SPECIAL PROJECTS GROUP

AVRO AIRCRAFT LIMITED

JUNE 1959

AVROMOBILE

AVROCOACH

AVROMOBILE

AVROTRUCK

AVROMOBILE

AVROCAR

JUNE 1958

a new family of AIR VEHICLES

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AVROMOBILE

The AVROMOBILE is a new type of air vehicle, which is able to operate close to the ground and is capable of speeds of over 200 miles per hour if desired. It can be adapted for several operational applications. The design is derived from the Avro Aircraft Limited VTOL/STOL aircraft presently under investigation in the form of a full scale static test vehicle incorporating 6 ASM Viper 8 engines. The United States Air Force has supplemented this development program with subsonic, transonic and supersonic wind tunnel models, wind tunnel facilities and studies.

Technical data arising out of this research and development program is directly applicable to the three versions of the subsonic AVROMOBILE described in this brochure.

AVRO AIRCRAFT LIMITED

DECLASSIFIED IN ACCORDANCE WITH
USAF SRCL DATED JULY 25/60

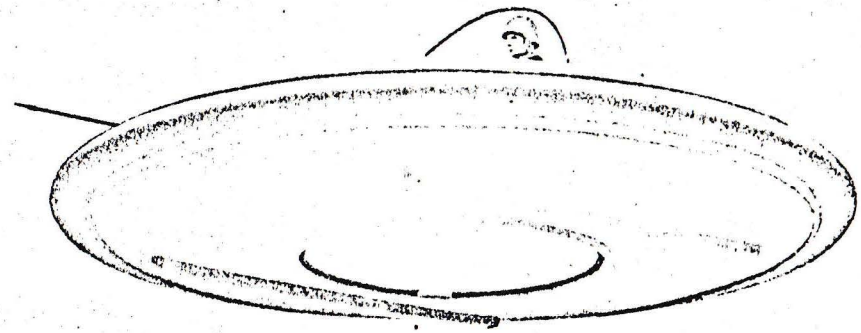
a new family of AIR VEHICLES

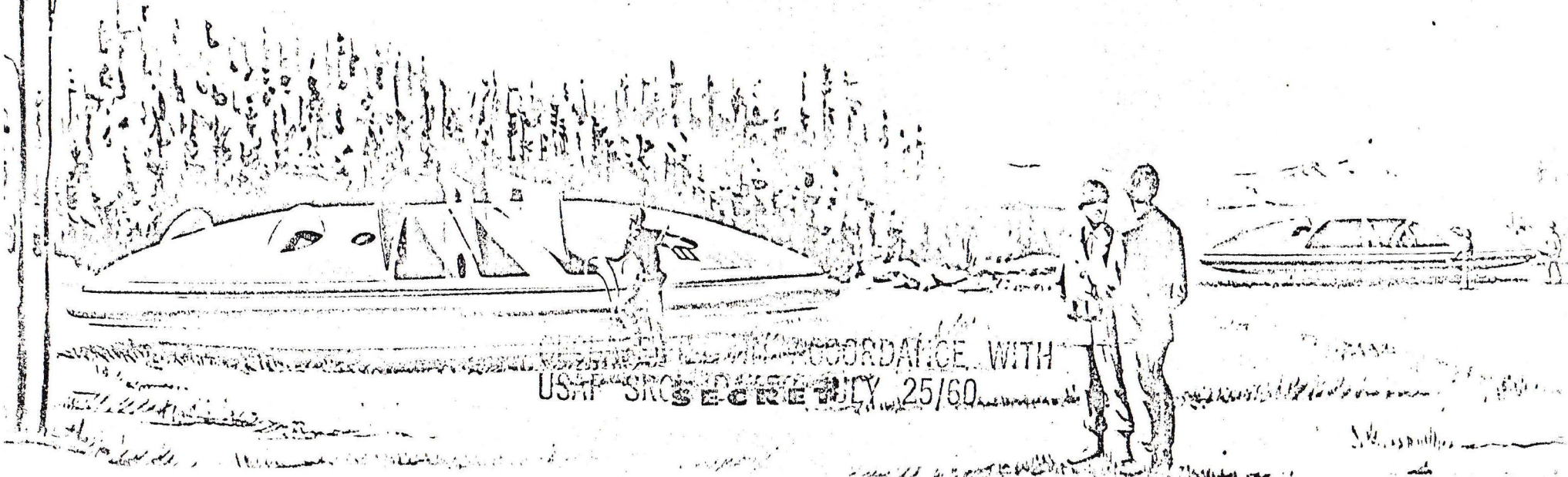
AVROMOBILE

AVROTRUCK

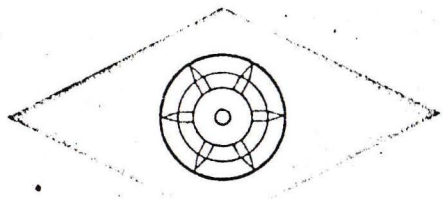
AVROGAR

AVROCOACH



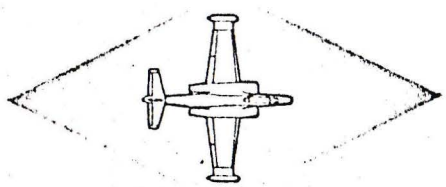


THE COMPANY - AND ITS PRODUCTS

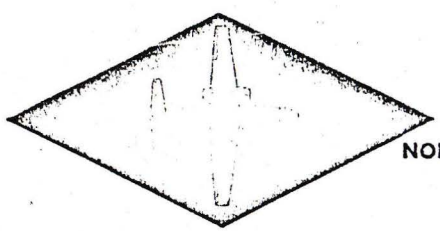


AVRO VTOL

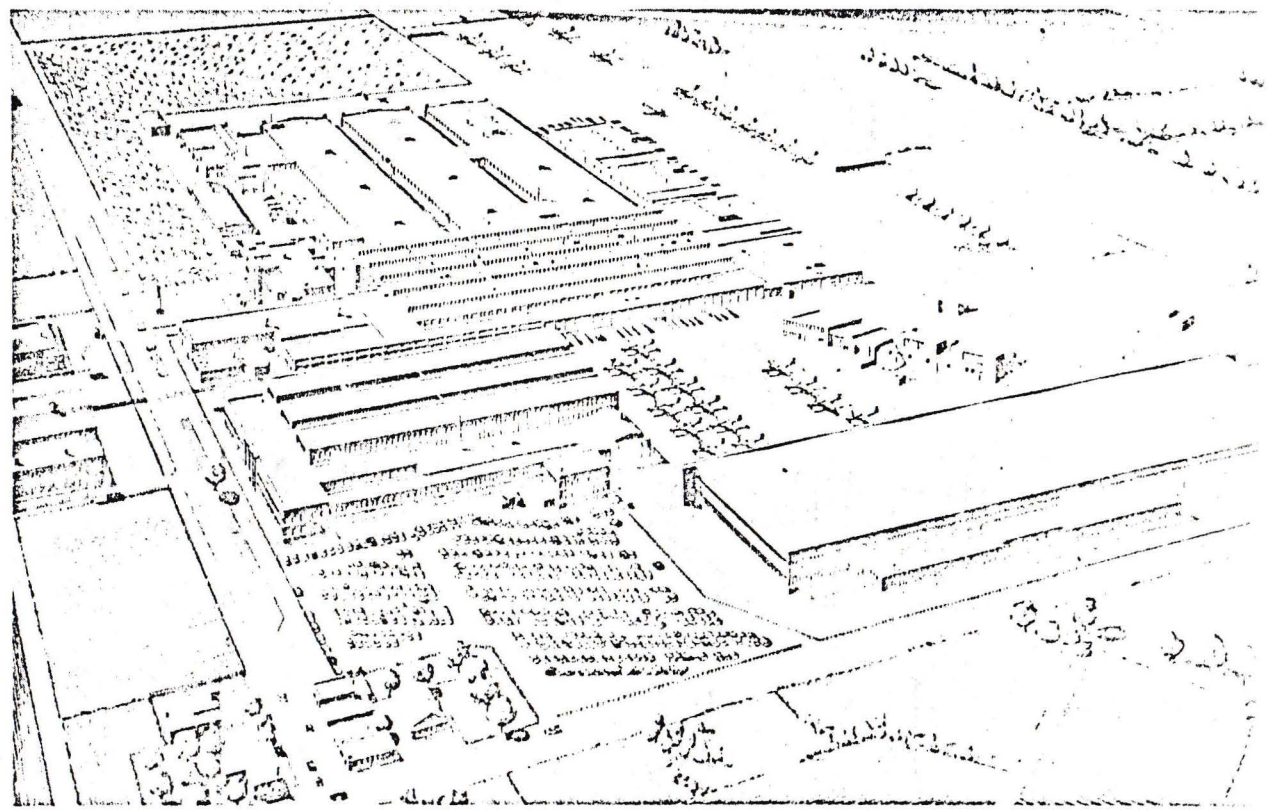
AVRO ARROW



AVRO CF-100



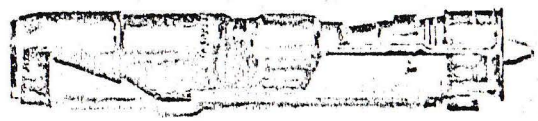
AVRO JETLINER
NORTH AMERICA'S FIRST



- OVER 9,500 EMPLOYEES
- 1,700,000 SQ. FT. FLOOR SPACE

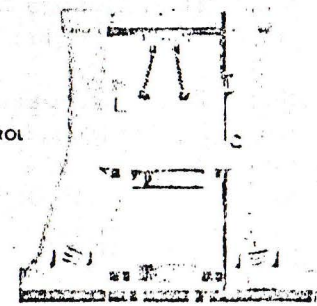
THE FAMILY

CANADIAN STEEL WHEEL LIMITED

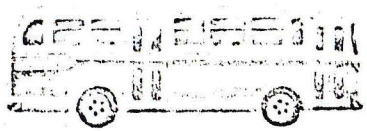


ORENDA ENGINES LIMITED

CANADIAN THERMO CONTROL COMPANY LIMITED



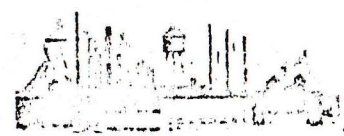
CANADIAN STEEL IMPROVEMENT LIMITED



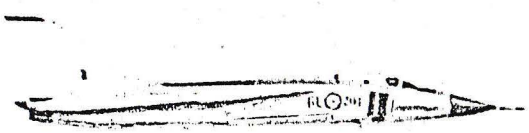
CANADIAN CAR COMPANY LIMITED

THE ROE GROUP

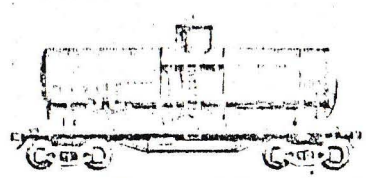
CANADIAN STEEL FOUNDRIES (1956) LIMITED



DOMINION STEEL AND COAL CORPORATION LIMITED



AVRO AIRCRAFT LIMITED



CANADIAN GENERAL TRANSIT COMPANY LIMITED

CANADIAN APPLIED RESEARCH LIMITED

THE RECORD

The Aircraft Division of A. V. Roe Canada Limited started operations in 1945. Reorganized in 1955 as Avro Aircraft Limited, it is the only Canadian aircraft company owning its own research, design, development and production facilities. It is a single integrated unit with everything necessary to design and manufacture aircraft from initial conception to delivery.

