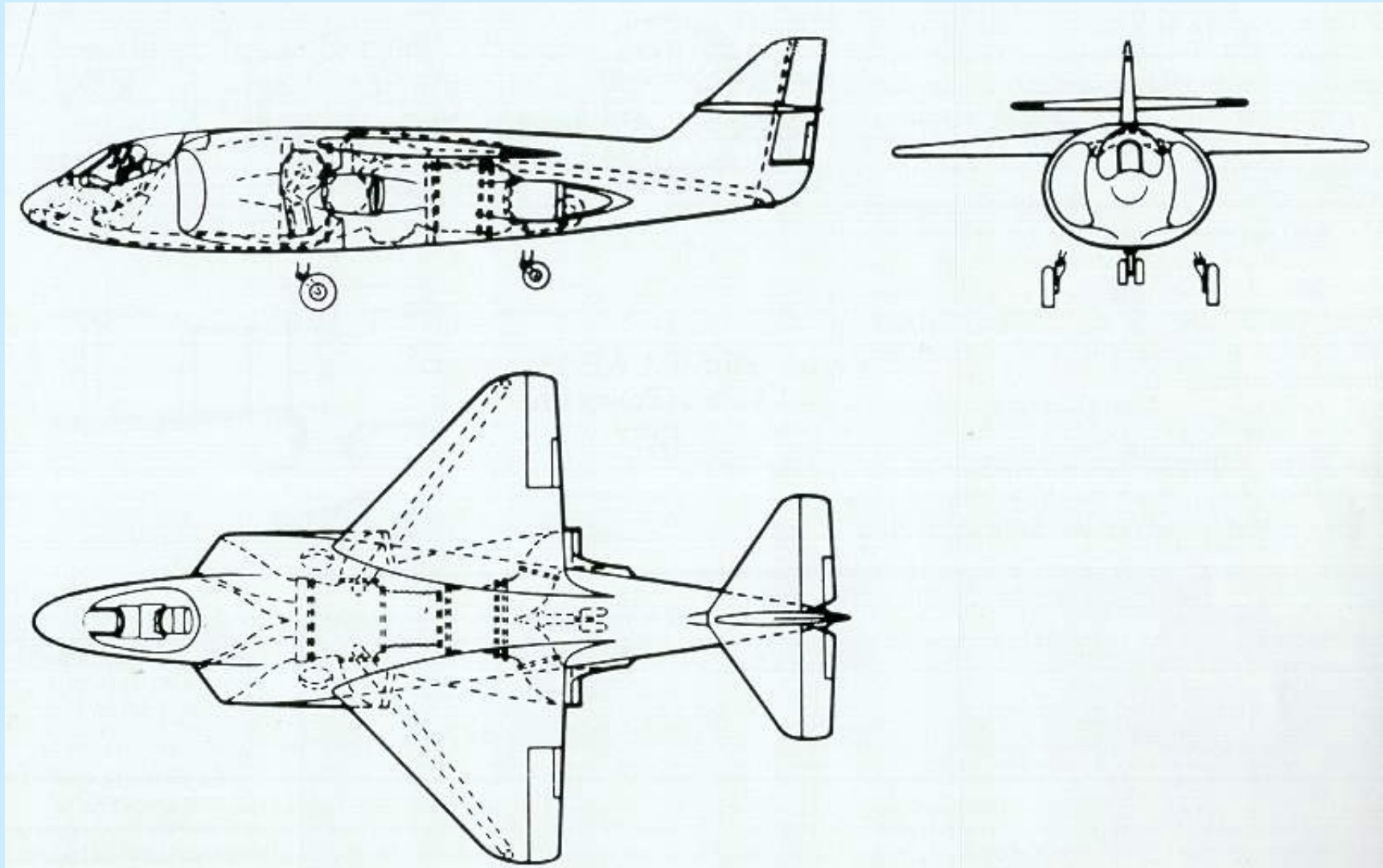
Hooper's first try nose intake – June 1957



