AVROCAR CONTINUATION TEST PROGRAM

INSTRUMENTATION SPECIFICATION FOR AMES TUNNEL TESTS 1ST AVROCAR VEHICLE

500/AERO TEST/415

ISSUE 2

AVRO AIRCRAFT LIMITED

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1ST AVROCAR VEHICLE

500/AERO TEST/415

ISSUE 2

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1. INTRODUCTION

The Avrocar is a VTOL research aircraft of circular planform with designation VZ-9AV which is under development by Avro Aircraft Limited for the U.S. Army and Air Force.

Two prototypes have been built. The first was tested in the Static Test Rig at Malton, Ontario, and then shipped to the Ames Research Center for testing in the 40 x 80 ft. Low Speed Wind Tunnel. The second was retained at Avro for flight test purposes. Reports covering these tests will be found in references 1 - 6.

The results of the wind tunnel tests indicated that some modifications to the vehicle would be necessary and further testing would be required. (Ref. 7).

The opportunity has been taken to modify the instrumentation before the second series of tests commence.

2. FACILITIES

The testing will be carried out in the 40 x 80 ft. Low Speed Wind Tunnel at N.A.S.A. Ames Research Center, Moffett Field, California, commencing February 15th, 1961.

The Ames Research Center will provision the vehicle and record data. It is anticipated that approximately five weeks tunnel occupancy will be required.

3. INSTRUMENTATION SPECIFICATION

3.1 Pressure Instrumentation

1. Fan inlet

A total head rake consisting of 10 probes will be installed above the fan behind the forward intake lip and behind the intake lip guide vane (Fig. 1) to detect any flow breakaway in this region. Existing fan inlet static pressure probes will be retained.

2. Fan outlet

The two rakes under the fan will be replaced by six rakes symmetrically arranged approximately 6.0" below the fan. Each rake will consist of five total pressure and five static pressure probes, see Fig. 2.

3. Peripheral nozzle

The peripheral nozzle rakes will be moved to the peripheral nozzle throat at a point just inboard of the transition doors. These rakes, six in all, will each consist of six total head probes and five static probes, (see Fig. 3).

4. Surface pressures

The intake lip statics in the fore and aft positions will be retained. The statics buried in the skin on the aircraft centreline will be retained and extended around the wing leading edge. The aft skin statics will be extended to the wing trailing edge. The remaining skin statics and intake lip statics will be disconnected.

5. Trunk compartment

A static probe will be placed in the trunk compartment to be used in conjunction with local skin statics to determine the pressure differential across the trunk door.

3.2 Temperature Instrumentation

1. Intake to gas generator

Three thermocouples will be installed in each engine intake and they will be ganged to read on one indicator per engine.

2. Gas generator exhaust

Existing thermocouples will be retained.

3. Fan inlet

Existing thermocouples will be retained.

3.3 Engine Operation

1. Gas generator r.p.m. will be measured as previously.

2. Rotor r.p.m. will be measured as previously.

3. Gas generator controls

The remote operator's panel is considered to be part of the rig and details are not included in this specification. Instrument requirements are as for the previous test and are described in Ref. 6.

3.4 Aircraft Parameters

1. Angle of attack

Angle of attack will be recorded manually, using the standard tunnel gauge.

2. The aircraft pitot-static boom will be removed.

3.5 Control Positions

1. Focussing Control Ring position

Movement and distortion will be measured by four potentiometers situated around the periphery as shown in Fig. 4.

2. Pitch and Roll Control Vane position

Movement will be determined by three potentiometers located as shown in Fig. 4.

3. Rudder vane angle will be measured by means of a potentiometer on each side of the aircraft.

4. Nozzle transition door

The travel of one port, one starboard and one rear transition door will be obtained by means of Magnesyn transmitters attached to the three drive motors.

3.6 Structural Loads

1. Focussing control ring

A strain-gauged link will be inserted into the forward control cable to the focussing ring control to determine cable load. The maximum allowable load is 1200 lb.

2. Rotor vibration

Vibration of the rotor will be monitored by means of a C.E.C. vibration analyser as used previously.

3.7 Data Readout

Measurements of forces and moments on the aircraft will be obtained from two sources.

1. Six-component balance

The output of the balance is on printed tape from which IBM cards are punched manually for use with an IBM 704 program to calculate lift, drag and side forces and pitching, rolling and yawing moments.