As early as 1946, three projects were in progress. The Avro Jetliner pioneered jet transport on the North American continent, when its design and development were culminated by flight in August 1949. This project was shelved to meet Canadian defense commitments arising from the Korean war, all efforts being concentrated on the development and production of the CF-100 twin jet, all-weather day and night interceptor.

Several hundred aircraft of this type, including trainer versions, have been produced for use by Royal Canadian Air Force squadrons in the defense of both North America and NATO countries in Europe.

The CF-100 has also been selected by the Belgian Air Force to fulfill its NATO commitments. The first two squadrons have already been delivered.

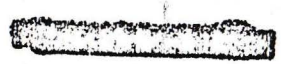
In March 1958, the successor to the CF-100 successfully completed its maiden flight and three weeks later achieved speeds in excess of 1000 mph. This is the Avro ARROW, a 60,000 lb. supersonic all-weather delta interceptor powered by two Pratt and Whitney J75 engines, and equipped with the most modern fire control system and guided missiles.

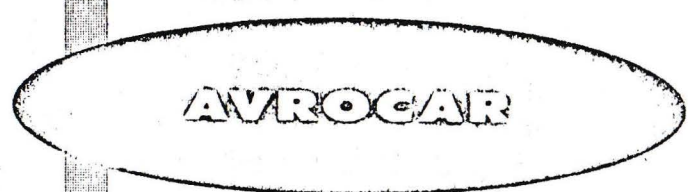
The Arrow 2 will be powered by the Iroquois, one of the most powerful turbojet engines in the world, designed and built by Orenda Engines Limited.

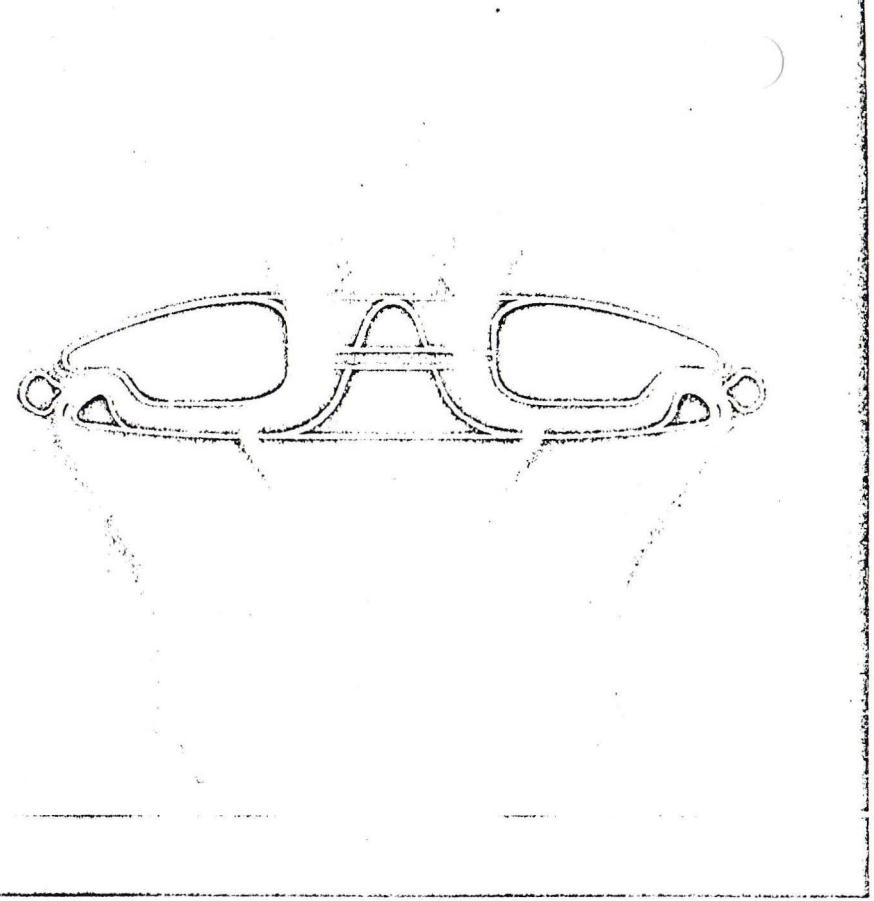
Since 1955 Avro has been directly engaged in an R & D program directed towards development of flat VTOL supersonic aircraft under Company-sponsored P. V. 704, USAF Project 1794 and USAF Research System 606A. Recently the USAF redirected a portion of its Research System 606A funds to support the Avrocar development program.

Introducing THE CONCEPT

Avro Aircraft Limited has been active in the investigation and development of various forms of VTOL/STOL aircraft for more than five years. Initial effort was focussed on a "tail-sitter" aircraft which was later discarded in favour of a flat VTOL vehicle because of the fundamental advantages of the latter. In 1953 the basic concept of what has become the Avro VTOL design was established. This design integrates a versatile propulsion system into a circular planform to combine efficient VTOL/STOL characteristics with outstanding mission performance capability.







How it works

Primary power is provided by J69-T-9 turbojet engines driving a single stage turborotor, which in turn draws in air through an intake located on the wing upper surface.

This air is diffused radially outwards to an annular nozzle at the wing periphery.

To take off, spoilers located in the nozzle throat are operated to deflect the air downwards forming a circular curtain of air. The throttle is opened and the vehicle leaves the ground at low power to float in the ground cushion, rising steadily to a greater height in the cushion as the power is increased.

The vehicle may be operated to move or to hover entirely within the ground cushion at extremely low speeds and altitudes. Transition to forward flight at any altitude is effected by operating the spoilers to redirect the air backwards over the lower and upper wing surfaces to form a jet flap at the rear. As the vehicle accelerates forward it is inclined upward; the jet flap at the rear of the wing induces a large lift coefficient. This, together with the low wing loading, enables the entire weight of the vehicle to be supported aerodynamically at speeds as low as 45 miles per hour.

In landing, descent is made at constant power until the presence of the ground is sensed as the vehicle enters the ground cushion. The throttle is then progressively closed to settle the vehicle onto the ground.

DESCRIPTION

The AVROMOBILE is conceived as an all-wing design of circular planform having a thickness to chord ratio of approximately 20%. The wing section is symmetrical about the vertical centerline and elliptical in profile.

The structure is fabricated from aluminum alloy in all areas not affected by engine exhaust temperature. The design of the vehicle lends itself to conventional methods of fabrication and manufacture.

The main structure consists of a center base and three similar segments. When assembled these units together form an integral structure of radial ribs and circular spars contained by internal and external skins.

The top surface of the vehicle consists of doors, cowlings, access panels and cockpit enclosures supported on vertical partitions.

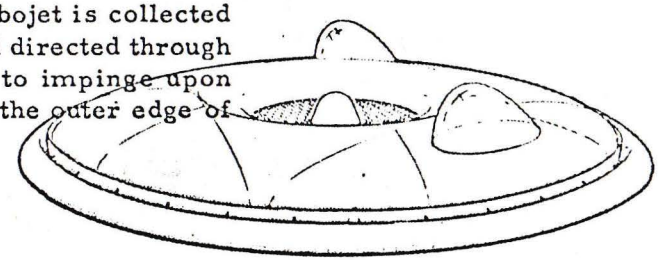
The circular wing tip is assembled to the main structure in segments to complete the peripheral exhaust outlets.

The turborotor assembly is an integral unit which is installed within the main structure and is supported from the center base.

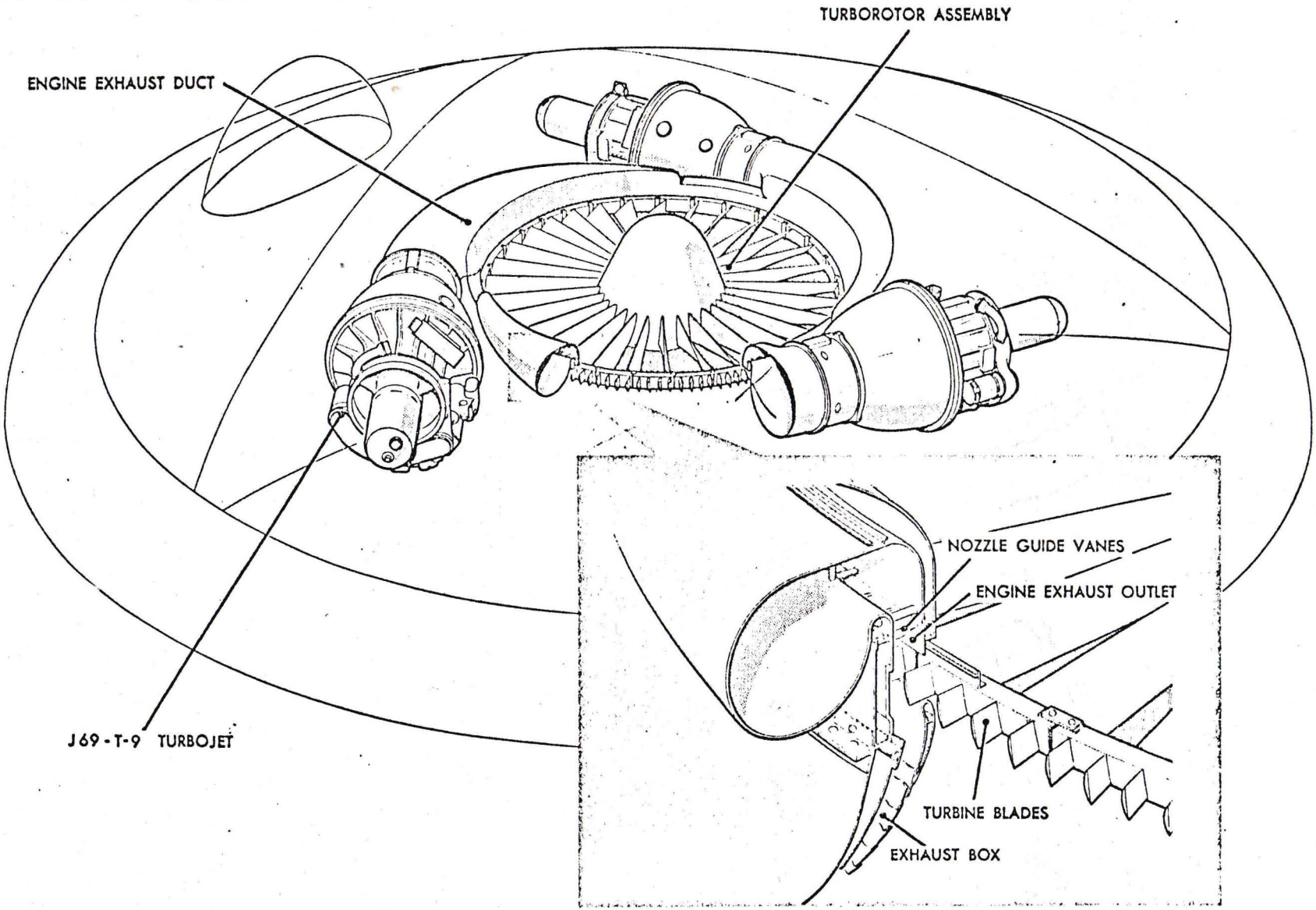
The symmetry of the circular planform configuration leads to an economy of parts, thereby reducing construction time and cost.