A few days later with side intakes



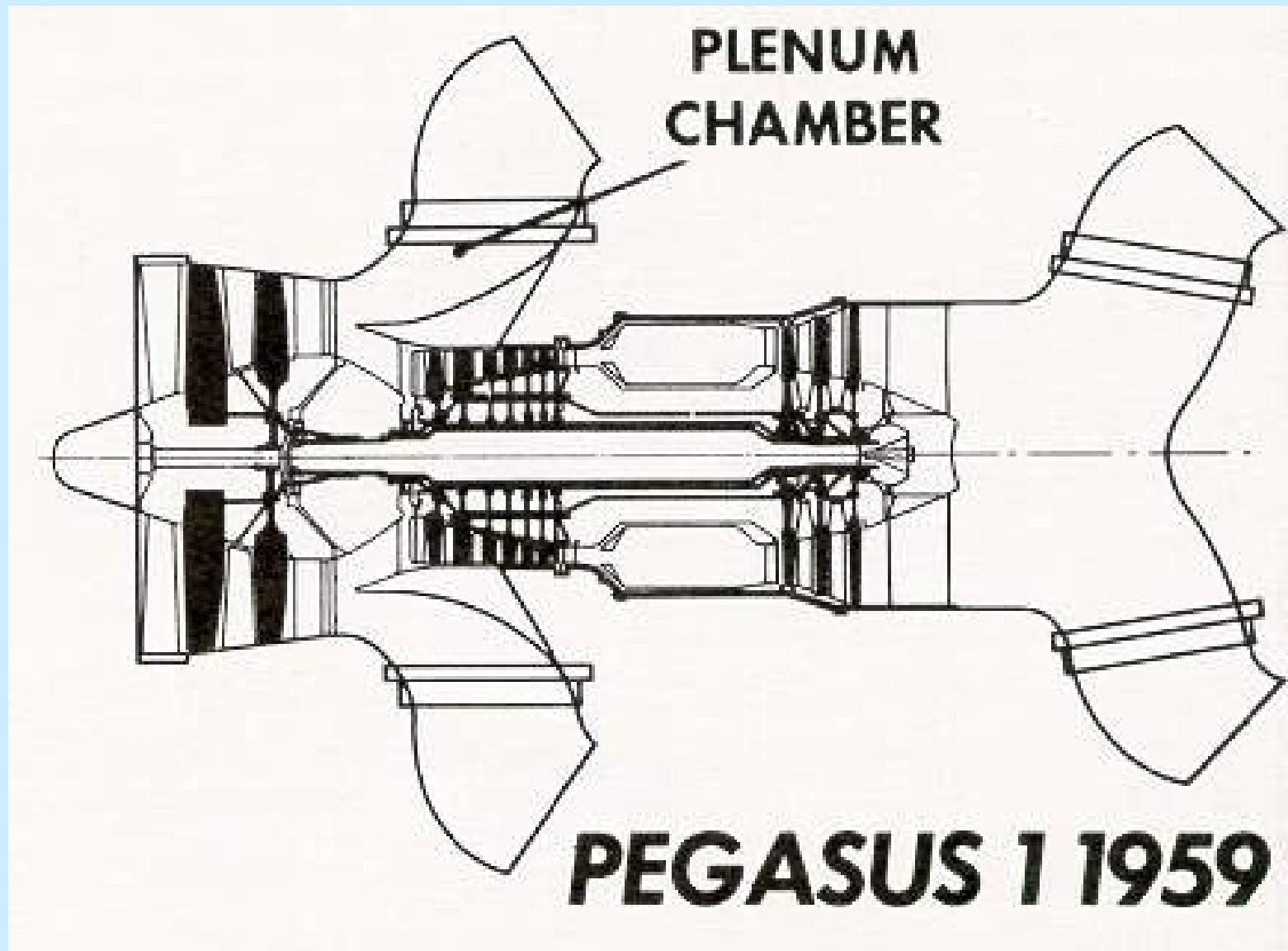
Ralph's brainwave - *split the rear exhaust*