2. Load cells

The load cells, which are mounted on top of the adjustable aircraft support struts, feed into a digitizer whose output is fed to a Flexowriter. The data is available on punched tape for processing by the Datatron computer. Using the output from the load cells, an analog computer will be used for a first look at test results.

The instrumentation requirements are summarized in tabular form on page 8. Wherever possible the range, source and type number of each instrument is given.

4. INSTALLATION SCHEMATICS

Figure 5 shows the mounting arrangement of the Avrocar in the Ames Wind Tunnel. Figure 6 shows the general layout and equipment supplied by Avro.

5. REFERENCES

1. Tethered and Free Flight Tests of the Avrocar Fitted with Nozzle Spoiler Control
   AVRO/SPG/TR304

2. The Avrocar in the Static Test Rig
   AVRO/SPG/TR305

3. Second Progress Report on the Hovering Flight tests of the Avrocar Fitted with the Focussing Ring Control
   500/AERO TEST/400

4. Tests of the Avrocar in the N.A.S.A. 40 x 80 ft. Wind Tunnel, Ames Research Center Data Report
   500/AERO TEST/401

5. General Review of the Tests of the Avrocar in the Ames Research Center 40 x 80 ft. Wind Tunnel
   500/AERO TEST/403

6. Avrocar Ground and Hovering Flight Test Specification
   AVRO/SPG/TR195

7. Specification for Phase 2 Tests of an Avrocar in the 40 x 80 ft. Wind Tunnel at N.A.S.A., Ames Research Center.
   500/AERO TEST/405
   Issue 2, Dec 1960.

PARAMETER	SENSING UNIT / READ OUT DEVICE	REMARKS	NO. REQ'D	RANGE	EXPECTED SUPPLIER
Fan Inlet Static Pressure	Wall Static Probes	Equally spaced approx. 6" above fan Dwg. 166A 553	4		Avro
	Manometer		4	± 40" H_2O	NASA
Fan Intake Total Head Rake	Total Head Probes	One rake above fan; 10 total head probes	10		Avro
	Manometer		10		NASA
Fan Outlet Pressure	Total and Static Probes	Six rakes located approx. 6" below fan each consisting of 5 totals; 5 statics	60		Avro
	Manometer		60		NASA
Peripheral Nozzle Total and Static Pressure	Total and Static Probes	Six rakes of 6 total head probes and 5 statics	66		Avro
	Manometer		66		NASA
Surface Pressure	Static Probes	Intake lip Dwg. 637N553 (Fore and aft only along C_L of aircraft only (Dwg. 467A553) extended round L.E. and to T.E. at 4" pitch	36		Avro
	Manometer		36		NASA

PARAMETER	SENSING UNIT / READ OUT DEVICE	REMARKS	NO. REQ'D	RANGE	EXPECTED SUPPLIER
Trunk Compartment	Static Probe	Static probe in Upstream trunk compartment	1		Avro
	Manometer		1		NASA
Intake to Gas Generator	Thermocouples	Three thermocouples per intake (ganged)	6		Avro
	Dial Indicator 76 at 3BG	Photo panel	3	-50°C to 350°C	WADC
Gas Generator Exhaust	Thermocouples	Four thermocouples (ganged) per engine. (Dwg. 86N553)	12		Avro
	Dial Indicator MS 28006-2	Photo panel	3	0°C to+ 1000°C	WADC
Fan Inlet Temperature	Thermocouples	Equally spaced approx. 6" above fan. (Dwg. 166A553)	4		Avro
	Dial Indicator AN5536	Photo panel	2	-30°C to+100°C	NASA
Gas Generator R.P.M.		Tacho generator part of J.69 engine assy.	3		
	Dial Indicator 6119-80J-13 MOD	Photo panel	3	22700 R.P.M.	WADC

PARAMETER	SENSING UNIT / READ OUT DEVICE	REMARKS	NO. REQ'D	RANGE	EXPECTED SUPPLIER
Rotor R.P.M.	Tacho Generator	Orenda Design	1		Orenda
	Dial Indicator E9A 6119-8DJ13AAS	Photo panel	1	3000 R.P.M.	Orenda
	Pressure transducer		1		Orenda
	Oscilloscope		1		Orenda
Rudder Angle	Potentiometer	One each side; connect to rudder vanes. Dwg. 1163N and 1164N553	2		Avro
	Dial Indicator		2		Avro
Control Ring and Nozzle Vane Position	Potentiometer	Connect to control ring, one rear vane and extreme port and starboard vanes	4 plus 3		Avro
	Dial Indicator		7		Avro
Nozzle Transition Door	Magnesyn Transmitter	Connect to aft, port and starboard motors	3		Avro
	Dial Indicator		3		Avro
Control Ring Actuator Jack Pressure	Pressure Gauge		1		NASA

