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# CANADIAN DEFENCE PRODUCTS

*Department of*  
INDUSTRY  
TRADE and COMMERCE  
CANADA • 1970

(Third Edition—Abridged)

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**CANADIAN  
DEFENCE  
PRODUCTS**  
(ABRIDGED)

**THIRD EDITION — MARCH, 1970**  
**(ABRIDGED)**

**QUEEN'S PRINTER FOR CANADA**  
**OTTAWA, 1970**

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# **CANADIAN DEFENCE PRODUCTS**

**(THIRD EDITION — ABRIDGED)**

**DEPARTMENT OF INDUSTRY, TRADE and COMMERCE  
OTTAWA                      •                      1970                      •                      CANADA**



## INTRODUCTION

This publication is an extract of the "Illustrated Section" of the Canadian Department of Industry, Trade and Commerce publication, "Canadian Defence Products", to which the reader is referred for a detailed study of Canada's defence related industry.

The illustrated articles on the following pages are examples of some types of equipment conceived and produced in Canada. These items of equipment also serve to establish that Canada possesses the engineering and laboratory back-up facilities so vital to a modern and progressive industrial complex. The equipment exhibited is only indicative of the defence related segment of Canadian industry and demonstrates that Canada possesses the inventive resourcefulness and the production skills to meet the most exacting modern military requirements.

Inquiries originating in the under-mentioned countries relating to Canadian defence equipment and facilities may be addressed to:

Counsellor (Defence Production),  
Department of Industry, Trade and Commerce  
Ambassade du Canada,  
35 Ave. Montaigne,  
Paris 8e, France.

Counsellor (Defence Production),  
Department of Industry, Trade and Commerce,  
Canadian Embassy,  
53 Bonn-Bad Godesberg,  
Friedrich-Wilhelm-Strasse 14-18,  
Federal Republic of Germany.

Counsellor (Defence Production),  
Department of Industry, Trade and Commerce,  
Canadian Embassy,  
Via G.B. de Rossi 27,  
Rome, Italy.

Counsellor (Defence Production),  
Department of Industry, Trade and Commerce,  
Office of the High Commissioner for Canada,  
Macdonald House,  
No. 1 Grosvenor Square,  
London, W1X 0AB, England.

Inquiries from other countries should be addressed to the Canadian Embassy in the country concerned, to the attention of the Commercial Section, or directly to the Canadian Commercial Corporation.





## CANADIAN COMMERCIAL CORPORATION

Canadian Commercial Corporation, which is wholly owned by the Government of Canada and is responsible to the Minister of Supply and Services, was established to act as the contracting agency when other governments wish to purchase defence or other supplies and services from Canada on a government-to-government basis. The management and staff of the Corporation are provided by the Department of Supply and Services. Accordingly, procurement in Canada which is undertaken by the Corporation for other governments, is carried out by the same officers and according to the same standards as procurement being undertaken for the Canadian Armed Forces and other Canadian Government agencies.

Upon receipt of a request for quotation or other such enquiry document, Canadian Commercial Corporation will, whenever possible, obtain competitive quotations from Canadian contractors or suppliers. These quotations will be evaluated in accordance with the procurement standards of the Government of Canada. Where a quotation meets these requirements, it will be submitted as a CCC offer to the enquiring government. If the offer is accepted, the Corporation will, on behalf of the Government of Canada, enter into contracts, containing identical terms and conditions, with the other government and with the Canadian supplier. This arrangement makes available to the other government the complete purchasing organization and procedures of the Government of Canada.

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3. The contract with the Canadian supplier will be subject to technical and management control during production by an experienced procurement staff, who will also facilitate any change action which may be required by the other government during the performance of the contract and will expedite delivery of the supplies.
4. Quality control, inspection and acceptance on behalf of other governments may be carried out in Canada by the Quality Assurance Branch of the Canadian Department of National Defence to the extent desired by the other government.

5. All billings of the Canadian supplier for work performed will be certified by Canadian Commercial Corporation according to Canadian government practices before payment, and the Corporation will pay the Canadian supplier on the basis of the payment terms of the contract between the Corporation and the other government.
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7. Arrangements for shipment of goods will be made by the Corporation as required.
8. All contracts entered into by the Corporation are guaranteed by the Government of Canada.

The services of Canadian Commercial Corporation, as outlined above, are available without charge to any other government in the procurement in Canada of defence or other supplies and services, with the exception that in certain special cases there may be a minimal charge for inspection.

It is to be noted that the availability of the services of the Corporation in no way precludes other governments from procuring in Canada directly from Canadian manufacturers if they so wish. In such circumstances, the Corporation will provide all possible advice and assistance as requested.

Specific enquiries as to price and availability as well as requests for general information on Canadian defence products may, accordingly, be directed to:

Canadian Commercial Corporation,  
70 Lyon Street,  
Ottawa 4, Ontario,  
Canada.

## **ILLUSTRATIONS**

This book portrays the broad and diverse lines of equipment now being designed, developed and produced in Canada. A deeper evaluation of each item will make it clear that Canada possesses the high engineering capability, the production facilities, and the laboratory back-up so vital to a modern industrial complex.

This section demonstrates that Canada possesses the proven competence in resourceful production skills to meet the most sophisticated military and commercial requirements.

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# THE TWIN OTTER

The Twin Otter, latest de Havilland Canada STOL aircraft to enter military service is operating in the livery of nine military forces. Designed for dependable operation with a minimum of ground support, the Twin Otter brings a new standard of performance to the light transport role. Folding seats permit the 20 passenger cabin to be quickly converted to provide 364 cubic feet of cargo space. For casualty evacuation nine litters and five seats can be accommodated. Available on wheels skis or floats, this aircraft offers unsurpassed versatility.

As a short-haul airliner the Twin Otter has won wide acclaim and is used on high frequency scheduled services from some of the busiest airports in North America.

Outstanding STOL (short take-off and landing) performance is a feature of the Twin Otter, which can take off at maximum weight of 12,500 lb. (5,660 kg) with a ground run of only 700 feet (213 m) and clear a 50 foot (15 m) obstacle in 1,200 feet (366 m). With a payload of 3,350 lb. (1,520 kg) the Twin Otter has a range of 650 nautical miles with 45 minutes fuel reserve. Maximum payload is 5,250 lb. (2,381 kg), cruising speed 175 knots.

Powerplants are United Aircraft Canada PT6A-27 gas turbines each rated at 620 shp at temperatures up to 91°F (33°C).

The Twin Otter is certified in the normal category (CAR-3) by the Canadian Department of Transport (Aircraft Type Approval A-82) and the United States Federal Aviation Administration (Type Certificate A9-EA). In addition the Series 300 meets the U.S. Special Federal Aviation Regulation No. 23 which establishes additional airworthiness standards for emergency evacuation, systems design and aircraft operation.

## SPECIFICATIONS

### Dimensions

Wing Span .....	65 ft. (19.81 m.)
Length .....	51.8 ft. (15.77 m.)
Height .....	18.6 ft. ( 5.66 m.)

Main Wheel Track .....	12.5 ft. ( 3.81 m.)
Wheel Base .....	14.8 ft. ( 4.49 m.)
Propeller Ground Clearance .....	4.5 ft. ( 1.37 m.)

### Weights

Maximum Takeoff .....	12,500 lb. (5,660 kg.)
Maximum Landing .....	12,300 lb. (5,570 kg.)
Basic (20 Seat "Commuter") .....	6,750 lb. (3,060 kg.)

Fuel Capacity—Standard .....	2,457 lb. (1,112 kg.)
—With Wing Tanks ..	3,057 lb. (1,385 kg.)
Wing Loading .....	29.8 lb./sq.ft. (14.5 kg./sq.m.)

### Performance at Maximum Weight

		STOL CAPABILITY	
Takeoff Distance (Sea Level, ISA)	Ground Run .....	860 ft. (262 m.)	700 ft. (213 m.)
	Distance over 50 ft. ...	1,500 ft. (457 m.)	1,200 ft. (366 m.)
Landing Distance (Sea Level, ISA)	Ground Run .....	950 ft. (290 m.)	515 ft. (157 m.)
	Distance over 50 ft. ...	1,940 ft. (591 m.)	1,050 ft. (320 m.)
Stalling Speed (Power Off)	Flaps Retracted .....	74 knots EAS (137 km./hr.)	
	Flaps Extended .....	58 knots EAS (108 km./hr.)	
Rate of Climb (Sea Level, ISA)	Two Engines .....	1,600 ft./min. (488 m./min.)	
	One Engine .....	340 ft./min. (103 m./min.)	
Service Ceiling (R/C = 100ft./min., ISA)	Two Engines .....	26,700 ft. (8,140 m.)	
	One Engine .....	11,600 ft. (3,540 m.)	
Maximum Cruise Speed (ISA)	Sea Level .....	160 knots TAS (296 km./hr.)	
	5,000 ft. (1,524 m.) .....	167 knots TAS (309 km./hr.)	
	10,000 ft. (3,048 m.) .....	175 knots TAS (324 km./hr.)	
Maximum Range (ISA, 45 min. fuel reserve, 1 crew, 100 lb. radio)	Range	Payload	
Standard Tanks .....	40 NM ( 75 km.)	5,250 lb. (2,380 kg.)	
	650 NM (1,200 km.)	3,350 lb. (1,520 kg.)	
With Wing Tanks .....	850 NM (1,575 km.)	2,600 lb. (1,180 kg.)	

*The Twin Otter on the facing page is in the markings of the Argentine Army. Argentina is one of seven countries which use the Twin Otter in the para-military role. The Argentine Navy and Air Force also employ Twin Otters in this role.*





## CANADAIR CL-215

### AMPHIBIOUS UTILITY TRANSPORT

CL-215 WATER BOMBER is the first aircraft to be designed specifically to protect valuable forest areas against the ravages of fire. The size and performance of the CL-215 have been dictated by the requirements of fire protection authorities in Canada and other countries, where forest resources are valued highly and where fire is regarded as a foe of the national economy.

Devastation of forest regions due to fire is of concern in a number of countries. The growing cycle of a tree is lengthy, taking upwards of 80 years to develop an area of merchantable timber, the loss of which can mean permanent depression for a locality. With small towns developing on the fringes of large forest areas, fire control assumes a more urgent meaning and water bombing is the most effective control yet devised.

Simplicity of operation and maintainability are prime features in the CL-215 design. As a water bomber it can carry 1200 Imp. gallons (1440 U.S. gallons). With water tanks removed there is unobstructed cargo space allowing loads of 7800 lbs. Structural provision is made for the addition of further windows and doors which would meet the FAR25 requirements for a passenger aircraft capable of carrying 35 passengers.

Although designed primarily as a water bomber, the CL-215 can be employed to advantage as a land or water based passenger and/or cargo transport aircraft. There are many areas where the capability to operate from stretches of water is desirable: countries abounding in lakes or rivers; islands with considerable resident or tourist populations. Accommodating 30 passengers the CL-215 has a range of 700 miles, and operating costs comparable to other new aircraft of this size.

#### Performance

Cruising speed, normal power .....	185 m.p.h. (297 km/hr.)
Take-off distance to 50 ft. (15.2 m)	
at 35,000 lb. (15,876 kg) .....	water, 2,070 ft. (631 m)
41,500 lb. (18,824 kg) .....	land, 2,640 ft. (805 m)
Landing distance from 50 ft. (15.2 m) .....	water, 2,825 ft. (861 m)
at 33,400 lb. (15,150 kg) .....	land, 2,200 ft. (671 m)
Max. take-off weight .....	41,500 lb. (18,824 kg)
Max. Landing weight .....	33,400 lb. (15,150 kg)
Zero fuel weight .....	37,000 lb. (16,783 kg)
Operating weight empty .....	25,000 lb. (11,340 kg)
Maximum payload .....	12,000 lb. ( 5,443 kg)
Max. Fuel load .....	6,500 lb. ( 2,950 kg)
Manoeuvre factors .....	+ 3.25 g;—1 g.





## DHC 5 "BUFFALO"

The DHC-5 Buffalo has been speciécally developed to fill the operational requirement for a STOL (sort take-off and landing) aircraft capable of handling short to medium range transport support operations and of operating from rough, improvised airstrips. The Buffalo was designed from the outset to perform sustained operations in harsh tactical environments.

Capable of carrying 7 tons of cargo or 41 fully equipped troops the Buffalo requires a ground run of only 800 feet (244 m) for take-off at a full gross weight of 41,000 lb. (18,598 kg.). Take-off distance over a 50 ft. (15 m) obstacle is 1,260 feet (384 m), landing distance 1,170 feet (357 m). The interaction of automatic lift-dumping spoilers with the reverse pitch propellers and wheel brakes ensure a controlled short ground roll regardless of surface condition.

Power plants in the Buffalo are General Electric CT64-820-1 propeller turbines each rated at 3060 eshp. The provision of an extra low pitch stop on the propellers, together with the superior capabilities of the free turbine for quick power acceleration or deceleration provides the thrust control necessary for precise, steep approach to confined land areas. Outstanding low-speed handling characteristics make this aircraft ideal for accurate air dropping of troops or supplies.

The large rear doors and lower ramp facilitate the loading of wheeled vehicles or bulky cargo and permit the delivery of palletized cargo using the LAPES (Low Altitude Parachute Extraction) technique.

The Buffalo has a cruising speed of 245 knots and a maximum range of 1,930 nautical miles.

### BUFFALO—GENERAL DATA

<b>Dimensions (1)</b>			<b>Weights (2)</b>	
Wing Span	96 ft.	(29.26 m.)	Maximum Take-off	41,000 lb. (18,598 kg.)
Length	77.4 ft.	(23.59 m.)		
Height	28.75 ft.	( 8.8 m.)	Maximum Landing	39,100 lb. (17,736 kg.)
Main Wheel Track	30.5 ft.	( 9.30 m.)		
Wheel Base	28 ft.	( 8.53 m.)	Basic, with crew of 2	22,900 lb. (10,390 kg.)
Propeller			Maximum Fuel Capacity	13,556 lb. (6,490 kg.)
Ground Clearance	40 in.	( 1.01 m.)		
Takeoff weight			41,000 lb.	(18,598 kg.)
Landing weight			39,100 lb.	(17,736 kg.)
STOL takeoff distance to 50 ft. (firm dry sod)			1260 ft.	(384 m.)
STOL landing distance from 50 ft. (firm dry sod)			1170 ft.	(357 m.)
Rate of climb — two engines at NRP			2080 ft./min.	(634 m. min.)
Rate of climb — one engine at MP			695 ft./min.	(212 m. min.)
Service ceiling — two engines at NRP			31,500 ft.	(9601 m.)
Service ceiling — one engine at MP			17,000 ft.	(5182 m.)
Cruise speed (10,000 ft.)				
NRP			245 kt.	(454 km. hr.)
80% NRP			224 kt.	(415 km. hr.)
52% NRP			181 kt.	(335 km. hr.)
Maximum Payload			14,100 lb.	(6396 kg.)
Range with maximum payload			450 nm.	(834 km.)
Range with 8000 lb. payload			1390 nm.	(2576 km.)
Range with 4000 lb. payload			1910 nm.	(3539 km.)
Range with zero payload			1930 nm.	(3576 km.)

*This BUFFALO carries Canadian Forces Markings.*







## DHC 4 "CARIBOU"

The DHC-4 Caribou is now in its eleventh year of continuous production. This aircraft was the first of the DHC twin engine STOLs and is the last piston-powered DHC design still in production. Well proved by many years of service in some of the world's most difficult terrain the Caribou offers exceptional STOL performance from improvised airstrips.

The Caribou is designed to carry out aerial supply dropping, transportation of men and materials, and casualty evacuation. In troop transport configuration it carries 32 fully equipped combat troops in quickly folding seats. As an air ambulance it can accommodate 22 litters.

Large rear loading doors provide access to the 1,150 cubic foot (32.5 cu. m) cabin and can be opened in flight for dropping paratroops or supplies. The lower ramp facilitates rapid loading of wheeled vehicles or bulky cargo.

At a maximum weight of 28,500 lb. (12,928 kg) the Caribou has a payload of 8,620 lb. (3,910 kg) and requires a take-off ground run of only 725 feet (220 m). Take-off distance over a 50 ft. (15 m) obstacle is 1,185 ft. (361 m); landing distance 1,235 ft. (376 m).

Powered by dependable Pratt and Whitney R2000 engines each rated at 1,450 bhp the Caribou has a cruising speed of 158 knots.

### General

Gross Weight .....	28,500 lb.	12,928 kg
Basic Weight .....	17,630 lb.	7997 kg
Wing Span .....	95 ft. 7½ in.	29.15 m
Overall Length .....	72 ft. 7 in.	22.12 m
Overall Height .....	31 ft. 9 in.	9.67 m
Wing Area .....	912 sq. ft.	84.7 sq. m
Wing Loading .....	31.25 psf	153 kg/sq. m
Wing Aspect Ratio .....	10.0	

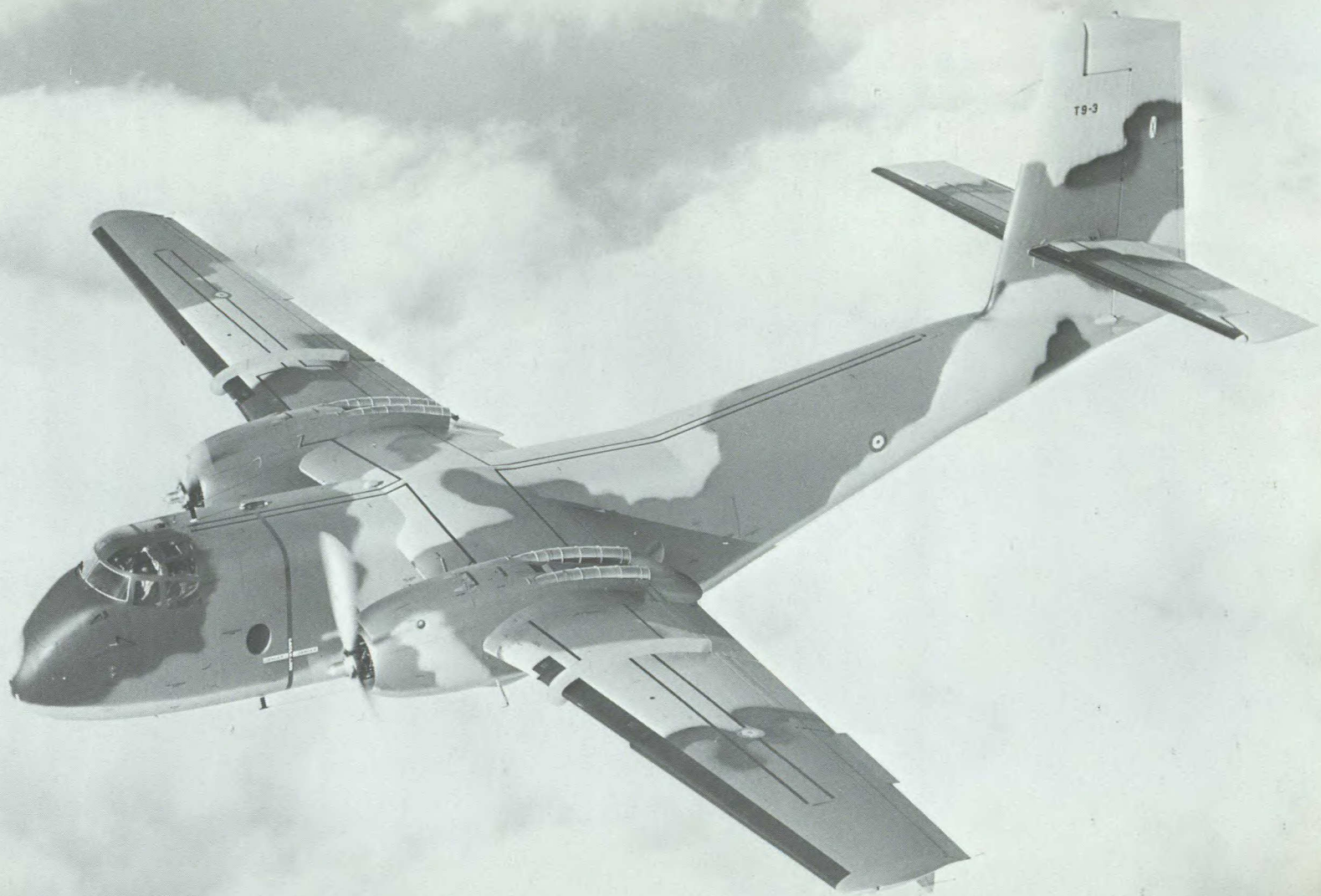
### Cabin Dimensions

Length .....	28 ft. 9 in.	8.76 m
Width (max.) .....	87 in.	221 cm
Width (at floor) .....	73.5 in.	186.7 cm
Height (on center line) .....	75 in.	190.5 cm
Cabin Capacity .....	1150 cu. ft.	32.5 cu. m
Max. Floor Loading .....	200 lb./sq. ft.	976.4 kg/sq. m

### Doors

Loading Doors	Width	73.5 in.	186.7 cm
	Height	75 in.	190.5 cm
Side Doors (2)	Width	30 in.	76.2 cm
	Height	55 in.	139.7 cm
Crew Hatch	Width	25 in.	63.5 cm
	Height	29 in.	73.7 cm

*The Caribou on the facing page is shown in the livery of the Spanish Air Force.*



## CANADAIR CL-41A TUTOR

Complete pilot training from first flight through to operational level is practical with the CL-41A Tutor, now in service with the Royal Canadian Air Force, Training Command and the Royal Malaysian Air Force. The aircraft has a performance that ranges from 80 to 488 mph (129 to 785 km/hr.), thereby providing good slow flight characteristics for the new student and high speed training for the advanced student. The service ceiling of 43,200 ft. (13,167m) provides ample range for training and operational flying. The side-by-side seating arrangement permits excellent visual instruction techniques between the instructor and student.

Construction features of the CL-41A include a very robust airframe structure designed for long service life; a spacious, pressurized and airconditioned cockpit; very good harmony of flying controls throughout the wide speed-range; wide-track undercarriage with nose wheel steering; and superior cockpit visibility.

The CL-41A is considered to be an excellent basic and/or advanced jet trainer for both military and civil pilots.

## CANADAIR CL-41G TACTICAL TRAINER

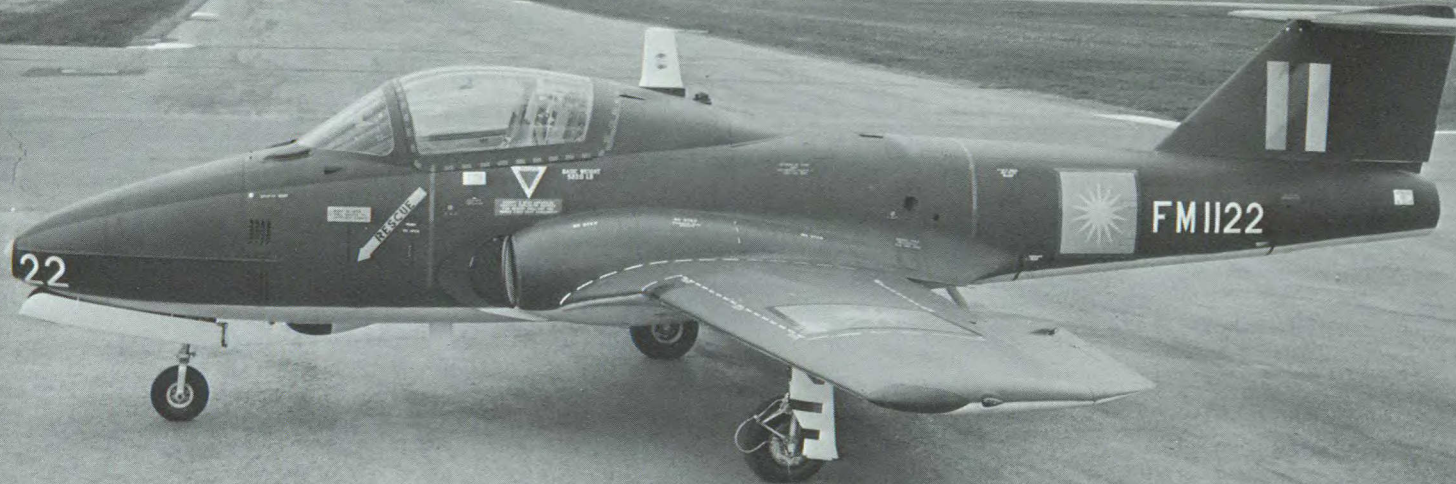
The CL-41G has been developed from the CL-41A Tutor. As an operational trainer or counter-insurgency aircraft, the CL-41G is capable of multi-mission versatility maintaining the very good construction features of the Tutor trainer mentioned above. The CL-41G can carry a 3,500 lb. (1587.6 kg) load of ordnance stores on two underfuselage mountings and four under-wing hardpoints. Various mixes of stores can be mounted, including 250 and 500 lb. (113.4 & 226.8 kg) bombs, G. E. Minigun six-barrel machine gun pods, 500 and 750 lb. (226.8 & 340.2 kg) napalm bombs, and a variety of air-to-surface rockets.

High aircraft utilization rates are achieved as a result of the special attention that was given in designing the aircraft to ease of servicing and maintenance. There are over 50 panels provided for access to the airframe and engine, and the major portion of flight control runs, hydraulic lines and electrical cables are easily reached in a large trough in the bottom of the fuselage. The G.E. J85-CAN 40 engine, common to both the CL-41A and 41G is widely used in civil and military aircraft.

Growth potential for the CL-41G includes additional fuel tanks for increased range, pod mounted reconnaissance equipment, and increased flexibility through multi-purpose armament hardpoints.

*Facing page shows one of the CL-41G's now in service with the Royal Malaysian Air Force.*





# CANADAIR CF-5

Canadair is manufacturing 115 CF-5s for the Canadian Armed Forces and 105 for the Royal Netherlands Air Force. The CF-5 incorporates many improvements on the basic F-5 which is already in service with the Air Forces of ten Free World Nations and had been proven in operations by the U.S.A.F. The F-5 was designed for tactical support, interdiction and interceptor roles and to these, the CF-5 now adds both a high and low level photo reconnaissance capability.

## CF-5 Improvement

Improved Take-Off Performance.  
Alternative Quick-Change Reconnaissance  
Nose.  
In-Flight Refuelling Capability.  
Arrestor Hook.  
Inlet Anti-Icing.

Strengthened Windshield.  
Jettisonable Pylons.  
Improved Navigation/Radio Facilities.  
Lead-Computing Sight.  
87% Increase in Electrical Generating  
Capacity.

In addition, provision is made in all production CF-5s for fitment of armour protection, JATO facilities, a doppler radar and navigation computer, depending on customer's requirements.

## Performance

The increased power available from the General Electric J.85-15 engines, combined with auxiliary intake doors on the rear fuselage and a two-position nose undercarriage giving a 3° increase in angle of attack, produces an improvement in take-off run of between 15% to 25% depending upon load. The additional power also increases the rate of climb and gives the CF-5 a supersonic dash speed at low altitude in level flight.

## Weapon Delivery

The CF-5 carries an external payload of 6,200 lbs. — nearly half its own weight. With a mix of missiles, bombs, rockets and napalm, in addition to its internal armament of two 20 mm. cannon, the CF-5 is an ideal vehicle for close support tasks, armed reconnaissance sorties or interceptor missions. The two-seat version of the CF-5, designated CF-5D, retains the key features of the CF-5A — rapid acceleration to supersonic speeds, high rate of climb, manoeuvrability and has the same external load carrying capability. In addition to its function in the training role therefore, the CF-5D is equally effective as an operational aircraft except for the absence of the internally fitted cannon armament.

## Photo-Recce Capability

The quick-change alternative recce nose section of the CF-5 uses groups of three Vinten 70mm. cameras to provide forward and side-oblique photography in the low level recce role, or a horizon-to-horizon tri-camera fit for high level photography.

## Economy

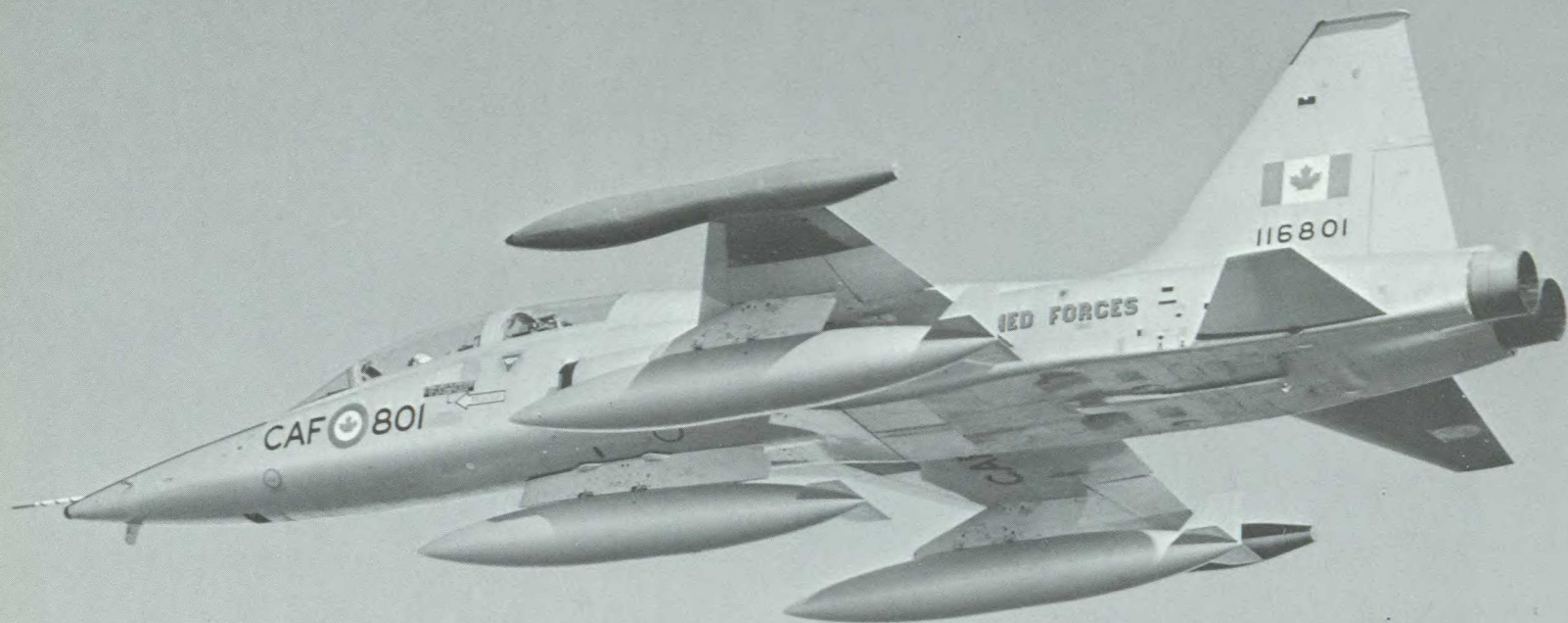
In addition to excellent responsive handling qualities and potent armament capability, cost effectiveness from factory to flight line to weapon delivery has been a constant factor in both the F-5 and the CF-5. The aircraft's light weight and economical fuel consumption reduce operating costs. Specially designed ease-of-maintenance features, the use of relatively unsophisticated components, and the ground level accessibility of all systems reduce maintenance costs.

## Flight Safety

Hand in hand with twin-engine reliability and safety is outstanding single-engine performance, thus effectively reducing the attrition rate. Dual fuel, hydraulic, and electrical systems, plus armour protection of vital areas, also enhance the combat reliability of the aircraft. Both hydraulic systems provide power to the dual flight control system — each continually backing up the other — another safety feature.

The CF-5 combines the capabilities and performance normally associated with larger and more complex aircraft, with the rugged strength necessary for the low level tactical role and for operating from semi-prepared forward airstrips. With a low operating cost and many ease-of-maintenance and safety features, the CF-5 is a weapon system ideally suited to the constantly changing requirements of an increasingly complex cost and defence environment.





## CANADAIR CL-84

The CL-84 is being developed as a highly versatile vehicle with the potential of fulfilling a wide variety of roles that otherwise require the use of both fixed and rotary-wing aircraft. Its military applications are expected to comprise combat support, personnel and cargo transport, reconnaissance, search and rescue, helicopter escort, and communications, from both land bases and aircraft carriers.

Performance flexibility of this order is made possible by the novel "tilt-wing" design of the CL-84 which allows the aircraft to take off vertically and hover like a helicopter, yet fly forward like an airplane at speeds up to 350 m.p.h. (563 km/hr). With the wing tilted between the vertical and horizontal, the CL-84 will have impressive performance and manoeuvrability at very low speeds and outstanding short take-off and landing (STOL) capabilities.

Although this aircraft is designed for vertical, STOL, and fixed-wing flight, the pilot's primary cockpit controls consist of the standard aeroplane rudder pedals, stick, and single throttle (power lever) which incorporates the wing-tilt switch. (There is no requirement for a collective pitch lever). Because of this simplicity, an experienced pilot will be able to devote virtually his full attention to his operational task rather than to flying the aircraft.

Commercial developments of the Canadair CL-84 would substantially reduce total travel time for passenger transportation between city-centres 100 to 500 miles (161 to 805 km) apart. Also, because such aircraft can operate independent of normal runways, they have considerable potential for survey, exploration and general transport work in undeveloped areas.

Evaluation models for the Canadian Armed Forces are now in production at Canadair.









## THE PT6 TURBINE ENGINE

The PT6, designed and produced by United Aircraft of Canada Limited, is a lightweight free turbine engine designed for use in both fixed and rotary aircraft. In the western world, it is the leading seller of its class.

The current production models are available in turbo-prop and turboshaft versions in the 500 to 1100 SHP power range. A total of 4500 engines had been ordered by the end of 1969 and more than 3300 engines have been delivered.

At that time there were 78 different applications of which 27 were certified airborne applications. Powered aircraft, flown by 600 different operators in 53 different countries, had logged almost 3,000,000 flying hours by the end of 1969. Time between overhauls was 2500 hours, with hightime TBO at 3,500 hours. Customers in the commuter airline business are achieving a high time utilization rate of 325 hours per month. The PT6 is also achieving a premature removal rate of 1 per 6250 hours and an in-flight shutdown rate of 1 per 25,000 hours.

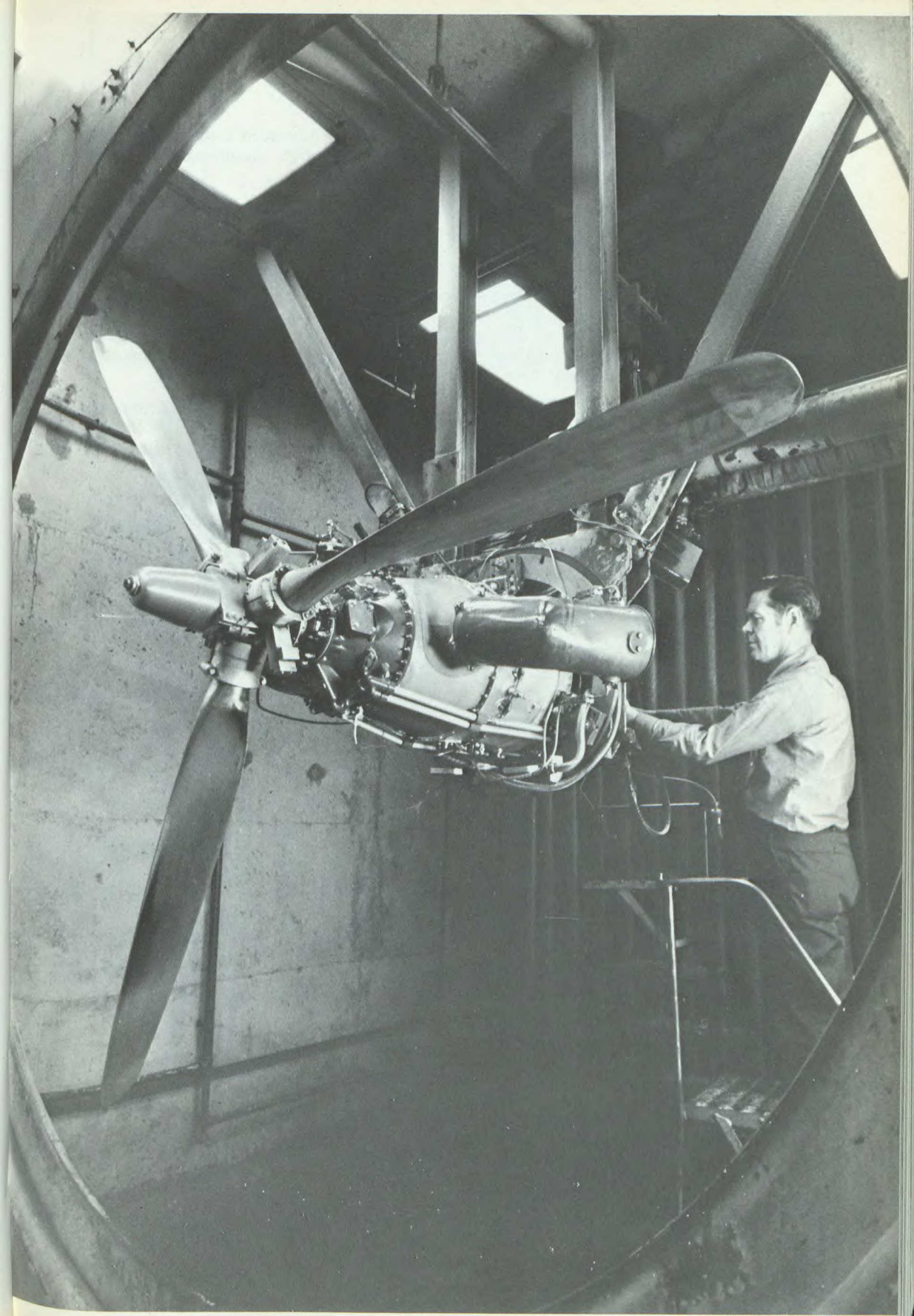
Many new applications were under consideration. Major contract awards will result in new and more powerful models to go into production starting in early 1970, while the current basic models will remain available as long as demand exists. Following are the expected PT6 program highlights during 1970:

Accelerated penetration of the commuter airline market mainly with the Beech Model 99 Commuter Liner and the de Havilland of Canada Twin Otter. Other PT6-powered installations designed for the commuter market are expected to be available in the next few years.