The primary power plant consists of three turbojet engines used as gas generators. These engines are symmetrically disposed with their exhausts directed tangentially inboard to drive the turborotor. Air for the turbojet engines is supplied from the rotor through three intake ducts within the main structure.

The exhaust from each turbojet is collected in a cochleate chamber and directed through the nozzle guide vanes to impinge upon turbine blades attached at the outer edge of the turborotor assembly.



ENGINE INSTALLATION



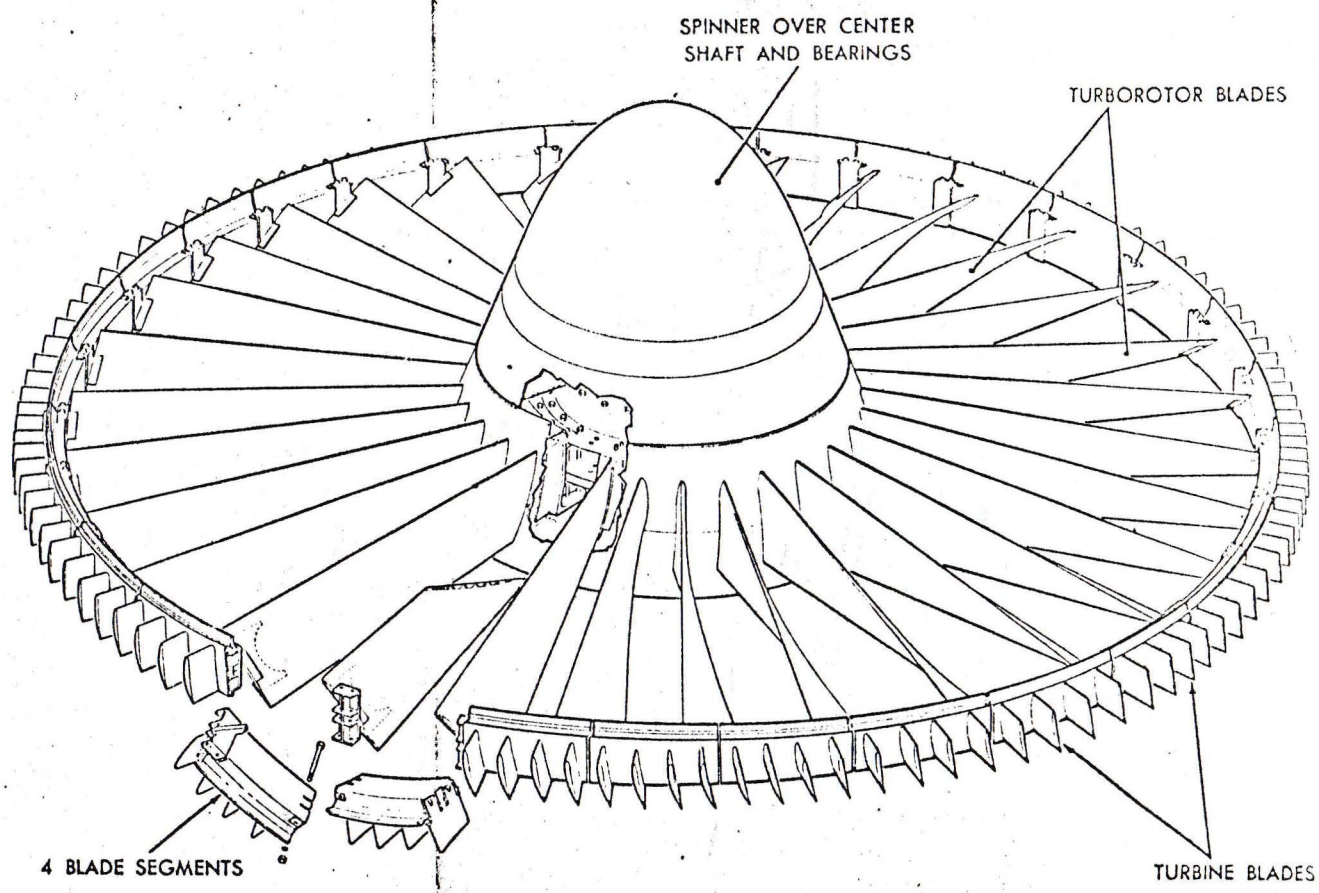
TURBOROTOR ASSEMBLY

The turborotor arrangement is extremely simple in design and light in weight, having a moderate tip velocity of 788 ft./sec. The turborotor is mounted horizontally in the center of the structure and rotates on a pair of tapered roller bearings mounted on a central vertical shaft.

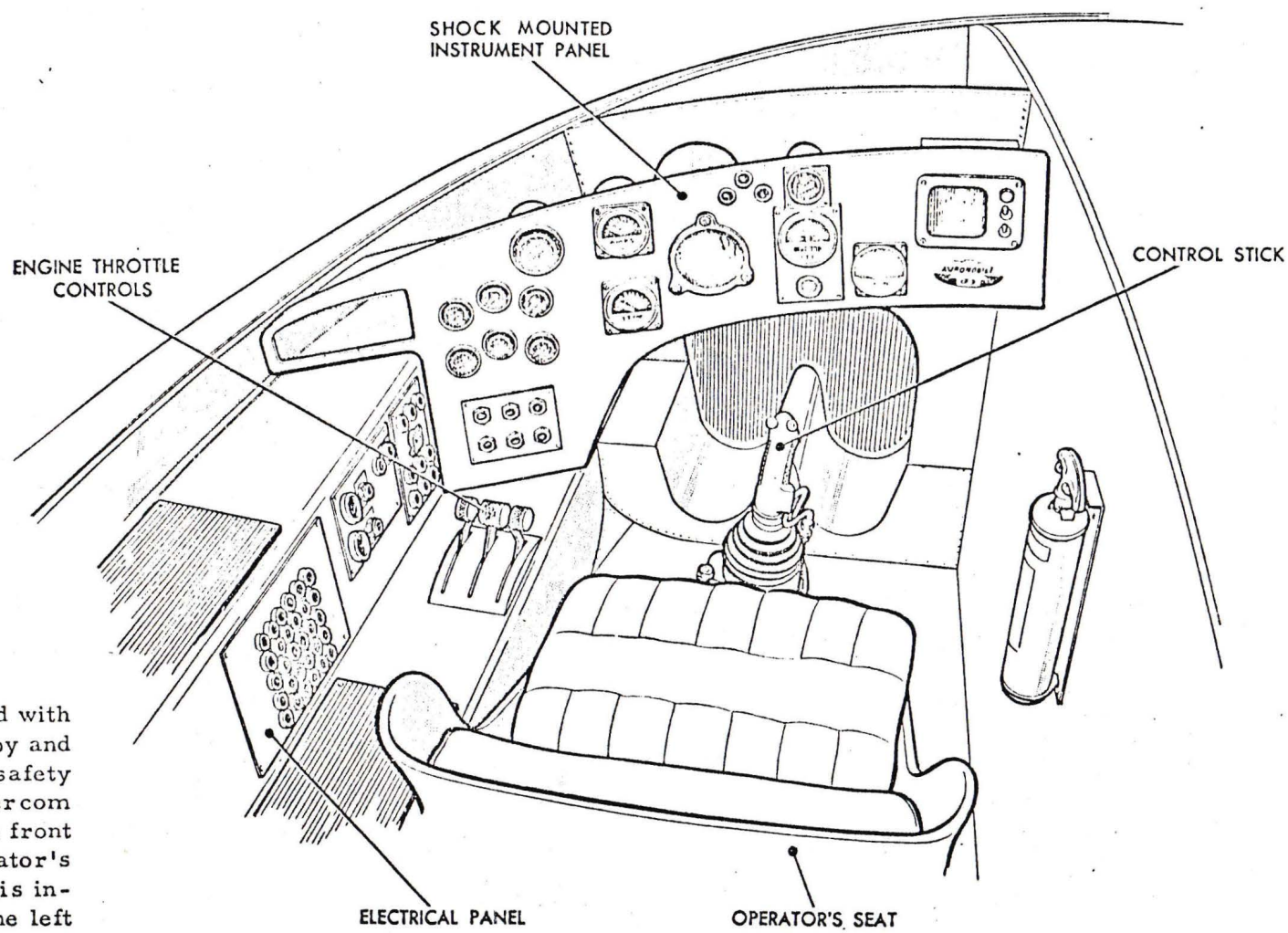
Lubrication and cooling of the bearings are effected by an integral oil pressure system.

The turborotor assembly, which acts as a large gyroscope is mounted on a spherical bearing and is allowed the freedom of a very small angle normal to the axis. The gyroscopic precessional motion is coupled into the flying control system to give the vehicle automatic stability.

In operation, air is drawn through a circular intake from the wing upper surface and directed radially outwards through diffuser passages which form part of the wing lower structure.