PARAMETER	SENSING UNIT / READ OUT DEVICE	REMARKS	NO. REQ'D	RANGE	EXPECTED SUPPLIER
Load in Forward Cable Rod	Strain Gauge	Bonded to cable rod. Calibrated with Thermo-couple	1		Avro
	Dial Indicator		1	0 - 2000 lb.	Avro
	Thermocouple	Dwg. 1198D553	1		Avro
	Dial Indicator		1	0 - 300°F	Avro
Rotor Vibration	C.E.C. Vibration analyser		1		Avro
Clock		8 day clockwork (Photo panel)	1		Avro
Digital Counter	6101-NL-B-124806		1		WADC

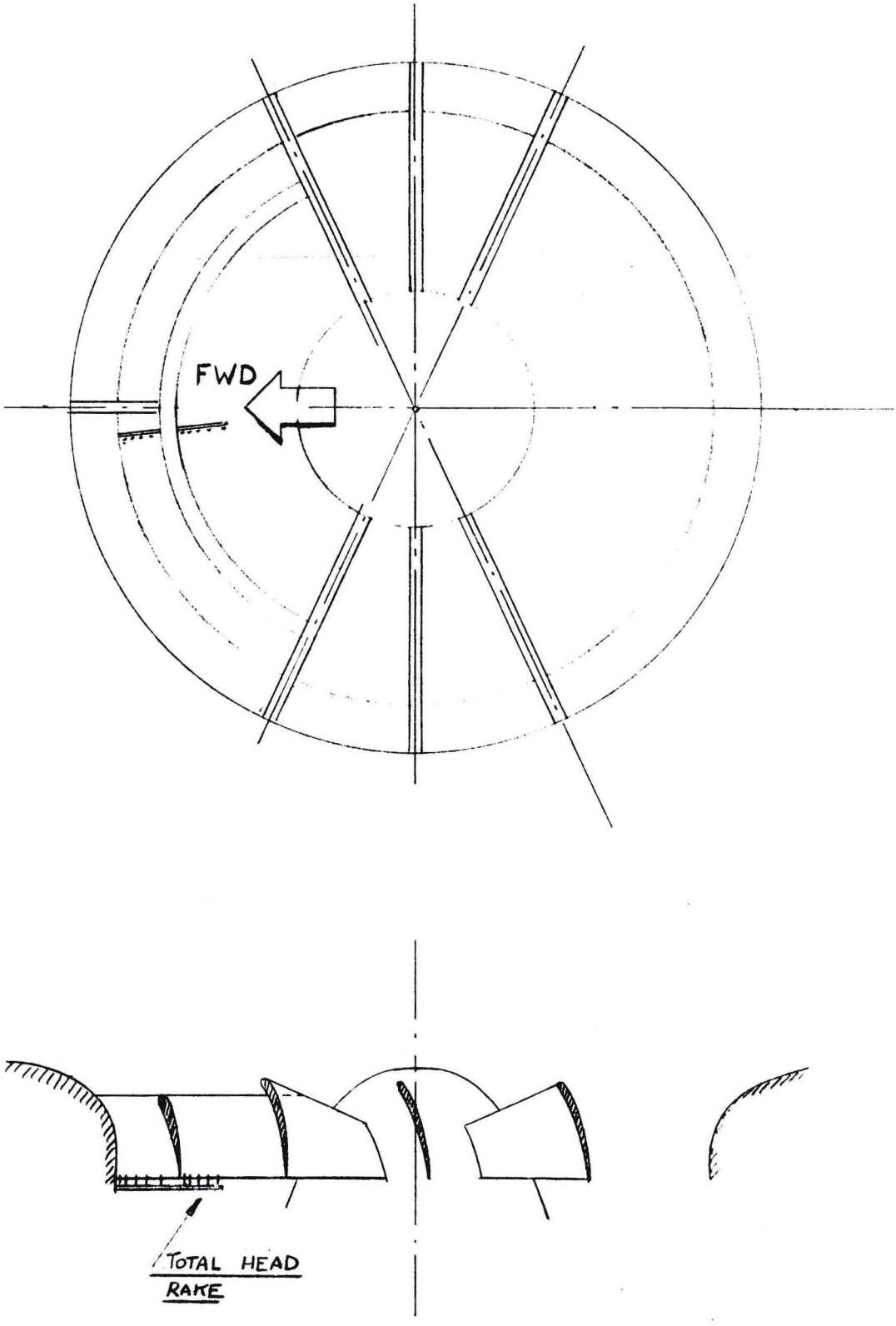


FIG. 1 FAN INTAKE PRESSURE RAKE