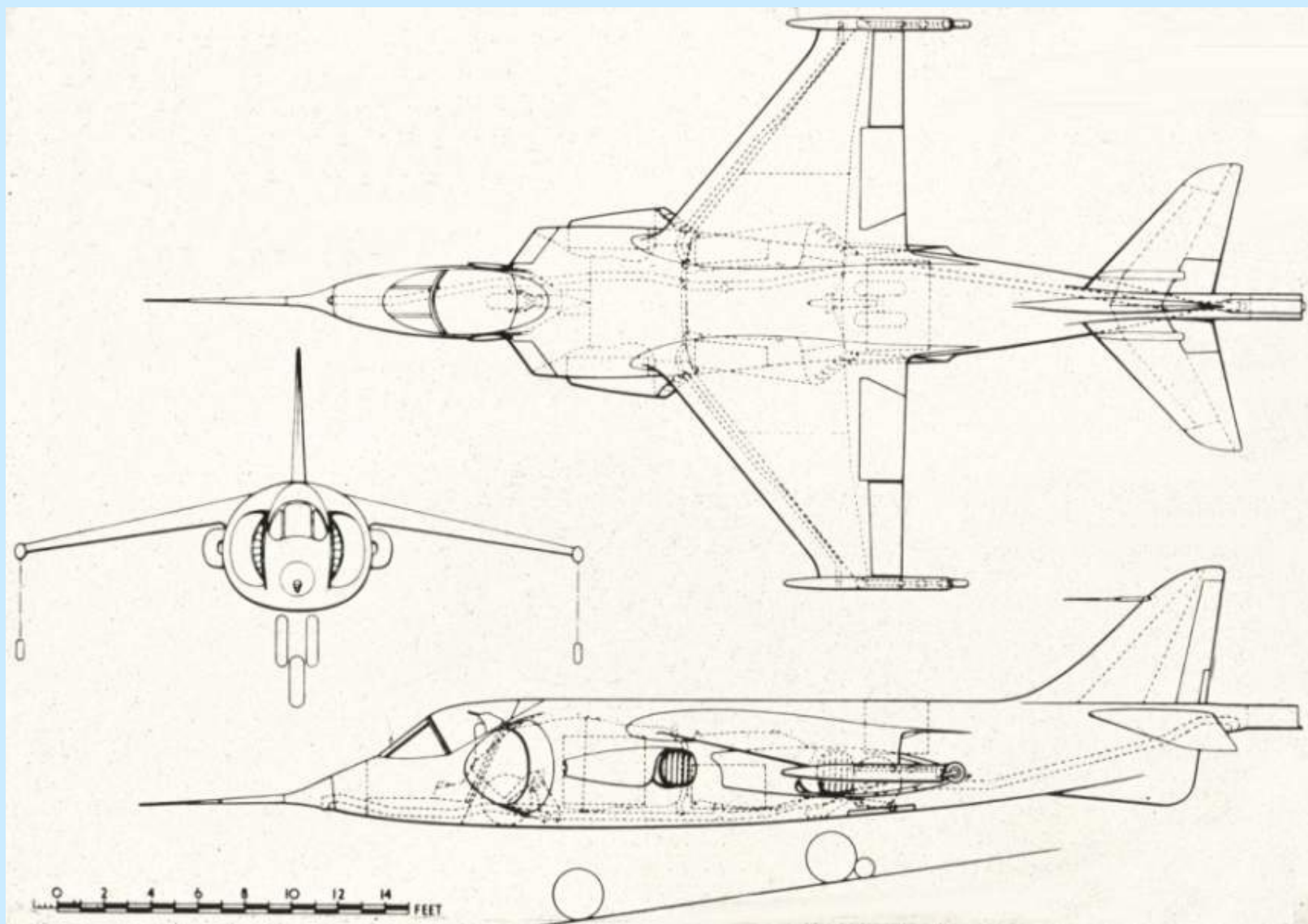
P1127

August 1957

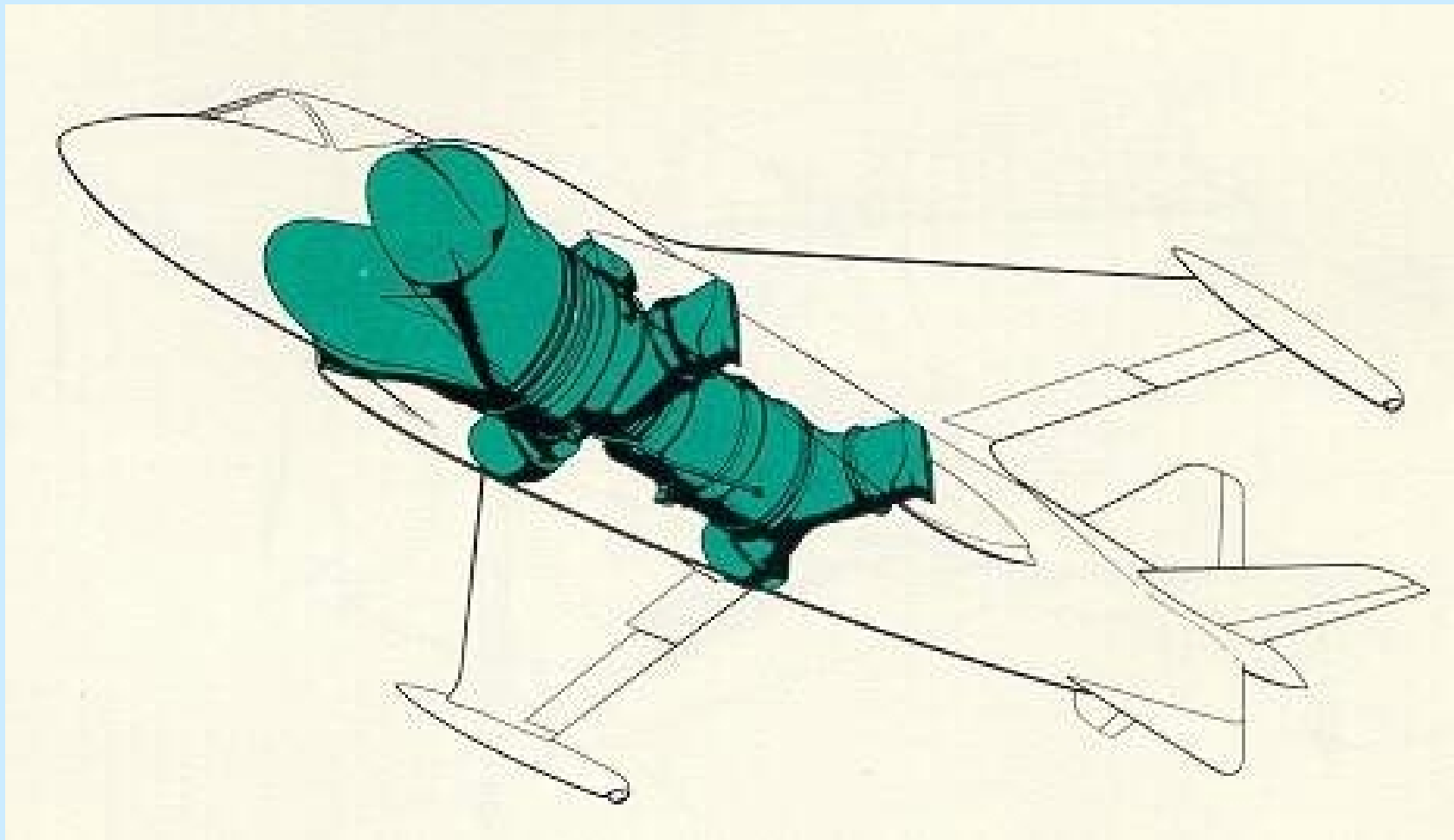
So they had a V/STOL engine at last



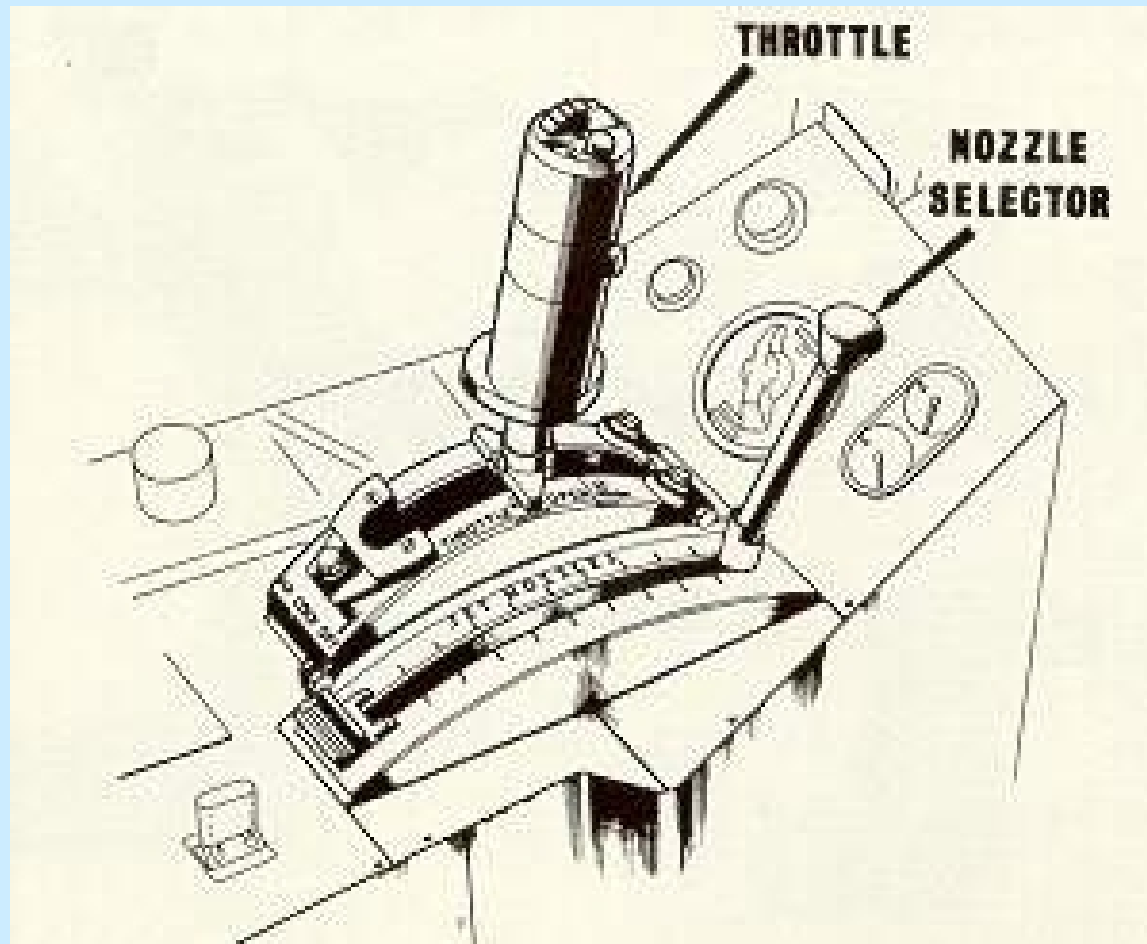
Ralph Hooper's definitive Hawker P1127