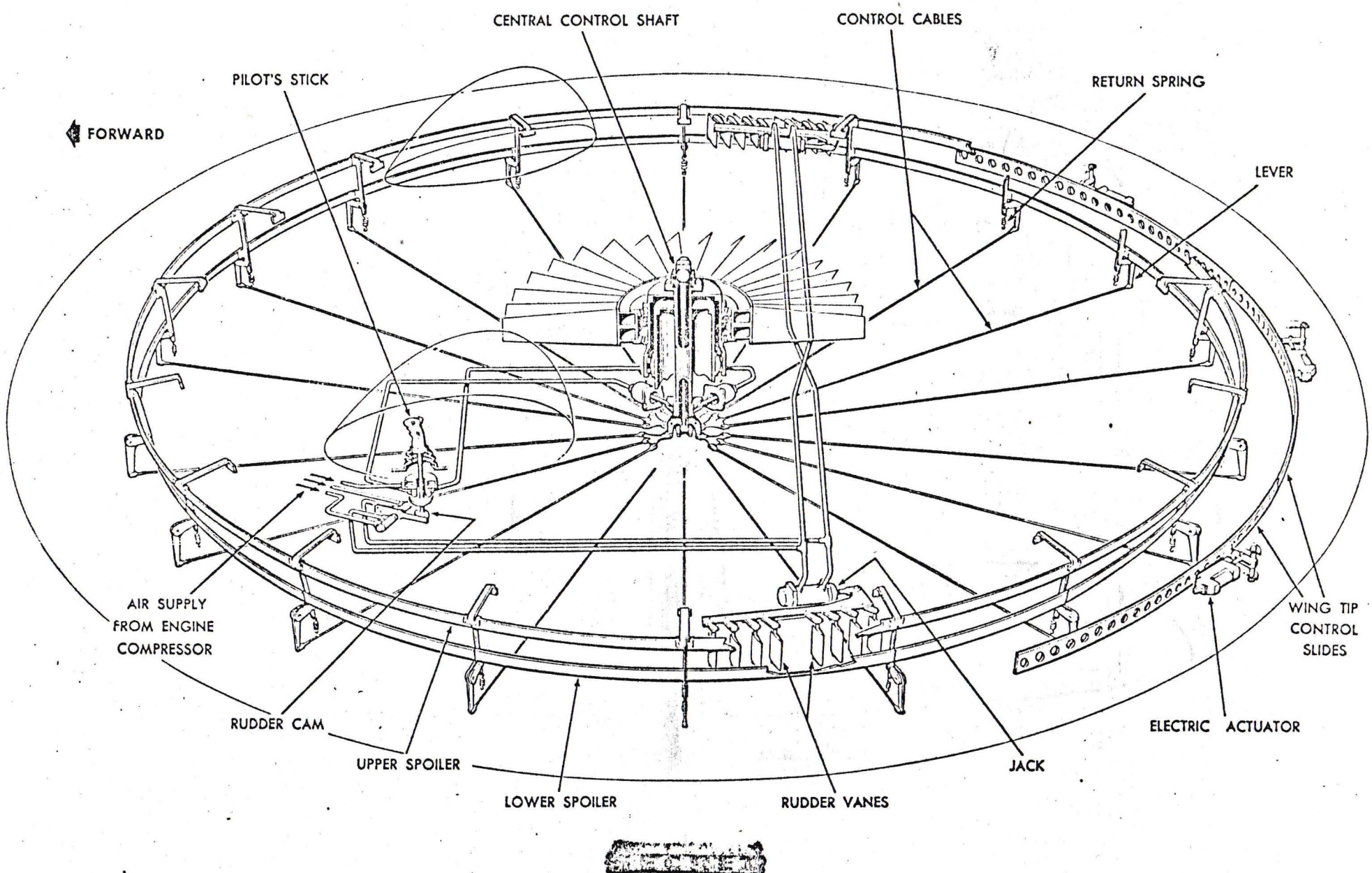


OPERATOR'S CAB LAYOUT

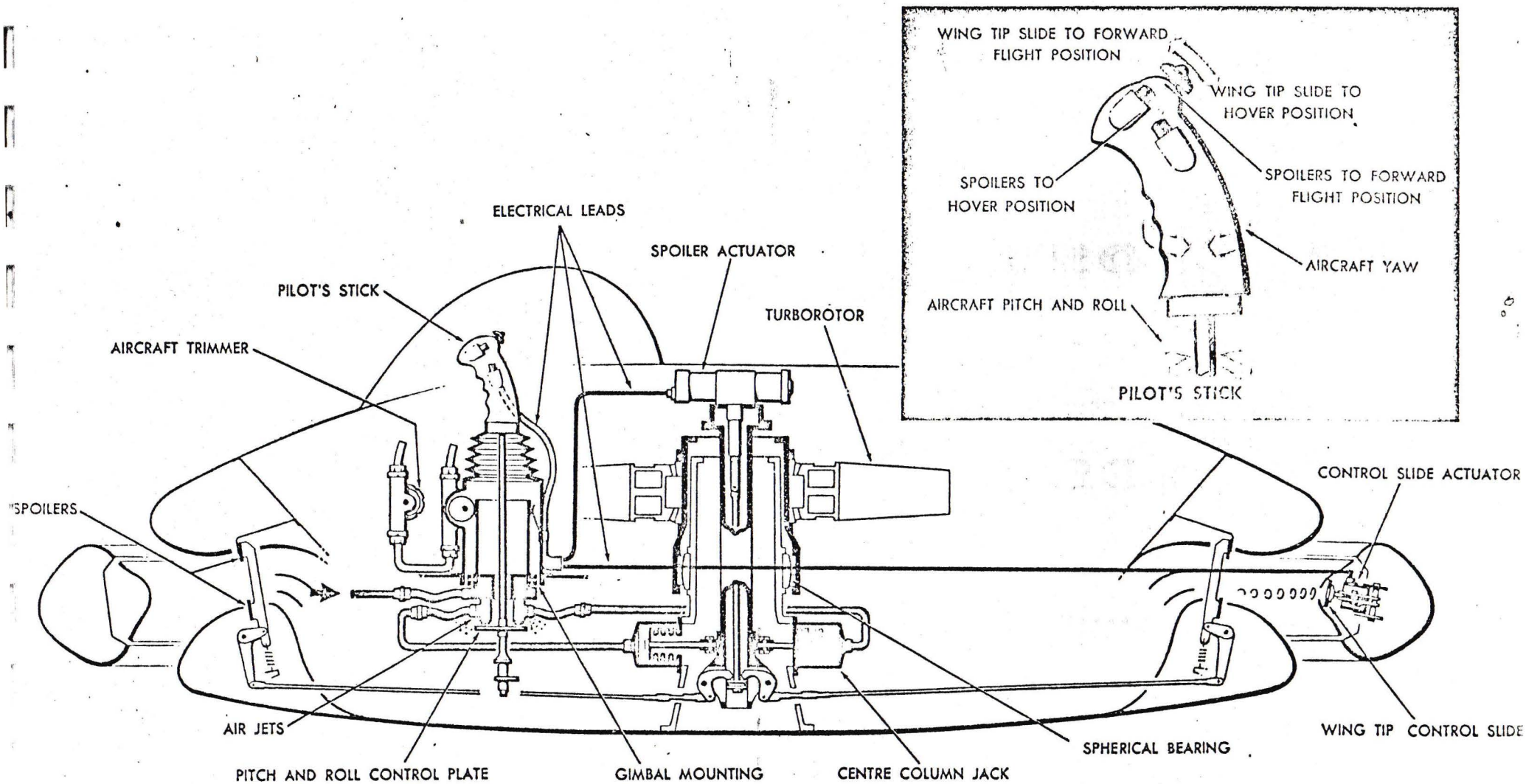


Each enclosure is furnished with a reinforced plexiglas canopy and a bucket seat embodying safety harness. Radio and intercom equipment is installed at the front and to the right of the operator's cab; electrical equipment is installed at the front and to the left of the operator's cab.

CONTROL SYSTEM



CONTROL MECHANISM - SCHEMATIC

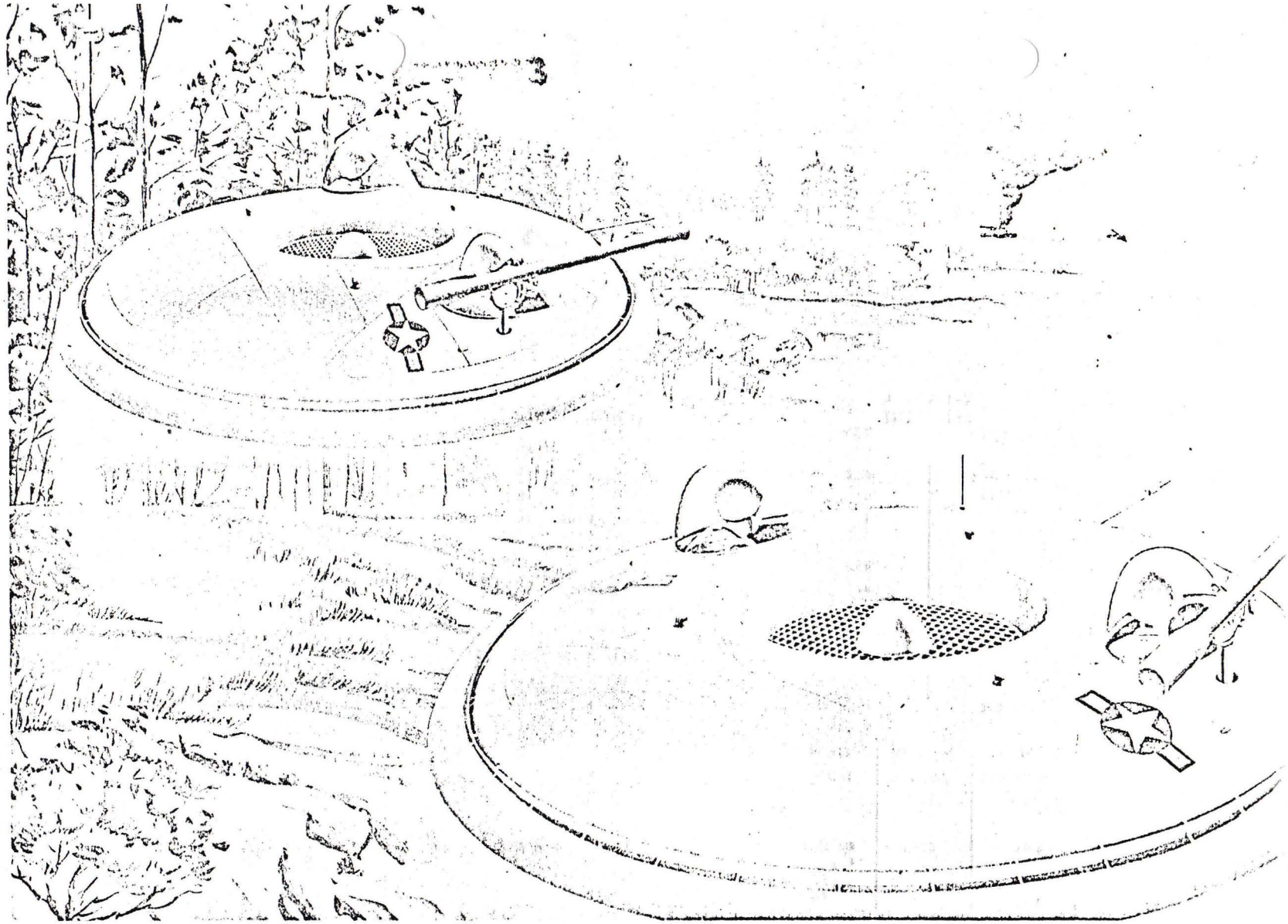


AVROCOACH

Leading Particulars

AVROTRUCK

AVROCAR



AVROCAR

Leading Particulars

DIMENSIONS AND WEIGHTS	3 J69-T-9 TURBOJETS
DIAMETER = SPAN	18 FT.
GROSS WING AREA	254 SQ. FT.
HEIGHT ABOVE GROUND TO TOP OF CANOPY	4.8 FT.
ASPECT RATIO	1.27
THICKNESS/CHORD RATIO	20%
MAXIMUM V.T.O.L. PAYLOAD	2,020 LB.
MAXIMUM CAPACITY PAYLOAD	3,000 LB.
MAXIMUM FUEL CAPACITY	177 U.S. GALS.
MAXIMUM GROSS WEIGHT FOR V.T.O.L.	5,650 LB.
EMPTY WEIGHT	2,820 LB.
TAKE-OFF WING LOADING AT MAXIMUM GROSS WEIGHT FOR V.T.O.L.	22.2 LB./SQ. FT.