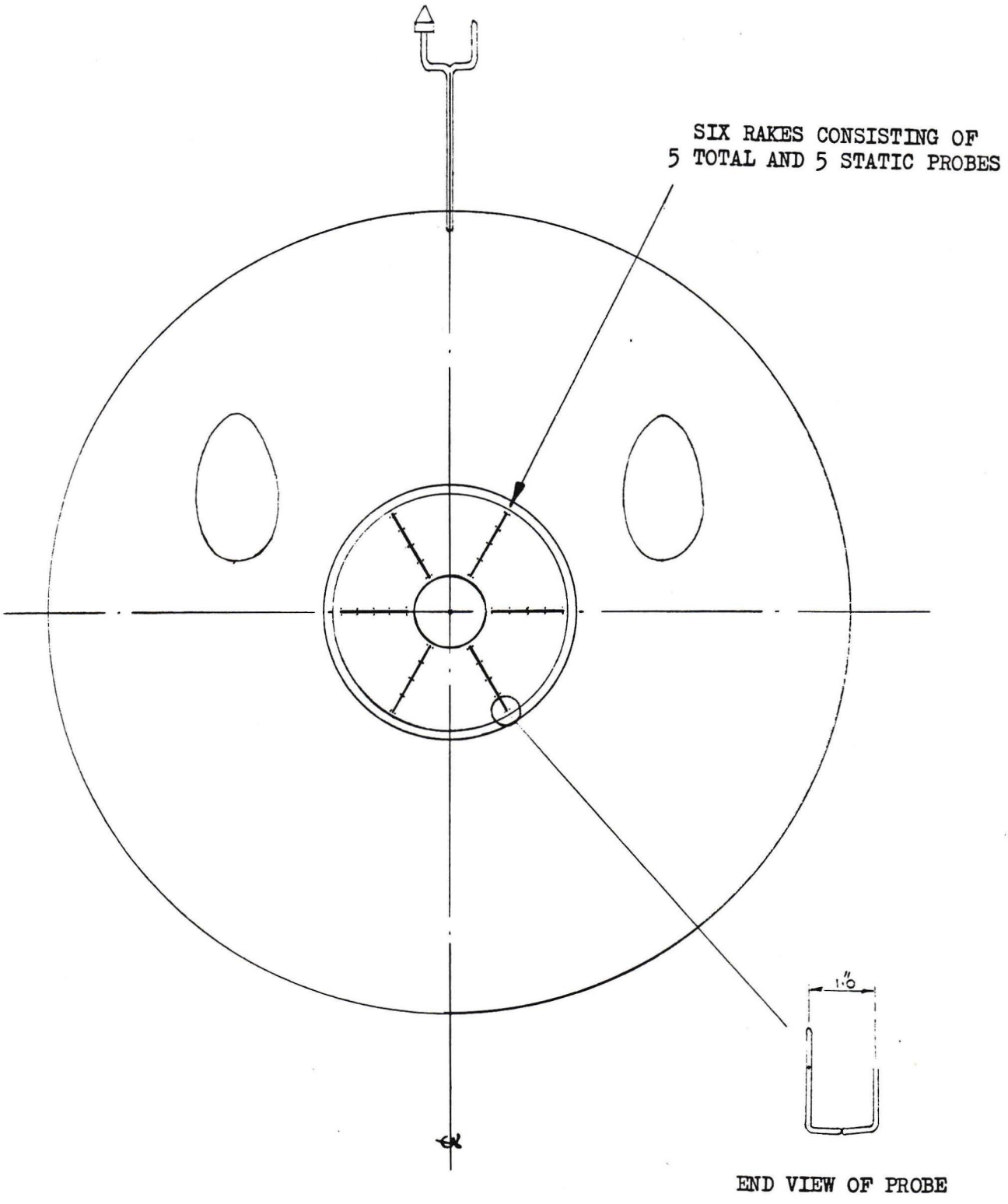


FIG.2 FAN OUTLET PRESSURE RAKES

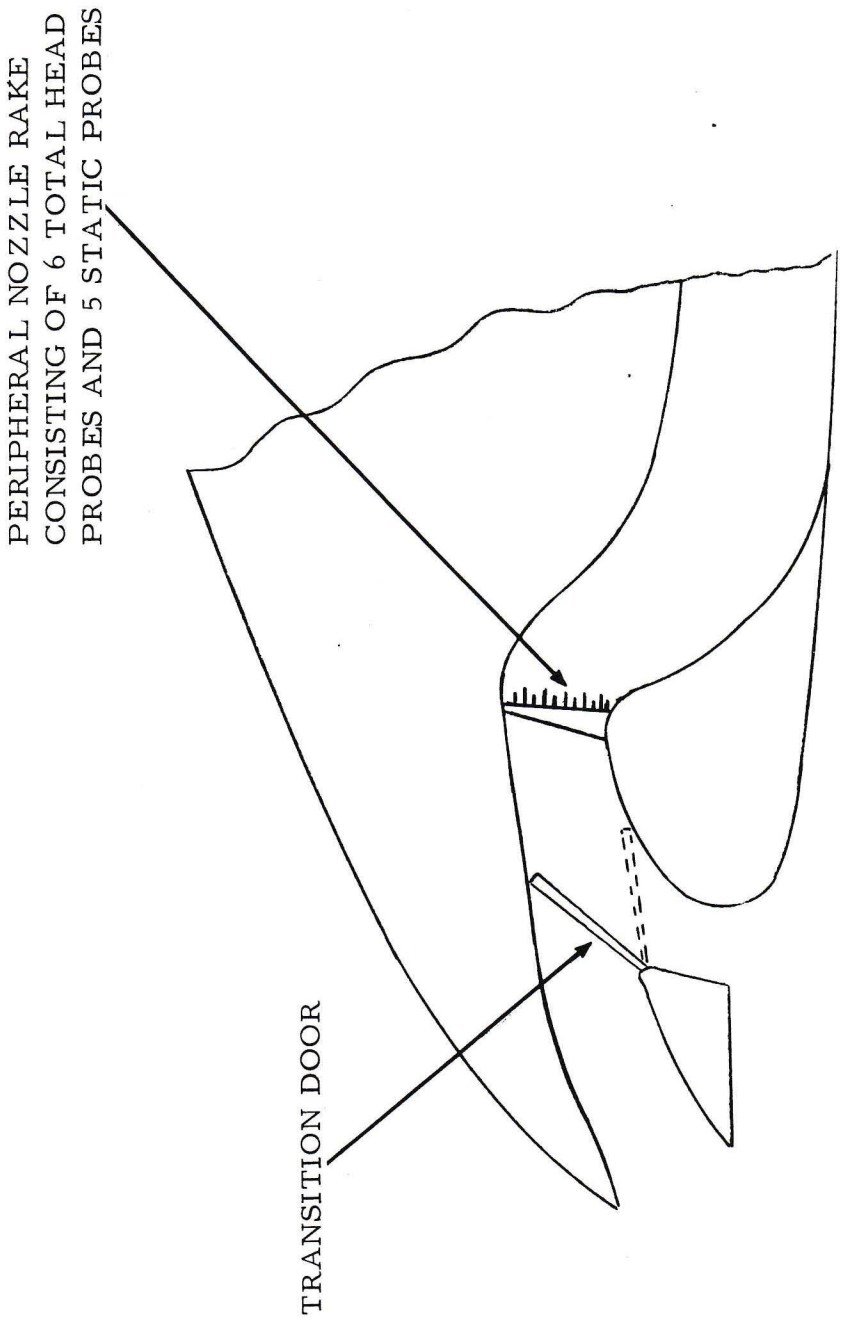
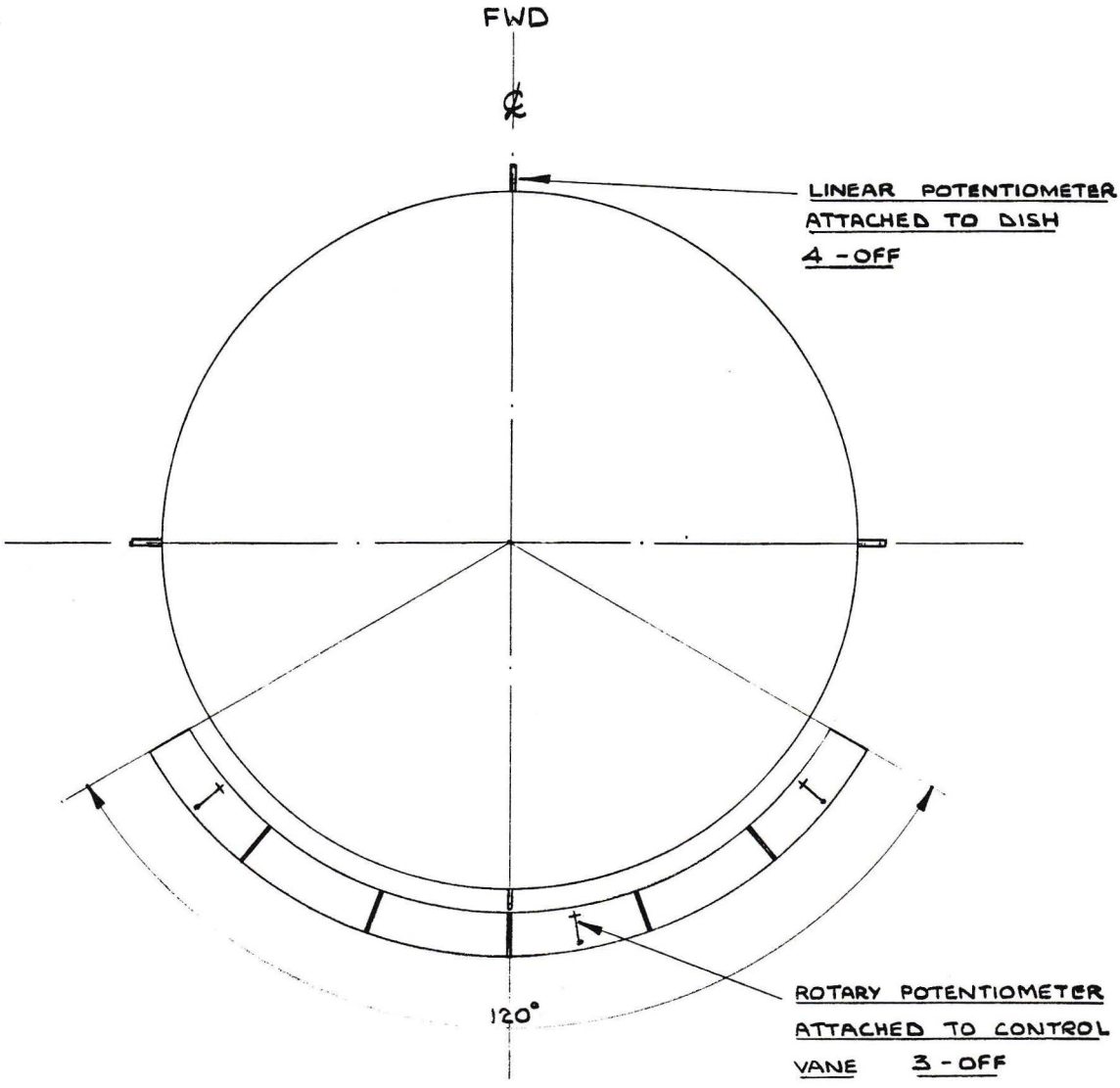