The PT6T-3, whose military designation is T400-CP-400, is an 1800 SHP powerplant, consisting of two 900 SHP PT6 engines side by side and driving a single output shaft through a combining gearbox. Intended for helicopter application, the PT6T-3 offers twin-engine reliability. It has been selected to power Bell Helicopter Company's commercial Model 212. The T400 version will power the UH-1N helicopter for the Canadian Armed Forces and the USAF. These aircraft are twinned versions of the Bell Huey helicopters ordered for the U.S. Marines. It is intended to develop the PT6T-3 to 2400 SHP by 1972. Production will start in early 1970.

The ST6L-73 is a 900 SHP turboshaft version of the PT6, designed to power the Hamilton Standard Auxiliary Power Unit for the Lockheed Model L-1011 TriStar jetliner. This is the first application of the PT6 in an on-board auxiliary power unit. Intensive development has taken place through 1969 on the ST6L-73 and production deliveries will begin in early 1970.

The PT6 engine has been developed through about 55,000 hours of test cell running. Development continues at a brisk pace in support of the engines already delivered and in anticipation of future requirements for more power and more efficient performance.



## THE JT15D

The JT15D engine under development at UACL is an advanced technology turbo-fan in the 2000-2500 lbs. thrust category, for executive, commuter and other light transport aircraft of the 1970s.

Its first two applications are the Cessna Citation and the Sud-Nord 600 Corvette, France's newest business aircraft. The eight-place twin jet Corvette is scheduled to be certified by the end of 1970. Civil certification of the Cessna Citation is also expected in 1970.

First flight of an aircraft powered by JT15Ds took place on September 15, 1969, at the Cessna facility in Wichita, Kansas. Flight test work started in August 1968 with the JT15D in an external flight pod attached to the underside of a CF-100, a twin engine jet fighter acquired by the company from the Canadian Armed Forces. Engine tests were undertaken to 42,000 feet and Mach 0.8.

All phases of the JT15D development were on schedule. Eight experimental JT15D engines acquired more than 2400 hours of test bed running prior to first flight of the Cessna Citation. The high time engine accumulated more than 600 hours.

Three consecutive unofficial 150 hour civil endurance tests were carried out on one engine for a total test time of 450 hours. This engine showed excellent mechanical integrity and hot end life. Also prior to first flight, more than 4000 hours of component rig test time were completed.

The engine was flight tested for more than 70 hours, including flights to 42,000 ft. MACH 0.8 in a CF-100 aircraft. Engine handling, relight and altitude performance are satisfactory.

The outstanding features of the JT15D are:

- Take-off thrust 2200 lbs. with an SFC of 0.504. The dry engine-weight is 480 lbs. It measures 60 inches in overall length with a maximum diameter of 27 inches.

- A minimum number of aerodynamic components to give low cost, simplicity, ease of maintenance.

- A high bypass ratio for high static and climb thrust, and a low noise level.

- No compressor inlet guide vanes for good FOD tolerance, no blade anti-icing, low noise levels.

- Conventional turbine temperatures giving high TBO's and low maintenance costs.

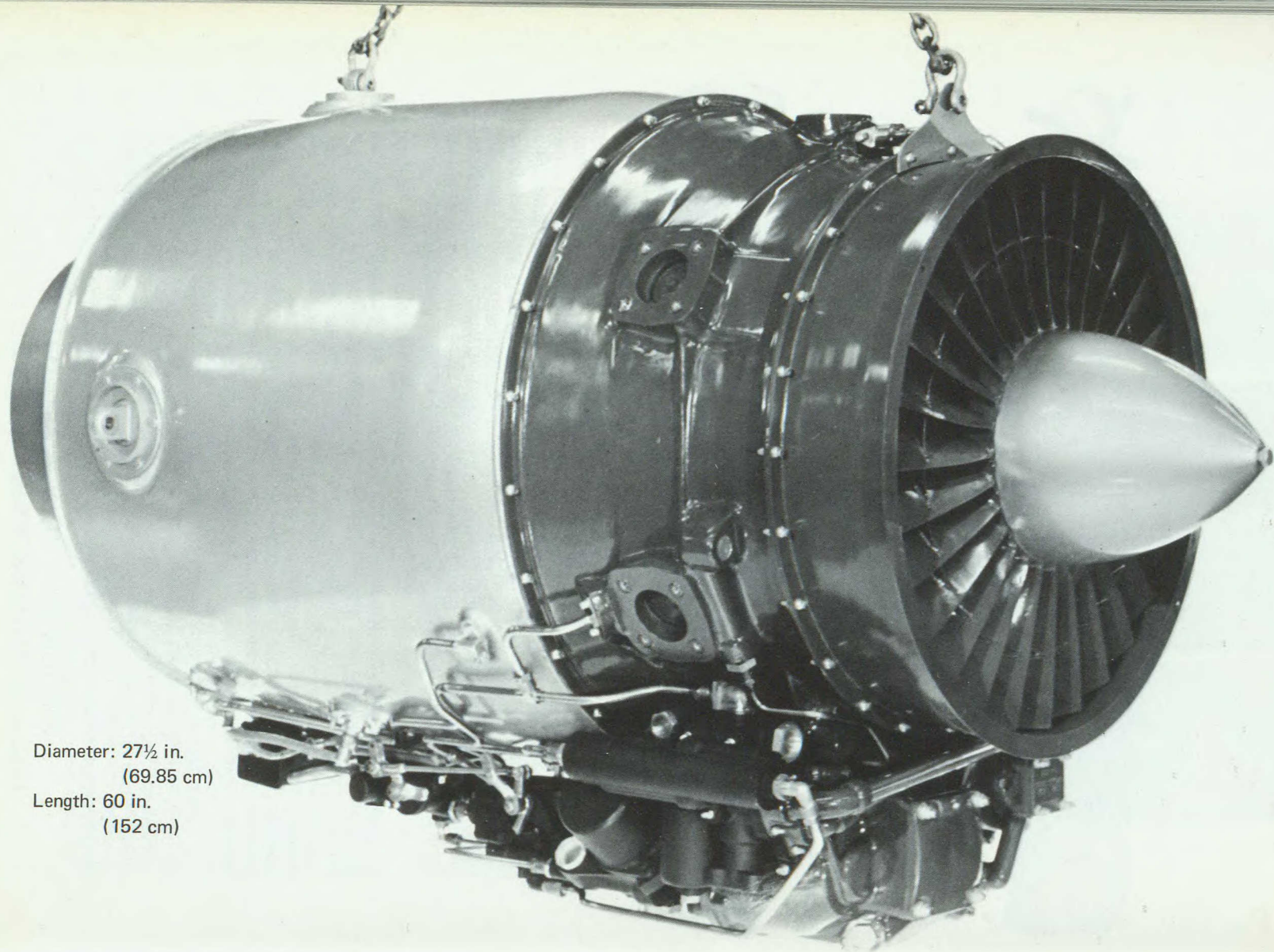
- Compressor bleed air, accessory power extraction, integral oil tank, ease of starting and low approach thrust.

- Low engine plus fuel weight at 2 to 3 hours endurance compared to pure jets.

- A good growth potential.

Production deliveries will begin in early 1971.





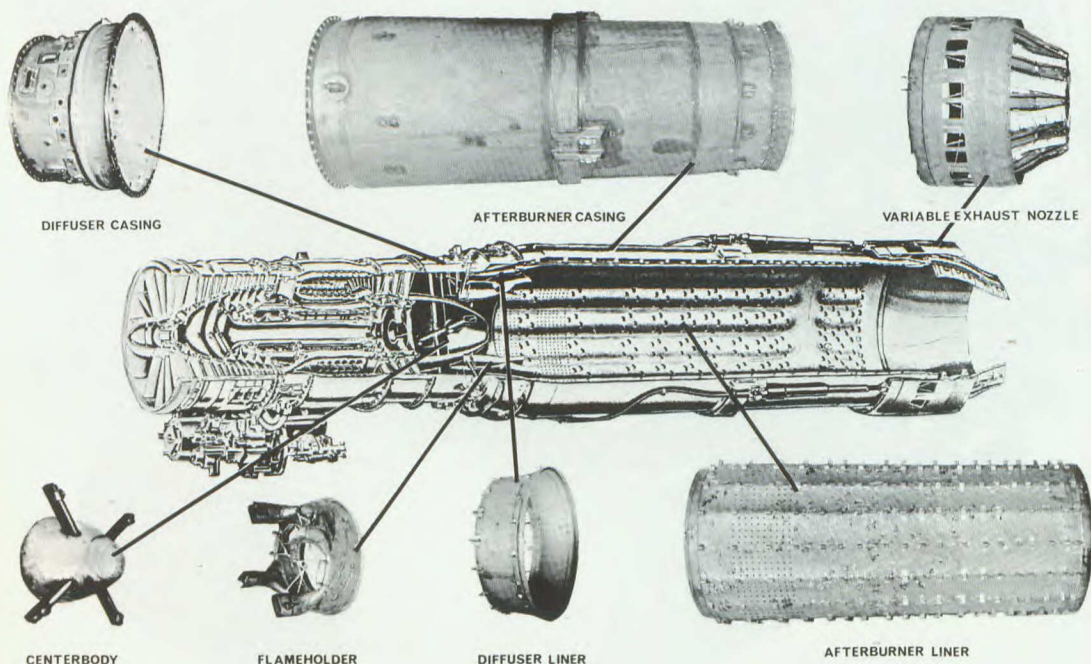
Diameter:  $27\frac{1}{2}$  in.  
(69.85 cm)  
Length: 60 in.  
(152 cm)

## GAS TURBINE ENGINE COMPONENTS AND ASSEMBLIES

The fabrication of complex precision gas turbine engine components and assemblies is one of the major lines of specialization at the Bristol Aerospace plant in Winnipeg. This facility has been supplying components of the types illustrated in the adjoining photograph to the leading aero-engine companies in North America for many years, and is fully equipped with a range of the most modern machine tools required for production to the close tolerances demanded in this field.

Most of the items produced are in the "hot" section of the engines, from the combustion chamber to the exit nozzle, these being the components requiring special alloys capable of withstanding continuous exposure to elevated temperatures. Many of the materials used in these applications require special forming, machining, welding and heat treatment techniques, for which the Winnipeg facilities are well equipped. Government approved quality control laboratories equipped with the latest range of metallurgical inspection and test equipment support the production programs and ensure adherence to the strictest standards imposed by military and commercial specifications.

The Bristol plant includes extensive tool design building and proving facilities, enabling new engine programs to be handled from the prototype stage through to quantity production. In recent years the economies which can accrue to engine operators through overhaul and repair of "hot" end components and assemblies, compared with the cost of the extensive replacement programs previously considered necessary, have led to substantial growth of R and D work for these items. This work is of a specialized nature, by virtue of the materials and techniques involved, and the Winnipeg facility is engaged in domestic and export R & D programs for both components and assemblies, including complete engine afterburners.





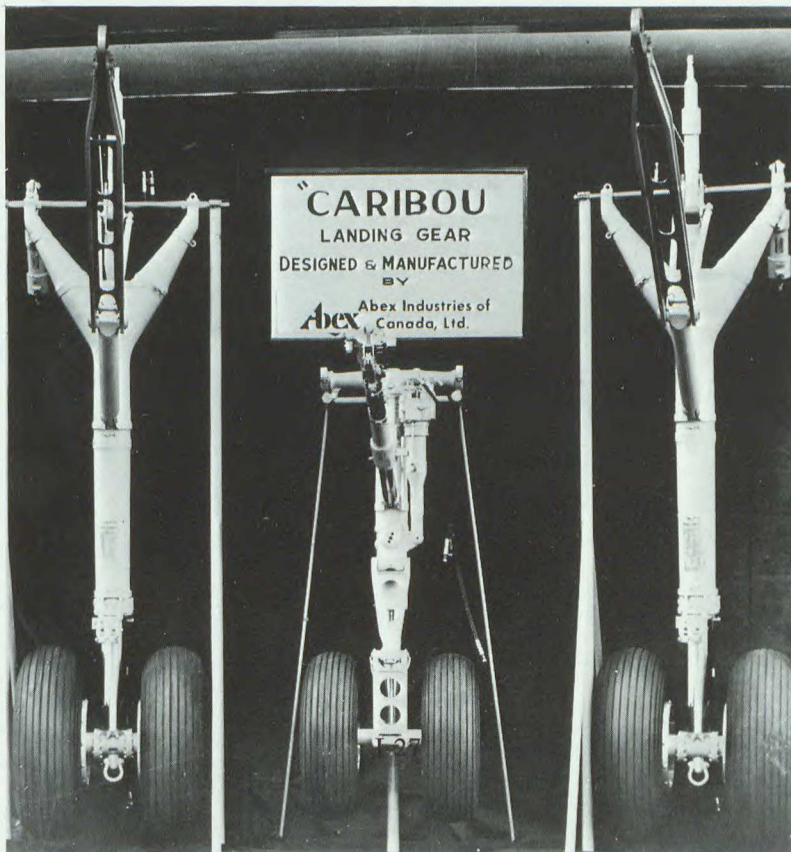
## DHC-4 MAIN AND NOSE LANDING GEARS

The main and nose landing gear for the DHC-4 are designed and manufactured by Abex Industries of Canada Limited, Aerospace Division.

The main gear assembly comprises the shock strut, drag strut, shortening mechanism, and retraction actuator. The shock strut is designed for rough field operation and provides a stable platform during loading operations. The strut is a two stage oleo-pneumatic arrangement with an overload relief device which prevents high transient loads being transmitted to the wing. The entire shock strut assembly is housed in a capsule tube which slides inside the outer housing thus enabling the gear to be shortened during the retraction cycle. The drag strut is a structural member and has provisions for connecting the stabilizer rods to the shortening mechanism.

The nose gear assembly consists of the shock strut, drag strut and steering actuator. The shock strut is a two stage oleo-pneumatic device and it is designed for rough field operation and provides a stable platform during loading operations.

The drag strut is a double acting hydraulic actuator incorporating an integral locking device in the extended and retracted positions. The drag strut functions as a retraction actuator for raising and lowering the gear and also provides a mechanical uplock and downlock for the gear assembly. Normal operation of the drag strut is achieved using the hydraulic system pressure and emergency provisions are incorporated in the unit to permit the gear to be unlocked, lowered and locked in the down position in the event of system failure.



## **DHC-5 MAIN AND NOSE LANDING GEARS**

The nose and main landing gears for the DHC-5 are designed and manufactured by Abex Industries of Canada Ltd., Aerospace Division.

The main gear assembly represents an advance in STOL rough field operational capability, the design concept having been proven in the DHC-4. The general arrangement of the gear is similar to the DHC-4 except that there is no shortening function. The basic gear comprises the shock strut, drag strut and retraction actuator.

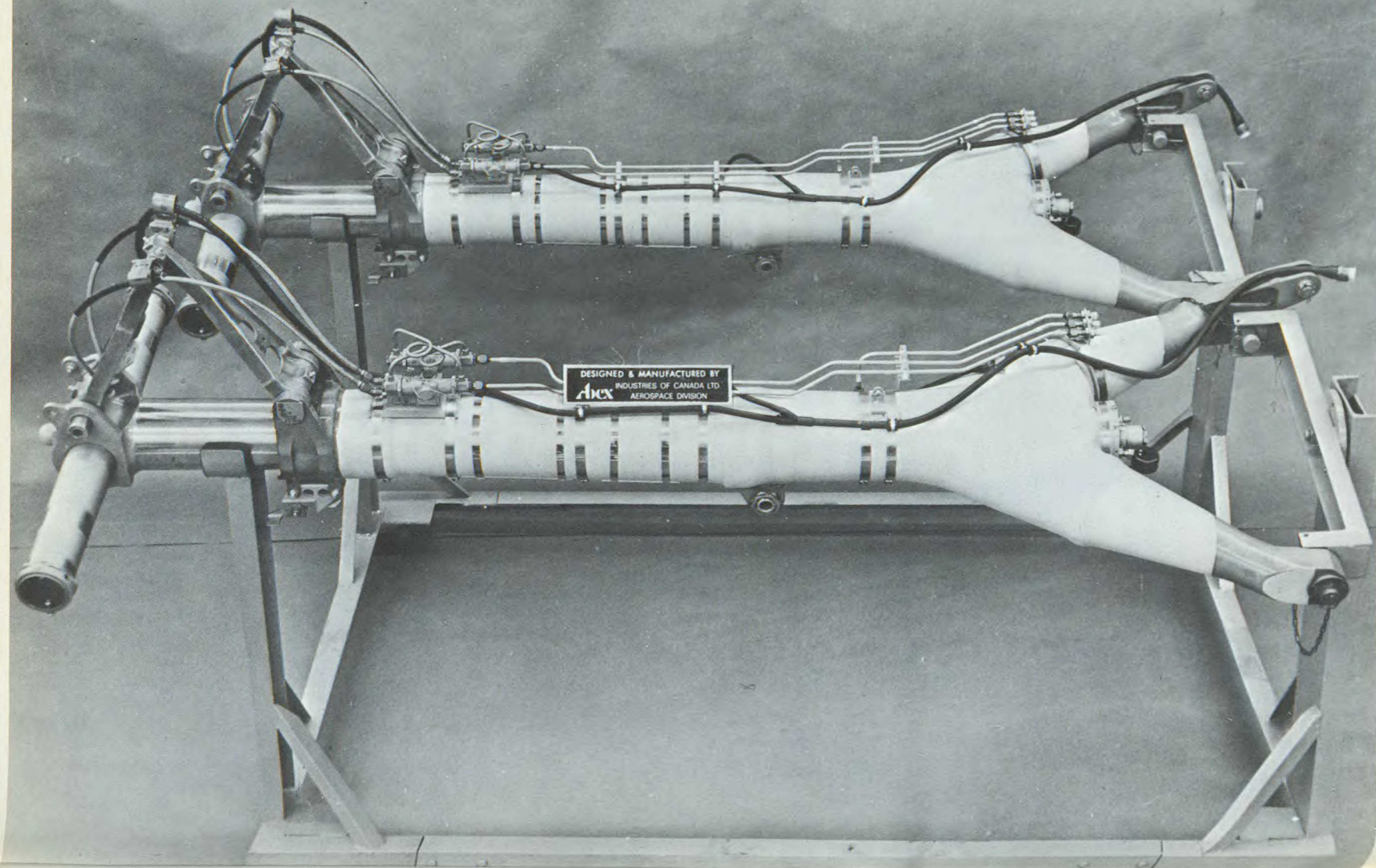
The shock strut is a two stage oleo-pneumatic arrangement with an improved overload relief device. The drag strut is a self-cracking strut incorporating an in-line mechanical locking device. An integral spring-biased hydraulic actuator provides the means for unlocking and cracking the strut and also ensures the positive locking of the gear in the down position. A double acting hydraulic actuator with snubbers at each end of the stroke raises and lowers the gear.

### **Nose Gear Assembly**

The nose gear assembly comprises the shock strut, drag strut, and steering actuator.

The shock strut is a two stage oleo-pneumatic device designed for rough field operation and provides a stable platform during loading operations. The drag strut is a double acting hydraulic actuator incorporating an internal locking device in the extended and retracted positions. The drag strut functions as a retraction actuator for raising and lowering the gear and also provides a mechanical uplock and downlock. Normal operation of the drag strut is achieved by the use of system pressure and emergency provisions are incorporated in the unit to permit the gear to be unlocked, lowered and locked in the down position in the event of system failure. The steering actuator is a balanced area linear actuator which operates a bell-crank arrangement to provide the necessary torque to steer the nose gear. The steering actuator has a steering valve, back pressure reservoir and shimmy damper valves.







## MAIN LANDING GEAR FOR TUTOR AIRCRAFT

The main landing gear for the RCAF CL41A Tutor jet trainer was designed and is currently produced by Dowty Equipment of Canada for Canadair Limited, Montreal.

Of simple design, the gear incorporates a conventional type air/oil shock absorption element. Main components comprise an anodized aluminum alloy main outer cylinder, a steel cylinder assembly, and steel torque links which are mounted between the main outer fitting and the sliding cylinder assembly. The wheel axle component and the sliding cylinder are machined from a single forging.

Air under pressure is contained in the bore of the sliding cylinder, while the bore of the main outer fitting is filled with hydraulic fluid. A floating piston separates the air from the fluid. In operation, the sliding cylinder telescopes into the main outer cylinder. Movement between these cylinders causes fluid to be forced through a valve in the piston head of the sliding cylinder to damp impact shocks. At the same time, air below the separator piston is further compressed; it is this 'air cushion' upon which the aircraft rides during take-off and landing runs and taxiing.

Salient characteristics: *Weight* 51.3 lb. approx. (23.3 kg); *Temperature range* -65° to 275°F. (-18C to + 135C); *Fluid* MIL—H—5606.

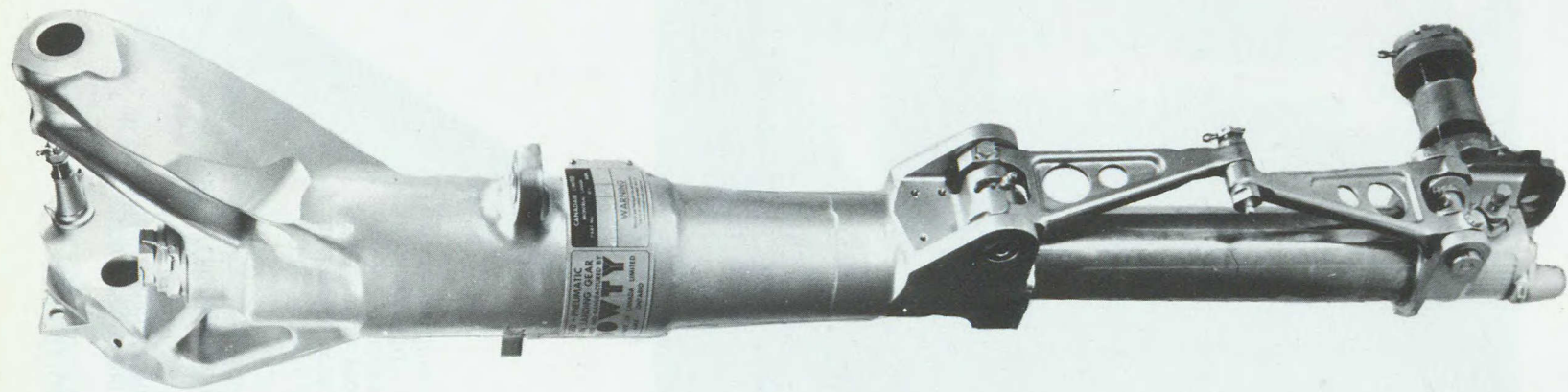
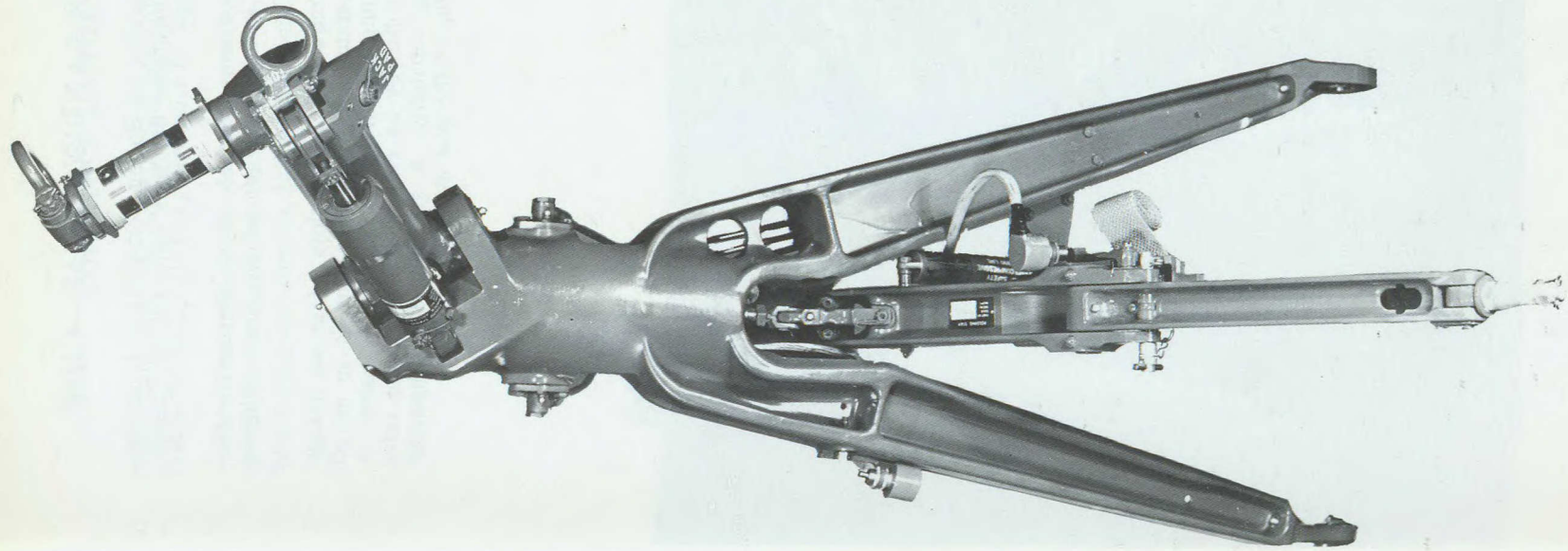
## HELICOPTER LANDING GEAR—UH-2

The wheeled main landing gear used on the Navy model UH-2 Helicopter was designed, developed and produced by Dowty Equipment of Canada Limited for Kaman Aircraft Corporation, Bloomfield, Connecticut.

Constructed predominantly of aluminum alloy, anodized, with a link and axle member machined from one steel forging, the gear is fully retractable. Compact, yet readily serviced, the gear is attached to aircraft pick-ups at the main 'Y' member extremities and at the drag strut swivel. Extension and retraction is accomplished by means of a hydraulic actuator housed within the bore of the main member. An internal claw-type lock within the actuator locks the gear upon full extension; an uplatch affixed to the aircraft fuselage contains the gear in its retracted position. A spring-box is incorporated to assist normal extension of the gear and to ensure emergency full extension. Operational shocks imposed on the gear are absorbed by a Dowty 'Liquid Spring' shock absorber mounted between the link and axle member and the main 'Y' member.

Aircraft towing and tie-down eyes are embodied.

Salient characteristics: *Weight* 92½ lb. approx. (42 kg); *Temperature range* -65°F to 160°F. (-18C to + 71.1C); *Fluid* MIL—H—5606.

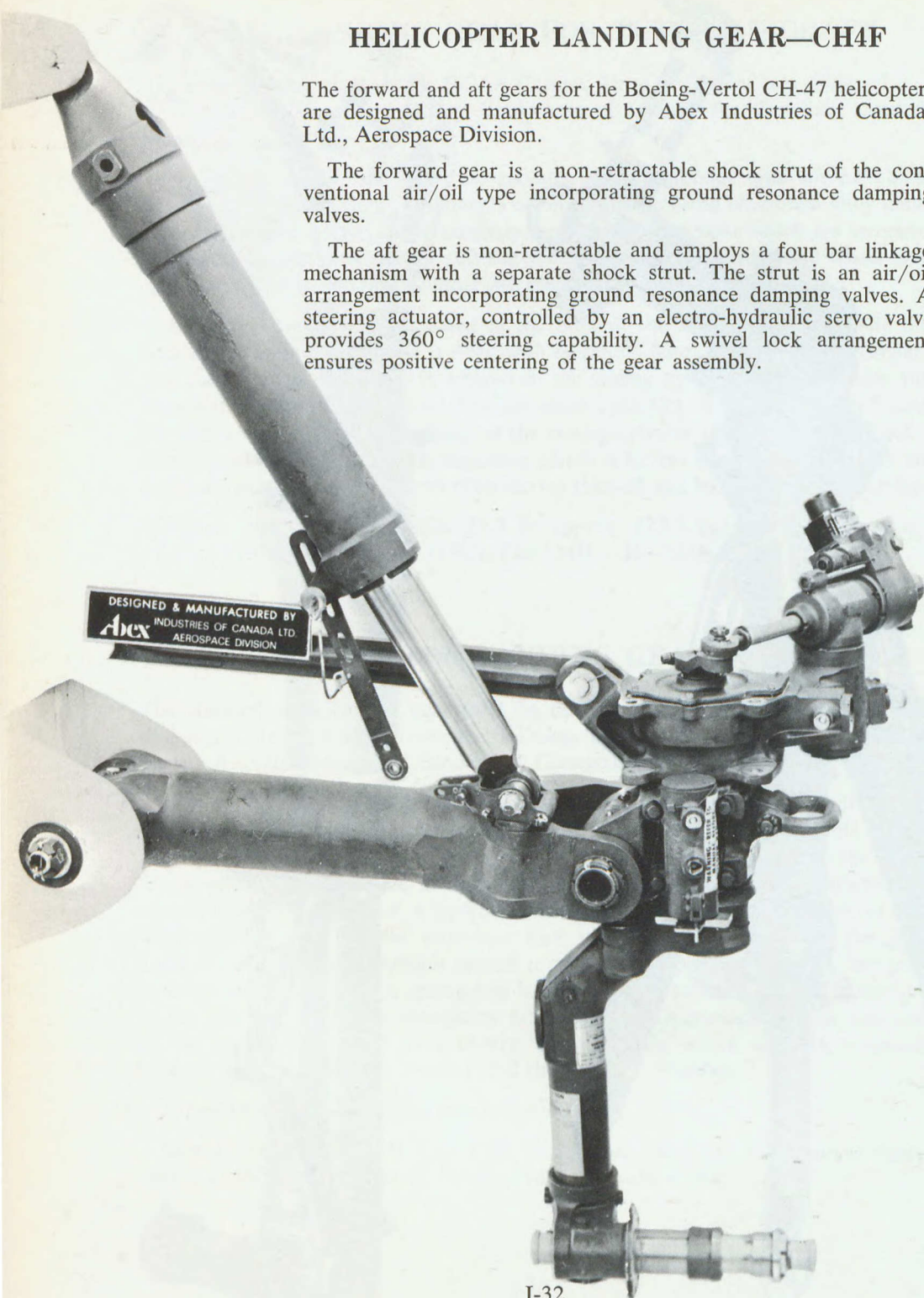


## HELICOPTER LANDING GEAR—CH4F

The forward and aft gears for the Boeing-Vertol CH-47 helicopter, are designed and manufactured by Abex Industries of Canada, Ltd., Aerospace Division.

The forward gear is a non-retractable shock strut of the conventional air/oil type incorporating ground resonance damping valves.

The aft gear is non-retractable and employs a four bar linkage mechanism with a separate shock strut. The strut is an air/oil arrangement incorporating ground resonance damping valves. A steering actuator, controlled by an electro-hydraulic servo valve provides 360° steering capability. A swivel lock arrangement ensures positive centering of the gear assembly.

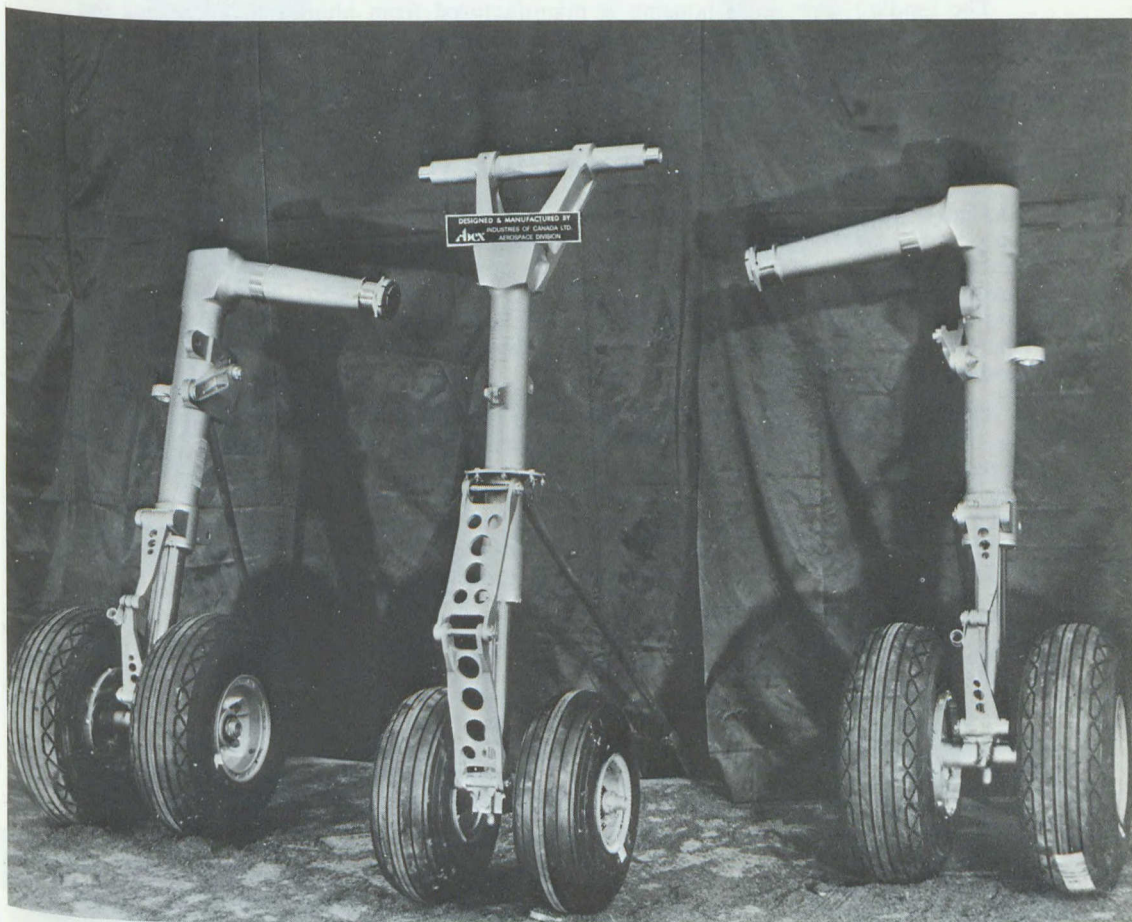




## AIRCRAFT LANDING GEAR—CL-84

The CL-84 main and nose landing gears are designed and manufactured by Abex Industries of Canada Ltd., Aerospace Division.

The shock struts are of the conventional air/oil type. The nose gear has provisions for castoring through 360° and is fitted with a shimmy damper to ensure adequate damping during taxiing and take off.



## TWO POSITION NOSE LANDING GEAR

The nose landing gear for the Northrop/Norair F-5 Jet Fighter is designed by Dowty Equipment of Canada Limited. The gear is currently in production for both Northrop and Canadair Limited, Montreal. The latter is constructing the Canadian version of the aircraft, the CF-5A. The first landing gears were delivered in August, 1967.

The landing gear incorporates a wheel fork and axle assembly attached to an oleo-pneumatic shock absorber which telescopes together with an auxiliary outer tube in the nose gear main housing. A design feature of the gear is a lengthening device which enables the pilot to lift the aircraft nose and increase the aircraft angle of attack, thus increasing the take-off distance. The lengthening device, in essence an hydraulic actuator, consists of a piston on the auxiliary tube which acts in the bore of the gear main housing under normal aircraft system hydraulic pressure. An internal splined tube prevents rotation when the gear is being shortened for stowage after take-off.

Torque arms connect the wheel fork assembly to a steering collar on the gear main housing and a quick-release pin is provided at the torque arm knee-joint to allow for towing of the aircraft. Provision for a nose wheel steering actuator attachment is made by a lug on the steering collar. An internal centering mechanism maintains the nose wheel fore and aft when off the ground.

The landing gear main housing is manufactured from aluminum alloy and the remaining component parts, including the torque arms, are steel.