PERFORMANCE

SPEED AND CLIMB	
MAXIMUM SPEED AT SEA LEVEL	225 KT.
RATE OF CLIMB AT SEA LEVEL	4,500 FT./MIN.
CEILING (PROVISIONAL LIMIT)	10,000 FT.

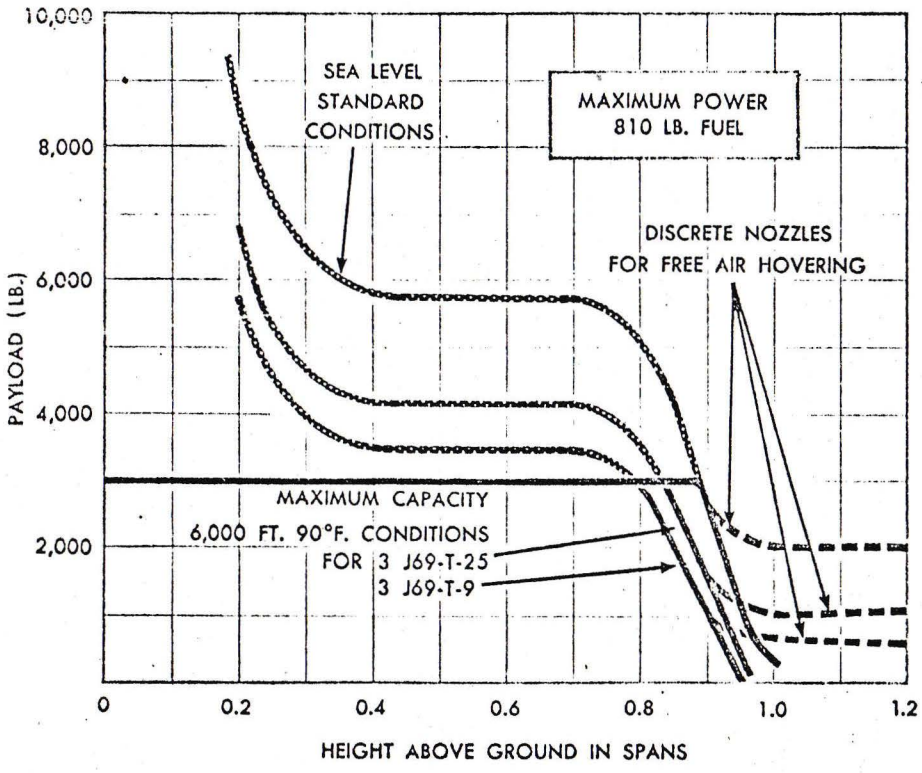
PERFORMANCE CURVES SHOWN ON PAGES 18, 19.

PERFORMANCE CONT'D	3 J69-T-9 TURBOJETS V.T.O.L.	S.T.O.L.
RANGE PAYLOAD		
PAYLOAD (LB.)	2,020	3,000†
RANGE AT SEA LEVEL (N. MILES)	105	130*
RANGE AT 10,000 FT. (N. MILES)	115	
PAYLOAD (LB.)	1,700	
RANGE AT SEA LEVEL (N. MILES)	140	
RANGE AT 10,000 FT. (N. MILES)	175	
MAXIMUM FERRY RANGE WITH SPECIAL TANKS (CRUISE AT SEA LEVEL) CREW ALLOWANCE 250 (LB.) (N. MILES)		570

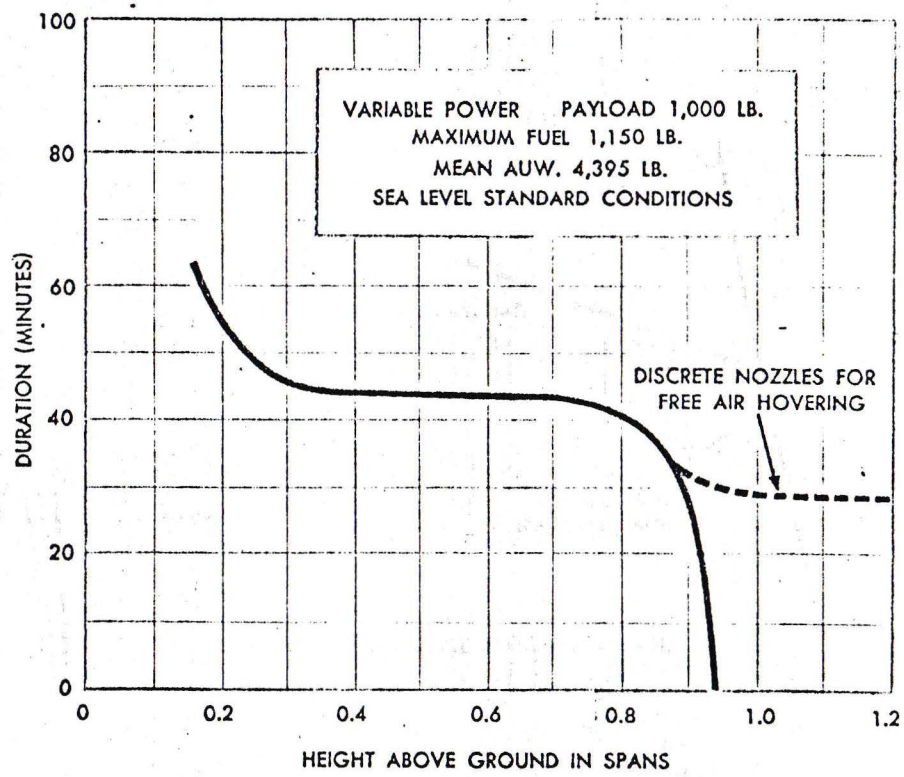
HOVERING	HOVER HEIGHT	MAXIMUM PAYLOAD (LB.)	HOVER DURATION (MINS.)
SEA LEVEL STANDARD DAY	FREE AIR	2,020	28 ↓
	12 FT.	3,000†	44 ↓
	3.5 FT.	3,000†	57 ↓
6,000 FT., HOT DAY	FREE AIR	650	
	12 FT.	3,000†	
	3.5 FT.	3,000†	