FIG.3 PERIPHERAL NOZZLE PRESSURE RAKE



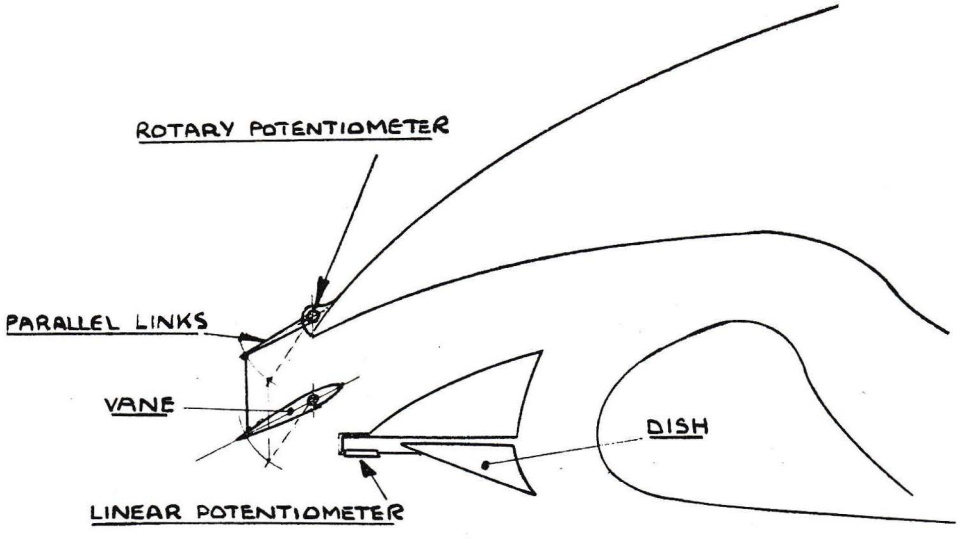
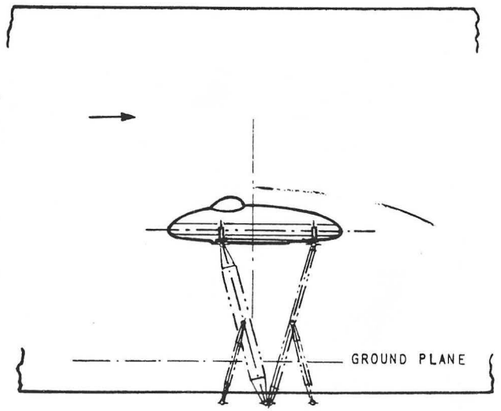
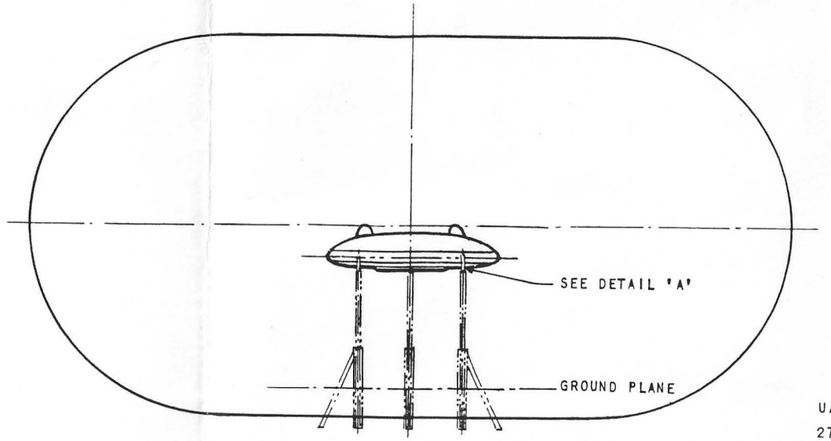
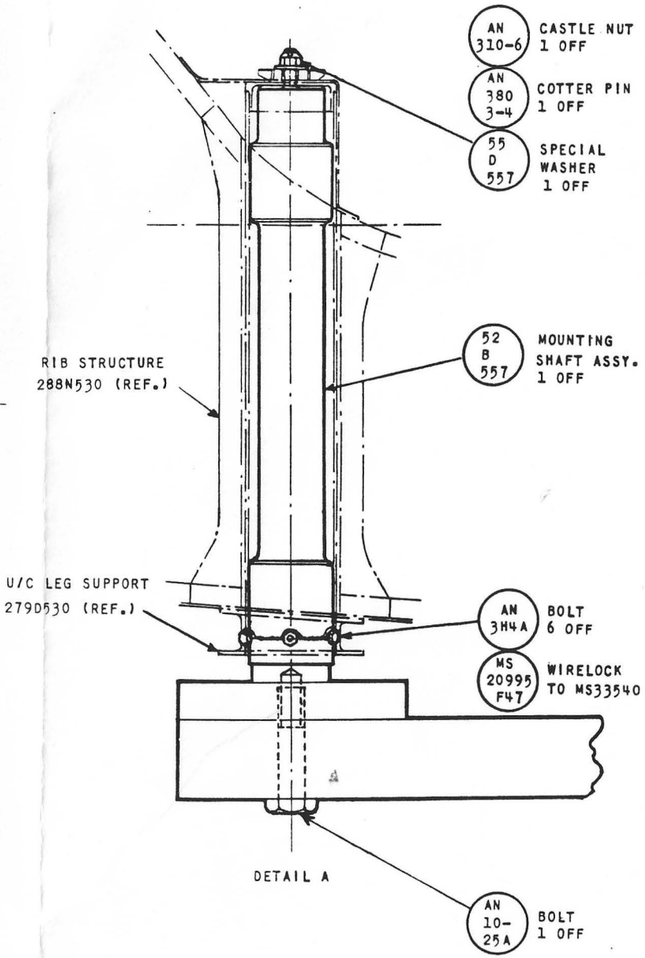