<b>Design Characteristics</b>	Length fully extended: 51.50 in. (130.81 cm.)
Weight 73 lbs. (33 kg.)	Length shortened for stowage: 40.00 in. (101.60 cm.)

## FLAP ACTUATOR/CONTROL

Designed and manufactured by Dowty Equipment of Canada for the operation and control of the De Havilland Caribou wing flaps, this unit comprises a double-acting hydraulic actuator and a spool type control valve with an interconnecting mechanism to cancel the selected flow path when the desired actuator traverse has been reached. Other elements embodied include an internal lock which sustains the actuator in its close state, an inlet filter and check valve, a rotary shut-off valve and a pressure relief valve.

Control is normally effected through push-pull linkage from the cockpit control to the external lever of the actuator. Upon selection of the desired degree of traverse, hydraulic pressure to the locked actuator causes the lock to disengage and permit piston movement. A spiralled rod connected to the rotary shutoff valve is rotated by the moving piston until the flow of pressure fluid is stopped. In this condition the actuator piston travel is also stopped. Return fluid flows through a drilling down the centre of the spiralled rod and to return line via the control valve.

Characteristics of this mode:

Weight .....	20 lb. (9 Kg.)
Maximum output force	
—Retraction .....	2310 lb. at 3000 p.s.i.
—Extension .....	7620 lb. at 3000 p.s.i.
No-load operating time	
—Extension .....	20/25 secs.
—Retraction .....	35/40 secs.
Input power requirement .....	3000 p.s.i. working pressure
Shaft stroke .....	12.29 inches maximum (31.2 cm)
Temperature Range .....	-65°F to + 160°F (-18C to + 71.1C)
Fluid .....	Hydraulic oil to Specification MIL-H-5606.



## ACTUATION SYSTEMS FOR VARIABLE GEOMETRY AIRPLANES

Abex Industries' experience in the design, development, manufacture and qualification of actuation systems for variable geometry airplanes commenced with the design and production of the Wing Tilt Actuator and the Flap Actuator for the XC 142. In addition has designed the Wing Tilt Actuator for the Canadair CL 84 Dynavert. Where the actuators are of the Ball Screw type. Further, the design, development and manufacture of the Wing Sweep Actuation System for the F-111 Airplane has established Abex Aerospace as a leader in this field.

In the F-111 the system consists of a control mechanism, two ACME screw actuators each having an hydraulic motor and reduction gear box. The actuator gear boxes are connected by a synchronizing shaft which permits either motor to drive both actuators. The pilot operates the Wing Sweep system by a pistol grip type sliding lever which supplies inputs to the position control mechanism and controls the actuator position.

The structural load carrying members of the actuator, which transmit a 510,000 lb. barricade load, are constructed of D6AC steel heated to a minimum of 220,000 psi. The gears, of particular geometry, are also manufactured in D6AC and have nitrided teeth.

Actuator back lash is limited to 0.020 inches inclusive of the teflon impregnated cotton fabric lined nut. The operating load is approximately 50,000 lb. and each hydraulic motor supplies 38 H.P. The actuator has a stroke of 31 inches and a fully extended length of 87 inches.

### **Spoiler Actuation Systems**

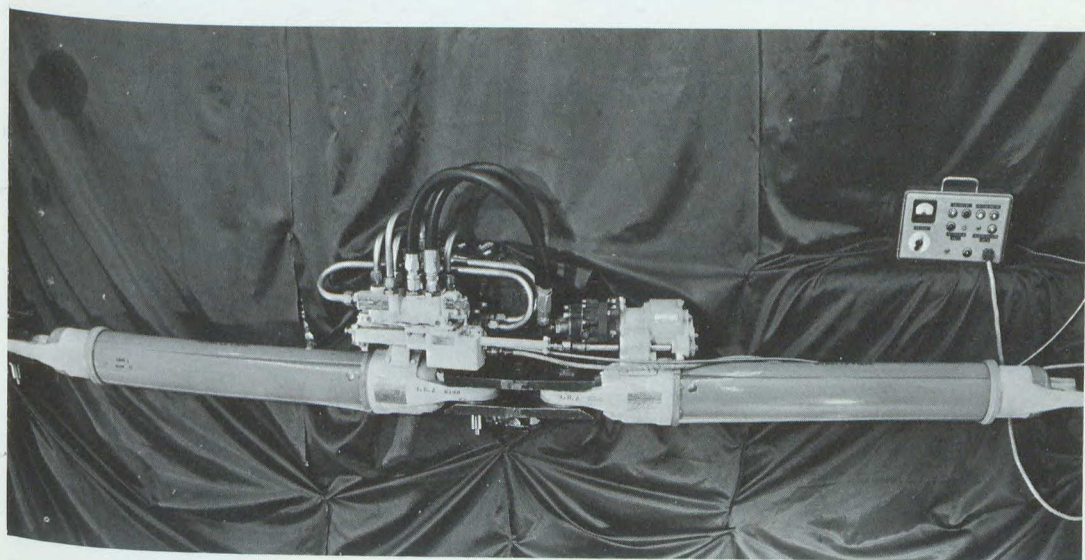
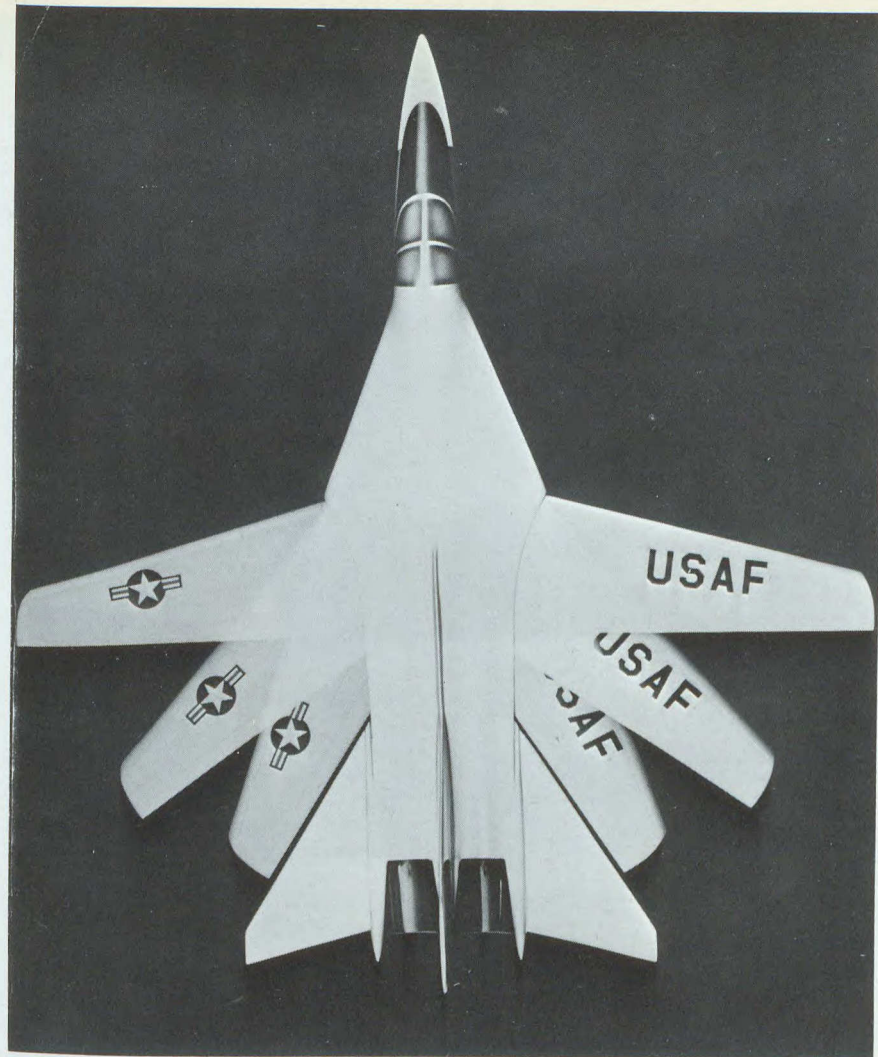
The Lockheed C141 has one Abex Aerospace Spoiler Actuator system in each wing.

In response to pilot and aileron inputs during flight and landing gear touch down input, the system actuates inboard and outboard spoiler panels. Each system accepts manual and electrical signals, the position control being a mechanical loop. The system has two tandem cylinders of 33,000 lb. output capacity and a control manifold.

The system performs the undermentioned functions.

- 1) actuator speed control
- 2) synchronization of inboard and outboard spoilers
- 3) synchronization of wing to wing spoiler operation
- 4) automatic spoiler closure in the event of wing to wing asymmetry
- 5) permits pilot hydraulic selection
- 6) permits continued operation in the event of servo valve failure
- 7) provides overload protection on spoiler panels
- 8) provides signal information to pilot







## HYDRO-MECHANICAL SYSTEMS

Heroux Limited is proud of the part it played in landing man on the moon. The Primary Land Gear Strut (main cylinder) together with many of the secondary support struts on the Lunar Module landed on the moon by Apollo 11, were manufactured by Heroux. The contract was won competitively and was based on Heroux's ability to perform to the extremely difficult specifications. Special types of equipment had to be developed by the company's tool designers to ensure quality parts for the total contract for 15 vehicles.

For over 27 years the company has been producing a wide range of machined parts for the aerospace industry. Production facilities are housed in two plants with a total floor area of 180,000 sq. feet (16,722 sq.m.). These plants are equipped to handle all sizes and shapes of precision machined parts. Special milling, profilers, lathes, honing and gear cutting machines are used. A bank of four Milwaukee Matic tape control (N/C) are used as well as a tape controlled automatic chucker. Three automatic lathes are in use. Parts are manufactured for aerospace, atomic energy, shipbuilding, pulp and paper and many other types of industry.

The design team has experience in the design development and manufacture of landing gears, aero and industrial electro-hydraulic, hydraulic, hydro-mechanical and electro-mechanical systems and servos. The nose landing gear for the De Havilland DHC6 Twin Otter (Page I-8) was designed, developed and manufactured here as well as the nose and main landing gears for the CL-215 Canadair Water Bomber (Page I-10). Actuators and servos used on the CL-84 (Page I-20) and CL-215 are other products from the design and manufacturing team.

The company maintains one of the largest and most complete electro-plating and metal finishing facilities in Canada. This facility holds approvals from most of the major aircraft manufacturers in North America as well as approvals from applicable government agencies and many air carriers.

The Repair and Overhaul facilities at Heroux are considered to be as sanitary and modern as any in North America. Four separate "clean rooms" are maintained for the following functions:

1. Assembly of Production items (landing gears — servos — actuators etc.).
2. Repair and Overhaul of Hydraulic components (Canadian Armed Forces — Air Lines and Private Operators).
3. Repair and Overhaul of Fan Jet Falcon Business Jets and Alouette helicopter hydraulic components (Metric System).
4. Manufacture of Spool and Sleeve Assemblies.

These clean rooms are class 100 with air filtration to less than three microns and subsequent use of Vertical Laminar Flow work benches filters the air to .36 microns. Hydraulic fluid is filtered to one micron absolute and maintained at a temperature of 70°F to 110°F by means of refrigeration.

Structural components, shown on Page I-41, have been made for General Dynamics — Grumman — Boeing — United Aircraft — Sikorsky — De Havilland of Canada — Canadair — Douglas of Canada and Douglas (Santa Monica) — Curtiss Wright — Northrop — Bell Helicopter — Republic — Vertol Division of Boeing — Bristol Aero Industries as well as many sub-contractors to primes, such as Entwistle — Menasco (L1011) — General Electric and others.

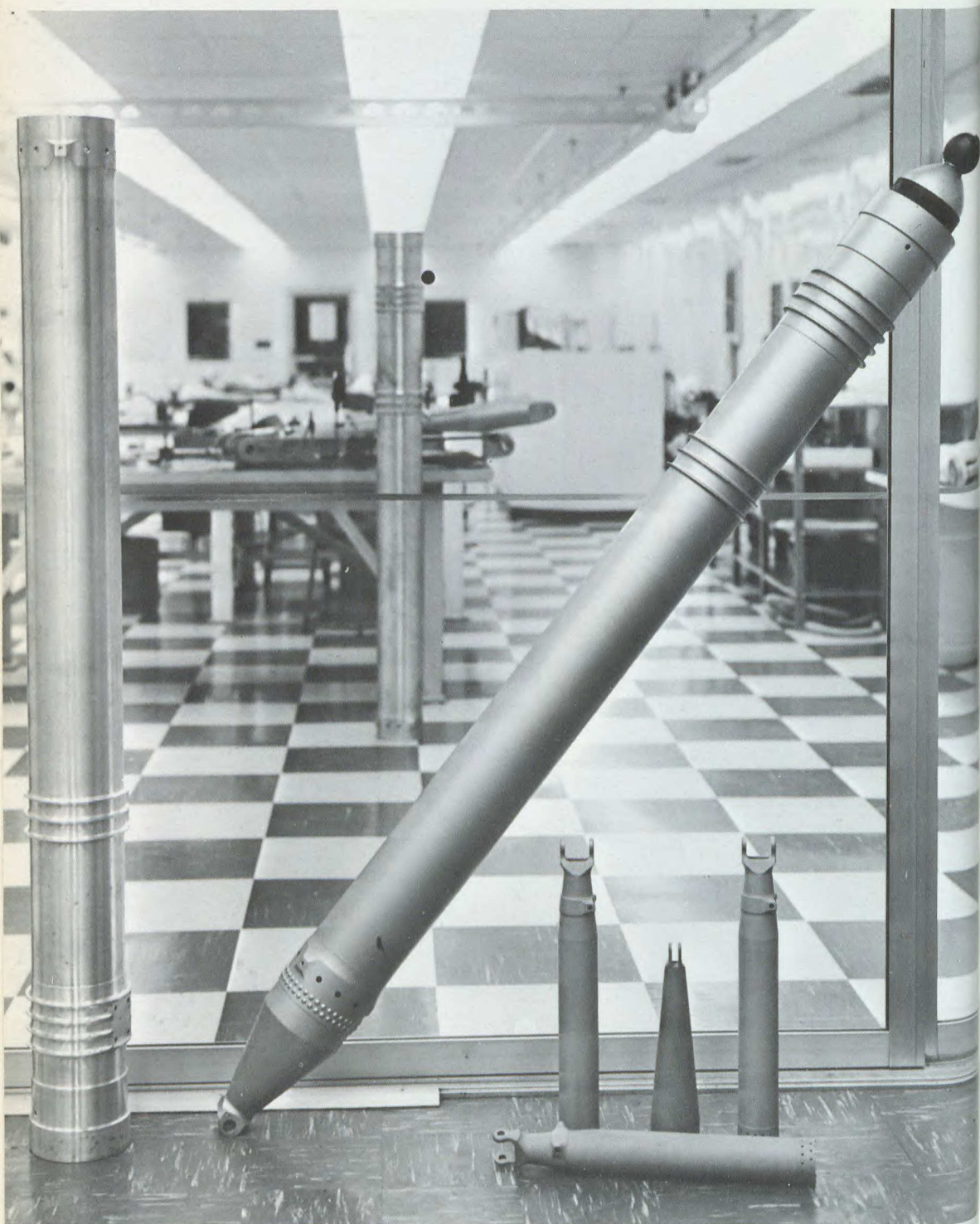
Quality Control is founded on the concept of total quality control. Each phase of the manufacturing process from the purchase of material and components through fabrication and assembly, to shipping of the finished product is carefully monitored by the Quality Control Department. Fabricated parts are inspected to exacting standards and each minor assembly is tested as a unit prior to being incorporated into a larger unit. Thus performance is checked to meet the most stringent standards at all levels of manufacturing. Quality Control policy and procedures are certified to the Department of National Defence DND/1015 and exceed the requirements of MIL-Q-9858A for the manufacture of airframe aero engine and hydraulic components. The Canadian Armed Forces maintain a detachment at the plant for in-house inspection services. Heroux's Quality Control and Quality Assurance capability has been exemplified by "Zero Defects" and "Gold Rotor" awards from General Dynamics and Bell Helicopter respectively.



A LEM leg with a representative landing pad at the base. A model LEM is shown in the left foreground.



## HYDRO-MECHANICAL SYSTEMS (cont'd)



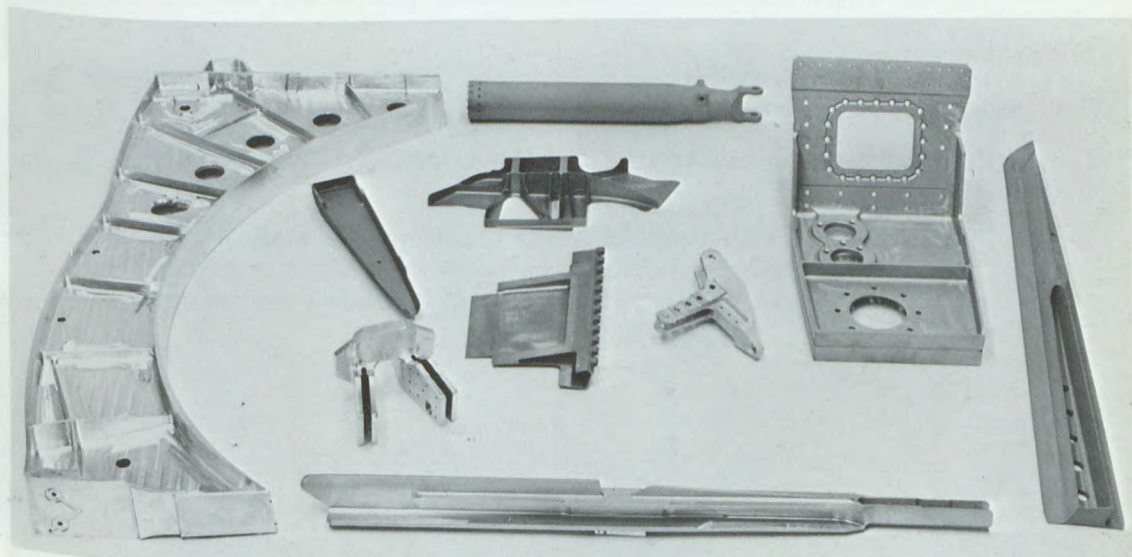
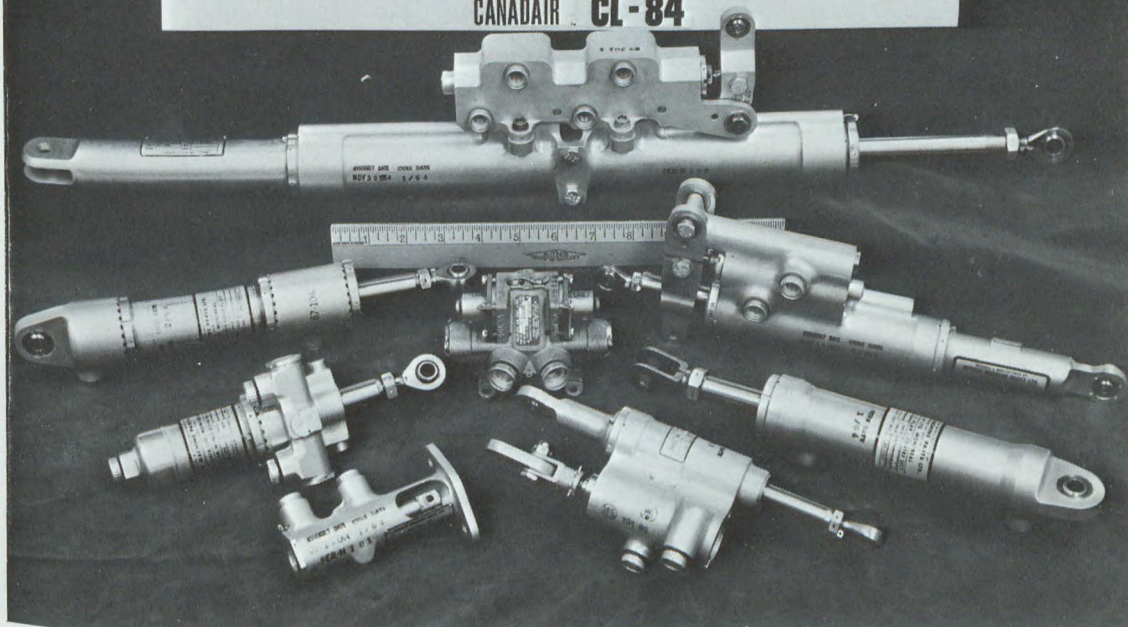
Further views of the LEM leg and the smaller retracting struts. One of the clean rooms provides background.

## HYDRO-MECHANICAL SYSTEMS (cont'd)

**DESIGNED & MANUFACTURED BY HEROUX MACHINE PARTS LTD.**

**FLIGHT CONTROL SERVOS  
VALVES & ACTUATORS**

FOR  
**CANADAIR CL-84**



A selection of contoured parts produced by Heroux.



## AIRBORNE FUEL SYSTEM UNITS

Airborne fuel system units must be light, compact and capable of operating under a wide range of environmental conditions without undergoing a change in output characteristic for a given set of input signals.

A typical example of an aircraft fuel system unit is shown on the opposite page.

This is a multi-purpose unit incorporating starter flow control, flow divider, pressure raising valve, shut-off cock, bypass and automatic manifold dump valve. It was designed and manufactured by Lucas-Rotax Limited for the United Aircraft JT15D turbopfan engine. Specifically designed for small gas turbine engines, the unit weighs four pounds and operates under the following conditions.

### *Temperature Range:*

The unit is self-compensating for changes in fuel viscosity over the temperature range of  $-60^{\circ}\text{F}$  to  $300^{\circ}\text{F}$ . ( $-51^{\circ}\text{C}$  to  $149^{\circ}\text{C}$ )

### *Pressure Conditions:*

Maximum acting pressure 1150 psig. Normal inlet pressure 800 psig. Maximum by-pass pressure 150 psig. Test pressure 2000 psig. Maximum compressor delivery pressure 200 psig.

### *Flow Range:*

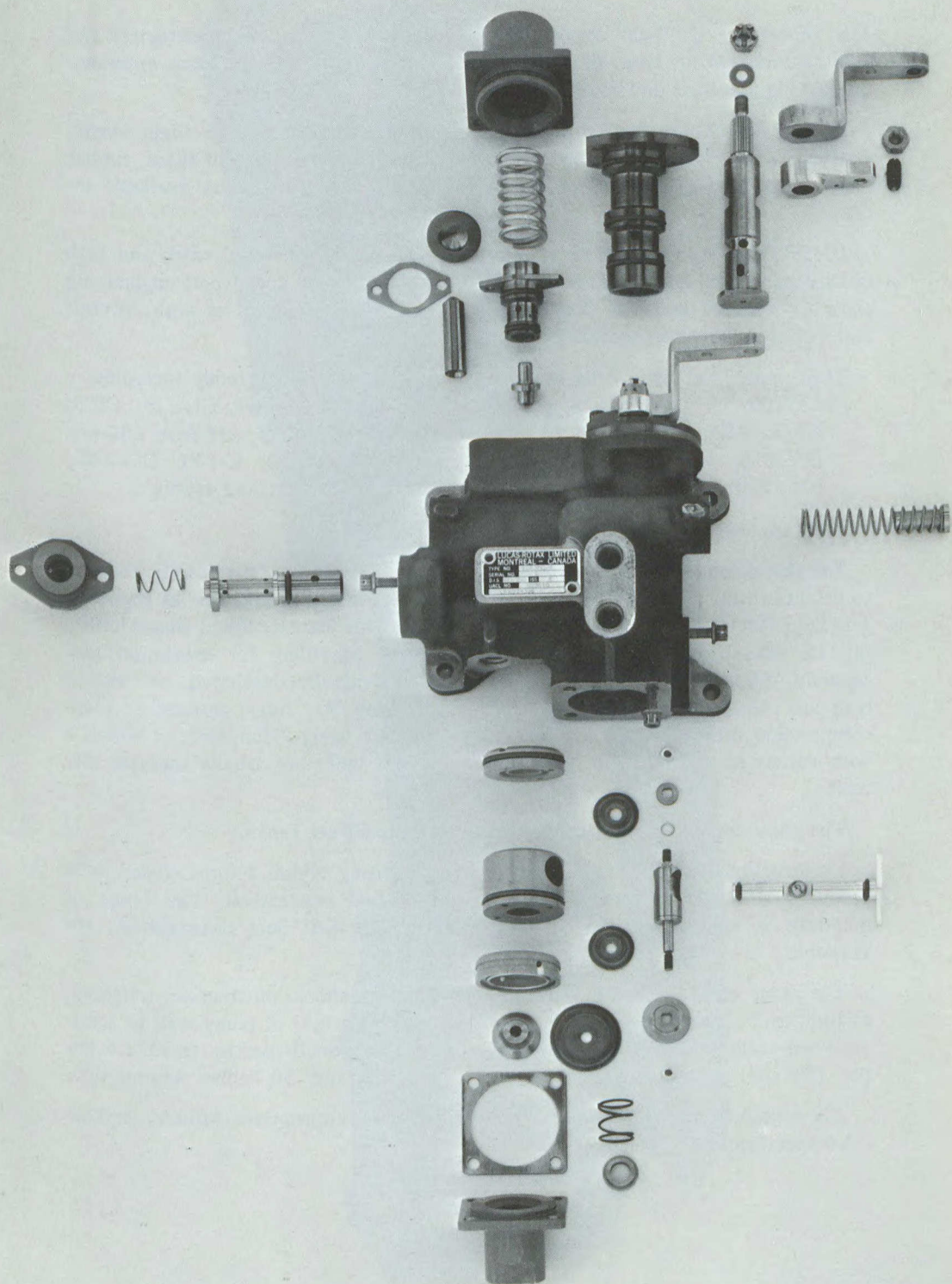
Maximum inlet flow, 1700 pph with pressure drop being adjustable to suit requirements. Starting flow from 90 pph at 50 psi to 160 pph at 175 psi with the output to the primary nozzles being held proportional to the compressor delivery pressure during starting.

The unit is fabricated from an aluminum casting with stainless steel and aluminum-bronze valves.

The first batch of prototype units have been manufactured and test bed and flight tested on the engine.

Design of the unit is such that with minor modification it can be adapted to a wide range of small engine sizes.

In keeping with current trends in aircraft control systems, automatic functions are a feature of the design which reduces the pilot's work. Minimum pressure, flow division, manifold fuel dumping and starting flow schedule are all controlled automatically.



## AIRCRAFT RUBBER FUEL TANKS

The importance of "Leak Proof" fuel containers is recognized by designers and manufacturers of all types of Aircraft. Pilots, too, appreciate the extra assurance of knowing that their fuel is securely stored.

Rubber Fuel Tanks have provided this assurance for many years. Light-weight, flexible, easy-to-install and tested over many thousands of hours of flight, rubber tanks have been established as the most reliable Fuel Containers available today.

UNIROYAL Ltd. has been in this business since 1942. Hard work and high quality standards, backed up by many years of experience and expert engineering skills have established this Company as a leading manufacturer of both Aircraft and Vehicle rubber fuel containers.

Their tanks are being used in most military aircraft flying today including — CF-100; CF-104; CL-28; CL-41; CL-44; CL-66; CL-84; CL-215; CF-5; NF-5; F-5A/B; F-86; F-104D/G; T-33; T-37B; T-38; A7; AH-56A; OH-6A; OV-10A; UH-1D; UH-12E; CH-46; CH-47; CH-53; C-130; DO-28D; FH-1100; Caribou; Otter; Twin Otter; Buffalo; Beaver; and Harvard.

They are also used in vehicles LVTP-5; T-97 and CL-91.

The shape and size of these tanks is practically unlimited for they can be tailored to fit almost any shape of Aircraft Structure, using stringers and ribs as supports. The flexibility of the bladder type materials allows for extreme fluted shapes utilizing all available interior aircraft space thereby providing for maximum fuel capacity. Fittings and connections are either individually developed, or existing type are utilized. Tight seals are achieved by using "O" rings, gaskets, or plain compression fittings. Tanks are held in position by using "Hangers", of which a wide variety is available. An average of five or six tanks are usually used per aircraft.

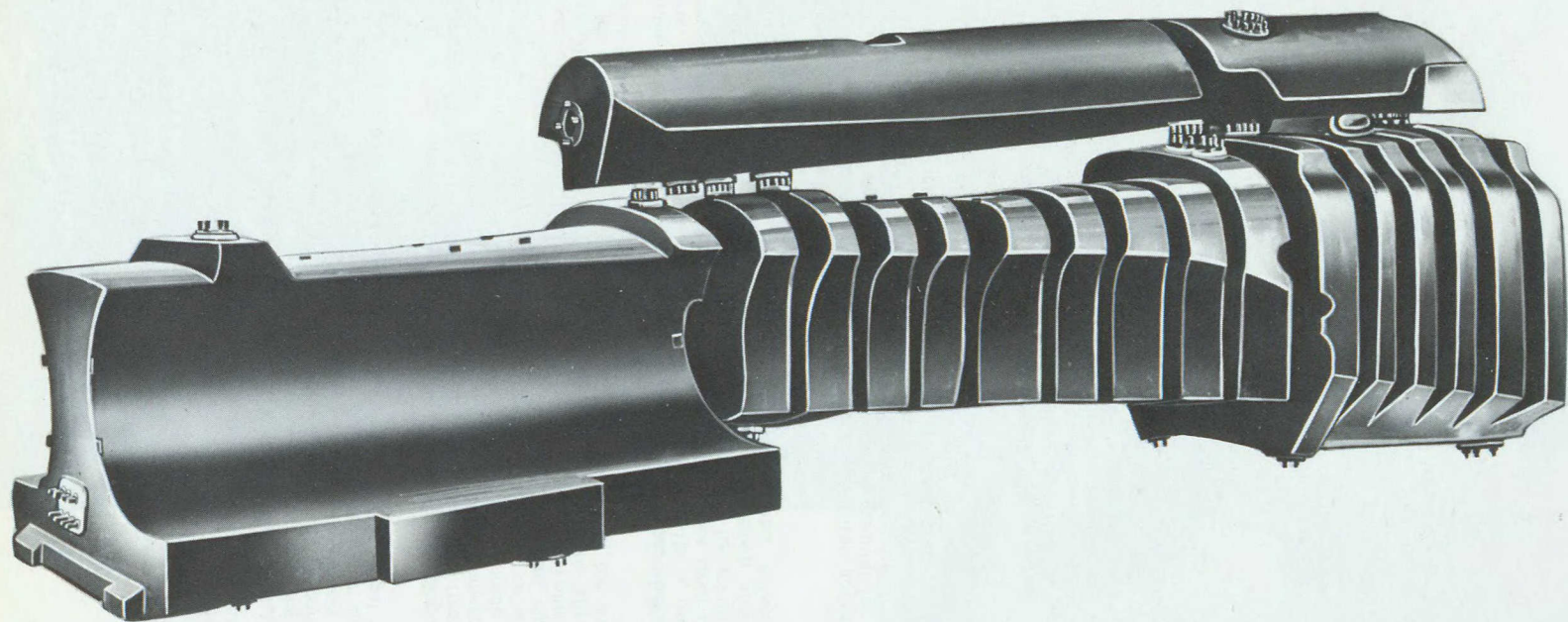
The photo on the right illustrates a group of typical Fuel Tanks.

Construction consists of alternate layers of strong Nylon Fabric coated with special grades of synthetic rubber to prevent fuel penetration. The range of materials is very expensive and both Bladder and Self Seal constructions are available.

The range extends from the flexible light-weight bladder construction, weighing, as little as 102 pounds per sq. ft. (46.3 gm. per .092 m<sup>2</sup>) of panel wall to semi-rigid self-sealing constructions, weighing up to 1.15 pounds per sq. ft. (521.6 gm per .029 m<sup>2</sup>) which provides protection against .30 and .50 calibre ammunition.

All constructions are produced and qualified to appropriate Military and/or FAA specifications.





# HELICOPTER SERVICES AND CONSTRUCTION TECHNIQUES

Okanagan Helicopters Ltd., a Canadian corporate company, which is owned and controlled by Canadian Shareholders was founded in 1947 with its initial market in spraying Okanagan Valley orchards. When mining and oil exploration increased in the northern reaches of British Columbia as well as into the Yukon and the Northwest Territories the company expanded to meet the demands for the transportation of men and materials.

By 1956 they were operating Sikorsky S55 and S58 models as well as Bells on operations which were strung from Vancouver to Newfoundland and north into the Arctic Islands. As Okanagan continued to acquire northern and remote operational experience they soon were offering unique services which brought about the award of a support contract to the radar sites of the USAF at Goose Bay in Labrador. By 1960 expansion included fourteen bases in British Columbia, additional ones in Alberta and one at Montreal to serve eastern Canada.

In 1965 Okanagan was awarded an offshore drilling contract by Shell Oil Company of England and purchased an S61N for that work, flying this helicopter from the factory in Stratford, Connecticut, to London, England. This was the first commercial ferry flight of a helicopter across the North Atlantic unescorted. For this operation the company's pilots were now trained for instrument flying on twin-engine helicopters as well. As a result, of this operation, they were awarded a contract to service Shell's drilling rig now operating off the west coast of Vancouver Island, and now bases a 204B at Tofino, making daily flights to the rig. A further contract has been awarded to service the Shell rig scheduled for erection in the Atlantic off the coast of Cape Breton Island in the summer of 1969, using a twin engine Sikorsky S61.

The construction of powerline transmission towers has now become routine work. Where the larger towers are being built section by section the Bell 204B is usually used with the left door removed so the pilot can watch his work while he flies from the left position. A record was established by one company pilot when he set 68 towers in one day using a 204B. The Sikorsky S61A has also been used in tower construction and the S58's have seen continuous duty in stringing powerlines by mileage rates which force ground operations into economic obsolescence.

## **History of the Air Borne Control Technique**

In this system, the helicopter serves both as an aerial platform above ground points on which a geodetic position is desired and as a transportation medium for ground support crews. In position, the craft serves as a target for angle measurements from one or more ground stations and as the 'remote' station for the electronic distance-measuring equipment. The system involves measurement of directions and distances from a few strategically located ground stations to the helicopter. Accurate hovering is facilitated by a specially designed 'hoversight', which establishes the vertical for the pilot allowing him to plumb the craft directly over the ground point.

The helicopter hovers high enough to be optically visible and produce a good distance measuring signal, yet as low as is practical for accurate hovering. A special plumbline device is used to measure the hovering height. On signal from the pilot that he is over the targeted point, horizontal and vertical angle readings are made to a high intensity rotating beacon on the helicopter from the theodolites at the occupied ground stations. At the same time, distance measurements are made electronically by the hydrodist, an instrument similar to the telurometer. In addition to the pilot, the airborne team includes an engineer to operate the distance measuring instrument, to determine helicopter height, to verify the identification of the ground points and to record pertinent data.

## **Research and Design Projects**

### **OKALS Aerial Line Stringer**

The OKALS Aerial Line Stringer is a device of simple construction and operation which permits the unreeling of cables, ropes or wires by aerial means. The stringer is designed to handle conventional reels with the line wound on by machine or by hand, thus eliminating any special winding procedures. The device has been thoroughly flight tested and has been successfully used on various construction projects in British Columbia and overseas. At the present time two sizes are in use, the Series 1000 which will handle reels of a gross weight of up to 1000 lbs., and the Series 4000 which is designed for use with reels with a gross weight of up to 4000 lbs. Stringing speeds of up to 50 mph have been obtained when laying polypropylene hauling ropes, and up to 20 mph with plastic insulated telephone cables and power conductors. *See bottom illustration Page I-47.*

Monsoon Bucket



OKALS Aerial Line Stinger





### **Multiple Hook System (Carousel)**

A multiple hook system has been designed for the carrying of multiple loads to utilize on a per-flight basis the optimum lifting capacity of the helicopter. It is a circular arrangement of six helicopter cargo hooks suspended by lanyards from the helicopter's own main cargo hook, and is used mainly in the supply of powerline, microwave and pipeline construction staging points, exploration-survey camps, ground-based forest firefighting crews, oil and gas field installations, disaster and rescue areas and control points.

Operation of each of the multiple hooks is through the selector switches, indicator lights and single firing button on the pilot's control console. The hooks can be released in sequenced order or in any order required and the complete assembly can be instantly jettisoned if required. Each hook has a rated capacity of 2000 lbs. and the complete assembly is rated for 4000 lbs. with the whole, including umbilical wiring weighing 120 lbs. Larger units are under development. *See bottom illustration Page I-49.*

### **Aerial Spray Equipment (HUSS — Helicopter Underslung Spray System)**

This is the first major innovation in development of helicopter liquid spray gear in almost 20 years.

It is based on the principle of suspending the entire spraying function liquid tank, pump, motor and booms — from the helicopter's cargo hook as an independently powered, self-contained unit directionally stable in forward flight. There can be no possibility of a center of gravity shift.

One of the greatest advantages of the HUSS system is that all mechanical components of the spray unit can be tested, serviced or repaired, without grounding the helicopter.

Electrical circuitry can be installed in about 10-15 minutes. There are no struts, stays, pumps, plumbing or booms to be attached to the helicopter, or that have to be taken off before the machine can be used for other purposes.