↓PAYLOAD 1,000 LB. *LIMITED BY FUEL CAPACITY †LIMITED BY CARGO CAPACITY

AVROCAR-HOVERING PERFORMANCE

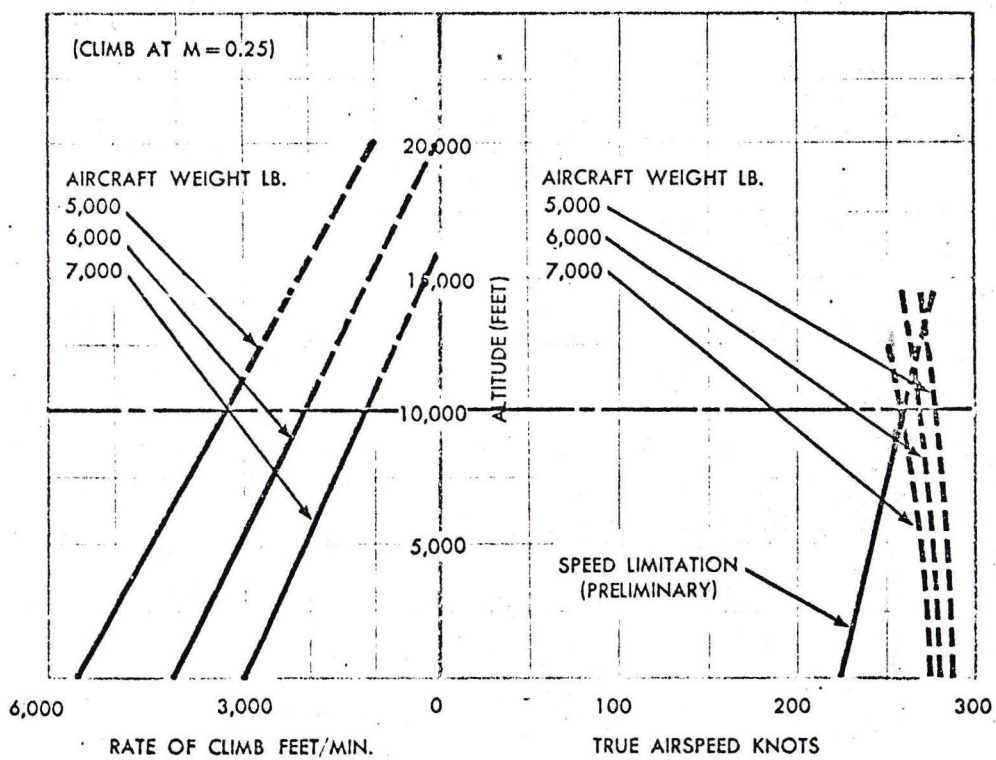


STATIC LIFTING PERFORMANCE

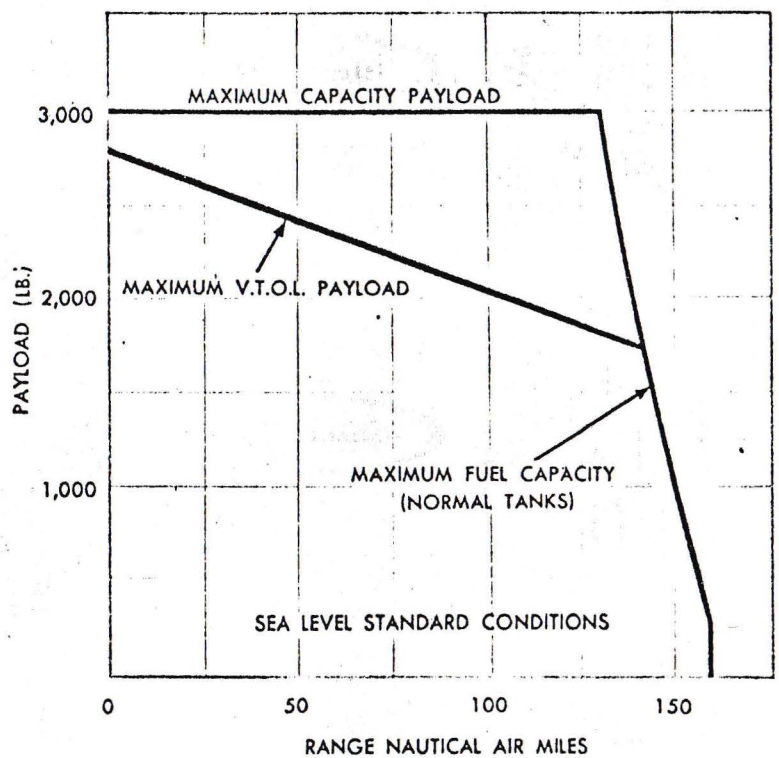


HOVERING ENDURANCE

AVROCAR-FLIGHT PERFORMANCE

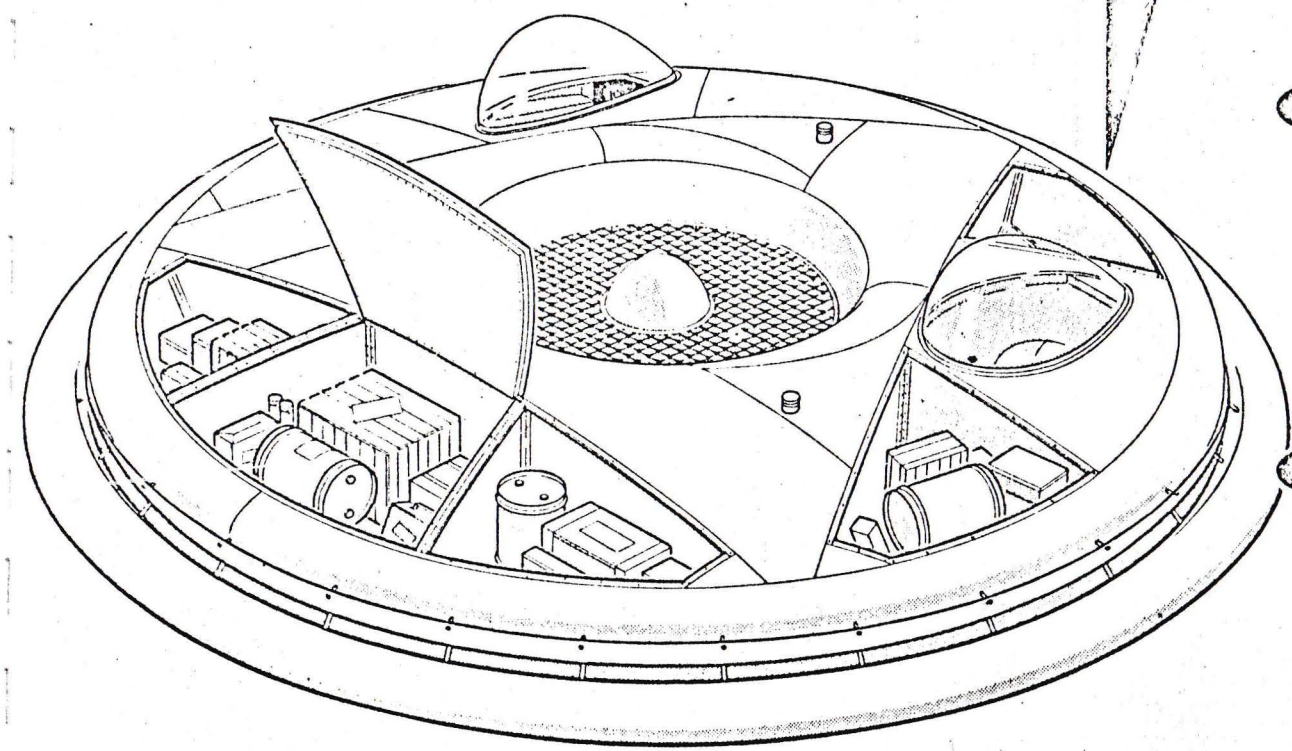


SPEED AND CLIMB

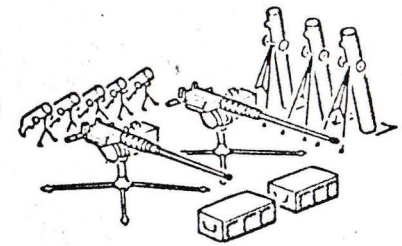


RANGE VS. PAYLOAD

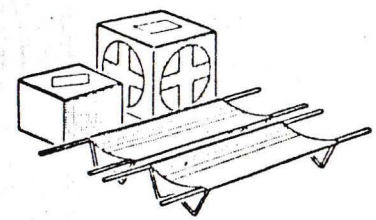
CARGO STOWAGE ARRANGEMENT



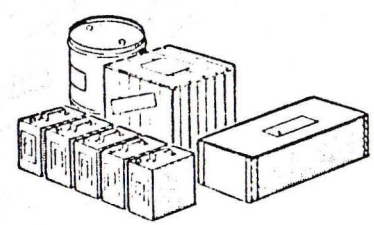
WEAPONS



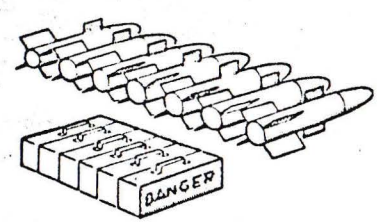
FIRST AID



SUPPLIES



AMMUNITION



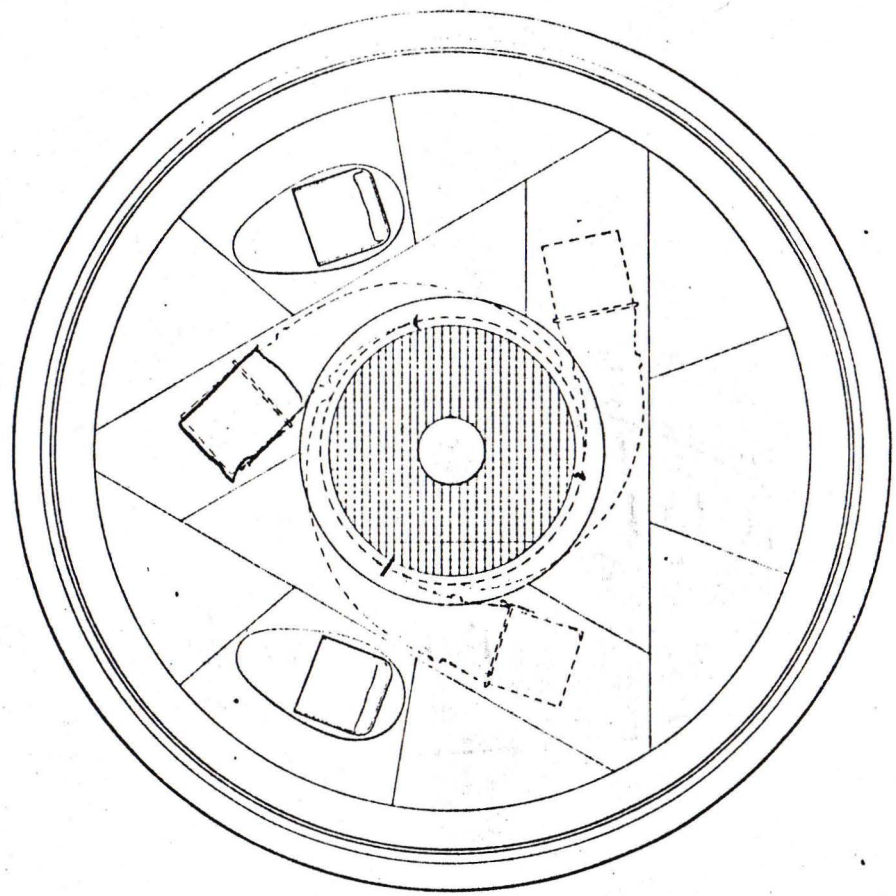
AVROCAR - SUMMARY

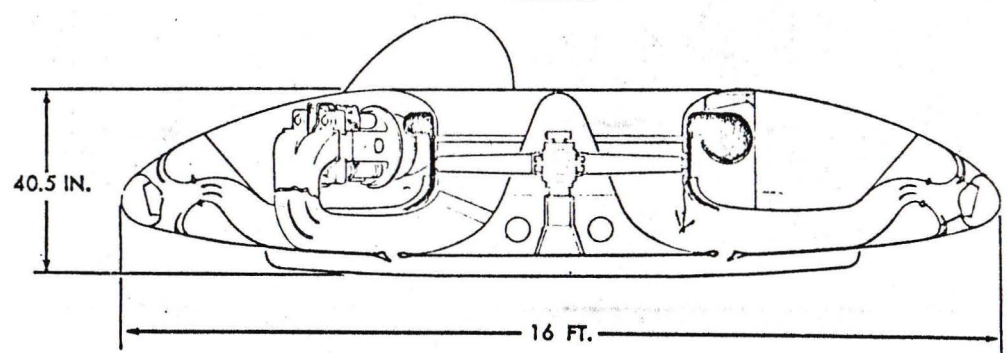
The Avrocar features a small turborotor assembly with tip mounted turbine. The exhausts from the three J69-T-9 turbojets impinge upon the turbine tip to drive the turborotor, thus eliminating the use of gears and clutches. The turborotor is installed in the center of a capacious circular planform wing. Control for hovering and forward flight is effected by directing the mass flow from the turborotor through a series of radial ducts in the main structure to an annular nozzle at the wing tip.

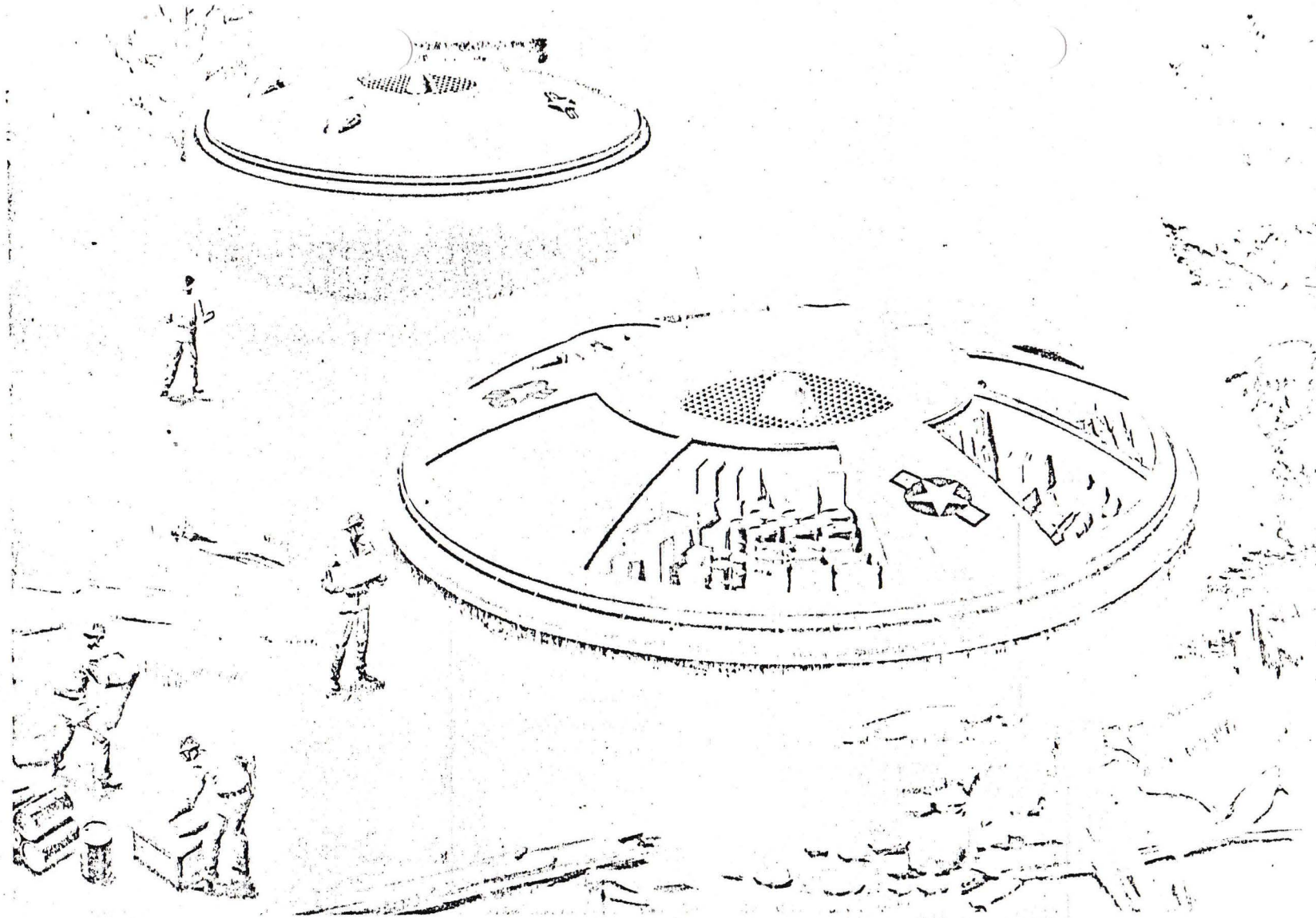
Because of the simplicity of operation, the annular nozzle produces a unique VTOL characteristic particularly favourable to operation near the ground, powerful control and high maneuverability and avoids the adhesion complication experienced on other VTOL craft which employ a downward central jet.