FIG.4 LOCATION OF POTENTIOMETERS - CONTROL RING AND VANES







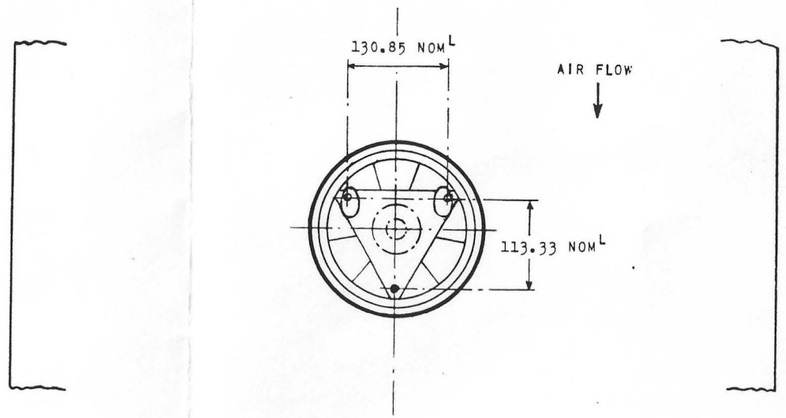


FIG. 5 MOUNTING OF TEST VEHICLE IN WIND TUNNEL

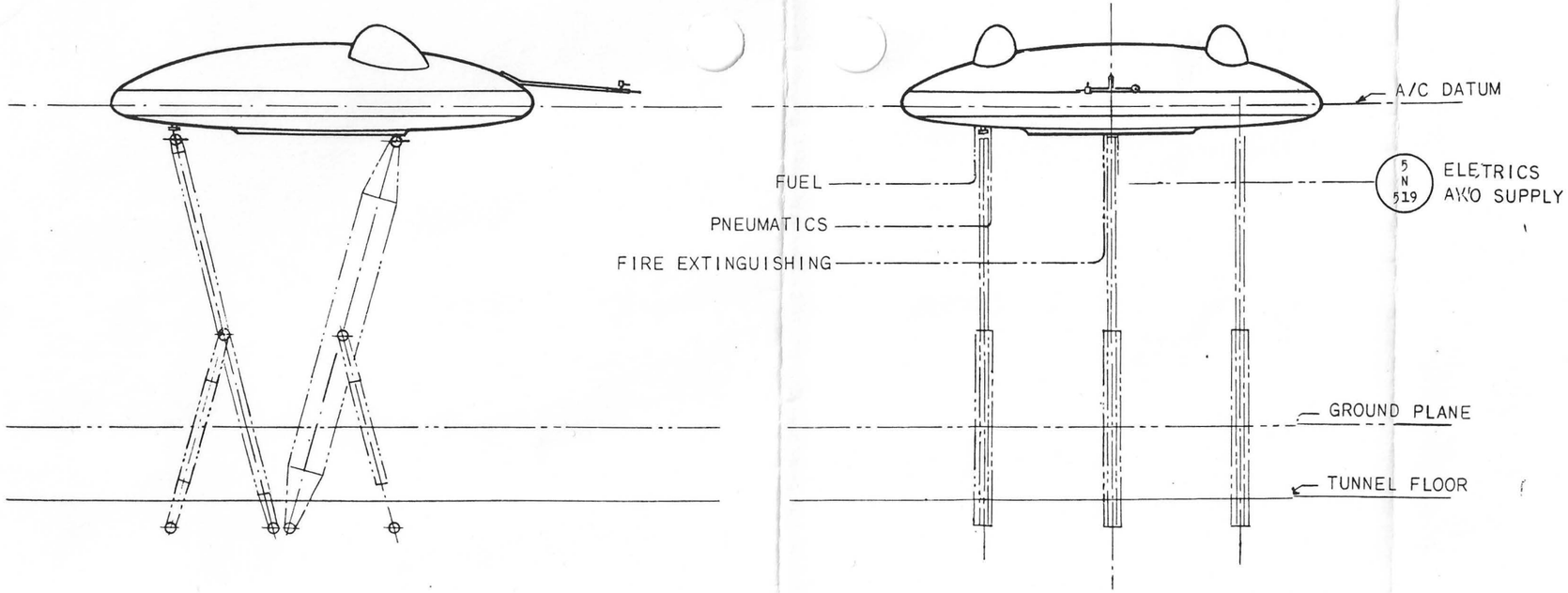


FIG.6 AVRO EQUIPMENT SUPPLY - AMES TUNNEL