A HUSS unit is instantly jettisonable in the event of an air emergency. Chemical corrosion and fire hazard are eliminated. Landing for tank refilling is eliminated as the helicopter works from an emptied unit to a full one. An ideal operating combination is three HUSS units, two helicopters.

Empty weight is only 105 pounds (47.6 kg) and tank capacity in this model is 70 Imp. gallons (318 lit.). Larger HUSS units are under development. *See top illustration Page I-49.*

### **Monsoon Bucket**

The Monsoon bucket is one of the most useful, versatile pieces of auxiliary equipment ever developed for the light helicopter.

Its primary purpose is to convert any helicopter into an "instant" water bomber for swift containment and suppression of lightning strikes and spot fires in forested or bush areas.

Its principal feature is that it can be refilled in 10 seconds with water from the sea or any lake, stream, swamp, reservoir, swimming pool or open-topped tank — without the helicopter having to land. Where such water sources are available it does away entirely with the need for cumbersome ground support equipment, such as pumps, hoses and tank trucks, etc.

The Monsoon bucket has won acceptance as an indispensable aid to forest fire prevention and control by government Forest Service crews in British Columbia, Alberta and some U.S. states, including Alaska.

Suspended from the helicopter's cargo hook — and therefore instantly jettisonable, if required — it also does double duty as a tool and equipment carrier (pumps, hoses, hand tools, etc.) for immediate use by ground firefighters flying to the scene of an outbreak in the helicopter. Then the aircraft goes into service as a water bomber to support the men on the ground. *See top illustration Page I-47.*

### **Mechanical Features**

The Monsoon bucket is basically a standard 45 Imp. gallon (205 lit.) steel oil or gas drum, with its top cut out. A solenoid-operated dump valve and wooden stand assembly (available in kit form with lanyards and wiring) is fitted to the barrel bottom. Opening of the dump valve (adjustable) is controlled from a switch on the pilot's cyclic stick, and closing by contact of the valve gate with the surface of the water. A counterweight is fitted to the top rim of the drum or barrel to ensure speedy tipping and filling (10 seconds maximum). Positive closing of the valve gate is by a simple spring-loaded latch. A standard steel drum can be converted to a Monsoon bucket in about four man-hours. No special tools or equipment are required.



Aerial Spray Equipment  
(HUSS)



Multiple Hook System  
(Carousel)



## PARACHUTE SYSTEMS

Irvin Air Chute Ltd. has recently concluded development of several Aerospace Products of considerable significance as outlined below:

### **Irvin 'Variable Porosity Ribbon' Deceleration Parachute**

The Irvin Variable Porosity ribbon parachute is a further development of the standard ribbon type, and is adaptable to any aircraft deceleration system presently employing standard (FIST) ribbon, Ring Slot, Cruciform or other deceleration parachutes.

The amount of air allowed to flow through a ribbon type parachute canopy is controlled by the spacing of the concentric (horizontal) ribbons. In the Irvin Variable Porosity canopy, the ribbon spacing decreases progressively from the skirt to the vent while ribbon strengths are also adjusted to suit the particular application. Distribution of the ribbons in this manner increases the efficiency and strength towards the crown of the canopy, which is the primary source of drag.

#### **Advantages:**

- Reduced Maintenance Costs.
- Greater Drag Efficiency.
- Lower Opening Shock.
- Reduced Probability of Damage.
- Higher Emergency Landing Speed Capability.
- Fail-Safe Ribbon Construction.

#### **Systems In Service Use Include:**

##### *Model ID-86-101*

Northrop F-5 aircraft decelerator;

*Diameter of canopy:* 14.55 ft. (4.4 m)      *Service life rating:* 75 streams

*Deployment speed rating:* emergency max. 190 knots.

##### *Model ID-86-102*

Lockheed F-104 aircraft decelerator;

*Diameter of canopy:* 16.2 ft. (4.9 m)      *Service life rating:* 75 streams

*Deployment speed rating:* emergency max. 200 knots.

### **Irvin "Zero-Zero" Parachute System**

Irvin has developed a ZERO-ZERO modification kit which, when installed in a standard back type parachute, permits safe ejection under zero speed/zero altitude conditions.

#### **Features include:**

##### *MK-10A Barometric Release*

A proven altitude sensing/time delay device.

##### *Drogue Gun*

Instant fire type: develops 240 ft./lb. energy.

##### *Automatic Safety/Arming Cable*

Provides automatic "Safety on/Safety off" feature.

##### *Connect/Disconnect Device*

Automatically connects missile on firing; disconnects missile after deployment.

##### *High/Low Speed Deployment Bag*

Rapid deployment at low speed; controlled deployment at high speed. Operational Sequence In Automatic Mode:

1. Seat/man separation pulls MK10A Release Safety/Arming Cable.
2. MK10A provides time delay and altitude selection.
3. MK10A fires and actuates drogue gun.
4. Drogue gun missile extracts ripcord pins, activates connect/disconnect device and forcibly deploys the pilot chute and main chute.
5. Connect/disconnect and missile fall away.
6. Controlled deployment and inflation follow.

This system can be retro-fitted economically to almost any back style parachute type and through its simplicity and positive action affords the pilot remarkable reliability and performance under the most adverse conditions.

### **Irvin Seat Survival Containers**

These low-cost, rigid, fibreglass Survival Seat Packs are designed for use in aircraft equipped with ejection seats. The interior of the Pack provides space for survival equipment, while the top surface is shaped to receive a seated aircrew member and engineered to minimize possible injury on ejection.

Four nylon flaps on the underside of the pack form the closure, and are held in position by manual ripcord and pin method. Two adjustable side straps, attached to the cone plate during closing of the flaps, emerge through channels inside the Pack. Quick connector, quick release fittings at the end of the side straps provide the means of attaching the Survival Seat Pack to the harness of a back type parachute. A drop line is provided with an accessory container permanently attached at the end. Provision is also made for attachment of a life raft to the drop-line in a manner to permit automatic inflation during parachute descent.

The following types are currently available:

Model ID-52-137 — CF-5 Aircraft with Norair Ejection Seat.

Model ID-52-135 — CL-41 (Tutor) Aircraft with Weber Ejection Seat.

Model ID-52-139 — T-33 Aircraft with Lockheed MK3 Ejection Seat.

## INTERVALOMETERS

Designed to trigger Sonobuoy drops to achieve a high degree of spacing accuracy between buoys. Intervals of 350, 700, 1050, & 1400 feet (106.7, 213.4, 320 & 426.7m) can be selected, with aircraft ground speeds of 100 to 200 knots. The first drop pulse is initiated by the operator, the second pulse, on the same wire, is provided by the intervalometer at the precise instant calculated within the unit. This equipment was designed and developed by Leigh Instruments Limited and 40 units are now in use by the Canadian Armed Forces.

### FEATURES

- Doppler or Manual groundspeed selection
- Self Test functions provided
- Solid State switching — no relays
- Illuminated panel
- Safe: a drop pulse can only be initiated from an external trigger source, not from controls on the unit itself.
- Accurate — tolerance of  $\pm 14$  feet (4.3m) between buoys at any speed or interval setting.





## MOBILE AUTOMATIC TEST SET

Developed by the engineering division of Litton Systems (Canada) Limited, the Mobile Automatic Test Set (MATS) is Litton's approach to a rapid maintenance capability employing minimum skill levels for inertial navigation systems at squadron and base shop level. The MATS performs a complete and automatic checkout of inertial navigation systems in aircraft on the flight-line or in the base test laboratory with a minimum of skill and judgement required from the operator. In addition to establishing the serviceability or unserviceability of the system under test, the MATS provides precise information on the nature, location and remedy of a fault, to the extent of isolating a particular module or sub-assembly.

In addition to eliminating unnecessary removals of the guidance system, the MATS makes actual flights checks unnecessary after a malfunction has been corrected by doing a pre-flight confidence check itself.

In the MATS, emphasis has been placed on the convenient grouping of operating controls and displays and on the accessibility of components for easy maintenance. The Test Set is mounted on a chassis having an air-bag suspension to reduce shock loads and is fitted with a tow bar and brakes to assist moving with a tractor. Controls and displays are protected from rain by a hinged shield that can be clamped at any desired angle.

The MATS uses a programmed tape in conjunction with a photo block reader to perform automatic tests. The tape test programs used by Litton MATS can be used for any portion of the inertial navigation system without modification. It is not necessary to change tapes for various types of tests. Additional spare tapes can be punched in the field using inexpensive equipment. Program modification, if required, can be performed with ease. The unit uses relay matrices to select the signals to be tested, their tolerances, and the fault indicator readout instructions. The signal is then compared to an internal reference signal. If the signal is not within specified limits the automatic program is inhibited and the fault indicator readout is energized to indicate the source of the malfunction. A programmed self-test is included to enable the operator to test the MATS immediately, thereby verifying the integrity of the MATS.

Litton MATS vehicles are currently in use with the RCAF, RNLAFF, RDAF and USN.

Litton Canada has produced over 1000 major units of Aerospace Ground Equipment in addition to MATS. This covers manual and automatic test equipment for flight line, base service lab, depot, and factory applications.





## PRESSURE-TEMPERATURE TEST SET—TTU-205B/E

This test set is a Flight Line and Maintenance Depot Level Portable Pneumatic Test Set capable of testing the new Altitude Reporting System Computers (AIMS) now being introduced in military and commercial aircraft. The set is now in production at Garrett Manufacturing Limited where such equipments have been developed and produced to meet the needs of ever increasing complex aircraft systems and is being delivered in quantity to the U.S.A.F. and U.S. Navy. It is designed to meet the requirements of the new U.S.A.F. designation TTU-205B/E, MIL-T-38191D and it provides: plus or minus 18 feet (5.5 m) accuracy at sea level; .15 percent accuracy to 60,000 feet (18,288 m); .2 percent accuracy from 60,000 feet to 80,000 feet (18,288 to 24,384 m); plus or minus 2 knots accuracy at 50 knots increasing to plus or minus 1.5 knots from 100 to 1,000 knots; controllable altitude slew rates from 0 to 35,000 feet/minute (10,668 m) altitude; controllable airspeed slew rate from 0 to 250 knots. This unit is an improved version of the earlier TTU-205/E Test Set, MIL-T-38191A which is fully qualified and is also in service with the U.S.A.F. for checkout of flight instruments on aircraft such as F111, F4, C141 and CF5. All these units provide direct digital readout of altitude and airspeed without correction cards to the accuracies stated.

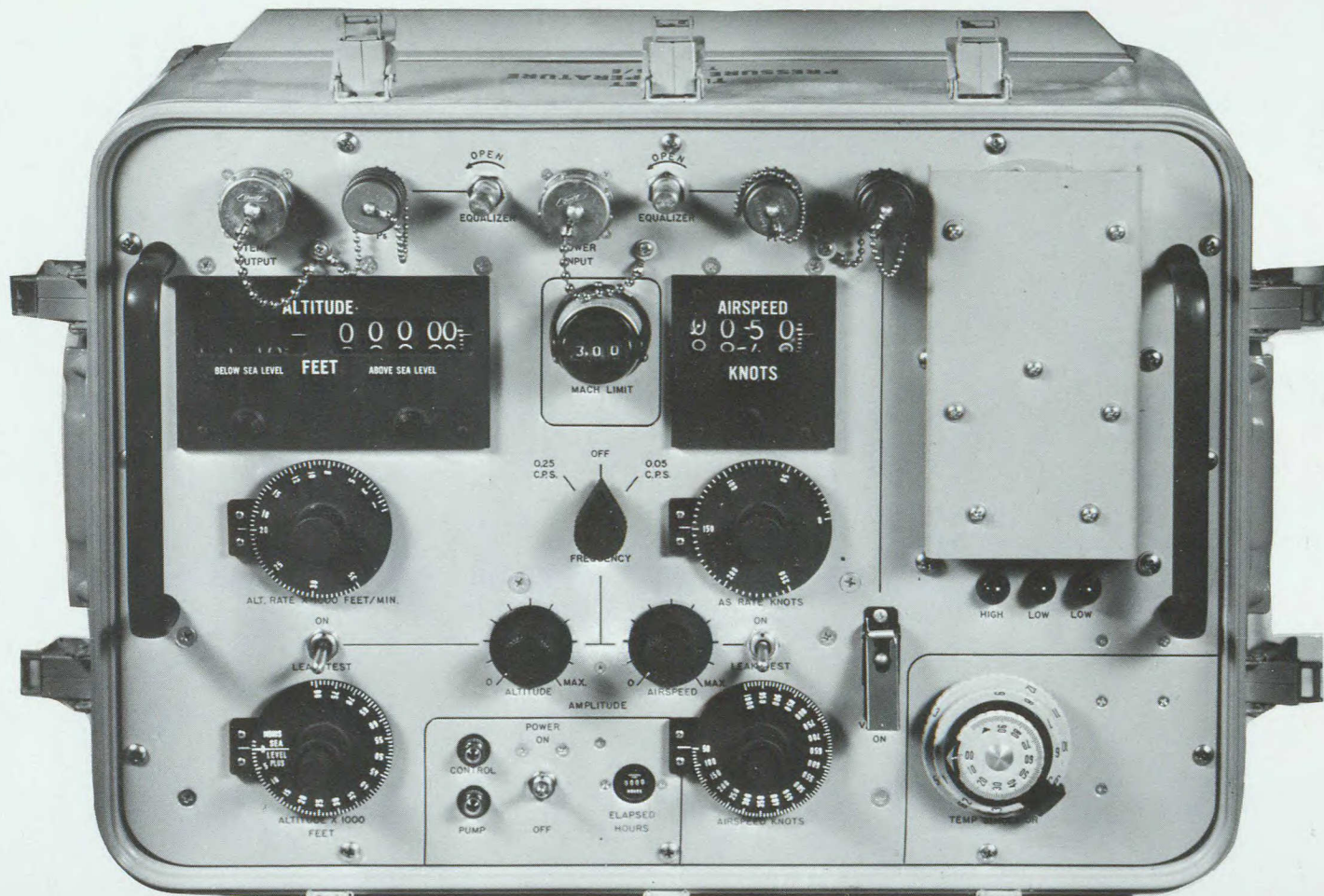
**Applications:** Checkout of flight instruments on the flight line — Leakage test of aircraft flight instrument pneumatic system — Checkout of the Central Air Data Computer on the flight line — Pneumatic excitation of auto pilot and navigational system on the flight line — Calibration and service of Central Air Data Computer on the bench — Pneumatic supply (airspeed and altitude for aircraft automatic systems test units).

### Specification — TTU-205B/E

#### PERFORMANCE FIGURES TTU-205B/E PRESSURE-TEMPERATURE TEST SET LATEST VERSION, DESIGNATED PART NUMBER 607330-8

ALTITUDE RANGE	-1,000 to 80,000 feet (305 to 24,384 m)
ALTITUDE ACCURACY	$\pm 18$ feet (5.5 m) or .15% of indicated altitude to 60,000 feet (18,288 m) increasing linearly to 160 feet (49 m) at 80,000 feet (24,384 m).
ALTITUDE SLEW RATE	Ramp controllable 0 to 35,000 feet (0-10,166 gm) per minute. Accuracy $\pm 5\%$ .
AIRSPEED RANGE	50 to 1,000 knots.
AIRSPEED ACCURACY	$\pm 2$ knots at 50 knots, $\pm 1.5$ knots at 100 to 1,000 knots.
AIRSPEED SLEW RATE	Airspeed ramp 0 to 250 knots per minute controllable. Accuracy $\pm 5\%$ .
MODULATION	Modulation 0.05 and 0.25 cps. either or both Ps and Pt.
TOTAL TEMPERATURE	30 to 130 ohms. Accuracy $\pm 0.1\%$ .
MACH LIMIT	.8 to 3.0 mach.





## PRD PROGRAMMABLE PNEUMATIC SIGNAL GENERATOR

The Pneumatic Signal Generator is a completely programmable module capable of accepting input commands directly from a digital computer. This unit is being used as the pneumatic signal generator for the new U.S. Navy Avionics System test unit referred to as VAST (Versatile Avionics Shop Tester). Similar equipment will be used by Sud Aviation with the French-British Concorde. The module includes logic control circuits, an analogue drive servo system and a pneumatic block. The unit is capable of translating 2 digit BCD inputs into analogue signals.

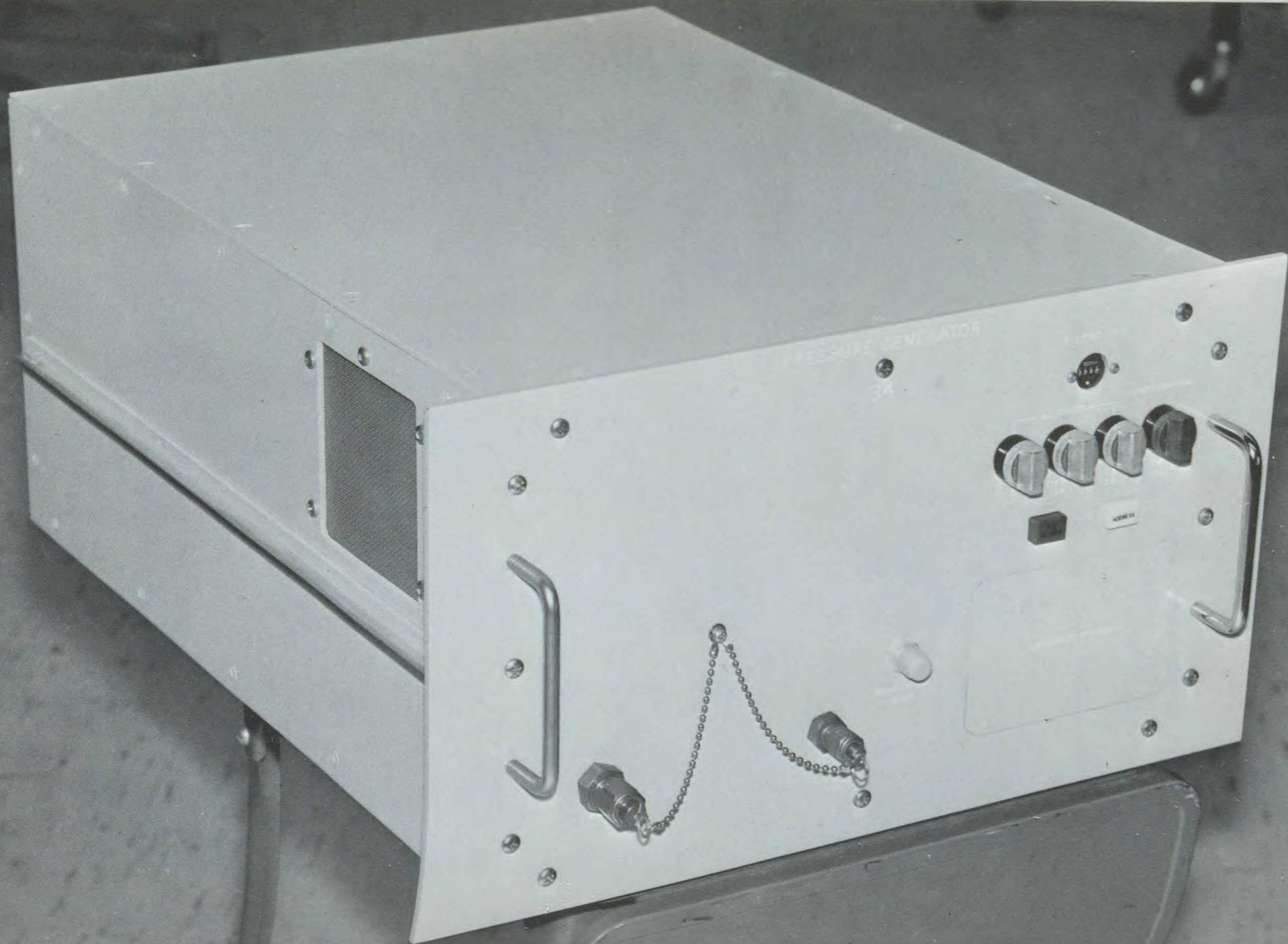
These are in turn translated into mechanical output controlling electro-mechanical sensors. The pneumatic block then generates pressures representative of altitude and airspeed. The unit is also capable of generating altitude ramp rates and altitude pressure modulation as required. The module is designed to provide a number of separate points in altitude and airspeed from 1,000 feet (304 m) below sea level to 90,000 feet (27,432 m) altitude and from 50 knots to 1,000 knots. Up to 100 points in both altitude and airspeed can be provided by this unit. Ramp rates are provided at 2,000, 5,000, 15,000, and 30,000 feet/minute (762, 1524, 3048 and 6096 m).

**Applications:** Flight Instruments — Engine Pressure Ration (EPR) — Overspeed sensors — Airspeed undercarriage warning systems — Oxygen mask control equipment — Cabin pressurization Control Systems — Pitch Trim Compensators — Rudder Throw Limiters — Air Data Warning Switches — Flight Recorder Sensors — Autopilot Systems — System Leakage Checks — Air Data Computing Systems.

### Specifications:

SIZE:	19" wide (panel) x 10.5" high x 20" deep (47 x 26.9 x 51 cm)
WEIGHT:	90 lbs. (41 kg)
ALTITUDE CHANNEL (Ps)	
INPUT:	2 digit B.C.D.
OUTPUT: Range:	-1000 ft. to 90,000 ft. (-304 m. to 27,432 m.) programmable in 1000 ft. (304 m.) increments.
Accuracy:	$\pm 0.005''$ Hg. from -1000 ft. to +30,000 ft. (-304 to 6096 m.) $\pm 0.010''$ Hg. from 30,000 ft. to 90,000 ft. (6096 to 27,432 m.)
Programmable Sinusoidal	
Modulation:	0.1 c.p.s. to 0.5 c.p.s.
Working Volume:	5 to 250 cu. ins.
AIRSPEED CHANNEL (Pt)	
INPUT:	2 digit B.C.D.
OUTPUT: Range:	50 knots to 1,000 knots
Accuracy:	2.0 knots at 50 knots decreasing to 0.75 knots at 150 knots. Linear at 0.75 knots to 1,000 knots.
Ramp Rate:	200 knots/min.
Working Volume:	5-250 cu. ins.





## A/11 PNEUMATIC SIGNAL GENERATOR

The A/11 Pneumatic Signal Generator is designed to provide pressure and vacuum signals suitable for checking out aircraft systems such as pitot-static flight instruments, mach trim, autopilot, engine pressure ratio transducers, etc. It has an airspeed range from 50 to 650 knots and an altitude range of 100 feet to 50,000 feet (30.5-15,240 m). Airspeed and altitudes are controlled through independent channels preventing undesirable interaction when either one requires a new setting. Every possible safety feature is included in the unit such as negative Qc protection, positive Qc protection, absolute pressure relief, rate of climb limited to 6,000 feet (1827 m) per minute or as specified, fail safe if power failure occurs protecting aircraft system from sudden change. The unit is lightweight, 35 lbs. (15.9 kg.) and in addition to aircraft checks, it can be used for bench checks of flight instruments or components requiring accurate pressure/vacuum inputs.

**Application:** Satisfies the Pneumatic requirements of all commercial aircraft presently in service (Boeing 707, 720, 727; Douglas DC-8, DC-9) — Simulates the flight envelopes of all new commercial aircraft — Exceeds the tolerance requirements and flight envelopes for AIMS (Altitude Reporting System) Types 1 and 11 (Type III requirements are covered by the Garrett Manufacturing Limited TTU-205B/E) — Exceeds the test requirement of F.A.A. Regulation F.A.R. 91.70 Part 43, Appendix E (Static Pressure Systems and Altimeter Instruments).

### Specifications:

SIZE:	Without lid 14½ x 20½ x 7 inches (36.8 x 52 x 17.8 cm.) with lid 14½ x 20½ x 9½ inches (36.8 x 52 x 24 cm.)
WEIGHT:	Complete with lid 35 pounds (15.9 kg.)
READOUTS:	Altitude: -1000 to +50,000 feet (-305 to 15,240 m) Airspeed: 50 to 650 knots (I.A.S.) Rate of Climb: 0 to ±6,000 feet/minute (Optional) (0 to ±1827 m per m)
READABILITY:	Altitude: 5 feet (1.52 m)
SENSITIVITY:	Airspeed: ½ knot better than 0.001 in. Hg. over entire altitude and airspeed range.
ACCURACY:	Altitude: ±25 feet (7.6 m) at sea level to ±70 feet (21.3 m) at 50,000 feet (15,240 m). Airspeed: ±2 knots over entire range
VACUUM:	Separate Vacuum/Source 25.0" Hg. (mini- mum)
POWER REQUIREMENTS:	115 V, 400 cps, single phase, 250 VA approx.
ENVIRONMENTAL CONDITIONS:	—Designed to comply with all applicable sections of MIL-T-21200D. —No warm up time required.





## FLIGHT DATA RECORDER SYSTEM

The basic Flight Data Recorder System as shown in the photograph consists of a Flight Identification Unit, a Recorder Electronics Unit, and a tape cassette in a crash-proofed package, (in this case an F104 CPI Airfoil\*. The heart of the system is the Recorder Electronics Unit, a standard  $\frac{3}{8}$  ATR short, containing solid state circuitry mounted on printed circuit boards. With 32, 64 or 128 channels per second capacity, the unit accepts aircraft signals from existing instrumentation, or from special transducers, conditions them to a basic 0-5 Vdc range, multiplexes them, and converts them to a Pulse Code Modulation (PCM) type format for recording on the tape cassette. The Flight Identification Unit allows the aircrew to insert Flight Identification and other pertinent data on the tape. The tape cassette shown contains a half-hour duration tape stored as an endless loop, together with the necessary erase, record and read heads, and an integral drive motor.

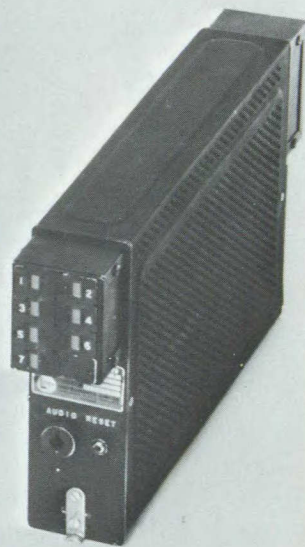
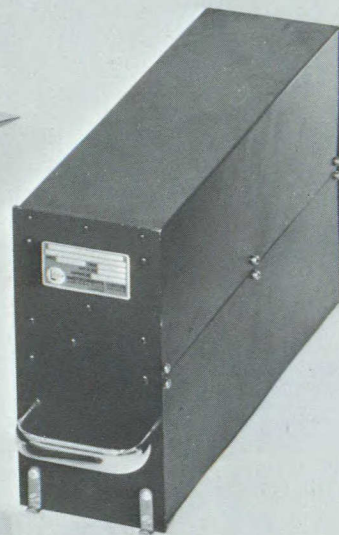
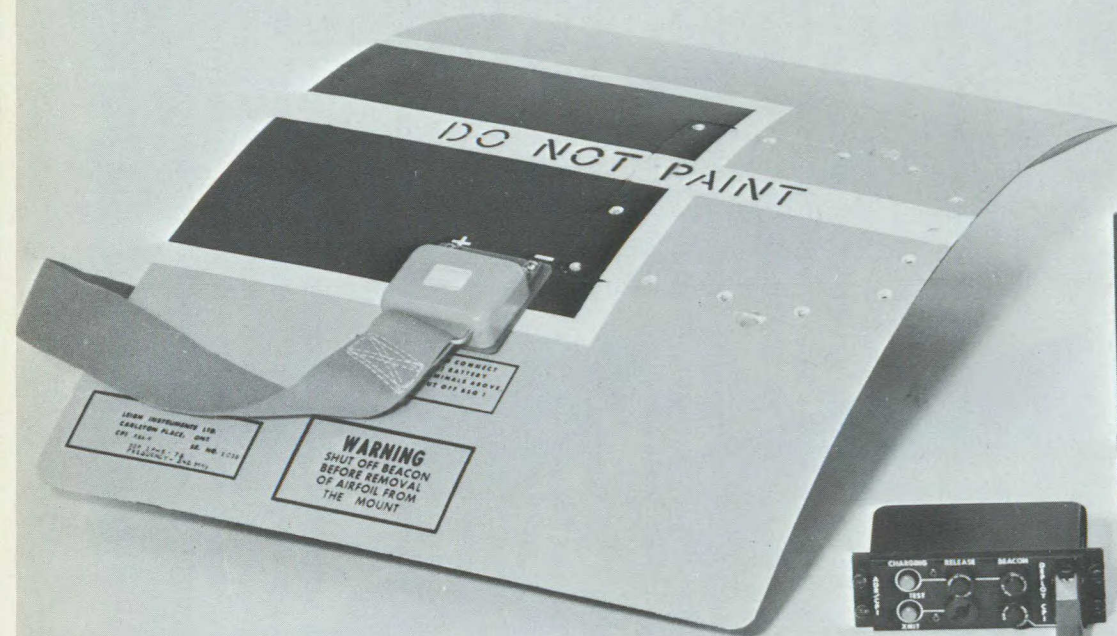
Variations of this basic system have been designed and produced by Leigh Instruments Limited to meet specific customer requirements. Fleet installation of Leigh recording systems has been carried out on the CC106 aircraft for the Canadian Armed Forces, and is being carried out on the DC8 and DC9 aircraft for Air Canada. Prototype systems have been or are now under evaluation for the USAF (C141, C133), the USN (P3) and the CAF and WGAF (F104).

Depending upon the requirements of the customer, the variations may include: additional Recorder Electronics Units to provide greater aircraft signal capacity, voice recording units, voice warning units, tape cassettes of greater capacity, either without crash-proofing, a Quick Access tape recorder for maintenance use, and an aircraft mounted Hard Copy Printer.

Leigh Instruments Limited also designs and manufactures Data Playback Systems for reading the Flight Data Recorder tapes on the ground. These Ground Playback Units will accept serial or parallel data from the recorders selected and will output both voice and data. The replayed data is presented in analog form onto ultra-violet sensitive paper, but can also output digital data suitable for direct entry into a computer. If required, data can also be played out in paper punch or teletype form. The facility is available, through a suitable additional formatter, to transmit the replayed data in teleprinter format along voice quality lines.

The Flight Data Recording Systems produced by Leigh Instruments Limited are designed to meet MIL-E-5400 for airborne equipment, MIL-E-4158 for Ground Equipment and MIL-T-21200 for Test Equipment.

CPI—Crash Position Indicator (see page I-62)



## CRASH POSITION INDICATOR

The Crash Position Indicator developed and manufactured by Leigh Instruments Limited is a radio transmitter encased in a plastic airfoil package, which is released from an aircraft on pilot command, or automatically in a crash situation, follows a tumbling, speed-reducing flight path to the ground, and transmits for more than 48 hours a distress frequency signal discernible at ranges in excess of 60-80 miles.

The solid-state radio transmitter is encapsulated in polyurethane foam and has a minimum rated output power of 250 milliwatts. The basic transmitter design comprises a crystal-controlled 243 Megahertz oscillator, a swept tone-modulator circuit, and a final amplifier. Modified versions include a Combat Beacon which remains quiescent after release until a coded interrogator signal is received. The battery power supply and the parallel-plate antenna, which has an omni-directional radiation pattern, are also encased within the airfoil package.

Leigh's unique, aerodynamically-designed airfoils are made of polyurethane foam, with a fibre glass covering where additional structural strength is necessary. They are produced in a variety of shapes to match particular aircraft installations.

For a high speed, high performance aircraft the airfoil is mounted in a tray built into the aircraft structure the exterior surface of the airfoil being shaped to the contours of the aircraft skin. Installations of this type have been designed for the following aircraft and are in service in the CAF and USAF C5, C9A, C130 (shown in the photograph), C133, C135, VC137, C141.

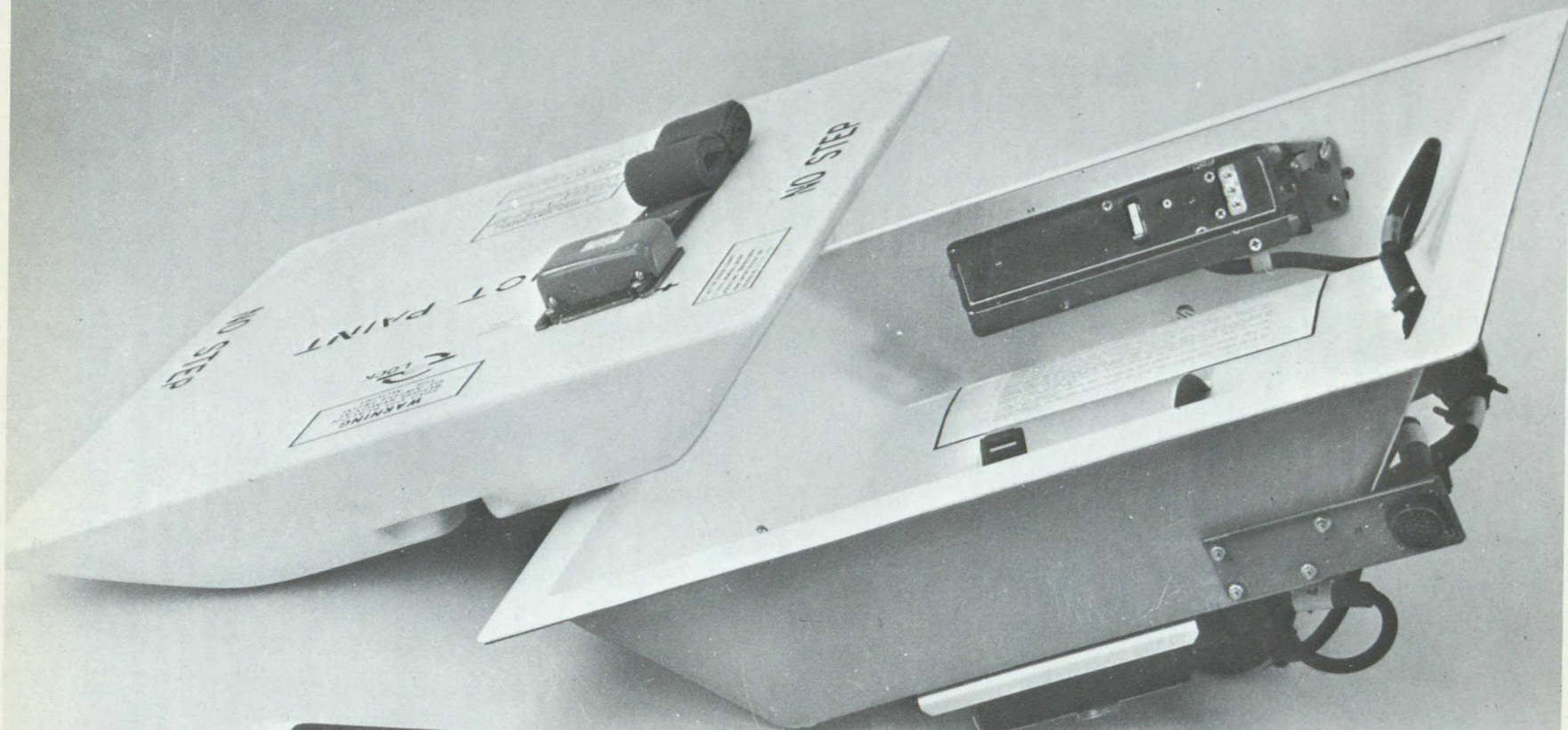
An externally-mounted airfoil shape designed for low speed aircraft has been fitted to the C124 and C10 aircraft in service with the USAF. A helicopter version has been produced and is now being marketed.

The Cockpit Control Unit, a standard, panel-mounted unit, allows the pilot to check the CPI transmitter operation, the CPI battery-charging circuits and whether the airfoil is properly mounted or has been removed, and a wire-locked switch is provided for manual release of the airfoil. Automatic release in the event of a crash is triggered by frangible switches located in sensitive areas, such as the wing tips and the nose, or if the aircraft lands in water, by a hydrostatic switch.

The Leigh Crash Position Indicator has proved its effectiveness in actual crash situations, as well as in extensive tests such as those conducted for the USAF between 1962 and 1964, following which the equipment was catalogued as USAF Inventory Item AN/URT 26 (V).

A light aircraft version of the Crash Position Indicator, which works on the same principle but requires no aircraft wiring or aircraft structural changes, has been designed and is being marketed under the name DAPI (Downed Aircraft Position Indicator).





## DOWNED AIRCRAFT LOCATOR

Garrett Manufacturing Limited have developed a downed aircraft beacon consisting of three principal components: a main case containing the transmitter and batteries, and two antenna assemblies containing the antennas and matching networks. The antenna assemblies are connected to the main case by coaxial cables. The beacon, on impact with the ground, is automatically turned on and commences transmission of a signal which can be received at a range of up to 200 miles (322 Km).

*Operating Frequencies:* — The beacon uses the military emergency frequency of 243 MHz and the civil of 121.5 MHz thus providing a common media of co-operation for both military and civil flying.