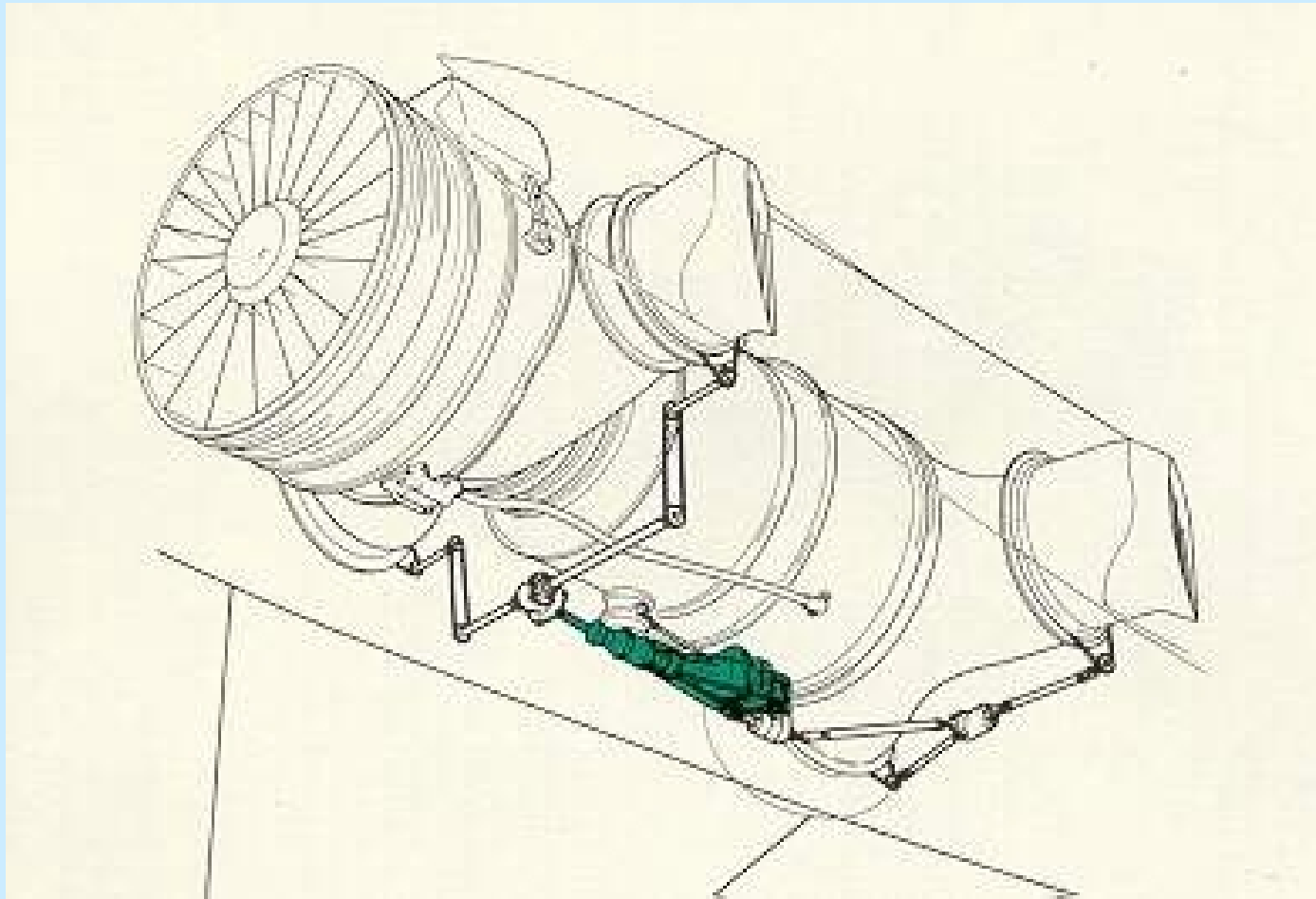
The engine installed



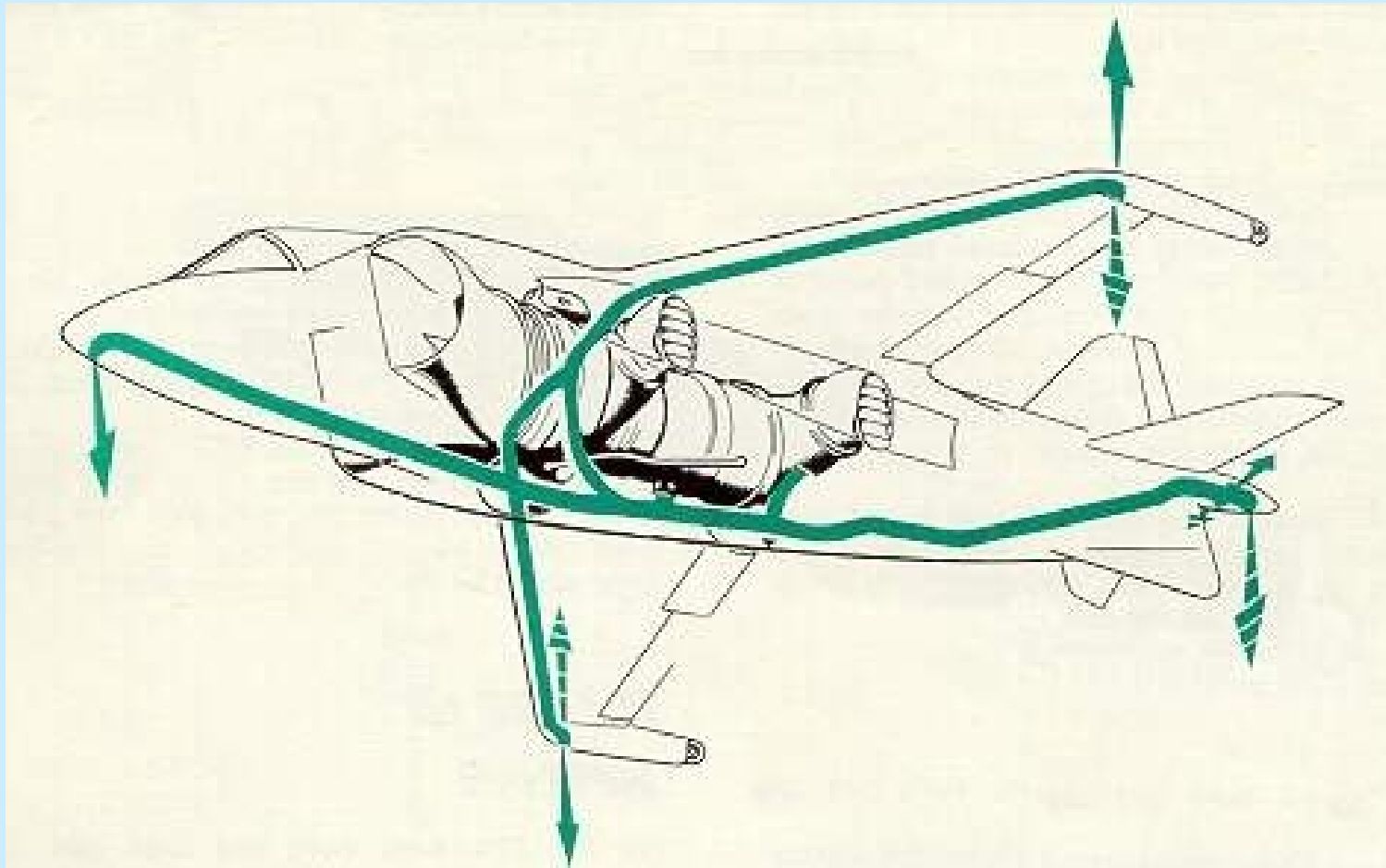
The nozzle selection lever



The nozzle actuation system



The reaction control system



A problem was born



The undercarriage needed **eight years** work



The self-shortening leg - perfection





Ship operations - USS Guam LPH class



The Ski-jump STO



The adjustable angle ramp



Trials ramp
at Bedford
showing
tramlines

Sea Harrier FRS Mk1



Farnborough 1978



Sea Harrier FA2retired in 2006



The Royal Navy single seat Sea Harrier FA2 was the first European aircraft capable of using the beyond visual range US AMRAAM missile