Because it is a wing, the Avrocar acquires aerodynamic lift in forward flight and is capable of moderate speeds and altitudes.

Multi-engine reliability is provided by the three turbojets installed in the three segment structure thus providing ease of maintenance, repair and overhaul. Noise and ground disturbance are low because of the moderate exhaust velocity and spreading ground jet. The vehicle illustrated is a smaller version than the AVROCAR I and is powered by three Palas turbojets.







AVROTRUCK

Leading Particulars

DIMENSIONS AND WEIGHTS	3 J-34 OR ORENDA P.S.16 TURBOJETS
DIAMETER = SPAN	30 FT.
GROSS WING AREA	706 SQ. FT.
HEIGHT ABOVE GROUND TO TOP OF CANOPY	6.4 FT.
ASPECT RATIO	1.27
THICKNESS/CHORD RATIO	18%
MAXIMUM V.T.O.L. PAYLOAD	8,200 LB.
MAXIMUM CAPACITY PAYLOAD	20,000 LB.
MAXIMUM FUEL CAPACITY	735 U.S. GALS.
MAXIMUM GROSS WEIGHT FOR V.T.O.L.	21,700 LB.
EMPTY WEIGHT	10,050 LB.
TAKE-OFF WING LOADING AT MAXIMUM GROSS WEIGHT FOR V.T.O.L.	30.7 LB./SQ. FT.

PERFORMANCE

SPEED AND CLIMB	
MAXIMUM SPEED AT SEA LEVEL	425 M.P.H.
RATE OF CLIMB AT SEA LEVEL	7,200 FT./MIN.
CEILING (1,000 FT./MIN.)	21,000 FT.

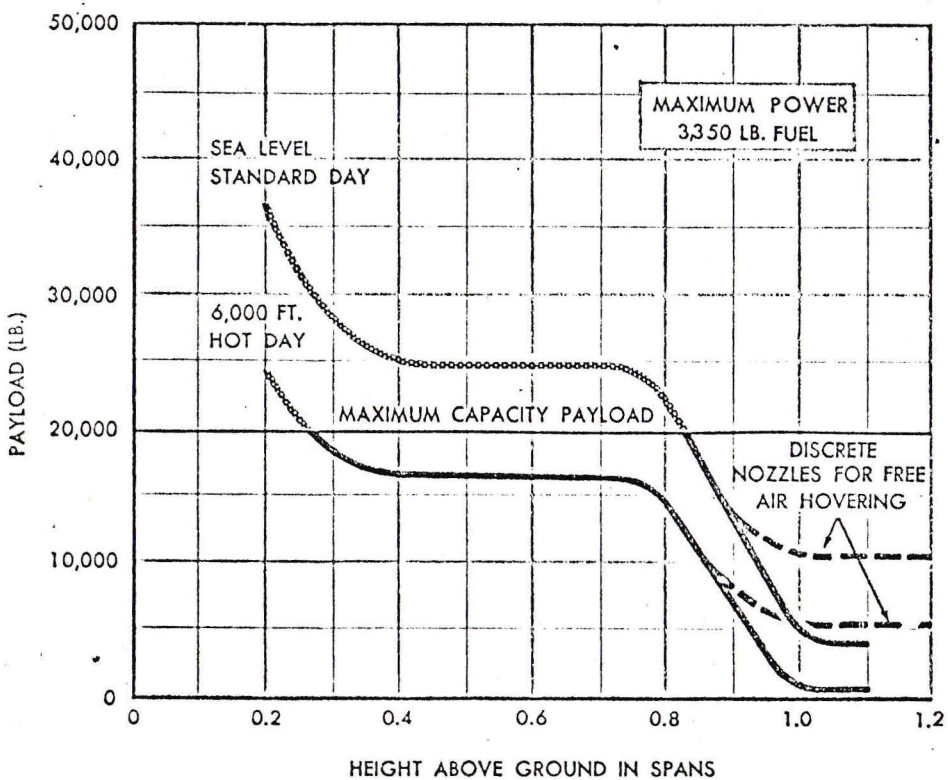
PERFORMANCE CURVES SHOWN ON PAGES 24,25.

PERFORMANCE CONT'D	3 J-34 OR ORENDA P.S.16 TURBOJETS V.T.O.L.	S.T.O.L.
RANGE PAYLOAD		
PAYLOAD (LB.)	8,200	20,000†
RANGE AT SEA LEVEL (MILES)	175	175*
RANGE AT 20,000 FT. (MILES)	210	
PAYLOAD (LB.)	6,550	
RANGE AT SEA LEVEL (MILES)	280	
RANGE AT 20,000 FT. (MILES)	355	
MAXIMUM FERRY RANGE WITH SPECIAL TANKS (CRUISE AT 20,000 FT., CREW ALLOWANCE 500 LB.)	1,000	1,600

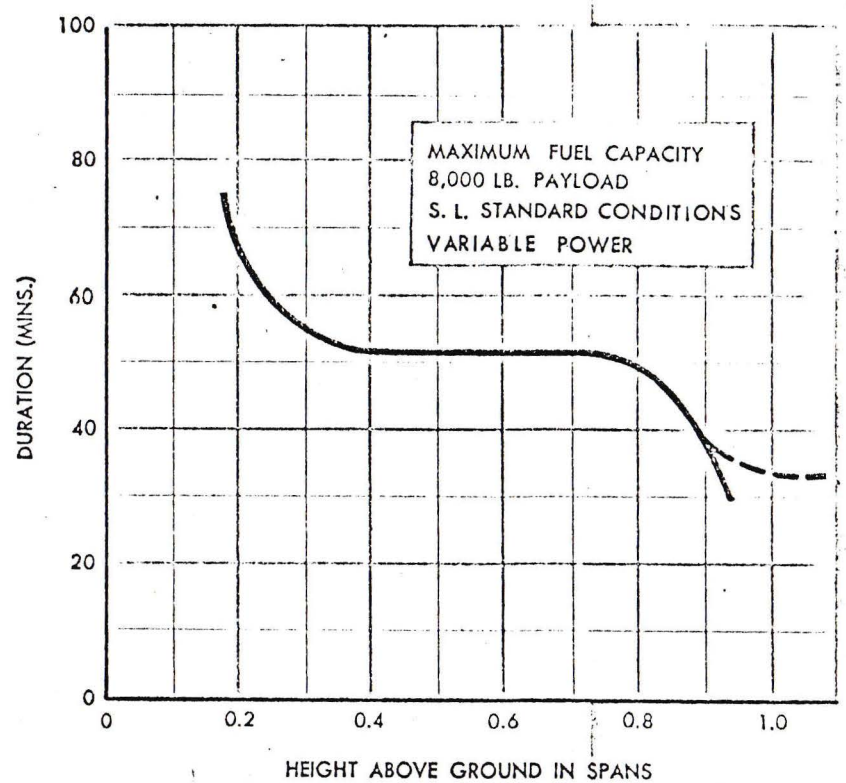
HOVERING	HOVER HEIGHT	MAXIMUM PAYLOAD (LB.)	HOVER DURATION (MINS)
SEA LEVEL, STANDARD DAY	FREE AIR	8,200	34↓
	21 FT.	20,000†	52↓
	6 FT.	20,000†	68↓
6,000 FT., HOT DAY	FREE AIR	3,500	
	21 FT.	13,500	
	6 FT.	20,000†	