*Power Output* — The power output of a VHF beacon need only be sufficient so that the range is horizon-limited rather than power-limited; no significant advantage is gained by exceeding this level therefore average power output of 225 milliwatts is adequate to meet this condition, and is the level specified by the U.S. Federal Aviation Agency. In this beacon, higher level of approximately 300 milliwatts is used to allow for random orientation of the antenna system and power output is provided at each of the two output frequencies.

*Transmit Duty Cycle* — There is a choice between continuous operation of the transmitter, and operating at some reduced duty cycle with periodic ON-OFF keying. The latter scheme has a significant advantage in reduced average power consumption, and hence reduced weight of power supply. This technique has certain restrictions, however; the "ON" period must be long enough to be compatible with the time — averaging properties of the human ear, and with the characteristics of direction finding equipment; and the "OFF" period must be short enough to preclude uncertainty in fixing the locations, with regard to the speed of the search aircraft. The system proposed by EUROCAE meets these requirements using a one-in-three duty cycle, with an "ON" period of 0.8 seconds and an "OFF" period of 1.6 seconds.

*Modulation* — the signal is 100% amplitude modulated by an audio tone sweeping downward over the range 1600 to 600 Hz at a rate of 2.5 sweeps per second. The modulating waveform is essentially square wave.

*Antenna System* — Dual opposed antennas are used, fed into anti-phase. In normal operation, the available power on both frequencies is divided equally between the two antennas. If one antenna is broken off, at least half of the available power is fed to the remaining antenna. A DC path is provided between the antenna rods and the airframe to prevent static build-up.

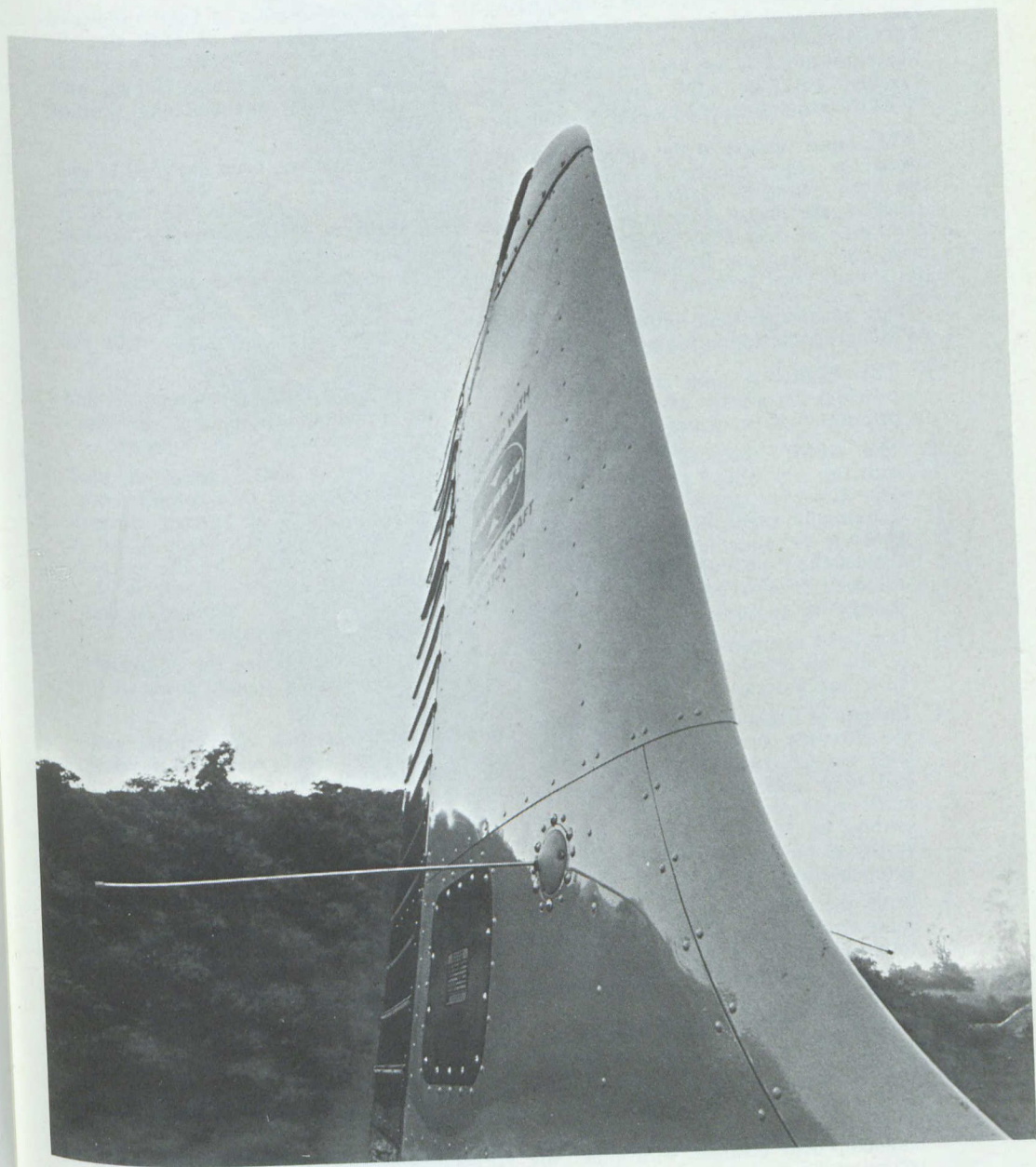
*Power Supply* — The beacon operates from a source of nominal 12 volts D.C. This source normally consists of eight size D manganese-alkaline cells. As an optional alternative at low temperatures, provision is made for the use of 8 size D sealed nickel-cadmium cells. It is possible to float charge these cells in flight.

*Operating Life* — The operating life of the beacon to the half-power point is nominally 48 hours after one year from the installation of fresh batteries. A somewhat reduced operating life is permissible at extremely low temperatures, but not less than 24 hours at -40°C using rechargeable batteries.

*Switching* — The beacon shall be provided with both automatic and manual switching. An automatic inertia switch shall operate and remain operated after being subjected to a steady-state rearward acceleration of 4.5G or to a transient acceleration equivalent to a sudden velocity change of 3 feet per second. A manual ON-OFF switch, normally located in the cockpit of the aircraft, with a shield to guard against accidental operation, shall be wired in parallel with the inertia switch. A second manual switch, to permit the inertia switch to be reset, shall be provided in a position accessible from the exterior of the aircraft.

Compatibility or mounting problems should be discussed with Garrett whose experience in this field and with this equipment covers many aircraft types and operating situations.







## AUTOMATIC PERMANENT MAGNETIC COMPENSATOR (APMC)

The APMC was designed and developed by the Electronics Division of CAE Industries Ltd. to improve Magnetic Anomaly Detection (MAD) performance of ASW aircraft. Production quantities have been manufactured and delivered to Canadian Forces and the equipment is in service in Canadian Argus (CL-28), Neptune (P2V), and Tracker (CS2F-2) ASW aircraft. The APMC has been fully qualified and satisfies all of the requirements of RCAF Specification RAD-1-18.

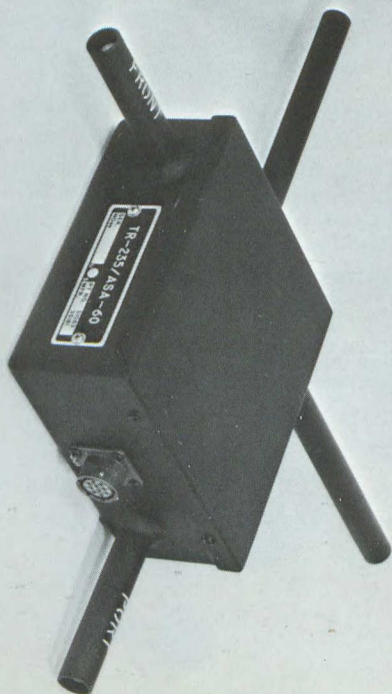
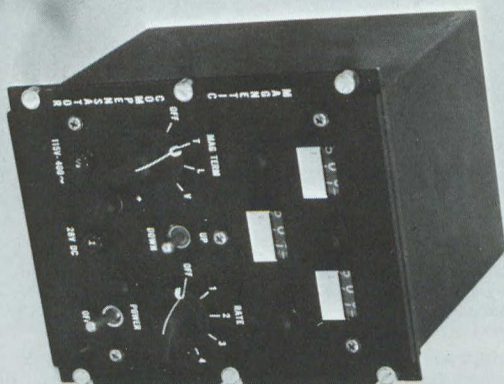
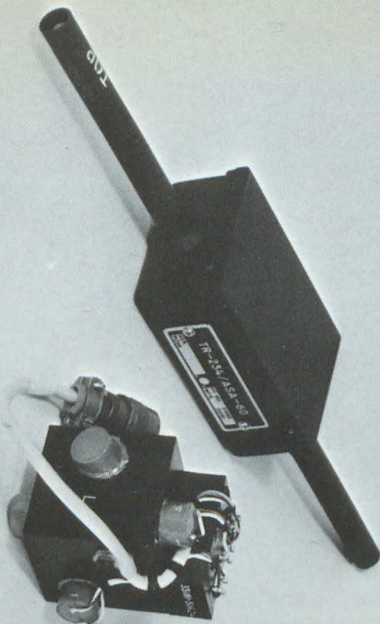
The latest version of the APMC is fully transistorized and has been designed to and meets the requirements of USN Specification MIL-C-81328 (WP). This equipment has been delivered to and is in service with the Royal Dutch Navy for the S2-A Trackers, the Royal Australian Navy in their S2-E Trackers, and the Royal Australian Air Force in their P2-V Neptunes. The U.S. Navy has also procured the APMC for their P2-V Neptune fleet and a substantial portion of the equipment on this order has already been delivered.

The advantages and improved MAD performance which are possible with the APMC are indicated in the following notes:

1. The APMC is used with AN/ASQ-8 or AN/ASQ-10A MAD equipment and provides improved MAD performance by the optimum elimination, or compensation, of permanent magnetic field interference generated by the aircraft.
2. The APMC replaces "Magnetic Compensator" CN-191/ASQ-8 which is used with the AN/ASQ-8 and AN/ASQ-10A for manual permanent field compensation. The CN-191/ASQ-8 provides for the manual adjustment of current through 3 mutually perpendicular coils located near the MAD detecting head, so as to generate an equal and opposite magnetic field to that produced by the aircraft. Cancellation of the permanent magnetic interference from the aircraft is thus achieved. The APMC does this automatically, decreases the time required to compensate by approximately 80% and achieves much improved compensation.
3. Improved compensation results in improved detecting ranges since the elimination of aircraft interference allows for identification of submarine signals down to the basic sensitivity of the AN/ASQ-8 and the AN/ASQ-10A.
4. Present practice in ASW Forces is to re-compensate on each ASW flight, since the aircraft's permanent magnetic field changes with time. Using manual techniques, with the CN-191/ASQ-8, permanent field recompensation requires approximately one hour and consists of flying the aircraft on cardinal headings while doing  $\pm 10^\circ$  rolls and  $\pm 5^\circ$  pitches. The operator must plot a graph of compensator settings vs. MAD manoeuvre signals in order to determine the best setting. These sustained manoeuvres can lessen the efficiency of the operator resulting in poor compensation.
5. With the APMC the operator merely has to actuate the equipment and the compensation is achieved automatically. No plotting of data is required and compensation time is reduced by at least 80%. Optimum compensation is assured which results in maximum detection range.
6. Considering the number of ASW missions which may be flown in one year and further considering the cost per flying hour of ASW aircraft, it can be readily shown that use of the APMC represents a considerable cost saving.

Also, manual compensation requires extended manoeuvring over a magnetically quiet area, usually at 10,000 ft. (3048 m) altitude. The APMC can be used at operational altitudes over almost any area. Since an aircraft's permanent magnetic field changes with time, the APMC allows for convenient and rapid recompensation, so that maximum MAD range is assured at all times.

7. The APMC is the same size and exactly fits into the space now occupied by the CN-191/ASQ-8. Installation is quick and convenient and cabling additions are minor.



## THE 9-TERM COMPENSATOR (9-TC)

The APMC was developed to compensate for interference generated by an aircraft's permanent magnetic field. There are two other sources of magnetic interference which require compensation on MAD equipped aircraft. Induced fields are caused by the ferromagnetic materials of an aircraft being magnetized as the aircraft moves through the earth's magnetic field and eddy-current fields are caused by currents created in control surfaces and fuselage as the aircraft moves through the earth's field. The 9-TC is an advanced compensator which was developed by the Electronics Division of CAE Industries Ltd. to eliminate interference from all permanent, induced and eddy-current field sources.

Before the development of the 9-TC, induced and eddy-current field were compensated for by the design of fixed permalloy strip configurations mounted near the MAD detector and by fixed coils also installed close to the detector. The strips and coils were designed to create equal and opposite induced and eddy-current fields to those generated by the aircraft. These fixed compensators require custom design for each aircraft type, involving lengthy experimental flying, and do not cater for changes in induced and eddy-current sources during the life of the aircraft. Also, they require close tolerance hardware to be installed close to the MAD detector, normally in the non-magnetic (fiberglass) MAD boom. Furthermore fixed compensation systems are not capable of providing adequate compensation levels for new, more sensitive, MAD systems.

The 9-TC has the following advantages:

1. The CAE 9 Term Compensator (AN/ASA-65) provides automatic compensation for aircraft generated manoeuvre interference signals.
2. By minimizing unwanted interference signals, the CAE 9-TC substantially improves MAD detection range, especially during tactical and turbulent flight conditions.
3. This equipment compensates all significant permanent, induced and eddy-current interference fields in approximately 30 to 45 minutes. Permanent terms can be trimmed up on each flight in about five minutes, compared to close to one hour for manual compensation systems.
4. The automatic nature of the 9-TC, together with simple operating procedures, eliminates the requirement for specialized operator training. Comprehensive tests have shown that experience is not a necessity in achieving satisfactory compensation levels with the CAE 9-TC.
5. The CAE 9-TC is compatible with all existing magnetometer systems in present use. Accommodation for the varying compensation requirements of different aircraft types is conveniently accomplished by means of internal patch connectors.
6. The CAE 9-TC, designed to satisfy the requirements of applicable military specifications using state-of-the-art techniques, has a demonstrated M.T.B.F. of more than 1000 hours. The use of completely solid-state circuitry has resulted in a total system weight of less than 30 lbs. (13.6 Kg.).

Production quantities have been manufactured and delivered to the Royal Air Force for its newest ASW aircraft, the Hawker Siddeley HS-801 "Nimrod". The 9-Term Compensator is also presently being manufactured and delivered to the U.S. Navy for use in the "ANEW" P-3C Orion ASW aircraft. The 9-TC has also been ordered by several geophysical exploration companies for use in compensating aircraft conducting airborne magnetic exploration and survey work.

### SPECIFICATIONS

Compensation Figure of Merit:  
Maximum Compensation Fields:

Consistently below one gamma.  
50 gamma on each of aircraft's Transverse, Longitudinal and Vertical axes.

Interference Field Reduction:

To 1/100th of original value.

Compensation Time:

Less than 30 seconds manoeuvre time for each term compensated.

Residual Interference Signals:

0.01 gamma or Magnetometer System internal noise, whichever is greater.

Military Specification Compliance:

Meets requirements of MIL-C-81461.

Environmental:

Meets requirements of MIL-E-5422.

Radio Frequency Interference:

Meets requirements of MIL-1-6181 and WR-101.

Operating Temperature Range:

-54°C to + 71°C.

Storage Temperature Range:

-62°C to + 85°C.

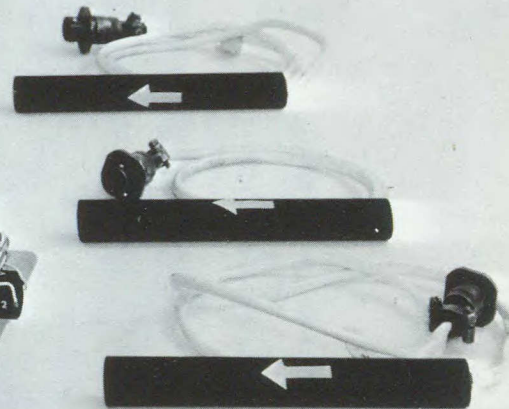
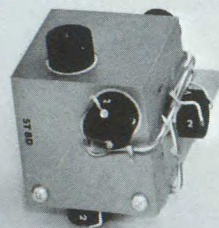
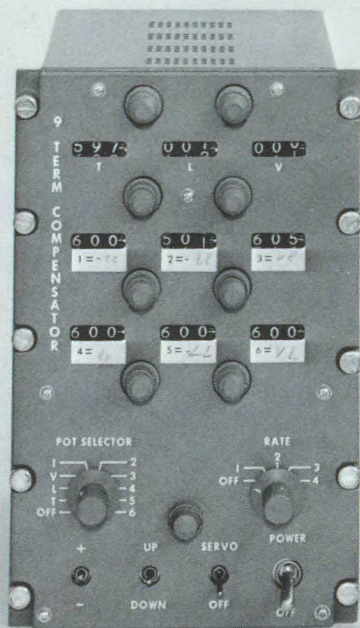
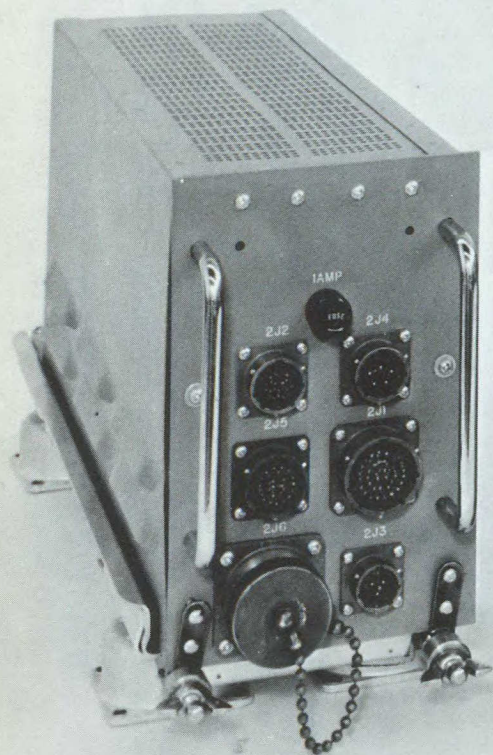
Power Requirements:

115 Volt 400 Hz, 100 VA 28V (DC or AC), 10 VA (for Panel Lamps only).

Reliability:

Meets specified MTBF 1000 Hours.





## SERVO REPEATER AMPLIFIER

The Leigh Servo Repeater Amplifier is designed to meet the need for accurate, reliable, and compact servo retransmission from a low power synchro source to a number of isolated high power torque receivers or control transformers.

The unit consists of a repeat servo using a high impedance control transformer and a transistor amplifier of unique design. The servo drives up to six, size 11 high-power synchro transmitters, all of which can be separately excited, and which can, in turn, drive up to 24 high torque synchro receivers. The constructional features of the unit are:

- Rugged construction — can be either shock mounted or mounted directly to aircraft structure.
- Rubber gasketed for effective dust sealing
- Uses all stainless steel Leigh gearhead
- MIL approved parts used throughout
- Meets design requirements of MIL-E/5400, Class II equipment.

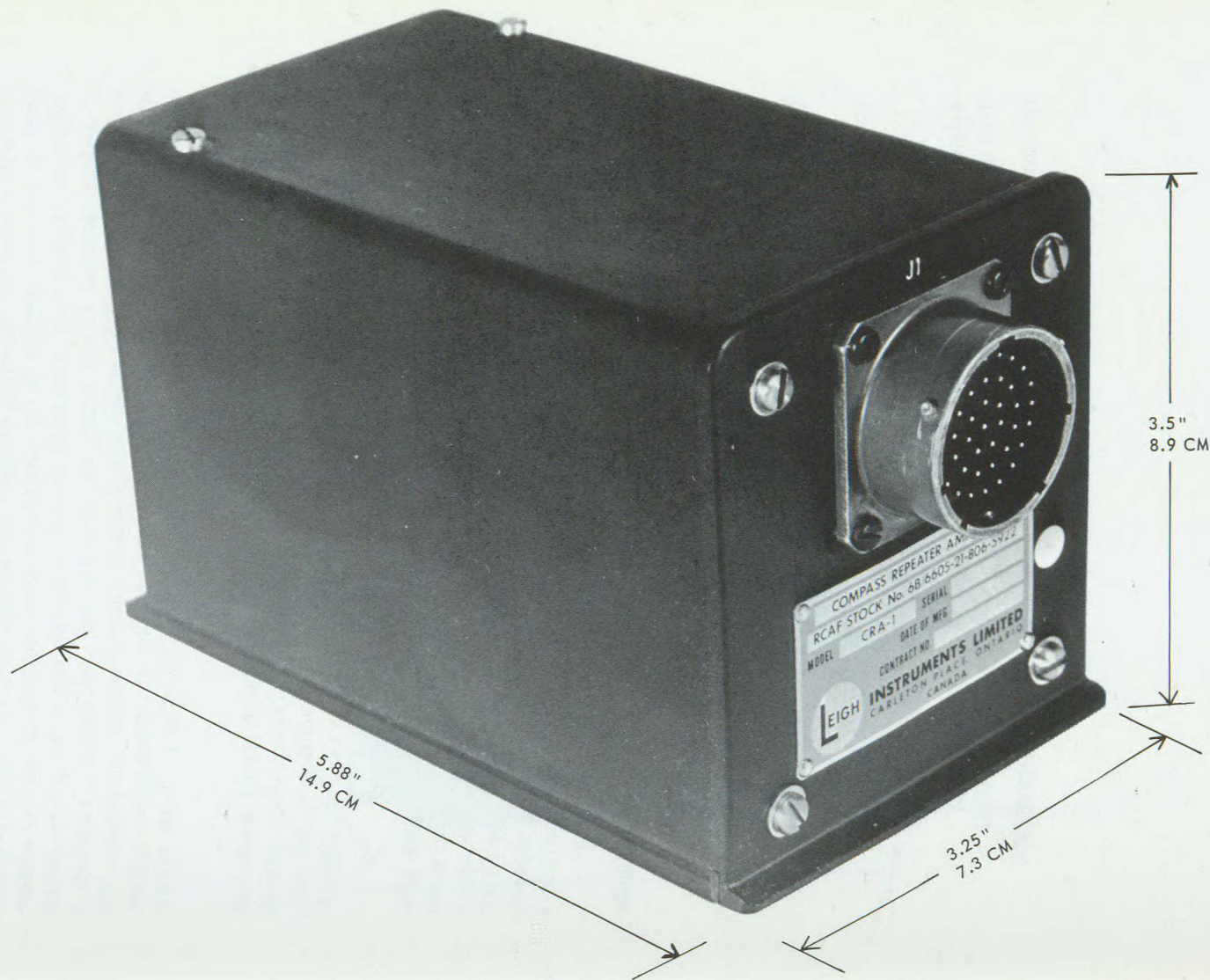
The unit is available in five different configurations to meet different requirements, and the company is capable of high volume production. Over 1000 units have been supplied to the Canadian Armed Services.

Complete qualification testing has been performed to MIL-E/5272, including vibration, shock, temperature  $-65^{\circ}$  to  $+160^{\circ}\text{F}$  ( $-54^{\circ}\text{C}$  to  $+71^{\circ}\text{C}$ ), sand and dust, rain, salt spray, humidity and radio interference.

The unit compatible with C-2, J-2, N-1 gyros and can drive indicators such as DRMI-1D416, MN97H and AN/ARN501 Tacan. It can also be used for multiple bearing and heading displays for navigation systems and other repeater applications.

### Specification (Standard Unit)

INPUT CT IMPEDANCE	$Z_{ro} 800 + j2900$ Optional — 2 extra size 11 transmitters and $Z_{ro} 115 + j470$ 1 size 10 standard or clutched synchro $Z_{rss} 890 + j350$ Overall Accuracy $\pm 20$ minutes maximum under all conditions
FOLLOW UP RATE	30 degrees/sec.
OPTIONAL	60 degrees/sec.
OUTPUTS	4 size 11 torque Power (not including synchro excitations) transmitters 26V 400 cps 10VA Optional 115V 400 cps
STATOR VOLTAGE	11.8V
	Output unit torque gradient 5700 mg.mm/deg.
	Weight (less mounting tray) 2.3 lbs. (1.04 kg)
	Weight (mounting tray only) 0.5 lbs. (.226 kg)





## SERVOED ALTITUDE INDICATORS

The Servo-Pneumatic Altimeter, designed and manufactured by Leigh Instruments Limited, normally operates in the servo mode from standard air data or altitude computers which provide a standard three wire synchro signal. Should an aircraft or system electrical failure occur, the altimeter will automatically revert to a mechanical mode (STBY) which uses a unique internal altitude mechanism. The combination counter-drum and pointer display provides an unambiguous altitude indication correct to  $\pm 20$  ft. (6 M) (servo mode) or 0.5%  $\pm 30$  ft. (9 M) (STBY mode).

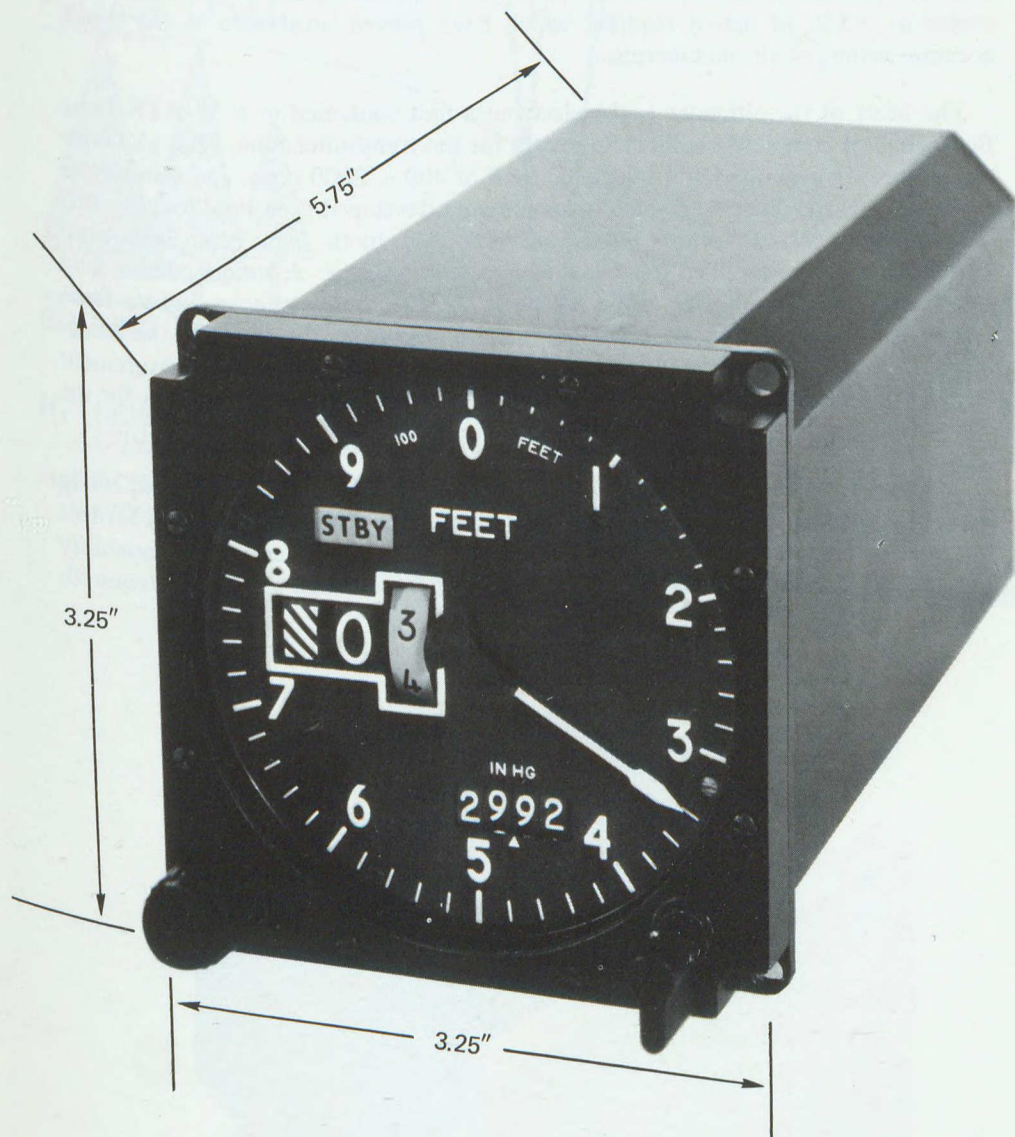
Two manual controls are provided: a standard barometer setting knob with a four digit counter-type display; and a STBY-RESET switch which permits manual control of the mode of operation of the altimeter in addition to the automatic control of servo-to-STBY mode switching. A flag indicates when the altimeter is in the STBY mode.

The servo mode circuitry consists of a control transformer and a high gain, integrated circuit, servo amplifier of advanced design which excites the servo motor control winding. The altimeter contains an integral power supply circuit, and a failure warning system which operates the servo-to-STBY mode switch. The STBY altitude mechanism is fully temperature compensated and consists of dual opposing capsular elements which respond to variations in pressure altitude to provide a high torque output drive to operate the low friction counter-pointer display.

Negotiations are presently underway to provide this equipment to the Canadian Armed Forces.

### SPECIFICATIONS

Range — 1,000 to 80,000 ft. (305 to 24,384 m)	Lighting MIL-L-25467
Accuracy — 0.5% $\pm$ 30 ft. (9 m) (STBY) $\pm$ 20 ft. (6 m) (servoed)	Power 10VA, 115 VAC 400 Hz
Weight — 3.25 lbs. (1.5 Kg) Static Connection AND 10050-6	Connector — MIL-C-26500 (MS24264M-7-24PN)
Synchro — 360° = 10,000 ft. (3048 m)	Case — MS33556 or ARINC 408



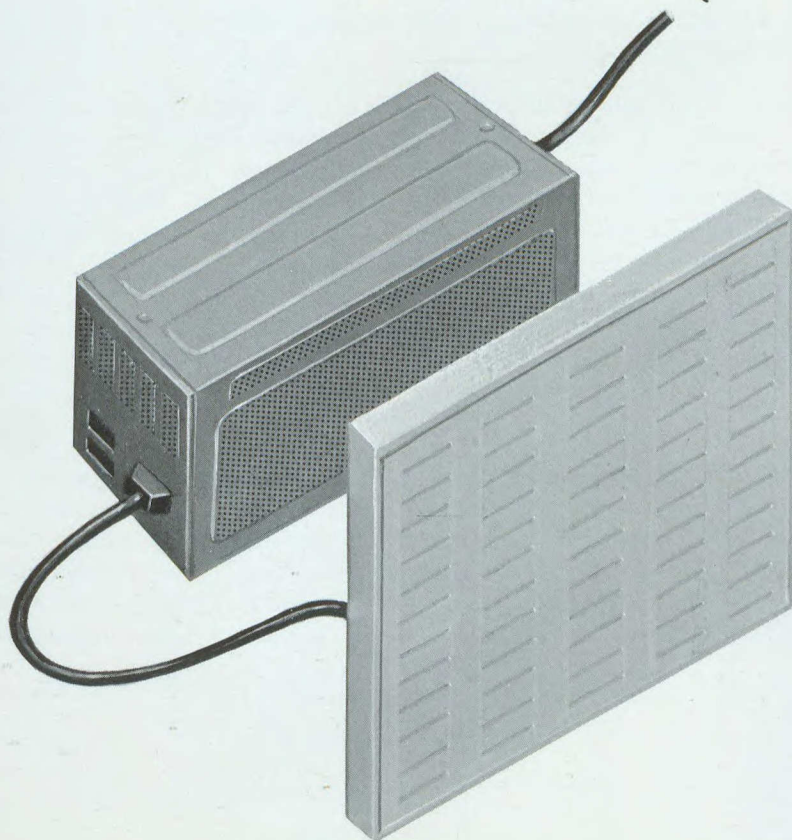
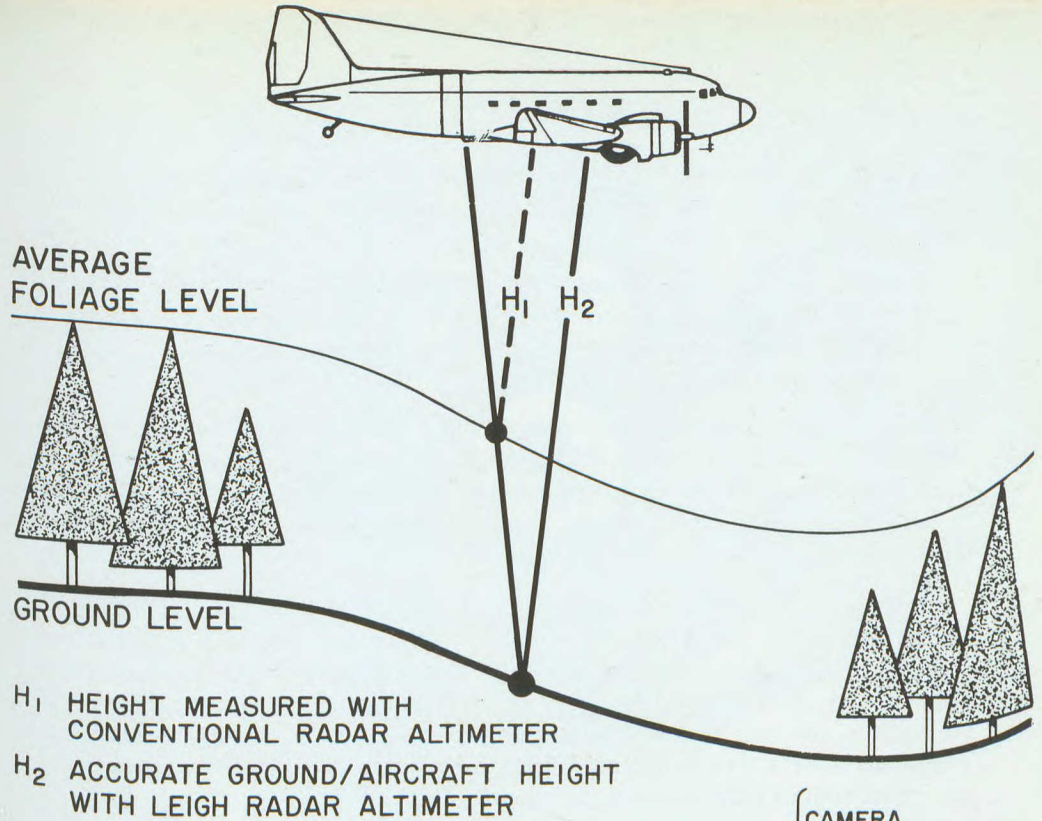
## FOLIAGE PENETRATING RADAR ALTIMETER

Unlike conventional radar and laser altimeters, the instrument developed and manufactured by Leigh Instruments Limited measures ground-to-aircraft height accurately through forest cover. Tested in use over tropical rain forests as well as Canada's northern coniferous woods, prototype units have given measurements accurate to  $\pm 1\%$  of actual reading, which have proved invaluable in the rapid, accurate scaling of air photographs.

The heart of the altimeter is the electronics unit contained in a  $\frac{3}{4}$  ATR Long Box, which is completely solid state except for the transmitter tube, 2Kw pk Gaussian pulses are generated at a selectable PRF of 400 – 2000 p.p.s. and transmitted from the flat, stripline, "sandwich"-type antenna developed especially for this altimeter. The received "echo" pulses are amplified by a high gain, wide-band logarithmic video amplifier fed by a square law detector. A unique timing and measuring circuit employing pulse by pulse AGC suppresses echo signals from forest foliage and allows an accurate measurement from the peak of the transmitter pulse to the peak of the ground echo signal to be made. This measurement is converted into a Digital Readout for the camera, and an Analog Readout for the Pilot's Indicator, or, with Fiducial Marking, for a Chart Recorder.

The Foliage Penetrating Radar Altimeter, which is now in production, while designed originally for forestry survey work, and under active consideration for this purpose by several air survey users, has potential usefulness wherever the capability for accurate ground-to-aircraft height measurement through foliage is required.





## AIRCRAFT SIMULATORS

The Electronics Division of CAE Industries Ltd., Montreal has achieved a position of world leadership in the development and manufacture of flight, weapons, ASW and radar simulators.

Since 1952 CAE has developed a total of eighty military simulators, including thirty-two F-104 Super-Starfighter simulators which are being used to train pilots by the RCAF, USAF and the Air Forces of West Germany, Netherlands, Belgium, Italy, Norway and Denmark.

The simulators weighing more than 25 tons each, reproduce for a pilot in a ground-based classroom the physical and visual sensations he would experience in flight, thus training him in all procedures and operations from checkout and takeoff to landing, including flight, engines, radar, combat tactics, missile launching and bomb attacks.

Each simulator includes an exact replica of the aircraft cockpit complete with all instruments for control of flight, engines, navigation, radar and weapons. The cockpit rolls and pitches like the actual aircraft and, by means of a unique visual simulation system developed by CAE, the pilot trainee in the cockpit is able to see the horizon and representative targets on the ground as he "flies" the simulator. The visual system also represents airport runways so that the trainee may maintain visual contact during takeoff and landing exercises.