**GR
7**

**GR
9**

**T
10**

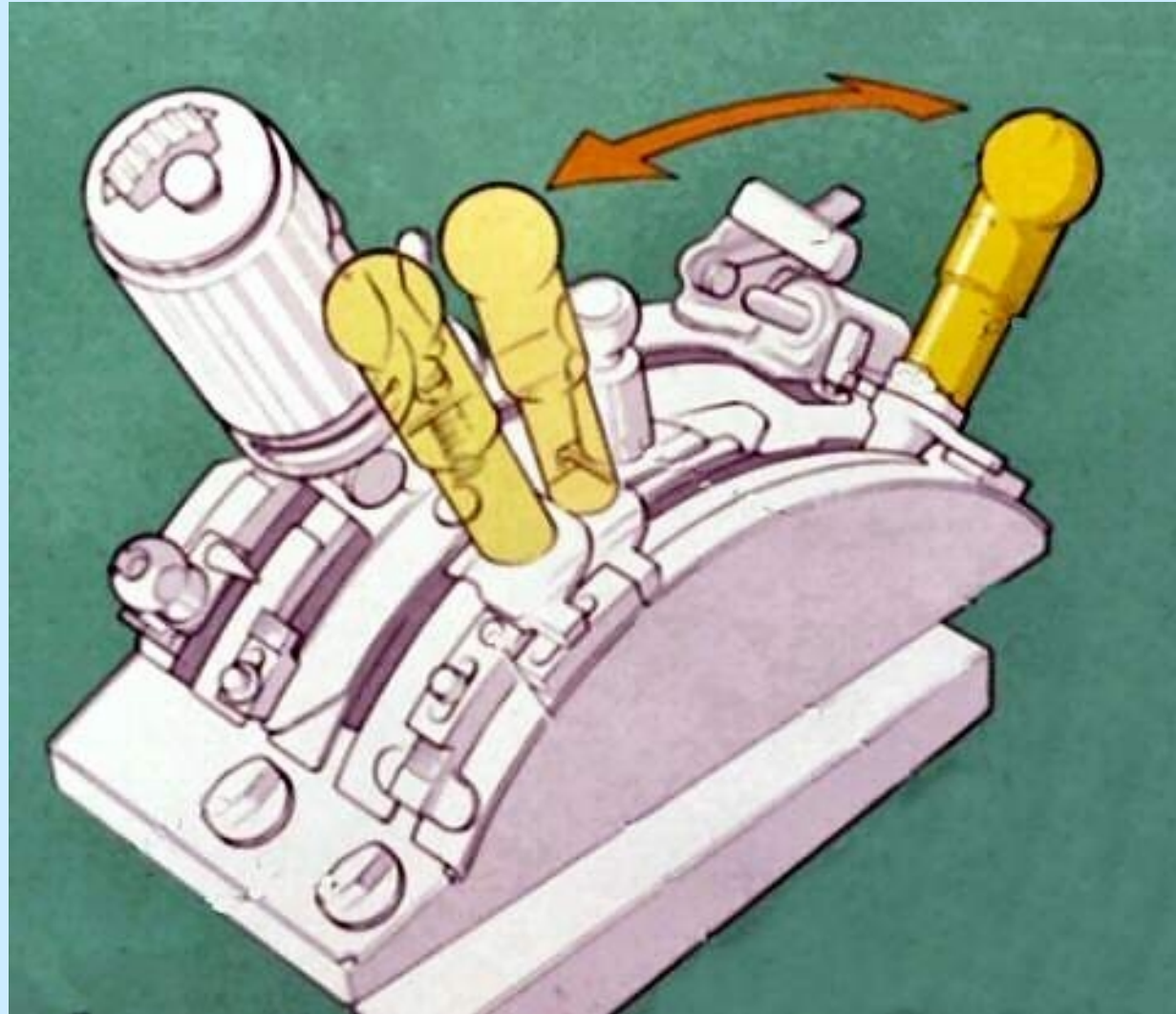
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To return to the RAE contribution.....

1970

Harrier throttle box



The VAAC Harrier



Bedford telemetry room 1993

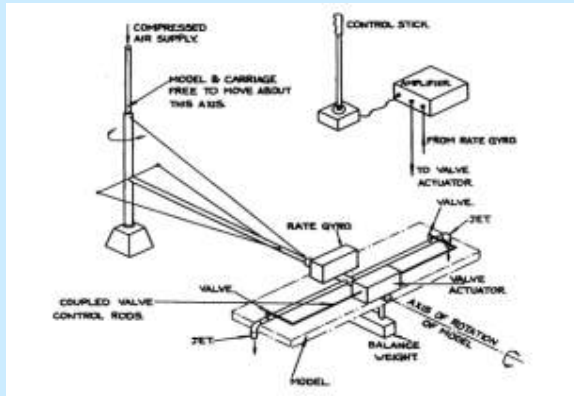


Sqn Ldr Justin Paines & JFF VAAC 1999





Worlds first automatic recovery to a deck vertical landing
HMS Invincible 16 May 2005



1952

Aero



2005

Flight



**Royal Aircraft Establishment
from RAE to DERA then QinetiQ**

JSF (JCA) is planned to be available
to replace Harriers from circa 2014

But until that golden day



Best V/STOL Bombers - Harrier GR7 and



Harrier GR9 hovering with 2 Paveway laser guided bombs and 2 AIM9L Sidewinders

(+1,100lbs at ISA conditions & +3,000lbs at ISA+35 conditions)

Harrier GR 9 – the latest version to join the JFH

But.....