↓ PAYLOAD 8,000 LB. *LIMITED BY FUEL CAPACITY †LIMITED BY CARGO CAPACITY

AVROTRUCK AND AVROCOACH HOVERING PERFORMANCE

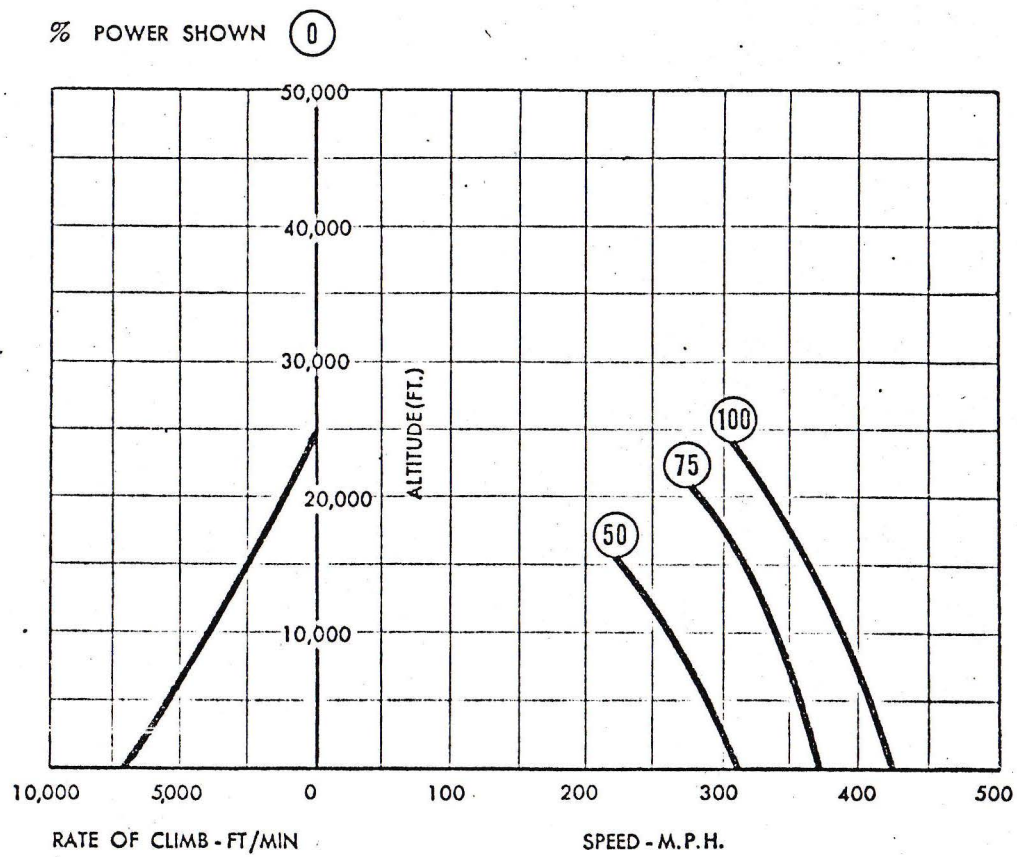


HOVERING PERFORMANCE

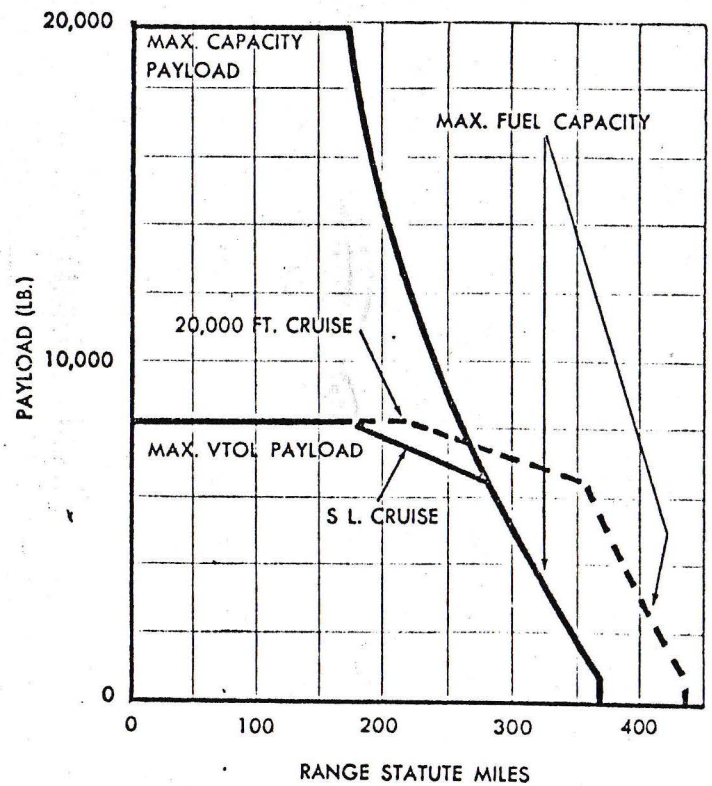


HOVERING ENDURANCE

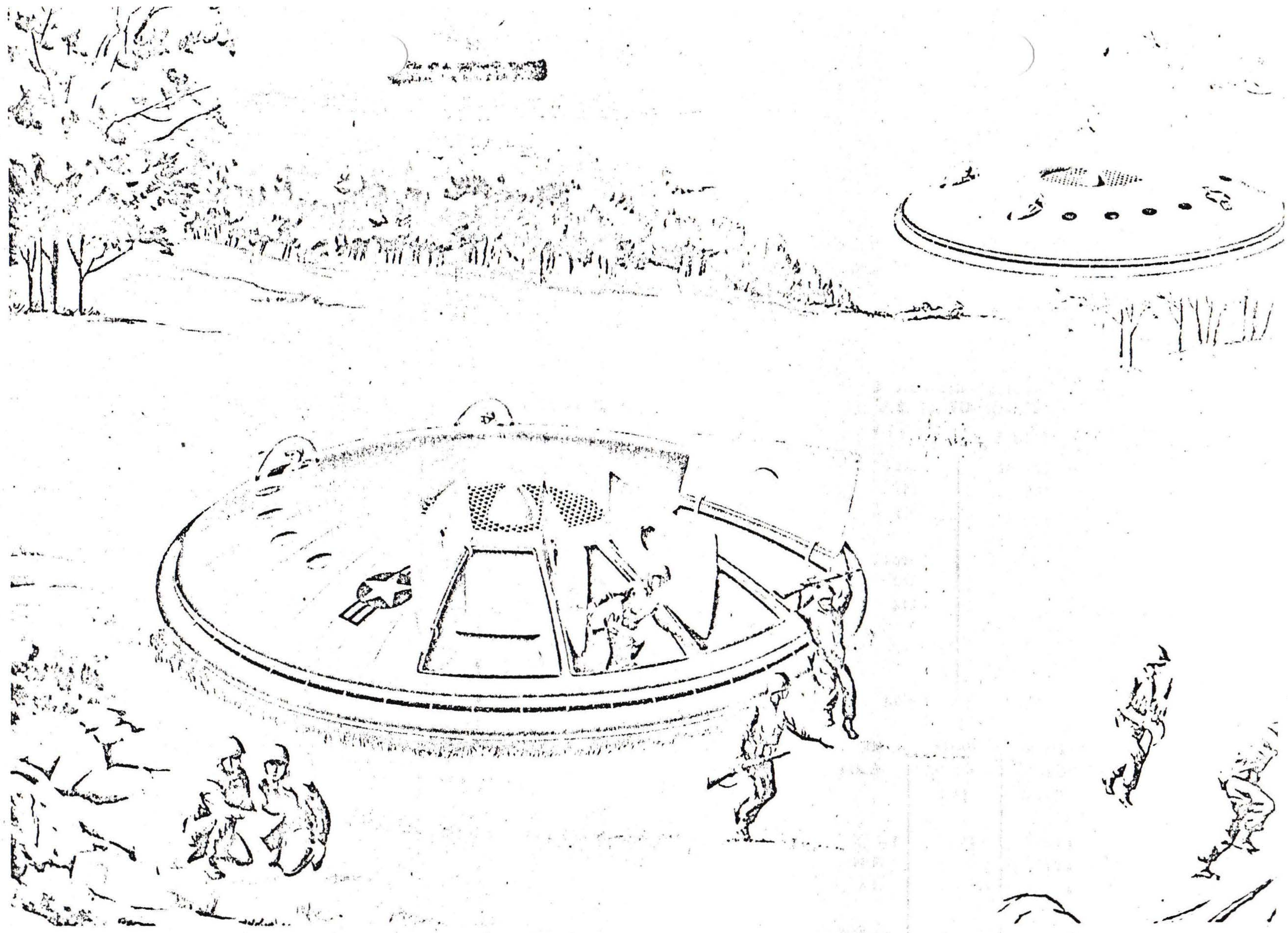
AVROTRUCK AND AVROCOACH - FLIGHT PERFORMANCE



SPEED AND CLIMB



RANGE VS. PAYLOAD



Leading Particulars

DIMENSIONS AND WEIGHTS	3 J-34 OR ORENDA P.S.16 TURBOJETS
DIAMETER = SPAN	30 FT.
GROSS WING AREA	706 SQ. FT.
HEIGHT ABOVE GROUND TO TOP OF CANOPY	6.4 FT.
ASPECT RATIO	1.27
THICKNESS/CHORD RATIO	18%
MAXIMUM V.T.O.L. PAYLOAD	8,200 LB.
MAXIMUM CAPACITY PAYLOAD	20,000 LB.
MAXIMUM FUEL CAPACITY	735 U.S. GALS.
MAXIMUM GROSS WEIGHT FOR V.T.O.L.	21,700 LB.
EMPTY WEIGHT	10,050 LB.
TAKE-OFF WING LOADING AT MAXIMUM GROSS WEIGHT FOR V.T.O.L.	30.7 LB./SQ. FT.

PERFORMANCE

SPEED AND CLIMB	
MAXIMUM SPEED AT SEA LEVEL	425 M.P.H.
RATE OF CLIMB AT SEA LEVEL	7,200 FT./MIN.
CEILING (1,000 FT./MIN.)	21,000 FT.

PERFORMANCE CURVES SHOWN ON PAGES 24,25.

PERFORMANCE CONT'D	3 J-34 OR ORENDA P.S. 16 TURBOJETS V.T.O.L.	S.T.O.L.
RANGE PAYLOAD		
PAYLOAD (LB.)	8,200	20,000†
RANGE AT SEA LEVEL (MILES)	175	175*
RANGE AT 20,000 FT. (MILES)	210	
PAYLOAD (LB.)	6,550	
RANGE AT SEA LEVEL (MILES)	280	
RANGE AT 20,000 FT. (MILES)	355	
MAXIMUM FERRY RANGE WITH SPECIAL TANKS (CRUISE AT 20,000 FT., CREW ALLOWANCE 500 LB.)	1,000	1,600

HOVERING	HOVER HEIGHT	MAXIMUM PAYLOAD (LB.)	HOVER DURATION (MINS)
SEA LEVEL, STANDARD DAY	FREE AIR	8,200	34↓
	21 FT.	20,000†	52↓
	6 FT.	20,000†	68↓
6,000 FT., HOT DAY	FREE AIR	3,500	
	21 FT.	13,500	
	6 FT.	20,000†	

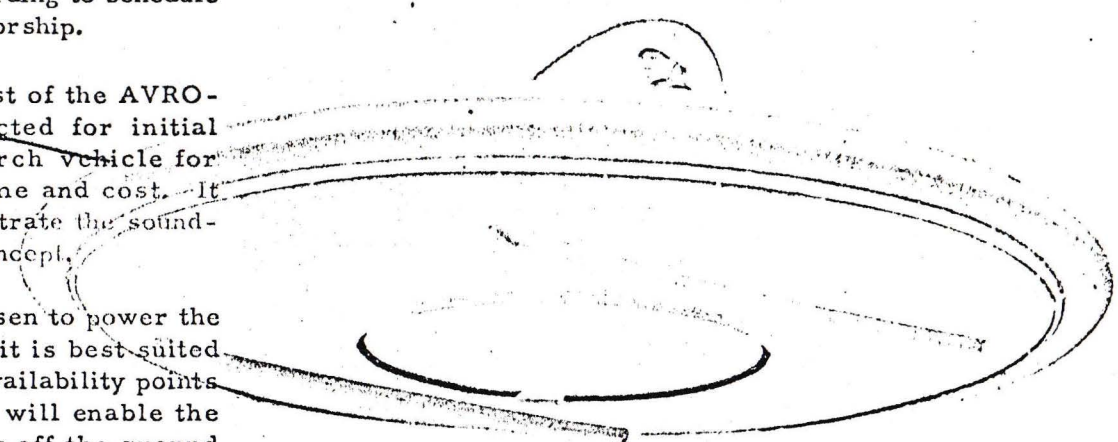
↓ PAYLOAD 8,000 LB. *LIMITED BY FUEL CAPACITY †LIMITED BY CARGO CAPACITY

RESEARCH VEHICLE

It was estimated that an Avrocar powered by J69-T-9 engines could be built and ready to fly within twelve months from the date of contract. A program with this objective was initiated by the Company in February 1958 and is proceeding according to schedule under US Government sponsorship.

The Avrocar, the smallest of the AVRO-MOBILE family, is selected for initial development as a research vehicle for reasons of economy in time and cost. It would nevertheless demonstrate the soundness of the basic design concept.

The J69-T-9 has been chosen to power the prototype vehicle because it is best suited from both the design and availability points of view. These engines will enable the vehicle to rise vertically off the ground carrying a payload of about 2,000 lb into free air.



Development Schedule