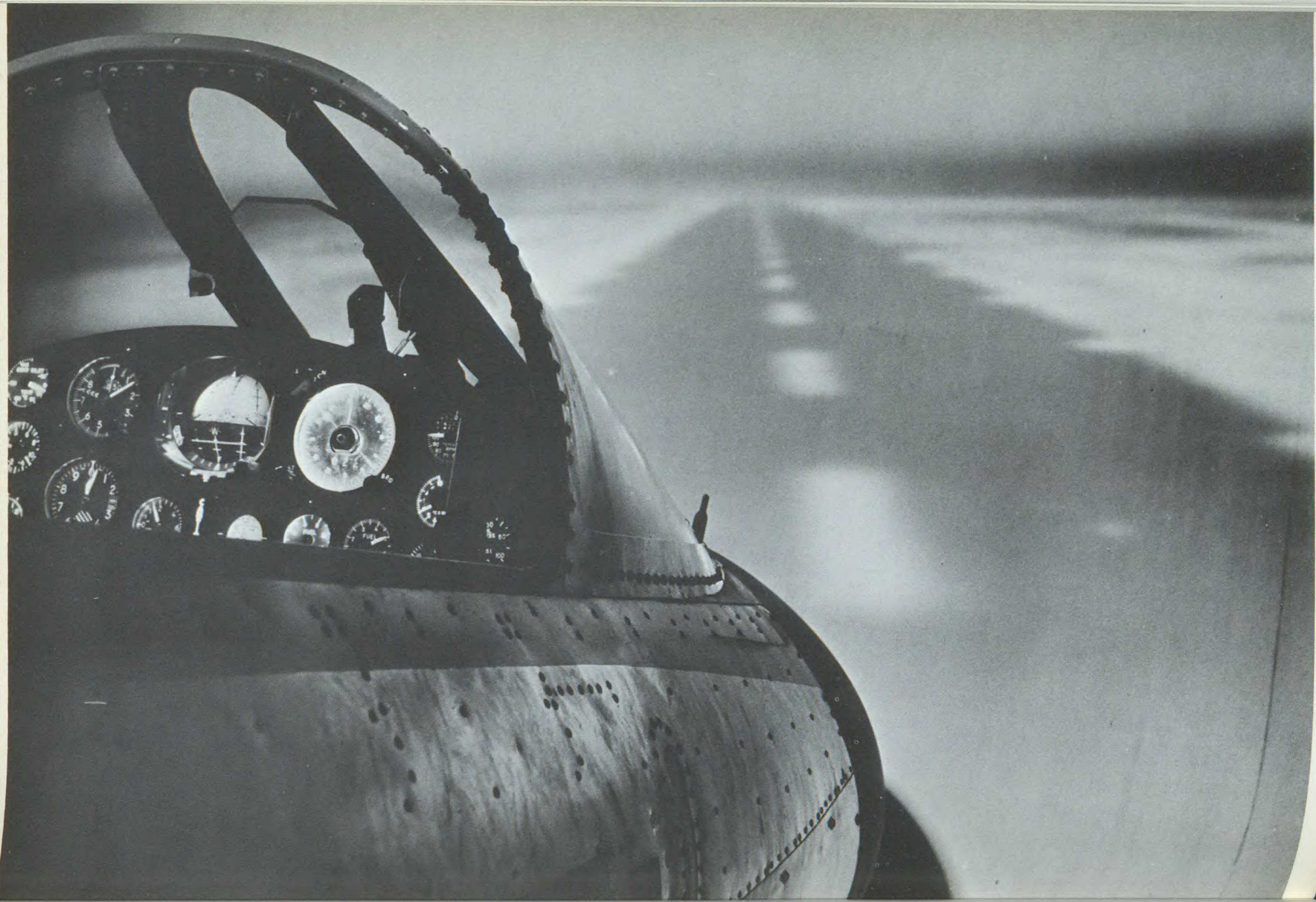
Due to the wide spread use of the F-104 Simulator, it has been chosen as an example of one of the types of simulators produced by CAE.

CAE are capable and ready to meet simulator requirements with respect to other aircraft or equipments.

In addition to its military simulators, CAE has delivered or is currently developing 14 commercial jet simulators for nine international airlines and one major aircraft manufacturer. Douglas DC-8 and DC-9 simulators have been ordered from CAE by Canadian Pacific Airlines, Air Canada, Swissair, KLM Royal Dutch Airlines, Iberia, Union de Transports Aériens and Air New Zealand. British Overseas Airways Corporation, Air India and a consortium consisting of KLM, Swissair and SAS Scandinavian Airways Systems have ordered Boeing 747 flight simulators from CAE, while the Lockheed-California Company chose CAE to develop and manufacture the first L-1011 flight simulator. These latter simulators will have CAE's unique six-degree motion system to provide real-life motion cues to the pilots.

All recent CAE simulators employ third-generation digital computers using silicon monolithic integrated circuits throughout and an all-core memory. CAE-developed flight instructor aids provide hard copy read-out of training exercises for post-flight performance evaluation. A cine-optical visual system providing true-life views for take-off and landing exercises down to Category 2 and Category 3 is available with new CAE simulators or for application to existing simulators.







# AN/ASN-503 NAVIGATION SYSTEM

The AN/ASN 503 Navigation System by Canadian Marconi Co., is a highly versatile, lightweight and reliable airborne integrated avionics package specifically designed for use in transport and tactical aircraft where the requirement is for a track oriented navigation system.

The AN/ASN 503 consisting of the AN/APN 508 Doppler Sensor, the AN/ASN 502 Navigation Computer and PT-5019/ASN 503 Roller Map Display, provides a comprehensive navigational capability independent of ground stations. Ground-speed, drift angle and absolute altitude are measured continuously by the Doppler sensor regardless of weather conditions while the accuracy specified below is maintained independent of terrain through the use of beam intersection techniques in conjunction with a track-stabilized antenna.

The groundspeed and drift angle outputs of the Doppler sensor are used to compute along and across track distance which is displayed on the control indicator. The computer also accepts inputs from the air data computer to provide a back-up navigation capability.

Aircraft present position is displayed continuously on the roller map display, which uses Standard Aeronautical charts with scales of 1:500,000 and 1:250,000.

All units of the AN/ASN 503 Navigation System incorporate built-in test equipment (BITE) which isolates system faults to the line replaceable unit without use of external test equipment. Further isolation of faults to the individual module is performed using standard test equipment. As all units of the AN/ASN 503 are of modular construction, maintenance costs are low due to the ease with which faulty modules can be detected and replaced.

The individual elements of the AN/ASN 503 can be used independently. The AN/APN 508 Doppler Sensor can be used alone to provide outputs of groundspeed, drift angle and altitude or to drive another navigation computer. The AN/AYA 502 Navigation Computer will interface with other CMC Doppler sensors and in addition will operate in an Air Data mode. Similarly the PT-5019 Roller Map Display can be used with other computers.

Principle features of the tactical aircraft navigation system AN/ASN 503 are listed below.

## Performance Data

<i>Temperature Range</i>	-55°F to + 125°F. (-48°C to + 52°C)
<i>Sensor Range</i>	40 - 45,000 ft. (12.4 m. to 13,716 m.)
<i>Altimeter Range</i>	40 - 2,500 ft. (12.4 m. to 762 m.)
<i>Automatic Acquisition</i>	30 secs. maximum.
<i>Reflectivity</i>	All terrain and sea states down to GPL2. Automatic compensation for sea bias.
<i>Warm-up time</i>	Nil
<i>Groundspeed range</i>	100 to 1000 knots
<i>Drift Angle</i>	±20°
<i>Pitch stabilisation limits</i>	±15°

## Displayed Outputs

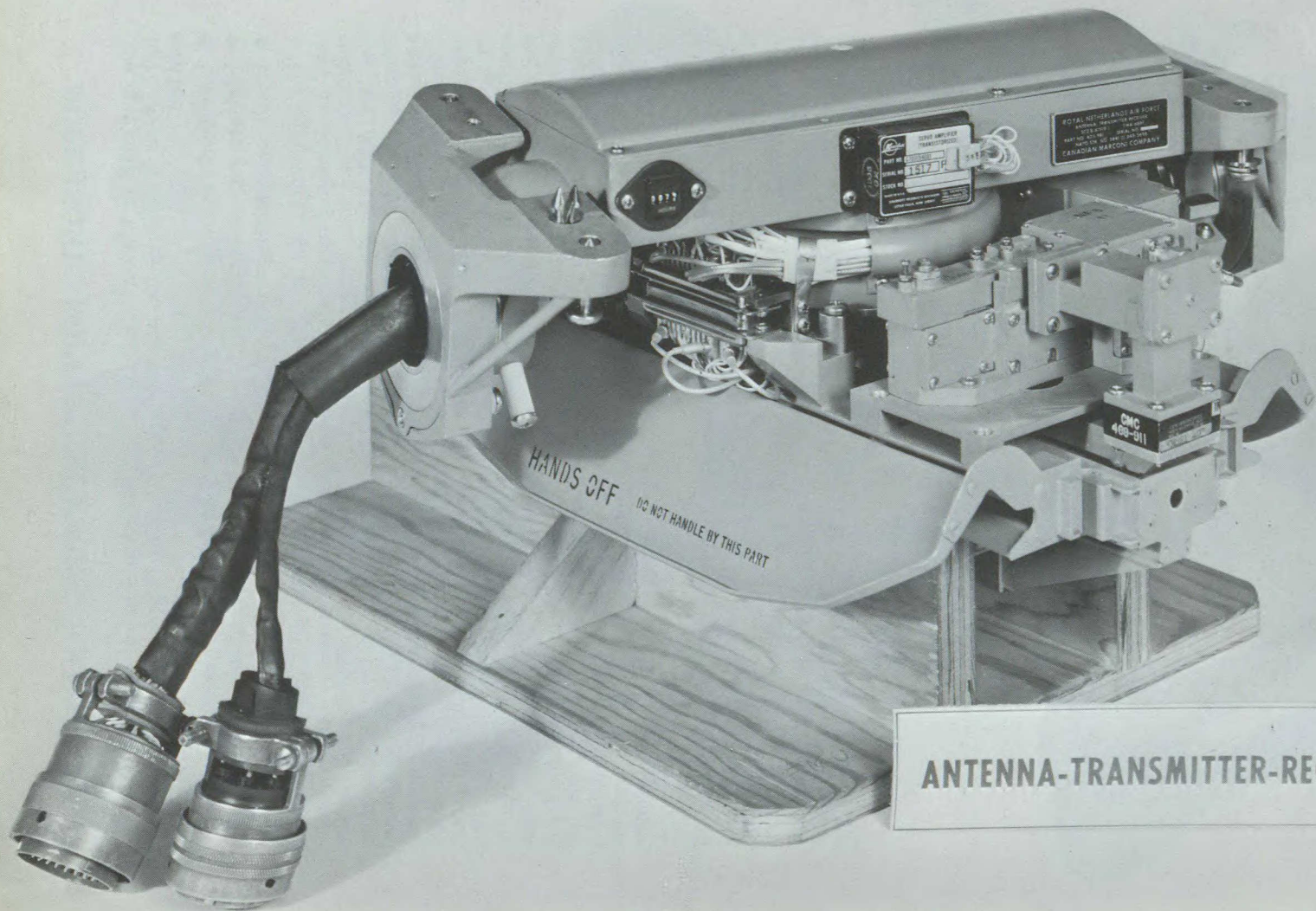
<i>Track Angle</i>	0-359.9°, Resolution .1°
<i>Distance to go</i>	0-999 nm. Resolution 1 nm.
<i>Distance cross track</i>	+ 99.9 nm. Resolution .1 nm.
<i>Groundspeed</i>	100 - 1000 knots Resolution 1 knot
<i>Drift Angle</i>	±20°
<i>Altitude</i>	40 - 2,500 ft. (12.4 m. to 762 m.)

## Output Accuracy

<i>Distance along Track</i>	0.2% of distance flown
<i>Distance across Track</i>	0.31% of distance flown
<i>Groundspeed</i>	0.14% of indicated value
<i>Drift Angle</i>	0.13 degrees
<i>Altitude</i>	± (4% +2 ft. (61 cm.))

## System Electrical Characteristics

<i>Primary Power</i>	115 VAC 400 Hz. (1ϕ) 430 VA max.
<i>Transmitter Output Power</i>	500 mW nominal
<i>Frequency</i>	13,325 ± 25 MHz
<i>Modulation</i>	FM/CW



ANTENNA-TRANSMITTER-RECEIVER

## SUPERSONIC DOPPLER SENSORS—AN/APN 189

One of Canadian Marconi Company's latest third generation Dopplers the AN/APN-189 is specifically for supersonic aircraft. This Doppler Sensor is characterized by:

- Low weight and volume
- High accuracy and reliability
- Inertial compatibility
- Built-In-Test Equipment
- Ease of field maintenance

The light weight, 45 lbs. (20.4 Kg) AN/APN-189, like all Canadian Marconi's third generation Dopplers is completely solid state, extensively utilizes micro-electronics, and uses the beam intersection technique to obviate sea bias errors. The AN/APN-189 also representative of previous generations of CMC Dopplers, featuring FM/CW modulation, track-stabilized antenna, and the Carrier Dispersal altimeter technique; these features have become trade marks of all CMC Dopplers. Other attributes incorporated in this supersonic Doppler sensor are automatic acquisition over the entire groundspeed range, a continuous data validity check, an operator initiated system self test and Built-In-Test Equipment (BITE). This combination of self test and BITE permits a failure to be detected and isolated to the line replaceable unit (LRU) without the aid of test equipment. Further fault isolation down to the module level is accomplished with this self contained test capabilities in conjunction with standard test equipment. Since the AN/APN-189 is of modular construction a faulty module can be quickly detected and replaced, and the system verified for service. This ease of maintenance combined with the inherent high reliability of the AN/APN-189 results in a minimal cost of ownership.

The AN/APN-189 family of Doppler sensors is designed to operate at horizontal and vertical speeds of Mach 2.9 and Mach 1.8 respectively at altitudes up to 65,000 feet (19,812 m). Optional intergral altimetry is available, which will measure altitude up to 30,000 feet (9,144 m) with an accuracy in the order of 2%. The highly accurate outputs (0.1% for groundspeed drift angle), which can be encoded for use in digital computers, have been optimized to provide Doppler Inertial system compatibility. Salient features of this new supersonic Doppler are listed below:

### Performance Data

<i>Temperature Range</i>	-65° to +160°F. (-53.8° to 71°C)
<i>Sensor Range</i>	50 - 65,000 ft. (15.2 to 19,812m)
<i>Automatic Acquisition</i>	Within 10 seconds
<i>Reflectivity</i>	All terrain and sea states down to Beaufort 1.
<i>MTBF</i>	Automatic compensation for sea bias. 1000 hrs.

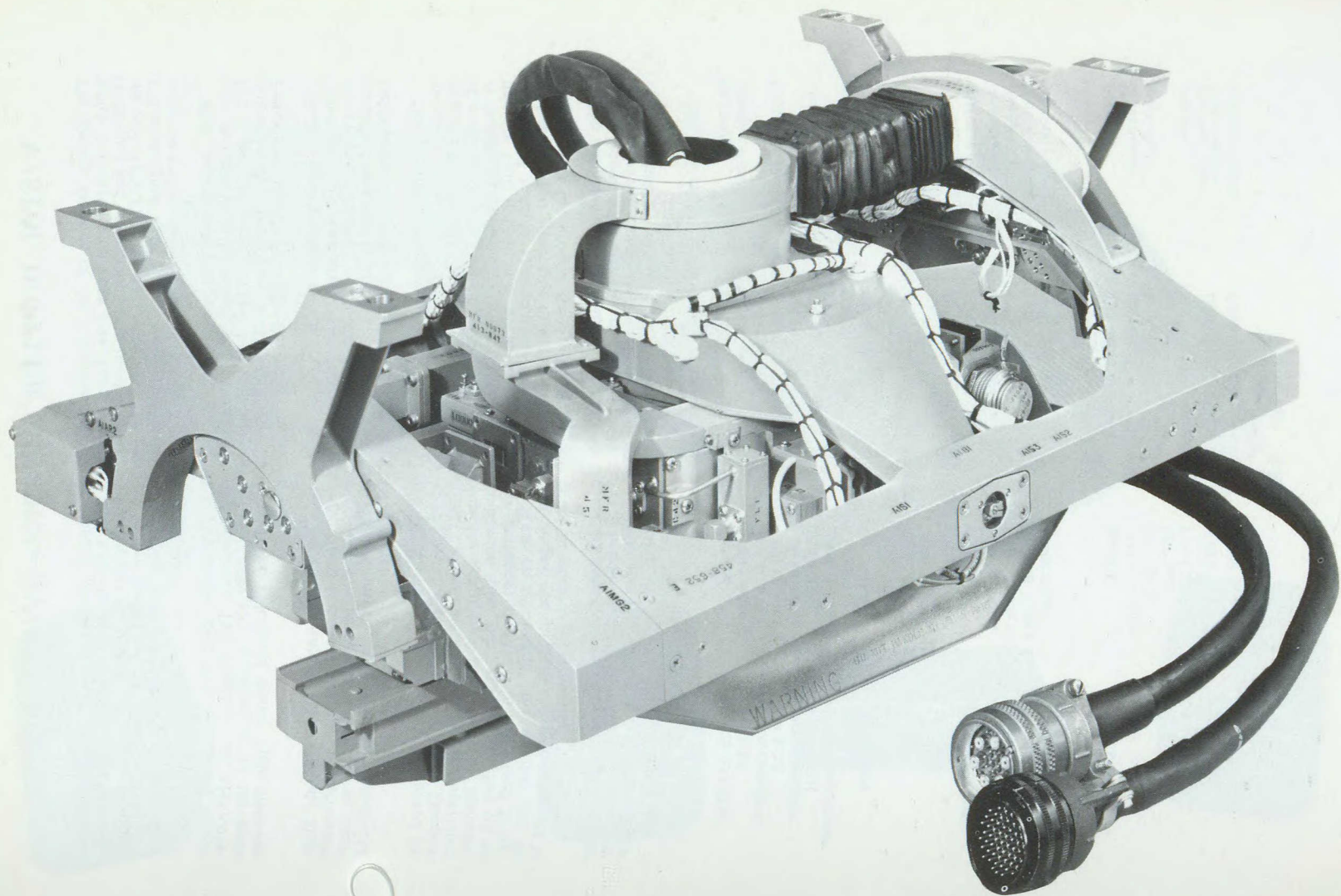
### Antenna Stabilization

<i>Gimball Limits</i>	Pitch $\pm 20^\circ$ to $-15^\circ$
<i>Gimbal Limits</i>	Roll $\pm 35^\circ$
	Drift $20^\circ$ right or left
<i>Attitude Rate</i>	Pitch $\pm 25^\circ/\text{sec.}$
	Roll $\pm 50^\circ/\text{sec.}$
	Drift $\pm 25^\circ/\text{sec.}$

### System Electrical Characteristics

<i>Input Power</i>	115 V AC 1 $\phi$ 400 Hz 200 VA max.
<i>Transmitter Output Power</i>	900 mW
<i>Transmitter Output Frequency</i>	13.325 $\pm$ 10 MHz
<i>Modulation</i>	FM/CW





## V/STOL DOPPLER SENSORS—AV/APN 172/173

The proven features of the Canadian Marconi Company general purpose Doppler Sensor, which is described on page I-xx, have been combined with the latest advances in electronics techniques and components in a third generation of helicopter Doppler sensors represented by the AN/APN-172 and AN/APN-173. The two sensors are similar except that the AN/APN-172 is designed to interface with a digital computer while the AN/APN-173 is designed to interface with an analog computer.

Wide use of micro-electronics and the use of a completely solid state microwave source have resulted in large weight savings and improved reliability. The weight of the AN/APN-172 is only 36 pounds (16.3 kg) and that of the AN/APN-173, including all of the units shown in the illustration is 42.8 pounds (19.4 kg). The calculated Mean Time Between Failures for the two systems is in excess of 1200 hours.

Each sensor contains two main units, A Receiver-Transmitter-Antenna and a Signal Data Converter. The Receiver-Transmitter-Antenna generates and transmits 150 mw of microwave energy at a frequency of 13,325 MHz. The reflected energy is processed and fed at an intermediate frequency to the second unit, the signal Data Converter where further processing yields outputs corresponding to aircraft velocity and altitude.

The performance of the AN/APN-172 and AN/APN-173 is automatically monitored by means of a tracker monitor, and a memory signal is generated immediately a usable Doppler signal is lost. In addition Built-In-Test-Equipment (BITE) continuously monitors the operation of every module in the system and if a fault develops the appropriate BITE indicator operates. A feature of these indicators is that they retain indication after the power is switched off so that the fault indication is available to maintenance personnel as an aid in rapid fault finding. The BITE module also contains circuitry for a "Test on Command" feature that can be initiated on the ground or in flight. During this test proper operation of the navigation set is indicated by the ground speed and drift angle going to pre-determined values.

The altimeter portion of these sensors uses the carrier dispersion principle used in previous CMC Dopplers. It permits measurement of aircraft height above terrain with an accuracy of  $\pm 2$  feet (.6 m)  $\pm 2\%$  over the range of 2 to 3000 feet (.6 to 914.4 m). The validity of the altimeter output is continuously monitored using the lock-check principle.

The AN/APN-172 provides the following outputs:

OUTPUT	FORM	RANGE	SCALE FACTOR
<i>Heading Velocity</i>	Digital	—50 to +250 k	0.140 k/bit
	Analog DCV	—50 to +50 k	5 microamps/knot
<i>Drift Velocity</i>	Digital	—100 to +100 k	0.140 k/bit
	Analog DCV	—50 to +50 k	5 microamps/knot
<i>Vertical Velocity</i>	Digital	$\pm 5000$ ft/min	4.9 ft/min/bit
	Analog DCV	$\pm 5000$ ft/min	0.2 microamps/ft/min
<i>Altitude</i>	Digital	2 to 3000 ft	1.40 ft/bit
	Analog DCV	2 to 3000 ft	3 millivolts/ft

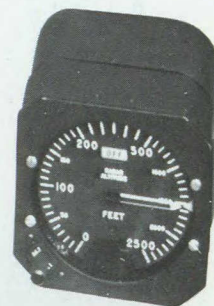
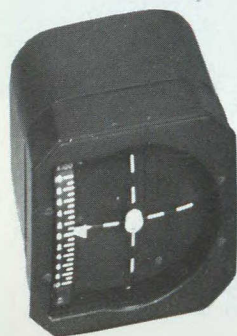
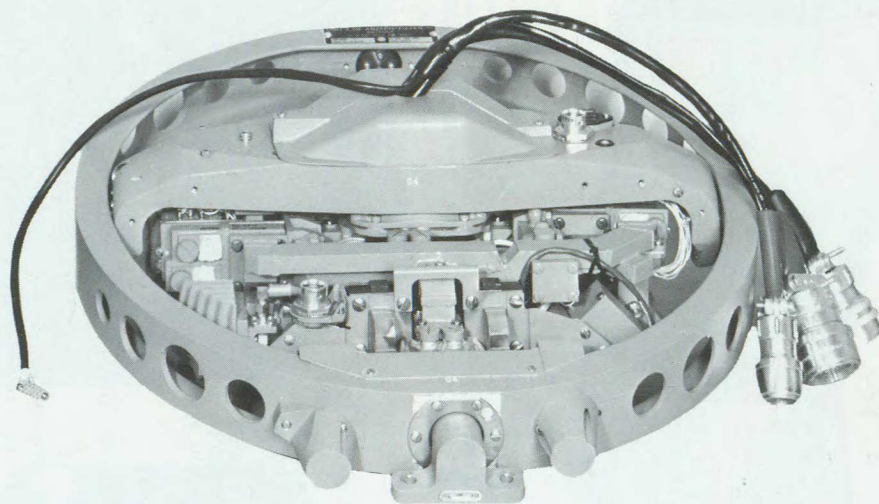
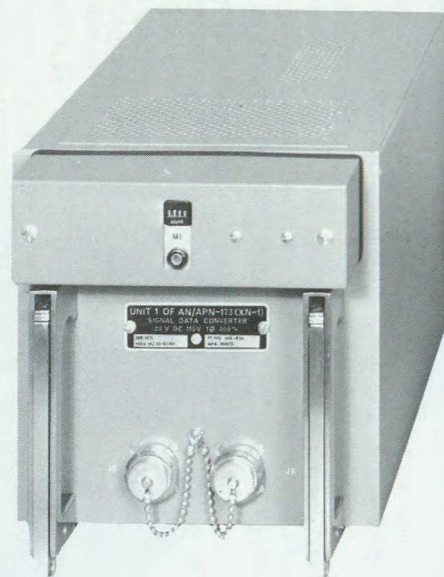
The AN/APN-173 provides the following outputs:

### ELECTRICAL

OUTPUT	FORM	RANGE	SCALE FACTOR
<i>Groundspeed</i>	Pulse Train	—50 to +250 k	As required
<i>Heading Velocity</i>	400 Hz voltage	—50 to +250 k	30 mvrms/k
<i>Drift Velocity</i>	400 Hz voltage	—100 to +100 k	30 mvrms/k
<i>Vertical Velocity</i>	400 Hz voltage	$\pm 5000$ ft/min	1.5 mvrms/ft/min

### VISUAL

OUTPUT	TYPE OF DISPLAY	RANGE	RESOLUTION
<i>Groundspeed</i>	Counter	—50 to +250 k	1 knot
<i>Drift Angle</i>	Pointer & Dial	180° left to 180° right	1°
<i>Altitude</i>	Pointer & Dial	2 to 2500 ft	5 ft
<i>Heading Velocity</i> }	Horizontal & Vertical Bars	$\pm 40$ k	2 k
<i>Drift Velocity</i> }			
<i>Vertical Velocity</i>	Pointer & Linear Scale	$\pm 1000$ ft/min	50 ft/min





# TACTICAL AIRCRAFT NAVIGATION SYSTEM

The CMA-712 navigation system, designed and produced by Canadian Marconi Company is a highly versatile, lightweight and reliable airborne integrated avionics package specifically designed for use in transport and tactical aircraft where the requirement is for a track orientated navigation system.

The CMA-712, consisting of the CMA-668F Doppler sensor, the CMA-703 navigation computer and CMA-704 roller map display, provides a comprehensive navigational capability independent of ground stations. Groundspeed, drift angle and absolute altitude are measured continuously by the Doppler sensor regardless of weather conditions while the accuracy specified below is maintained independently of terrain through the use of beam intersection techniques in conjunction with a track-stabilised antenna.

The groundspeed and drift angle outputs of the Doppler sensor are used to compute along and across track distance which is display on the control indicator. The computer also accepts inputs from the air data computer to provide a back-up navigation capability.

Aircraft present position is displayed continuously on the roller map display, which uses standard Aeronautical charts with scales of 1:500,000 and 1:250,000.

All units of the CMA-712 navigation system incorporate built-in test equipment (BITE) which isolates system faults to the line replaceable unit without use of external test equipment. Further isolation of faults to the individual module is performed using standard test equipment. As all units of the CMA-712 are of modular construction, maintenance costs are low due to the ease with which faulty modules can be detected and replaced.

Principle features of the tactical aircraft navigation system CMA-712 are listed below:

## PERFORMANCE DATA

<i>Temperature Range</i>	-55°F to +125°F (-48° to 52°C).
<i>Sensor Range</i>	40 - 45,000 ft. (12 to 13,716 m).
<i>Altimeter Range</i>	40 - 2,500 ft. (12 to 762 m).
<i>Automatic Acquisition</i>	30 secs. maximum.
<i>Reflectivity</i>	All terrain and sea states down to GPL2. Automatic compensation for sea bias.
<i>Warm-up time</i>	Nil.
<i>Groundspeed range</i>	100 to 1000 knots.
<i>Drift Angle</i>	±20°
<i>Pitch stabilisation limits</i>	±15°

## DISPLAYED OUTPUTS

<i>Track Angle</i>	0-359.9°, Resolution .1°
<i>Distance to go</i>	0-999 nm Resolution 1 nm
<i>Distance cross track</i>	+99.9 nm Resolution .1 nm
<i>Groundspeed</i>	100 - 1000 knots Resolution 1 knot
<i>Drift Angle</i>	±20°
<i>Altitude</i>	40 - 2,500 ft. (12 to 762 m)

## OUTPUT ACCURACY

<i>Distance along Track</i>	0.2% of distance flown
<i>Distance across Track</i>	0.31% of distance flown
<i>Groundspeed</i>	0.14% of indicated value
<i>Drift Angle</i>	0.13 degrees
<i>Altitude</i>	±(4% +2 ft. [.6 m])

## SYSTEM ELECTRICAL CHARACTERISTICS

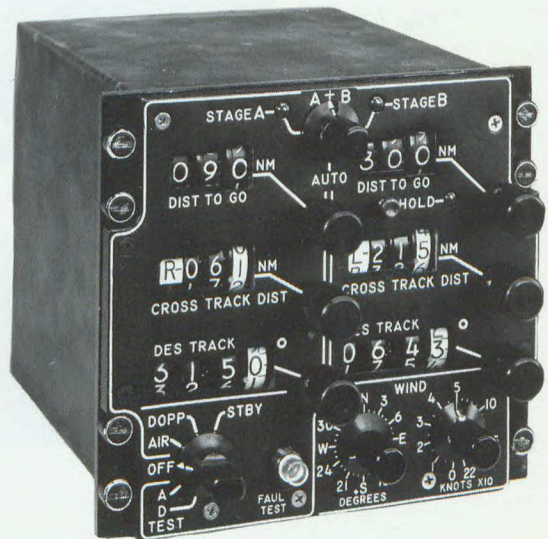
<i>Primary Power</i>	115 VAC 400 Hz(1ϕ) 430 VA max.
<i>Transmitter Output Power</i>	500 mW nominal
<i>Frequency</i>	13,325 ±25 MHz.
<i>Modulation</i>	FM/CW



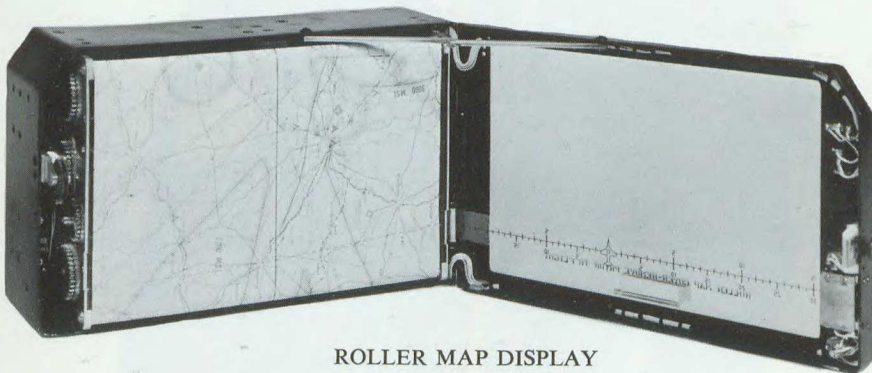
G/S & D/A INDICATOR



ALTITUDE INDICATOR



CONTROL INDICATOR



ROLLER MAP DISPLAY

## AIRBORNE INERTIAL NAVIGATION SYSTEMS

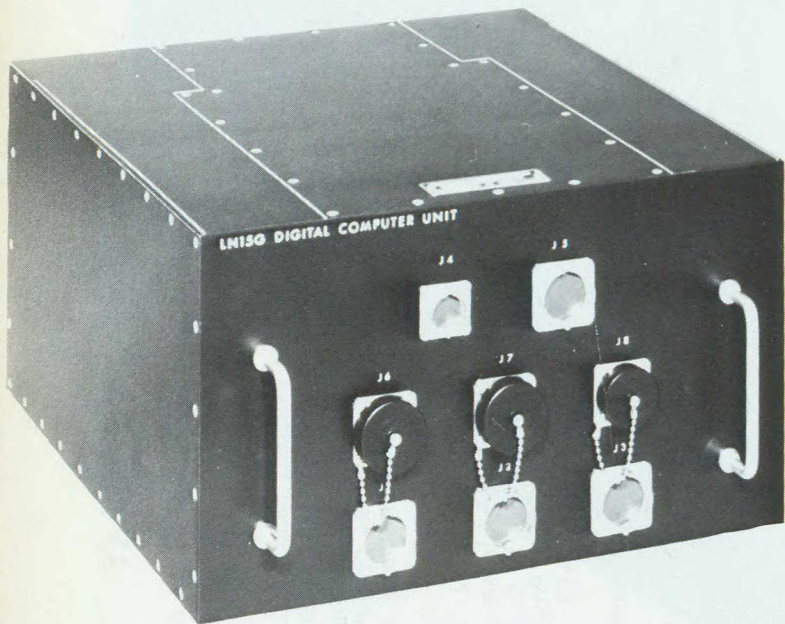
Litton Systems (Canada) Limited has produced over 2000 airborne inertial navigation systems in Canada since its inception in early 1960. Initially, production was devoted entirely to the Litton LN-3 systems for the F-104 Starfighter aircraft flown by the Canadian Air Force and various European NATO airforces. Litton Canada has since produced or has in production LN-12 systems for the USAF F-4 Phantom aircraft; LN-14 systems for the USAF F-111 aircraft and LN-15 systems flown in various other aircraft.

Litton inertial navigation systems are self-contained, fully automatic, light-weight inertial systems that continuously and instantaneously supply basic information on the aircraft's velocity, position and attitude during flight. These systems impose no restrictions on an aircraft's manoeuvrability; cannot be jammed by foreign transmissions; are unaffected by adverse weather conditions, and transmit no external signals that can be detected from outside the aircraft.

The LN-3, LN-12 and LN-14 systems use analog computers while the LN-15, the latest Litton inertial system in production uses a digital computer. In the LN-15 system, the application of advanced techniques at all levels of design, development and packaging has made possible the realization of a portable unit which combines accuracy and versatility with the ruggedness required for equipment operating in a combat environment.

The Litton LN-15 system has a multiple alignment capability that allows it to be aligned on the ground, in the air or at sea. These systems have comprehensive Self-Test and Built-In Gyro Calibration which eliminates the requirements for the types of test equipment traditionally required on a flight line or carrier flight deck.





## PROJECTED MAP DISPLAY

Computing Devices of Canada Limited, has developed and is producing a new device which revolutionizes the display of navigation information to aircraft pilots, both civil and military.

The projected Map Display (PMD) is a dynamic, pictorial display of aircraft position and progress relative to the environment of interest whether topographical or aeronautical. The PMD was developed initially to meet the requirements of the pilot of low-level, military tactical aircraft who must be continuously aware of the relation between his current flight path and the surrounding and approaching terrain.

The PMD has been in continuous development since 1962. Two generations of flyable prototype systems were built and flight evaluated by six different military services in three tactical fighters and three helicopters. It is now in quantity production for the U.S. Navy A-7E Corsair II attack fighter. Production contracts for military helicopter programs are also expected during 1969.

The PMD consists basically of a fixed aircraft symbol presented against a full colour moving map image which is back-projected from a roll of 35 mm film. The film is driven in two axes, north-south and east-west, and simultaneously oriented to either present aircraft ground track or north. In addition to the map picture there are peripheral displays of aircraft track direction, range and bearing to a selected navigation destination and steering error.

The display can be used to look ahead to destination with automatic return to current position upon command. Use of the HOLD and SLEW controls allows the pilot to quickly and easily up-date either navigation position or destination storage without any necessity for numerical coordinate setting.