*only thanks to four
British designers*



Hooper



Camm

Hooker



Lewis

and the scientists of the



Higton

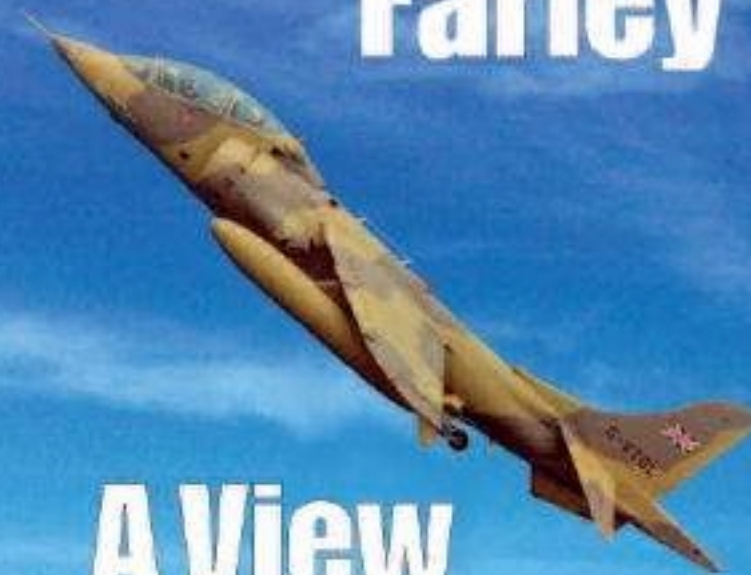
Royal Aircraft Establishment
DERA and QinetiQ



Thank you
for
your attention

*Do you have
any questions
?*

**John
Farley**



**A View
from the
Hover**

**My Life in
Aviation**



John Farley began a five-year student engineering apprenticeship at the Royal Aircraft

Establishment (RAE) Farnborough in 1950. Then he joined the Royal Air Force for pilot training as he intended to become a test pilot. After a tour flying Hunters he went to the RAF Central Flying School to train as an instructor. While a flying instructor at the RAF College Cranwell, he was selected for the 1963 course at the Empire Test Pilots' School. He was then posted to the RAE Aerodynamics Research Flight where he flew all the UK research aircraft then flying which included the Short SC1 and the Hawker P1127 prototype. This early experience of jet vertical takeoff led to nineteen years testing such aircraft until he retired as Harrier Chief Test Pilot in 1983. This was followed by five years as a freelance test pilot during which time he added another twenty types to the sixty already in his log book. Today he works to encourage youngsters to take up a career in the aerospace business. He is a chartered engineer, has received two honorary doctorates and has been awarded the OBE and the AFC.



John Farley is one of the world's most respected and admired aviation writers. His long and varied experience as a test pilot, most famously on the Harrier, makes him a leading authority on a very wide range of piloting and aviation issues.

Combine this extensive knowledge with John's inimitable and immensely readable style and you have 'A View from the Hover', a book which every pilot and aviation enthusiast will want to own. Whether it's the anecdotes about how as a young man he overcame the policy of the then Minister of Defence or his own lack of toes; whether it's his painstaking approach to test flying; whether it's the wonderfully clear explanations of the intricacies of aerodynamics or whether it's the sometimes thought-provoking, sometimes wonderfully obvious explanations of many aspects of general aviation, you won't be able to put this book down.

Since retiring from active flying, John has kept his hand in by teaching and takes special pleasure in introducing young people to the world of aviation. As you'll see in his chapters on aerodynamics and other traditionally tricky subjects, John is a clear thinker and a master of explanation.

This book is the result of a fascinating life shared with a variety of aircraft. It is a highly recommended read for anyone from aviation enthusiast to professional pilot.



John Farley

A View from the Hover

FLYER BOOKS

John Farley

A View from the Hover

My Life in Aviation

When I converted the first two USMC pilots to the aircraft in 1968, we had no two-seater, no simulator, the limited autostabs were unreliable so were left switched off and the aircraft was still seven months of development away from being cleared for RAF service. I propose you sit back and let me treat you as I did Col Tom Milker and Lt Col Bud Baker.

"And so you are invited to learn how to fly the Harrier by the master himself - John Farley. From taxiing lessons through your first vertical takeoff and landing (known as a 'push-up'), to your first complete circuit, John will explain every manoeuvre."

But as well as flying the Harrier, John will teach you about the development of the aircraft and many other types he's been involved with over the years; he'll let you in on the secrets of aerodynamics and how aeroplanes fly, and give you an insight into the life of the test pilot and how it's changed over the years. On top of that there are tips for private pilots on how to improve your flying, John's opinions on great aeroplanes of the past hundred years and much more.

You will certainly come away from this book entertained, enthused and inspired by John's passion for aviation.

£XX.XX