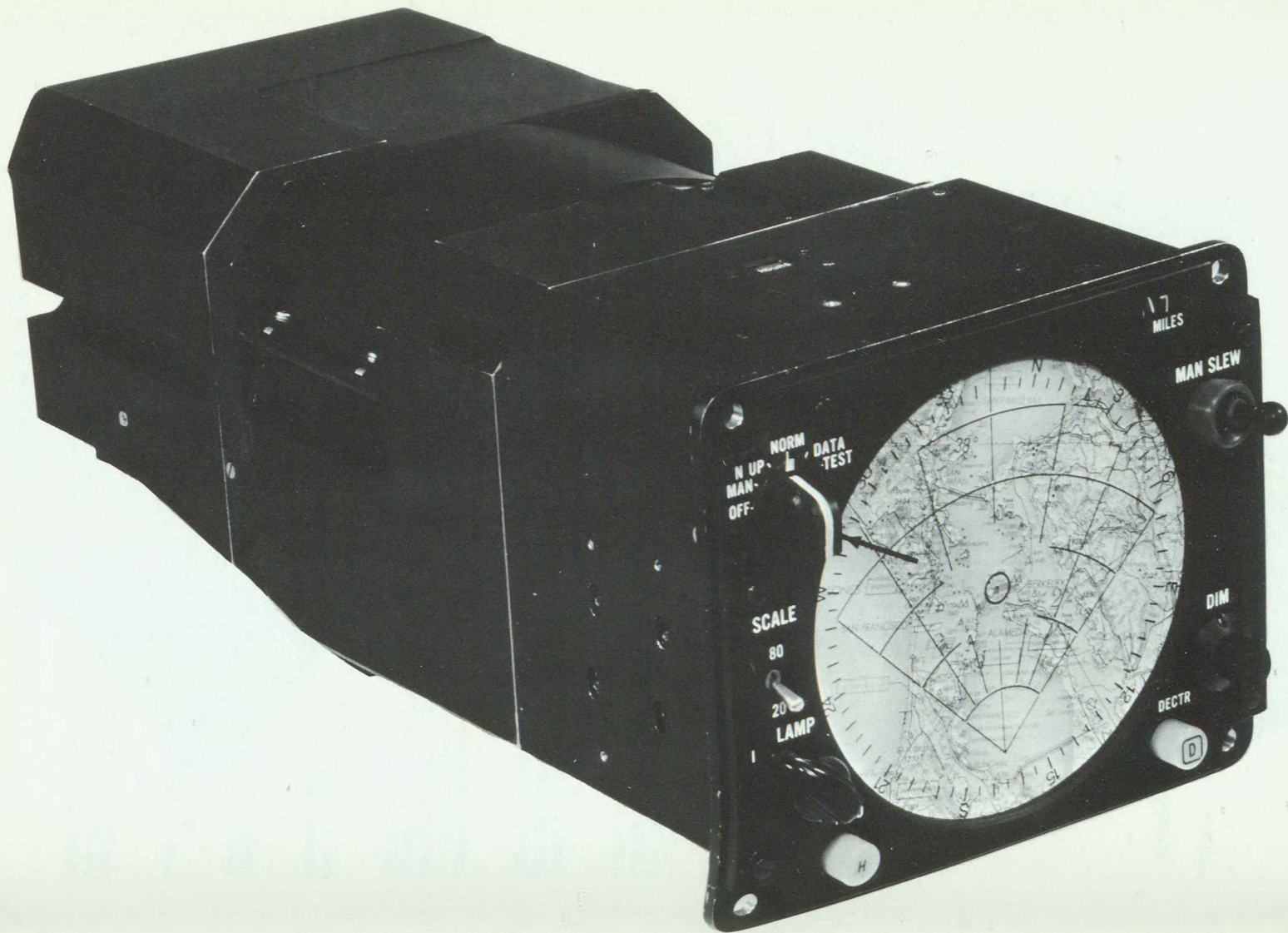
The high-light performance features of the PMD are: very large storage capacity — more than \*220 square feet (20 sq. m) of original paper maps plus 200 discrete data plates for instant recall, sufficient brightness to allow clear viewing in full sunlight or 10,000 foot candles ambient without any necessity for a hood, and resolution capability of 4.5 lines per mm which allows easy readability of six point type at 30 inches (76 cm.) viewing distance.

The PMD measures 6.2 x 7.4 x 15.6 inches (15.7 x 18.7 x 39.4 cm.) and weighs 21 lbs. (9.5 kg.).

Projected Map Systems (PMS) are available in three basic configurations:

- (a) The PMS-4 system interfaces the PMD with a central general purpose digital navigation computer.
- (b) The PMS-5 system interfaces the PMD with primary navigation sensors; dropper, inertial or air data; and performs navigation computations of position and steering information.
- (c) The PMS-6 system interfaces the PMD with either ground-based, VOR-DME or hyperbolic, or self-contained sensors and performs area navigation calculations for civil or military air transport application within the civil airways system.

\*e.g. An area of 1000 x 1000 nautical miles can be stored at two map scales of 1:500,000 and 1:2,000,000.





## MF/HF DIRECTION FINDER

General Precision Industries Ltd., of Montreal, has designed this direction finder which covers the frequency band from 60 KHz to 30.0 Mhz in a continuous manner, using one receiver and one antenna. It provides instantaneous indication of the bearing of a received signal in the form of a trace on the face of a Cathode Ray Tube.

The discrimination between the actual bearing and its 180 degree reciprocal is done simply by depressing a push-button switch located on the front panel of the receiver.

The overall frequency coverage is divided into six ranges. Range selection is by push-button control, and the tuning of the receiver to the required frequency is done rapidly by a two-speed manual drive.

The receiver consists of two frequency-gauged radio channels, accurately matched for gain and phase. The frequency of the signal, to which the receiver is tuned, is read off a scale-and-pointer combination with an accuracy of  $\pm 5$  KHz at 30 Mhz.

For some applications it might be necessary to know the frequency of the received signal with a much higher accuracy, or else to keep unattended watch on a frequency of specific interest. For this purpose the receiver can be made to operate in the digital mode, by fitting a special counter in the upper part of the cabinet. In this case the tuning accuracy is within  $\pm 50$  cps up to 30 Mhz and the stability is such that the tuning frequency remains within these limits for indefinite periods of time.

All IF and LF stages are transistorized. To facilitate servicing the receiver, circuitry is accommodated in readily replaceable modules of standard size and the set may be used in either the land or maritime environment as a fixed or mobile installation. A naval version, the Direction Finder, AN/SRD-501, is in service with the Royal Canadian Navy.

A complete mobile set consists of the receiver, a light-weight (approx. 40 lbs.) water-proof and dustproof antenna and a set of interconnecting cables. The remarkable feature of this antenna is that it covers the whole frequency span from 60 KHz to 30.0 Mhz with a high sensitivity.

In this configuration the set can be used as a land-roving unit mounted in a vehicle, in which case the antenna is located atop a retractable mast, permanently mounted on the vehicle. A suitable converter is added to feed the set directly from the 12V battery of the vehicle.

The set is admirably suited for fixed DF stations whose main purpose is to pin-point accurately the location of the source of received signals by triangulation. These stations usually feature an antenna array of the Adcock type consisting of 4 or 8 vertical elements arranged on the periphery of a circle. To get a high sensitivity at low frequency, two such arrays are used with frequency coverages of 0.25 Mhz to 1.5 Mhz and 1.5 Mhz to 30.0 Mhz respectively.

At least two such stations installed at a suitable distance and connected by a communication link are necessary to take triangulation fixes on received transmissions.

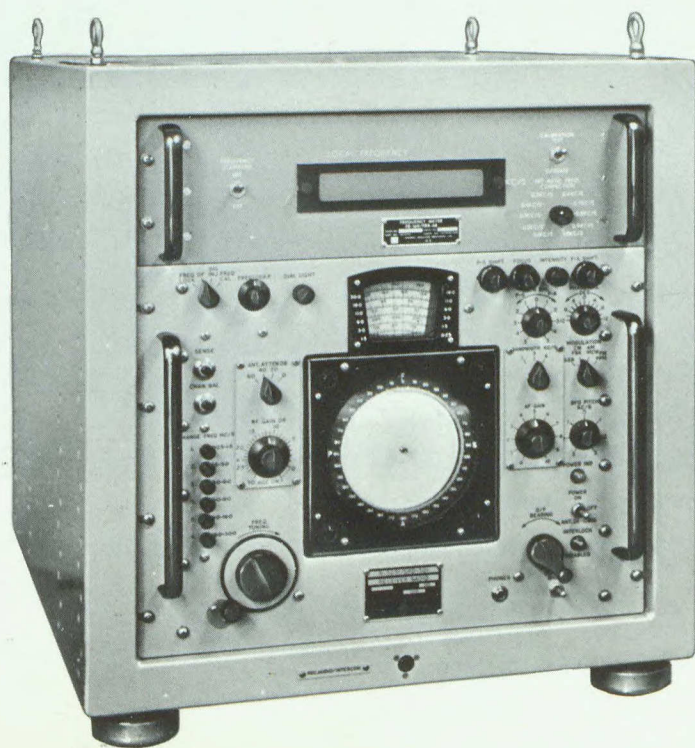
The direction finder includes the following features:

Instrumental accuracy  $\pm 1^\circ$  for 20 db  $\frac{S + N}{N}$  ratio on vertically polarized fields.

Azimuth display — instantaneous diametrical trace on 5" CRT.

Sense determination — quadrant outline superposition on depressing SENSE push-button.

Edge-illuminated scale, rotating alidade, manually operated and coupled with a synchro-transmitter for remote indication of azimuth.



## AUTOMATIC MASTER HEADING CONTROL

The Automatic Master Heading Control designed and produced by Leigh Instruments is a navigator's instrument which provides simultaneous displays of grid, magnetic and true aircraft heading at all times. Integral with this display are smaller displays of variation and grivation (grid variation).

Convergency and command azimuth are separately displayed on the True Heading Dial. The instrument enables continuous monitoring of the standby gyro.

The navigator may control the navigation system heading reference and update it as required. Using the AMHC, he may correct both main and standby gyros, select either as primary sensors, update convergency, variation or grivation.

Command azimuth bearing can be set in on a three digit counter.

The control function can be carried out without upsetting the pilot's magnetic heading reference.

The AMHC accepts inputs of grid heading, convergency and magnetic slaving. Its outputs are Magnetic Heading, Grid Heading, True Heading, Convergency and Relative Bearing.

Grid Heading is accepted from the standby gyro and Leigh Instruments' Compass Repeater Amplifier which is fed by the main gyro. This provides separate headings which are converted into Magnetic or True as required by the aircraft.

The AMHC enables the navigator to correct gyro heading without disturbing the pilot's magnetic reference by torquing variation equal and opposite to the grid correction for cases where the magnetic sensor is operating.

Convergency is accepted as an M transmission and retransmitted as a synchro signal.

### FEATURES

- Gives aircraft global heading capability.
- Simplifies Polar Navigation.
- Allows full pilot control of the magnetic reference and provides navigator control of the gyros.
- Enables primary heading system to be either True, Magnetic or Grid, depending on conditions.
- Standby or Main Gyro can be selected as primary heading sensor.
- Provides continuous monitoring of secondary system.
- Provides immediate indication of the need for corrective action.
- Automatic, accurate initial alignment.
- Automatic and continuous variation computation and display.





## **AUTOMATIC DIRECTION FINDER RECEIVER AN/ARN-89**

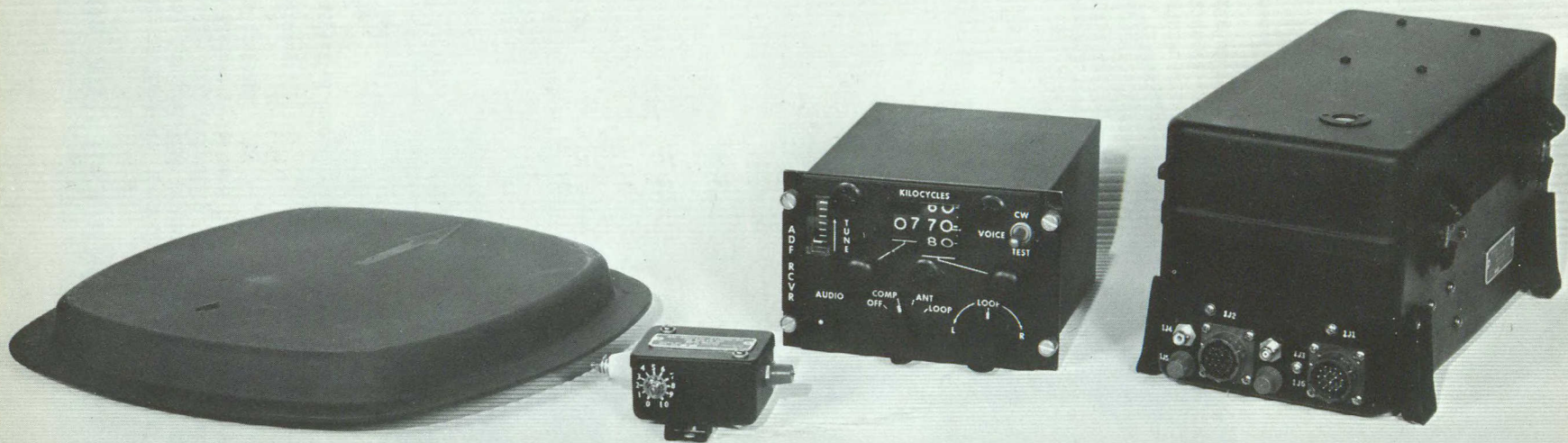
This lightweight automatic m.f. direction finder designed and produced by EMI Electronics, is suitable for both military and commercial fixed and rotary wing airplanes. Modular construction of major circuit blocks allows rapid fault location and speedy replacement of faulty parts.

The receiver provides crystal controlled station selection with the added benefit of continuous vernier tuning instead of incremental switching. The frequency coverage is 100 KHz to 3 MHz with an effective servo bandwidth of 2 Hz. Bearing accuracy at 25 micro volts per meter is  $\pm 2$  degrees. The speed of rotation is 30 degrees per second from 175 degrees offset making it particularly suitable for rapid manoeuvring aircraft and helicopters.

The loop antenna and sense antenna have pre-amplifiers to match the 50 ohm impedance of the coaxial feeder cables. This allows both antennas to be located at any distance from the receiver without compensation.

An internal 'confidence check' enables the operator to confirm that the system is functioning correctly by pressing a 'test' switch.

An internal 400 Hz power supply has adequate capacity to operate two remote magnetic indicators. Total power requirement for the system is 1 amp at 28 volts d.c. The complete system including interconnecting cables weighs 13 lbs. (6 kg).





# ATTITUDE AND HEADING REFERENCE SYSTEM

Through the use of long-life inertial instruments of simplified design, Litton Systems (Canada) Limited has produced an Attitude and Heading Reference System of unusually high reliability. The technology used in the design of this system is of the highest order and has been achieved through the production of over 2000 inertial systems.

The system features:

- 2 - Two degree of freedom gyros
- 4 gimbals
- 3 accelerometers
- A pendulous vertical  $\pm .06$  degrees
- Earth rate, coriolis and transport corrections
- Free gyro or slaved heading

The platform consists of 4 gimbals — Outer Roll, Pitch, Inner Roll and Azimuth with the latter being the inner gimbal. Each gimbal carries a dc torque motor and a synchro. The stable element (azimuth gimbal) carries three accelerometers and two, two degree of freedom gyros. The accelerometers are aligned with the NS(Y) and EW(X) axes. The gyro spin axes, both horizontal, are aligned with the X and Y axes, the first being sensitive to motion about the Y and Z axes, the second about the X and Z axes. The redundant Z axis is caged to the gyro case.

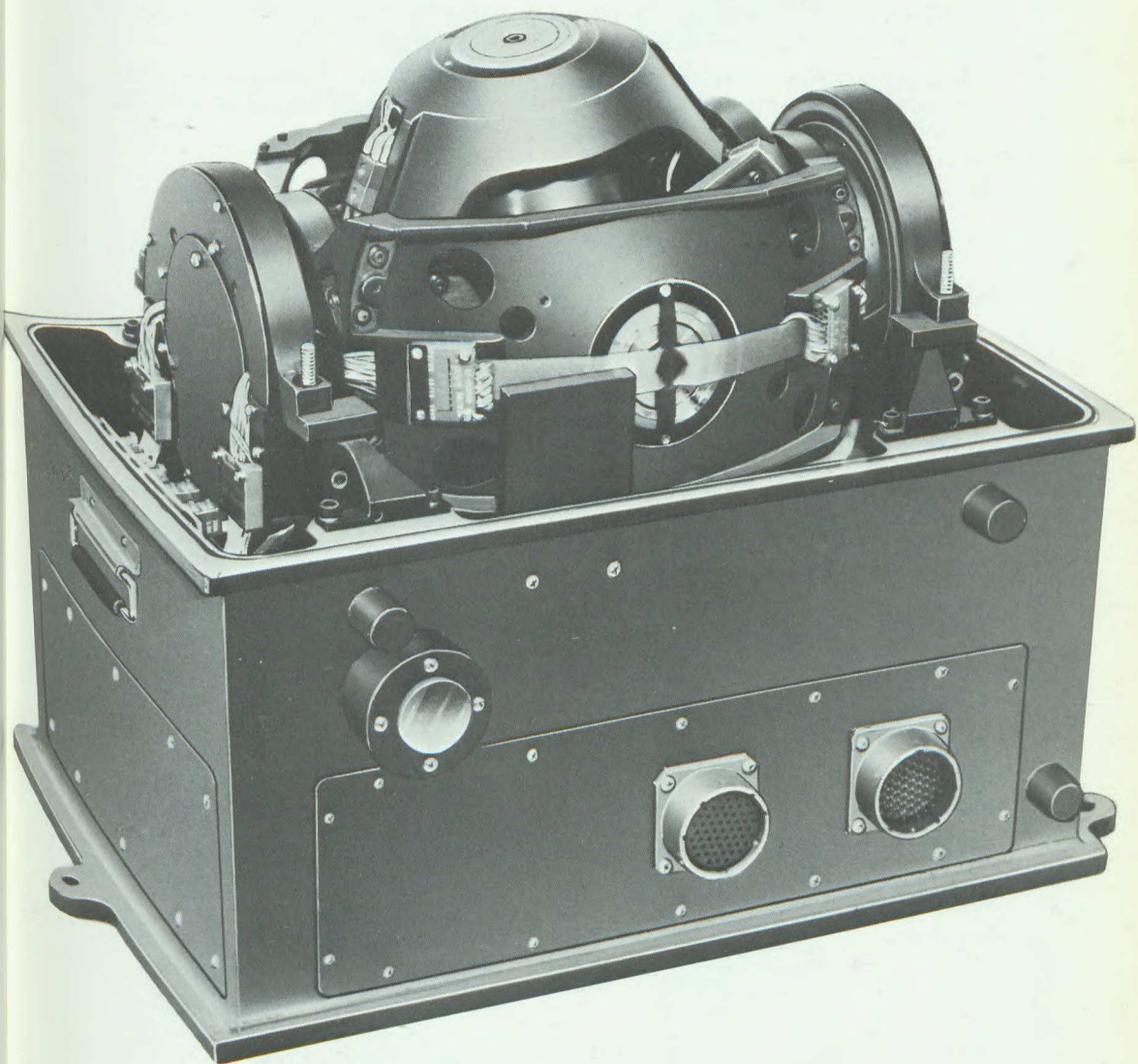
Each gyro has two pick-offs and two torque motors. The pick-offs sense angular displacement between the spin axis and the case and the torque motors when excited cause the gyro to precess in a controlled manner. A resolver on the azimuth shaft resolves the outputs of the X and Y pick-offs into roll and pitch error signals for application to the platform torquers. Two mercury switches parallel to the X and Y axes are normally closed and open when subjected to accelerations exceeding 0.1 g.

In addition to the gimbal structure the platform contains all the necessary electronics to make it a completely self-contained unit. These consist of four servo amplifiers to control the gimbals, temperature control circuits and heaters to maintain the floated gyros and accelerometers at the proper operating temperatures, a power supply to produce the gyro spin supply and excitation for the pick-offs and synchros, and mode switching relays.

The platform also contains the circuitry needed to slave the platform to the magnetic compass and to compute corrections for earth rates, transport rates and coriolis acceleration. Its main component is a follow-up servo which produces a shaft position representing the azimuth output of the platform. The same shaft carries a second control transformer fed from the flux valve, and sine cosine potentiometers which resolve vehicle velocity into NS and EW components. The remaining components are scaling resistors, summing amplifiers and two pulse width modulation multipliers.

## Physical Characteristics

SIZE:	8.4 x 12.6 x 13.6 inches 21.4 x 32 x 34.5 cm
WEIGHT:	24.9 lbs. 11.3 kg
POWER:	200 W 2 KW During Warm-up



## ATTACK SYSTEM—LCAS-5

The LCAS-5 is an attack system for airborne tactical support. The system, an Aided Visual configuration, has been designed by Litton Systems (Canada) Limited to provide the most effective bombing system for those aircraft not requiring or unable to afford inertial navigation capability.

Since the LCAS-5 consists of sub-systems which represent the present state-of-the-art, no extensive engineering tasks are required except for the re-packaging necessary to adapt the hardware to a particular aircraft.

The primary factors which determined the design of the individual subsystems were simplicity of operation, performance, accuracy, delivery mode flexibility, reliability, ease of maintenance and cost.

### System Characteristics

Modes:

Computed Release	Distometer
Laydown	Pitch Angle, Altitude or Slant Range
Dive Laydown	

### Operational Ranges

Altitude: 2000 to 25,000 feet (610 to 7620 m).

Speed: 300 to 800 knots.

Dive Angle: -45 to +20 degrees (at release).

A major factor in the development of the bombing computer mechanization is correction for the weapon ballistics. Through the use of computer simulation programs Litton has adopted an approximate ballistic solution which utilizes curve fitting techniques to derive a Cb factor which is used to modify the gravity term. Error analysis and optimization programs have indicated that a single value of Cb for each weapon, introduced impact errors of less than 30 feet for low to medium drag weapons.

### Subsystem Characteristics

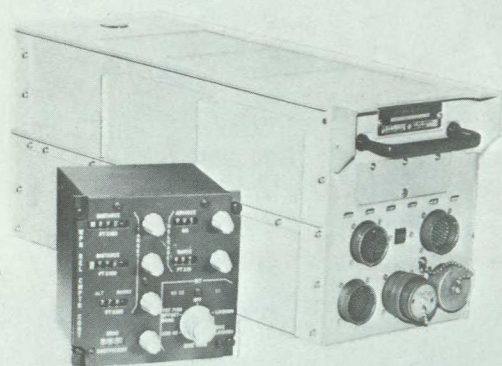
Attitude and Heading Reference	ACCURACY 0.06°	OPTIONAL FUNCTION Pitch, Roll, Heading Display, Auto Pilot Inputs	COMMENTS Latest Inertial Technology
Air Data Computer	2.5 ft./sec. 76 cm./sec.	Altitude, Mach No., I.S.S., h°	Proven Performance
Optical Sight	2 mr.	Heads up Display	Pitch Stabilized
Laser Rangefinder	10 ft. (3.5 m)		Most Accurate Ranging
Bombing Computer	75 ft. (22.9 m)		AN/ASQ-91 Technology

### Sub-System Physical Characteristics

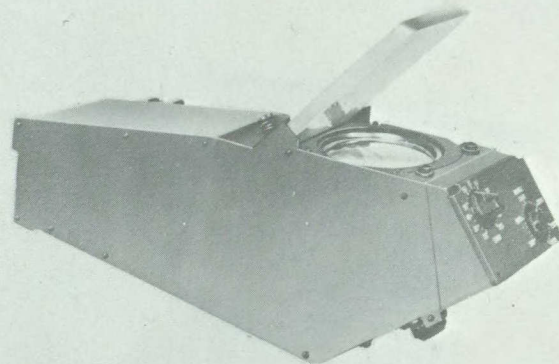
SUB-SYSTEM	SIZE	WEIGHT	POWER
Laser	Dia. 8.8 in. (22.5 cm.) Length 20.5 in. (52 cm.)	49.8 lbs. 22.6 kg.	200 W Standby 700 W Max. 1 sec. AVG. Duration
Air Data Computer	5.9 x 5.9 x 10.8 in. 15 x 15 x 27.5 cm.	15 lbs. 6.8 kg.	50 W
Bombing Computer	6.9 x 8.3 x 9.8 in. 17.5 x 21 x 25 cm.	19.8 lbs. 9 kg.	100 W
Attitude Reference System	8.4 x 12.6 x 13.5 in. 21.4 x 32 x 34.5 cm.	25 lbs. 11.3 kg.	200 W (2 KW)
Sight	3.9 x 6 x 10.6 in. 10.1 x 15.3 x 27.1 cm.	7.9 lbs. 3.6 kg.	During Warm-Up)



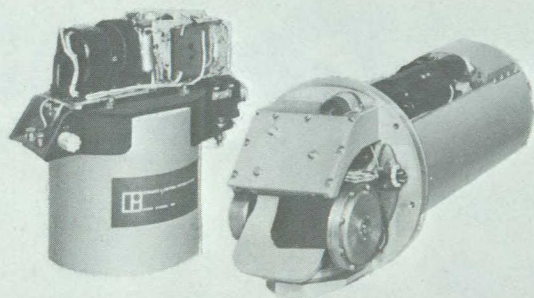
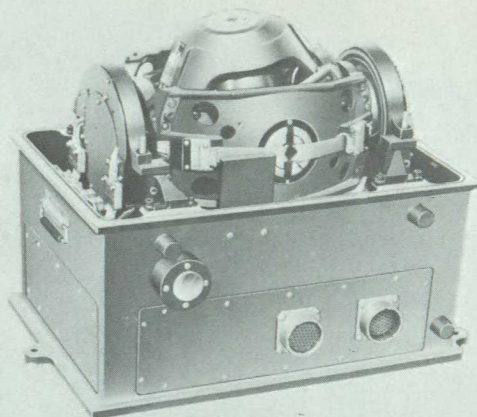
BOMBING COMPUTER



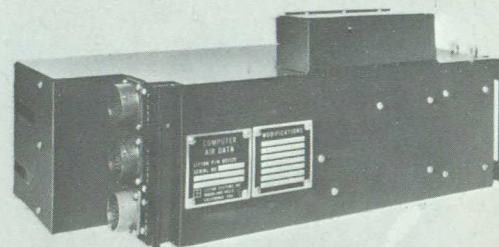
OPTICAL GUNSIGHT



ATTITUDE REFERENCE SYSTEM



LASER



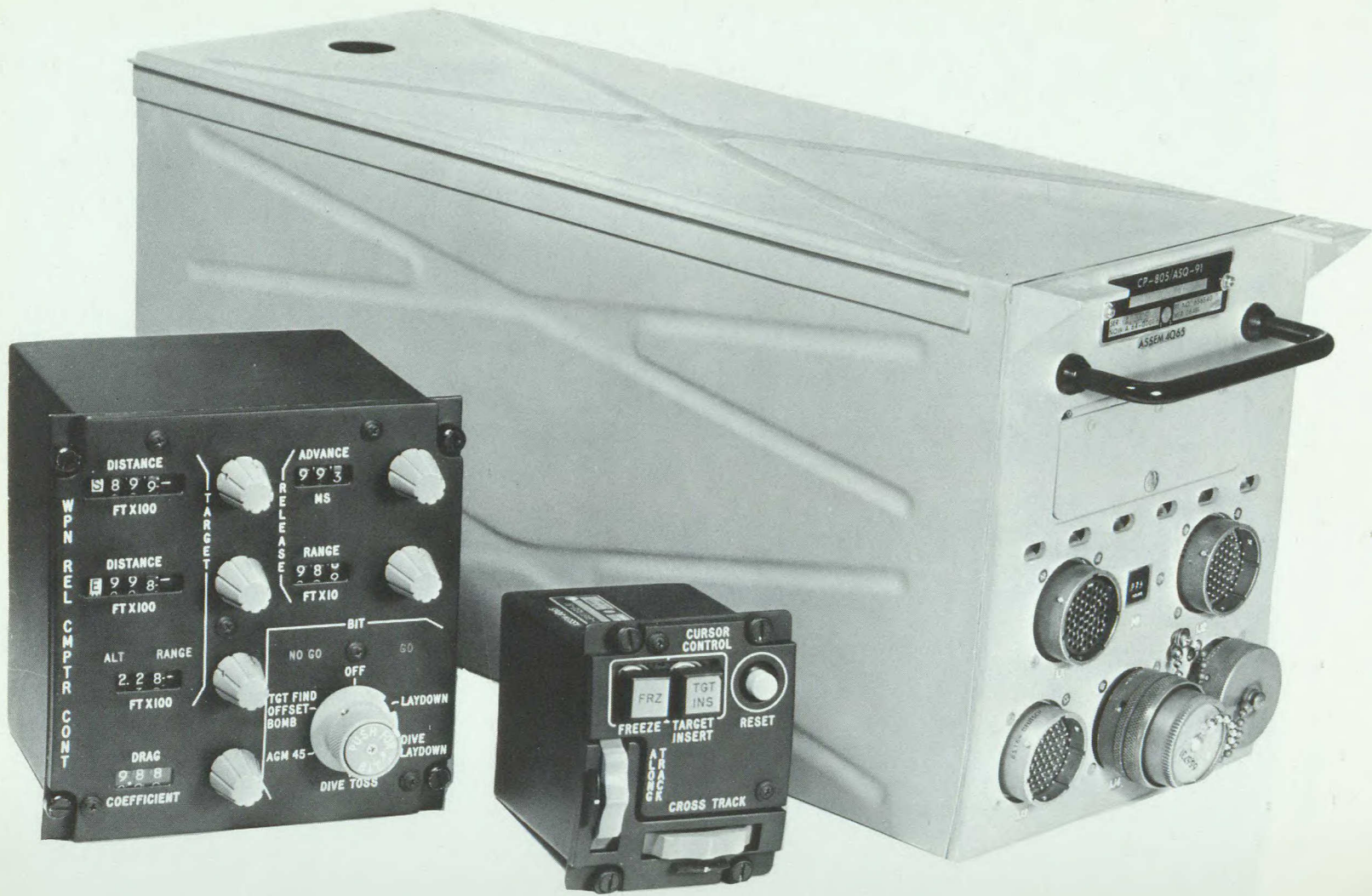
AIR DATA COMPUTER

## WEAPON RELEASE COMPUTER SET (AN/ASQ-91)

Manufactured in Canada by Litton Systems (Canada) Limited, the AN/ASQ-91 Weapon Release Computer Set is an analog weapon's delivery system designed to enhance the combat effectiveness of the McDonnell F-4D/E aircraft. Compatibility of the weapons release computer set with the LN-12A Inertial Navigation Set used in the F-4C aircraft may be achieved through substitution of the LN-12D Output Signal Distribution Unit. The weapons release computer set provides range calculations and automatic weapons release signals for the laydown, dive-laydown, dive-toss and off-set bombing modes of operation. Steering signals and range-to-target information are supplied for use in the target-finding and off-set bombing modes. Manoeuvre commands and the release signal are provided for successful delivery of the AGM-45 missile. Either low-drag or high-drag bombs may be used through proper adjustment of the weapons release computer control panel drag coefficient control. Maximum use of F-4D/E aircraft inertial navigation set output signals and electronic components and mode-sharing of weapons release computer set components has achieved substantial reductions in size, weight, and cost of the equipment.

The Litton computer set consists of:

- The **Ballistic Computer** unit which contains all of the analog circuitry required to solve the bombing problem for each mode of computer set operation;
- The **Cursor Control Panel** which incorporates two thumbwheel controls for adjusting the position of the long-track and cross-track cursors on the radar screen during the target finding and off-set bombing modes;
- The **Weapons Release Computer Control Panel** which contains controls and switches for mode selection, built-in test operation, and insertion of various range, altitude, time and ballistic information.





## SATELLITE COMMUNICATIONS

Canadian industry is in the forefront of countries providing earth stations and satellite for space communications. RCA Limited in Montreal built each of the two earth stations that comprise Canada's satellite communications terminal facilities at Mill Village, Nova Scotia, for handling Canada's trans-Atlantic commercial satellite communications service.

The first station, completed in 1965, uses an 85 ft. (26 m) diameter radome-enclosed antenna and is equipped to handle the transmission and reception of single sideband in addition to the FM mode. The single sideband facilities are available for cooperative international experiments.

The second station, completed in early 1969, uses a 97 ft. (29.6 m) diameter exposed antenna system fitted with a special reflector heating system to remove snow and ice during inclement weather conditions such as are experienced on Canada's east coast. The antenna is of the king post type of configuration, weighs 275 tons (249 metric), and mounts on a pyramid-shaped concrete tower 38 feet (11.6 m) high with walls 2½ feet (76 cm) thick. This station, with a communications capability of 1200 voice circuits for both transmission and reception, is able to receive multi-message communications from up to 10 countries simultaneously.

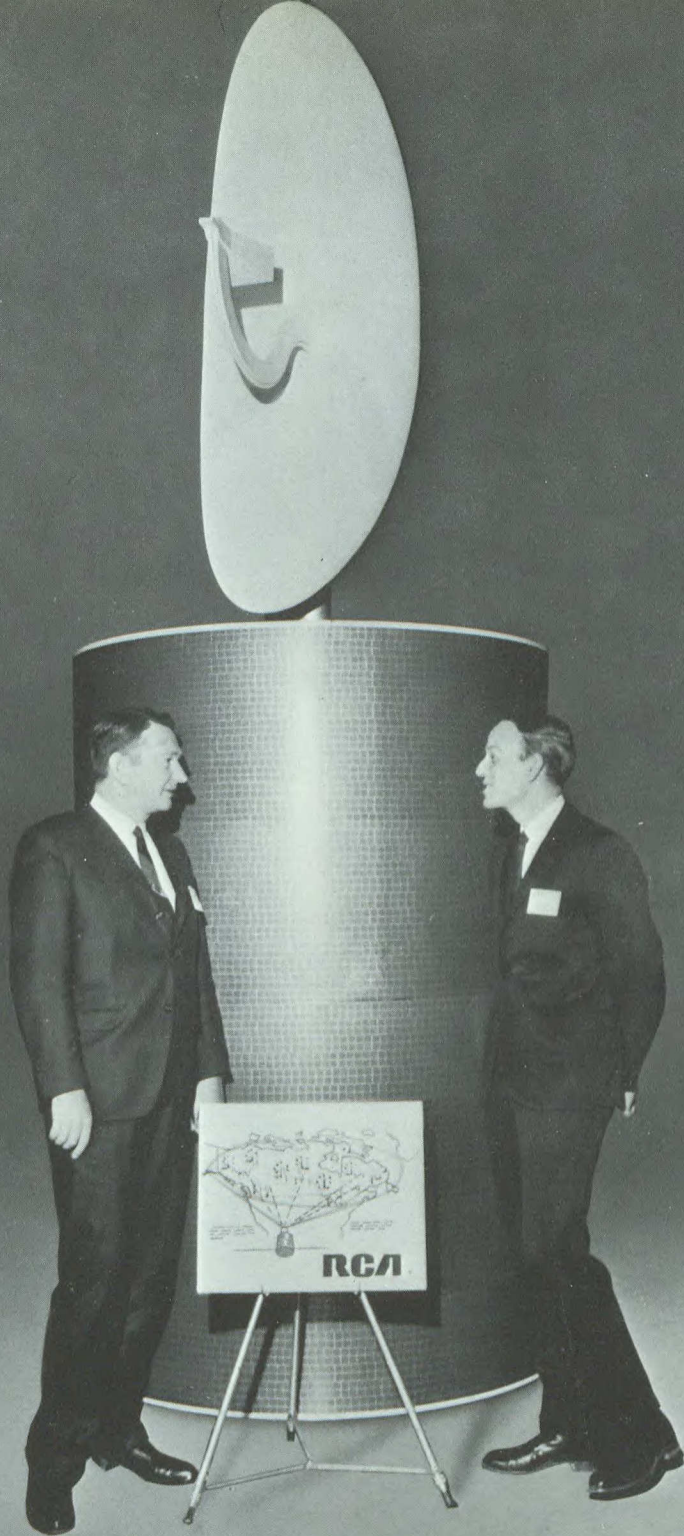
For other member countries of the Intelsat global satellite communications system, RCA Limited sells complete earth stations managed on a turnkey basis including the provision of buildings, diesel-electric power, and microwave communications link to connect with the national telecommunications network. The company has furnished major earth station subsystems for stations in Argentina, Brazil, Panama, Morocco, Thailand and Australia and a complete station for the Government of India. The Indian station, located at Poona, 120 miles south east of Bombay, will operate with the Atlantic Intelsat satellite to permit direct communications service with Europe, Middle East and Africa.

### Domestic Satellite Communications

In 1969, Canada commenced planning on the world's first domestic satellite communications system using geo-stationary satellites. The system, owned by Telesat Canada, is scheduled to go into commercial operation in the early 1970's and will consist initially of a satellite in a synchronous orbit above the Pacific Ocean, about 105° W. Long., 22,300 above the equator, and 3 basic types of ground stations. Large ground stations with limited steerability antennas with diameter of approximately 60 feet (18.4 m) will be used for heavy route transmission and reception of television and telephone and located at major population centres. Smaller, light route stations will be used by small telephony users in remote locations for multiple access to the satellite and equipped additionally for television reception. The largest group of stations would be used for TV reception only, serving areas not served by a terrestrial TV link.

The satellite for the system will be a mechanically despun antenna, a capacity of 6 TV channels or equivalent voice circuits, an in-orbit weight of approximately 500 lbs. (228 kg), and will be launched by NASA from Kennedy Eastern Test Range, Cape Kennedy, using a thrust augmented Thor Delta vehicle. RCA Limited, with experience in 7 spacecraft programs starting with the pioneer RELAY communications satellite in 1961, is the prime contractor for the program definition phase of the satellite program that precedes the production phase.

TRW Inc., Aerospace Products and Northern Electric Company Limited are participating with RCA Limited in the program definition phase of the spacecraft portion of the Canadian domestic satellite system.



A full-sized model of the proposed spacecraft for the Canadian domestic satellite system.



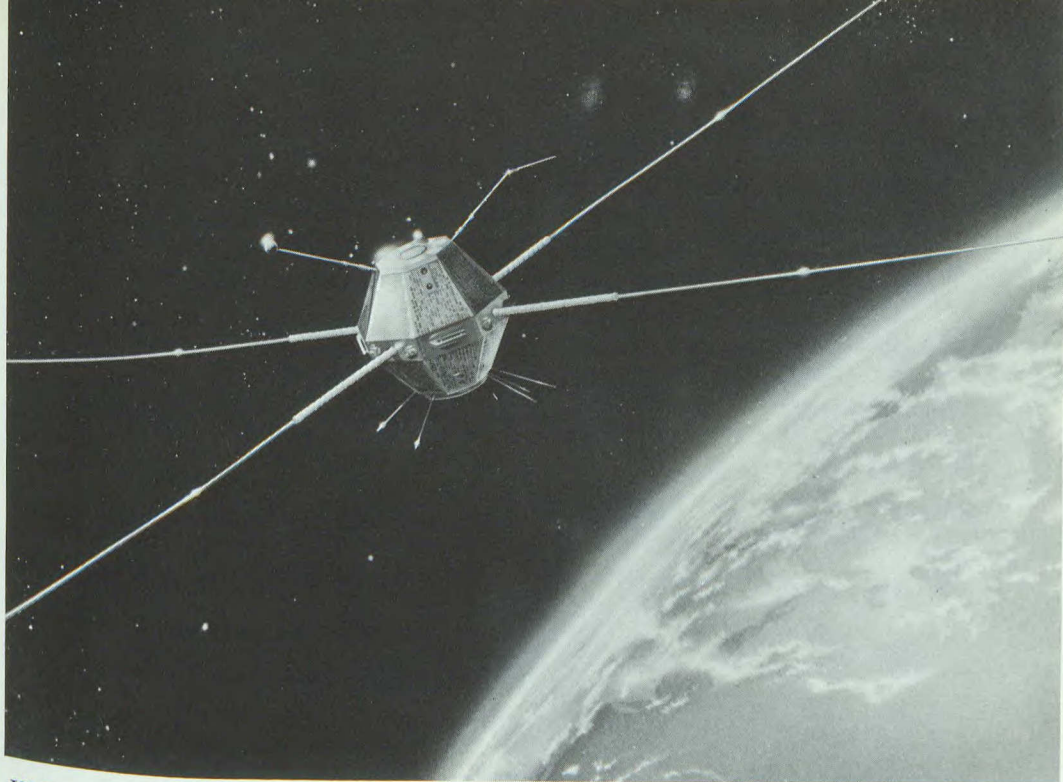
Canada has a great need for a satellite system to illuminate with wideband telecommunications its vast territory of 3.6 million square miles. Wideband microwave systems, of which Canada has over 10,000 miles (16,093 km), mostly in its southern reaches, cannot compete with satellite distribution for such an area, most of which is sparsely populated and with climatic conditions unfavorable to terrestrial systems. It is a need that is foreseen will persist for a very long time into the future, notwithstanding continued growth of high capacity, reliable and low cost microwave terrestrial systems, and of cable and waveguide systems. These systems will complement not compete in the growth towards an integrated communications service of greater coverage, capacity, speed, flexibility and reliability.

Regional satellite systems are being planned for several other countries of the world. The experienced Canadian industry team of specialists in domestic satellite communications arising from the implementation of the Canadian system, will be available for technological co-operation with other countries towards realization of their domestic satellite requirements. Low cost and reliable small earth station designs for transmit-receive and receive only will be available for application to other regional systems. In addition, the Canadian 6 TV channel satellite, or subsystems thereof, may be applied to other systems.

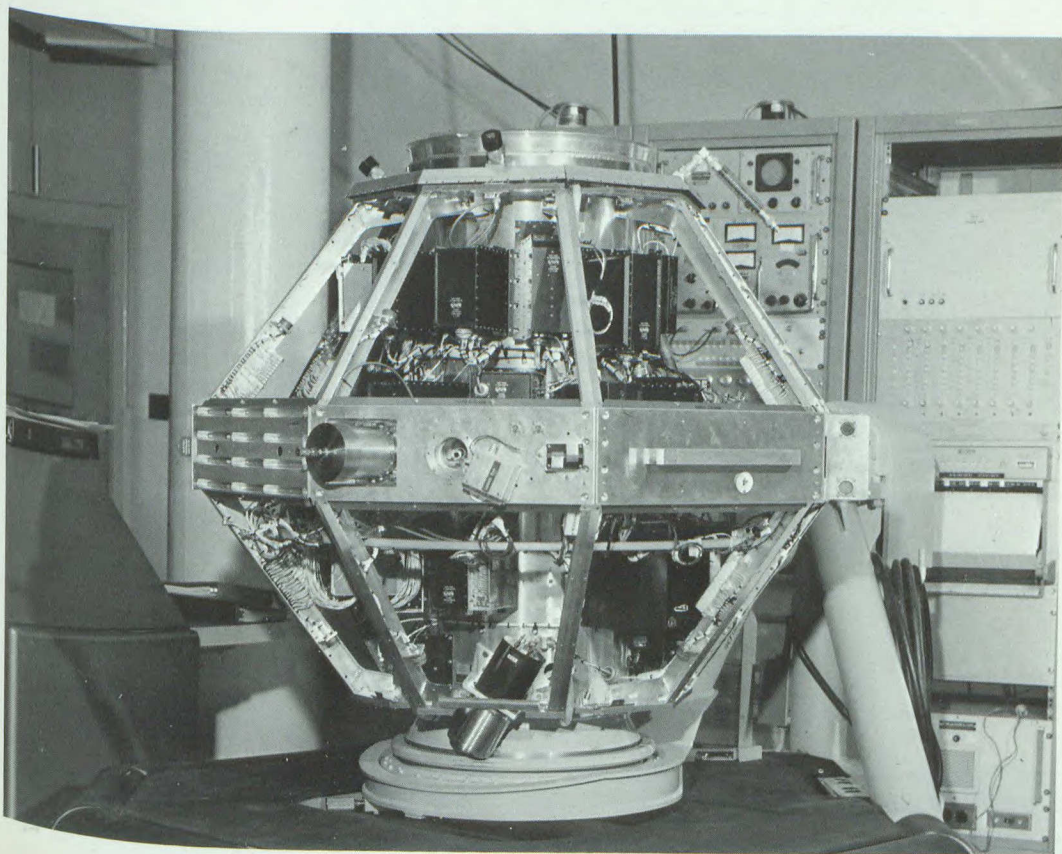
Canada's east coast satellite communications terminal facility at Mill Village, Nova Scotia for trans-Atlantic satellite service. In the background is the radome enclosed antenna of the initial station. The new, 97' (29.6m) fully steerable antenna system in the foreground weighs 275 tons (249 metric) and is mounted on a concrete tower 38' (9.1m) high.







ISIS "A" Scientific Satellite launched in January 1969 from Kennedy West Test Range. Built by RCA Limited, the ISIS "A" is the third in a series of Canadian satellites for ionospheric measurements. This vehicle weighs 500 lbs. (227 kg) and contains 10 scientific experiments.



The "ISIS A" satellite, one of series of Canadian experiments, under construction at RCA.

## SATELLITE COMMUNICATIONS—EARTH STATIONS

In helping to solve Canada's specialized telecommunications problems and those of other countries, the Aerospace Communications Laboratory of Northern Electric Company, Limited, has gained considerable experience in the design and development of advanced types of tracking antennas, satellite earth stations and associated subsystem components. Northern Electric is in a position to offer this complete communications earth station capability, backed up by systems engineering personnel and an elaborate manufacturing network to meet individual customer needs.

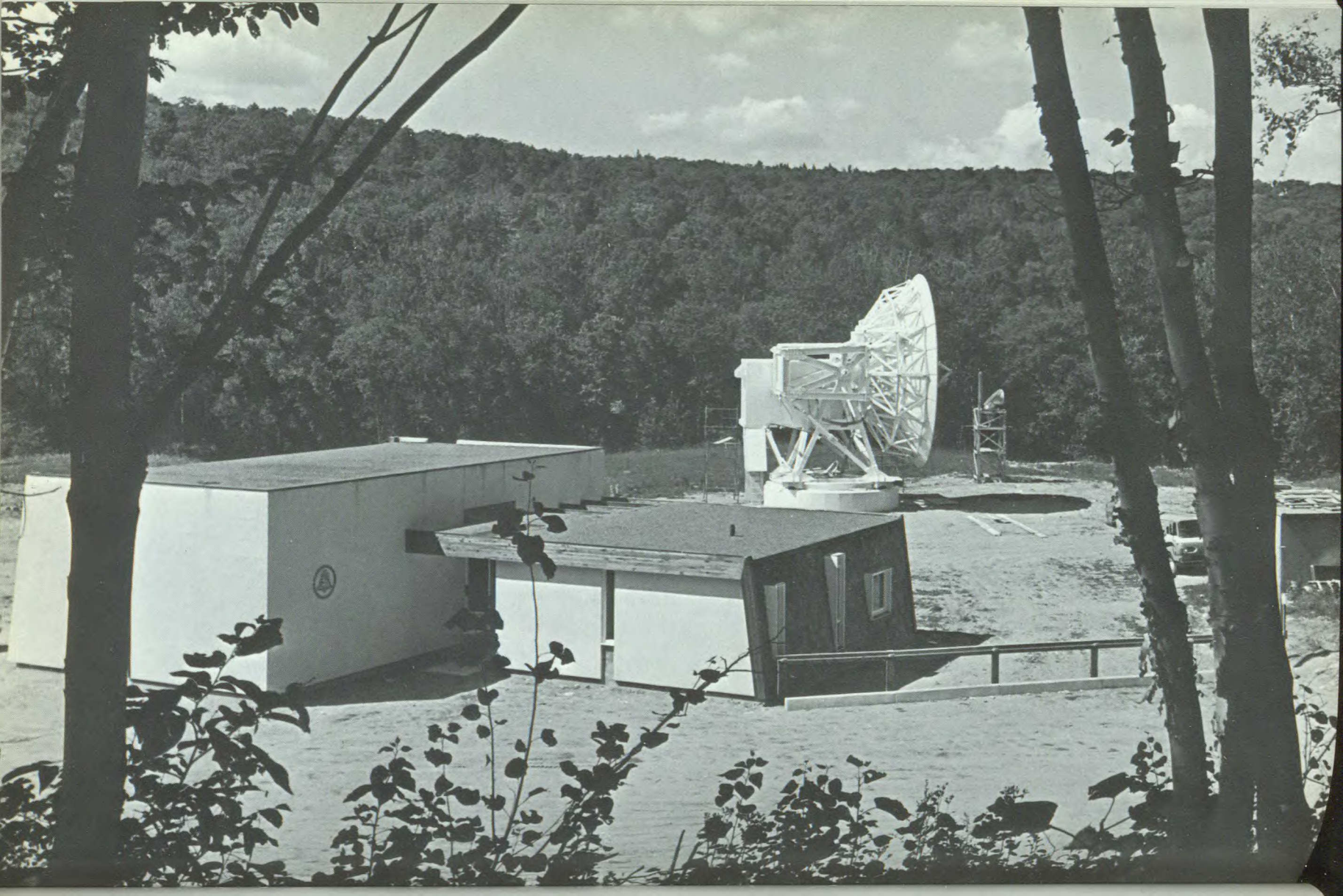
An example of this capability is typified by a 30-foot (9.1 m) precision satellite tracking antenna, completed for the Canadian Defence Research Telecommunications Establishment (DRTE). The antenna design is unique in that it operates without radome protection in the severe Canadian climate. It can move its 52,000 pound (23,600 kg) dish rapidly and accurately enough to track an aircraft flying at 40,000 feet (12,000 m) at the speed of sound, while its electronic capabilities allow transmit and receive operation in the 4, 8, 15 and 30 GHz bands. The equipment hut remains level throughout its elevation range by the action of a horn reflector feed configuration which passes into the equipment hut through the elevation bearing.

Another feature of the antenna structure is the high degree of surface accuracy. The centre 10 feet of the main dish is a one piece machined portion of a paraboloid, which is supported by a 10 foot (3.05 m) diameter cylindrical trunnion. The outer part of the dish is made up of 24 petals of 2 inch (50.8 mm) aluminum honeycomb construction, supported on backup frame sectors. The overall surface accuracy is 0.222 inches r.m.s., including effects of 40 m.p.h. (64.4 km) wind, 1/4 inch (6.4 mm) of ice, thermal expansion, inertia, and static tolerance.

Northern Electric has also designed a range of satellite earth stations for use in domestic communications systems. The first of these stations, an ARCOM-type remote transit-receive earth terminal intended for use in the Canadian North, has recently been completed for Bell Canada, and is presently operating experimentally at Bouchette, Quebec, 70 miles north of Ottawa, through the facilities of a synchronous satellite. The ARCOM (for ARctic COMMunications) earth terminal is designed to operate with several other terminals in a multiple access network providing voice communications between various Arctic terminals and a southern network station. It can also receive up to two colour television channels which are transmitted by the southern terminal.

Since the ARCOM station will operate with a synchronous satellite, this eliminates the need for elaborate tracking mechanisms. A sub-reflector scanning technique steers the antenna beam  $\pm 0.6$  degrees, sufficient to track the daily excursions of the satellite in its synchronous orbit. The design of the station is such that it can be erected in remote locations, operate in high winds, extreme cold and heavy icing conditions, and still maintain a high degree of reliability. An elevation-over-azimuth-mounted 30-foot diameter paraboloid is used as the main dish, operating without radome protection. All communications facilities are housed on the antenna in an equipment hut. One of the most significant features is that the station is designed for unattended operation, with very little maintenance.







## STEM

Spar Aerospace Products Ltd., has designed and manufactured a whole family of devices known as Storable Tubular Extendible Members (STEM). These devices have been used successfully as antennas, actuators and gravity gradient stabilization booms on satellites, spacecraft and also on ground installations. The tubular elements are formed of strip metal, heat-treated into a circular section in such a manner that the edges of the material overlap, thus providing the tubular element with a strength almost equivalent to that of a seamless tube of the same diameter and wall thickness. The elements, when retracted, are stored in a strained, flattened condition by winding them onto a drum. As the circular element is retracted it is smoothly transformed into the flattened condition by passing it through a suitable guidance system.

The wide range of STEM devices produced by Spar vary in length from one to one thousand feet (.3 to 304 m). Beryllium copper, stainless steel and titanium have been used to form the antenna elements. Both motorized and self-extending STEMs have been embodied in over one hundred different designs with varying extension rates and tube sizes. STEMs have been successfully employed in many aerospace, military and ground applications. On spacecraft they include antennas, directional arrays, solar panel actuators, unfurlable boom structures for sensor deployment, de-spin and attitude control, such as for gravity gradient satellite orientation. Over three hundred and fifty STEMs have been successfully launched on key scientific satellites, space probes and manned spacecraft programs.

Spar Aerospace Products is responsible for the sounder antennas of the Canadian series of Alouette and ISIS satellites. ISIS 1, launched in January 1969, deployed four STEM antennas measuring 240 feet and 62 feet, tip to tip, to probe the upper levels of the ionosphere. Similar extendible devices were also employed in all the Gemini spacecraft, Apollo, Mercury, OGO, GEOS, ATS and DODGE, to name but a few. These products have been procured on a world-wide basis including the United States, Europe and Japan.

In response to an acknowledged ground environmental need for masts and antennas with a high degree of extendibility, minimum space storability and light weight, Spar undertook a development program to design a line of deployable devices. These include a lightweight push-pull antenna for a portable manpack transceiver, vehicular mounted masts of 1 $\frac{3}{8}$  and 3 $\frac{1}{8}$  inch diameter STEM element, an ultra-lightweight tripod employing the push-pull technique, an air-droppable antenna device which extends under its own coiled energy upon impact, and a diffusion furnace actuator where withdrawal speeds must be accurately maintained and where installation space is at a premium.

Continual development at Spar has resulted in substantial product improvements. The BI-STEM principle allows a reduction in package size of over 50% and the interlocked BI-STEM provides deployable structures exhibiting an improvement in torsional strength of over 1,000 times that achievable with earlier STEM devices. These latest developments have led to flight-proven hardware with the same excellent reliability demonstrated previously by STEM devices in hundreds of operational flights.



## HIGH "G" ELECTRONICS

Computing Devices of Canada Limited has been engaged in aerophysics research since 1956. One of the major activities is the development of electronic systems for operation in high 'g' environments.

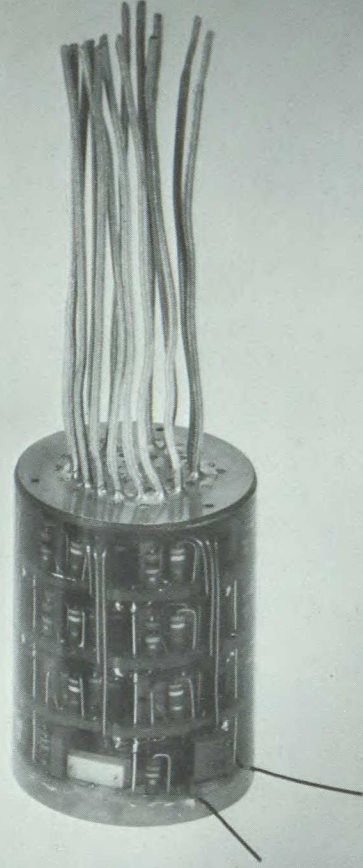
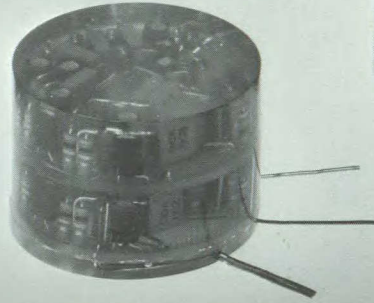
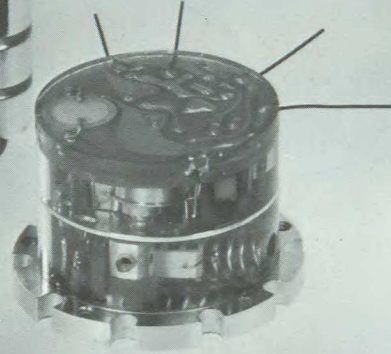
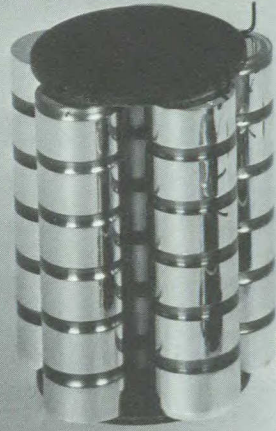
The 'Space Age' has brought increased requirements for the application of high g telemetry systems. Sensors, power supplies, voltage regulators, frequency modulators, sub-carrier oscillators, multi-channel commutators and transmitters have been developed at the company. High g telemetry units are being marketed for applications in data transmission systems for models launched in free-flight ballistic ranges, gun-launched meteorological and upper-atmosphere probes, hard-landing space probes and for fuse environmental testing in projectiles impacting on hard targets.

Solid state telemetry systems with 219-257 MHz FM transmitters operating at power levels have been designed and packaged to operate in a 30,000 g environment. These systems are available now for high g telemetry applications. The transmitters are assembled from selected components which have passed laboratory screening tests, and operational tests.

The frequency stability of the transmitter under long pulse high g loads is maintained with  $\pm 5$  kHz from the carrier frequency. Other specifications are as follows:

Modulation sensitivity	100 kHz/V
Modulation bandwidth	d.c. to 50 kHz
Temperature range	0 to 60°C
Dimensions	1-3/4 dia. x 1-1/18 long (44.5 x 26.8 mm)
Input power	18V and 50 mA max. d.c.
Battery Pack	Zinc — silver button cells rechargeable





## HIGH "G" TECHNOLOGY

The components which are illustrated are a high altitude guidance system for the Martlet IV vehicle and were designed and developed by Aviation Electric Limited. These include sun sensors, infra-red telescopes and potted electronic moulds, the low cost optical instruments and their solid state electronic circuits identify earth-line and sun-line to within a fraction of a degree. Coupled through electronic logic modules to fast-acting nitrogen valves, these instruments are used to process the roll-axis of the spinning vehicle onto its pre-determined course.

Many of these components found their early development phases associated with the HARP programme where the equipment was produced to operate at 10,000 g.

Horizon Sensing is accomplished through use of two infra-red telescopes mounted rigidly to the vehicle which scan from space to earth to space as the vehicle spins. Each of these telescopes has a field of view of approximately  $1^\circ$  and their 'look' angles are symmetrically displaced by  $30^\circ$  either side of a plane perpendicular to the vehicle roll axis and in a plane containing the roll axis. The sensing element is a strengthened bolometer bridge and as the field of view of the telescope crosses the earth a voltage pulse is generated whose time base is indicative of the time required for the telescope to sweep across the surface of the earth.

Sun Sensing is accomplished through use of photovoltaic cells placed in a specially shaped cavity with reflecting and shielding surfaces arranged to give a voltage output pulse once during each vehicle rotation. The amplitude of this pulse is proportional to the angle between the sun line and a reference plane normally taken to be perpendicular to the vehicle roll axis. The auxiliary and rear sun sensors are used to provide all-round coverage so that if the vehicle should tumble or be oriented so that the sun falls outside the field of view of the main sun sensor, attitude information can be obtained and the vehicle can initiate emergency pitch-out or yaw-out manoeuvres.

Spin Rate Sensing is accomplished through use of a mass spring accelerometer which features pneumatic plus frictional damping and a specially constructed potentiometer pick-off. It is mounted with its sensitive axis at right angles to the roll axis of the missile with the seismic mass located at a radius of 6 inches (15.2 cm) from the missile centre line. At this radius the nominal spin speed produces a radical acceleration of 15.3 g. The accelerometer is provided with limit switches to activate the roll jets whenever the spin rate is below 4.4 rps or above 5.6 rps. Between these limits the actual accelerometer resistance is used by the logic circuits to compensate for variation in sampling frequency (spin speed).

The Reaction Control Equipment consists of four valve/nozzle combination units, a fill valve, an explosive cutter valve and a pressure regulator in addition to the nitrogen storage tank and associated plumbing.

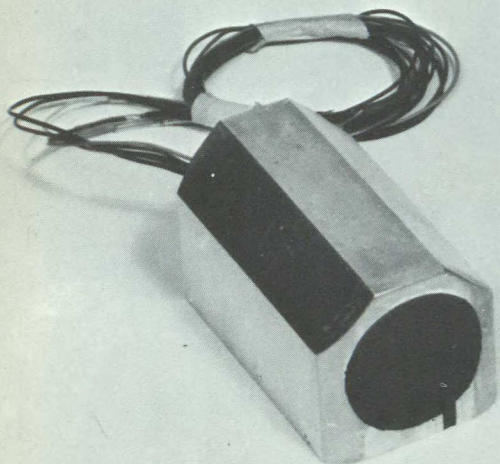
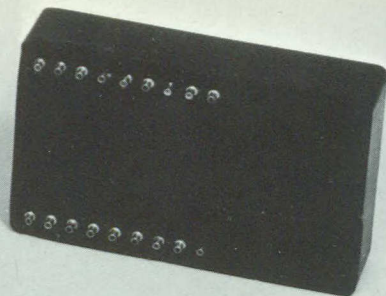
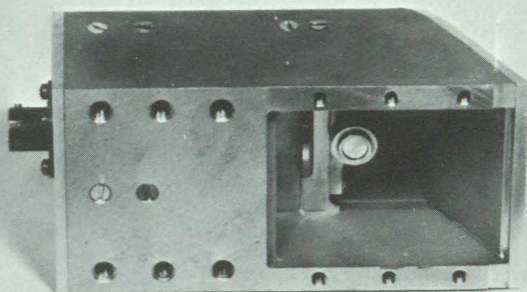
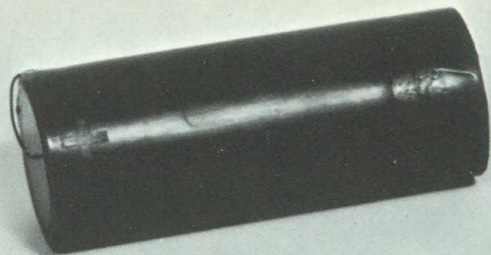
Computation and switching logic is supplied by solid state circuitry which is potted in a mixture of fine sand and epoxy resin.

An intermittent fluid release valve has also been developed in conjunction with HARP. As a part of the program, air currents at altitudes of up to 400,000 feet (121,920 m) are studied by releasing a stream of reactive liquid, in this case TMA — trimethyl aluminum, and observing the distortion of the resultant trail over a period of 15-30 minutes. Both continuous and interrupted trails are used—the interrupted trail having the advantage of vertical as well as horizontal wind shear determination plus an extension of the altitude range over which observations can be made with any one shot.

The valve design incorporates a bistable fluid amplifier which uses the TMA as both a power and a control source. The fluid element alternatively switches the TMA flow into a storage volume and then to atmosphere, while the fluid in the storage volume is being dumped overboard. The valve is completely self-contained, requiring no power supply, exterior control, or even a start signal. It is screwed into the rear of the vehicle and automatically begins releasing an intermittent stream when the high pressure TMA is admitted. A spool valve controlled by a pure fluid element operates to ensure complete cut-off of the TMA flow and also serves to keep the flame from the burning TMA from working back into the valve components during the cut-off portion of the cycle. Because of the requirement for complete cut-off, use of a vented fluid element was not practical.

The complete valve is of cylindrical shape, 4 inches (10.2 cm) in diameter by 3 inches (7.6 cm) long and weighs 3 lb. (1.4 kg).







## BLACK BRANT RESEARCH ROCKETS

The Black Brant research rockets have been especially developed for those wishing to conduct experiments in the upper atmosphere. The Black Brant rocket family comprises four (4) rocket systems capable of lifting scientific packages of 23-227 kg. (50-500 lbs.) to altitudes between 160-998 km. (100-620 miles).

Bristol Aerospace, responsible for the development of these rockets, has participated in their launching from such varied ranges as the Pacific Missile Range, Eglin Air Force Base, the NASA Wallops Island Range, the Churhill Research Range (Canada), ESRANGE (Sweden), and Natal (Brazil).

The principal characteristics of the Black Brant rockets and their associated instruments are as follows.

The Black Brant III, the smallest of the family, 250 mm (10 inches) in diameter by 5.5 meters (18.06 feet) in length. With a nominal thrust of 4900 kg. (10,800 lbs.) it can lift a scientific load of 23 kg. (50 lbs.) to an altitude of 177 km. (110 miles). This single stage solid propellant rocket of simple construction has excellent performance compared with competing two stage rockets used for this altitude range.

The Black Brant IV is a two stage solid propellant rocket capable of lifting a scientific load of 23 kg. (50 lbs.) to an altitude of 998 km. (620 miles). This rocket results from the installation of a Black Brant III motor on a Black Brant V-A rocket. Its length, under these conditions, is 11.3 meters (37 feet). Its characteristics are reliability and simplicity.

The Black Brant V-A is a solid propellant rocket of 431 mm. (17 inches) in diameter and 7.6 meters (25 feet) in length, with a nominal thrust of 11,340 kg. (25,000 lbs.). It can carry a scientific payload of 136 kg. (300 lbs.) to an altitude of 184 km. (115 miles).

The Black Brant V-B is a very advanced rocket, using an advanced solid propellant, 431 mm. (17 inches) in diameter and 7.6 meters (25 feet) in length, capable of carrying a scientific payload of 136 kg. (300 lbs.) to an altitude of 384 km. (240 miles).

The Black Brant vehicles, designed and developed for the use of the scientific community, have numerous applications in Canada, U.S.A. and Europe.

As well as the Black Brant rockets, Bristol produces a complete range of telemetry instruments, and equipment for measuring flight characteristics, in the Winnipeg plant. Bristol is also equipped to manufacture, integrate and test scientific payloads, prepare them for launching and provide data reduction.

Present developments now nearing completion are as follows:

1. The uprating of the Black Brant III to give a performance of 22.8 kg. (50 pounds) payload to an altitude of 192 km. (120 miles).
2. The creation of the Black Brant IV-B, the result of combining the uprated Black Brant III with the V-A. Performance will be a payload of 31.8 kg. (70 pounds) to 1200 km. (750 miles).
3. Engineering the V-B to a four fin configuration called the Black Brant V-C. This will allow the vehicle to be launched from the existing towers at Wallops Island and White Sands Missile Range (New Mexico).



## UHF AUXILIARY TRANSCEIVER—718B-8D

The Collins 718B-8D UHF Auxiliary Transceiver is designed to supplement the primary UHF transceiver in aircraft. It is a completely solid-state unit for operation in the 225-300 MHz band. Most applications are as an emergency radio on 243 MHz. In the event of loss of primary UHF the 718B-8D is activated to assist return to base, rescue and location of downed aircraft. Switching can be provided to automatically turn on the 718B-8D when the pilot ejects.

Up to five channels, crystal-controlled can be implemented in any 2 MHz spectrum within the 225-300 MHz frequency band. At least one other channel besides 243 MHz is usually provided for preflight testing to avoid interference on the emergency channel.

The transceiver is fully compatible with UHF ADF systems such as the ARA-25, 48 and 50. Homing can be accomplished on the 718B-8D while leaving the main UHF clear for other mission requirements.

Transmitter power output is nominally 3 watts. 28 VDC power input only is required. The 914Y-1 control unit is available for use when control over channel selection, squelch and volume are required. A 313H-3A control is also available to provide wider selection of modes i.e. ADF, interphone, rec, T/R and off. Additional audio input lines are provided to the 718B-8D to permit its use as an interphone amplifier in limited installations.

The 718B-8D is hard-mounted on the aircraft frame. Two choices of mounting configurations are available by rotating the radio 90° on the base plate. External connections are made by means of a coaxial connector and two multiple pin connectors on the side of the unit. Transmitter operation is controlled by a P.T.T. switch.

The transmitter and receiver circuits are separate except for antenna and control relays. Operation is possible only 100 milliseconds after power application.

The Collins 718B-8D is in production now for the Canadian and Netherlands F-5A being built in Canada as well as the Belgian Mirage V aircraft. Limited numbers have been used for application in experimental programs.

### 718B-8D SPECIFICATIONS

#### General Characteristics:

Frequency Range:	225-300 MHz
Channels:	5 channels within a 2 MHz segment
Frequency Stability:	±10 kHz
Warm-up Time:	100 milliseconds (instant on)
Antenna Impedance:	50 ohms
Power Consumption:	10 watts receive, 35 watts transmit (maximum with 30% modulation)
Size: 718B-8D:	5-1/8" W, 3-3/16" H, 6-3/4" D (13.11 cm W, 81. cm H, 17.15 cm D)
313H-3A:	5-3/4" W, 2-1/4" H, 2-13/32" D) (14.61 cm, W, 5.72 cm H, 6.1 cm D)
914Y-1:	2-15/32" W, 2-15/32" H, 4-1/16" D (6.3 cm W, 6.3 cm H, 10.3 cm D)
Weight: 718B-8D:	4.1 lbs. (1.85 kg)
313H-3A	1.1 lbs. (0.5 kg)
914Y-1	0.7 lb. (0.32 kg)
Lighting:	Integral, aviation white or red, 5 or 28 v
Environmental Conditions:	MIL-E-5400 Class II
Reliability:	Predicted MTBF 3500 hrs.
Service:	Continuous duty with transmit-receive duty cycle of 5:10 minutes

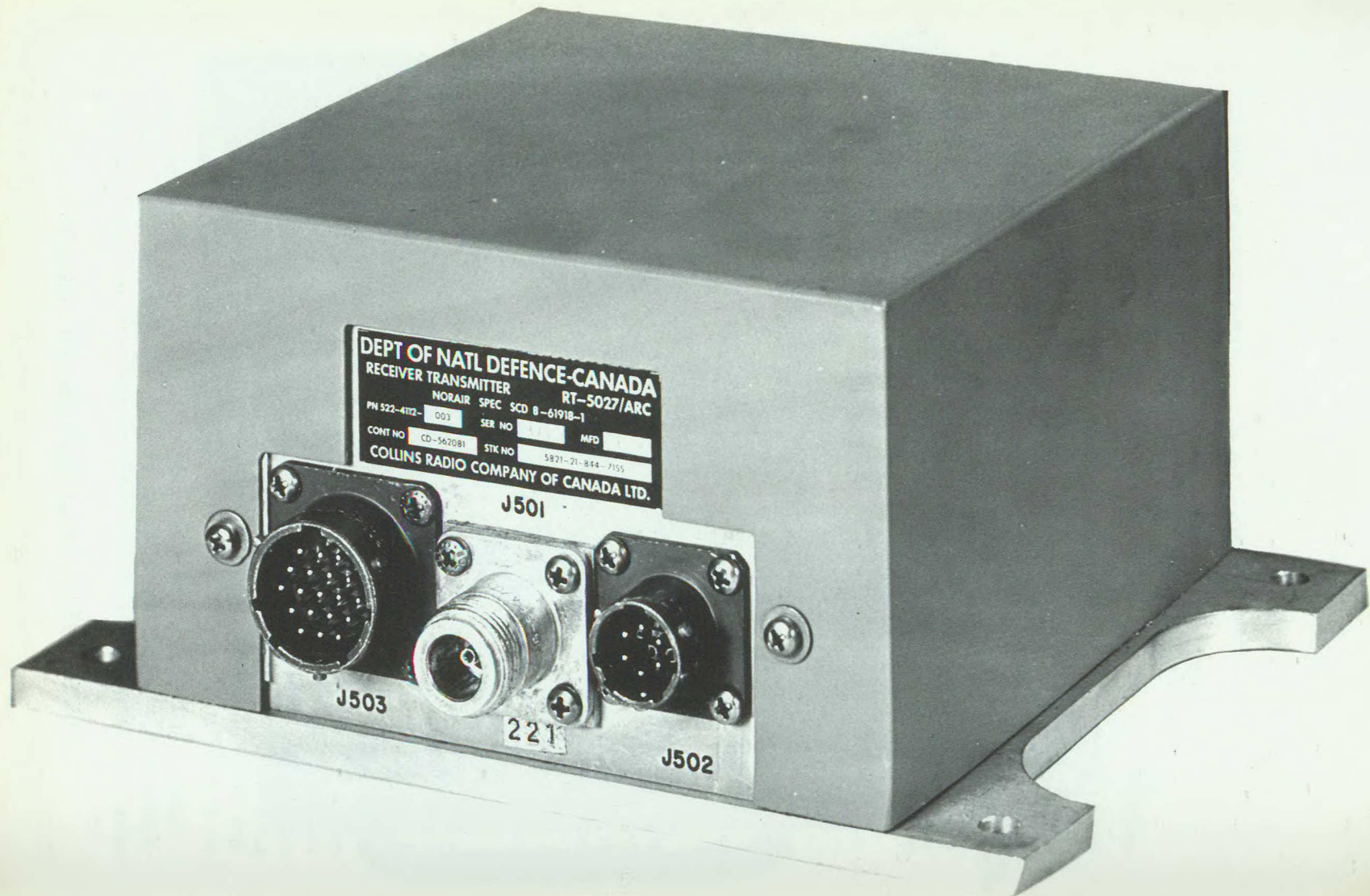
#### Receiver Characteristics:

Sensitivity:	4 uv signal (open circuit modulated 30% at 1,000 Hz shall produce a 10 db S+N/N ratio with at least 50 mw audio power)
Distortion:	Less than 10%
Audio Bandwidth:	300-4,000 Hz, +1 to -3 db of 1,000 Hz reference
Audio Power:	250 mw at 1,000 uv RF modulated 30% with 1,000 Hz
Audio Output Impedance:	9.5, 150 and 600 ohms
AVC Characteristics:	±3 db from 10-100,000 uv (open circuit) of the audio output for a 1,000 uv signal)
Selectivity:	6 db bandwidth, 45 kHz minimum; 60 db bandwidth, 200 kHz maximum

#### Transmitter Characteristics:

RF Power:	3 watts nominal
Modulation Capability:	At least 95% on negative peaks and 60% on positive peaks.
Microphone:	5-8 ohms dynamic; or 150 ohm carbon (no dc bias supplied)





DEPT OF NATL DEFENCE-CANADA  
RECEIVER TRANSMITTER  
NORAIR SPEC SCD RT-5027/ARC  
PN 522-4112- 003 SER NO 8-61918-1  
CONT NO CD-567081 STK NO 5871-21-844-7155  
COLLINS RADIO COMPANY OF CANADA LTD.

J501

J503

221

J502

## RADIO RECEIVER TYPE AN/ARR-501

Completely designed, developed and produced by Topping Electronics Radio Receiver Type AN/ARR-501 is a solid-state, high-performance, four-channel, low-frequency receiver for airborne use utilizing a self-contained power supply.

The receiver is designed for reception of frequency shift (F1) signals in the frequency band of 70 to 150 KHz. The four preset channels are crystal controlled. The receiver accepts from signals from two antenna loops, which are mutually at right angles, and suitably combines the input from these loops to provide an effectively omnidirectional antenna pattern. The outputs of the receiver are a keyed d.c. switch suitable for operation of a teleprinter; and a keyed 1 KHz tone, for operation of special telegraph equipment. A front panel jack provides an audio output of keyed 1 KHz tone for monitoring purposes.

Operation is from nominal 28 vdc aircraft power sources. At temperatures above 10°C (50°F), the current drain is approximately 0.25 amperes. Below 10°C, ovens operate and the drain varies, as high as 1.25 amperes.

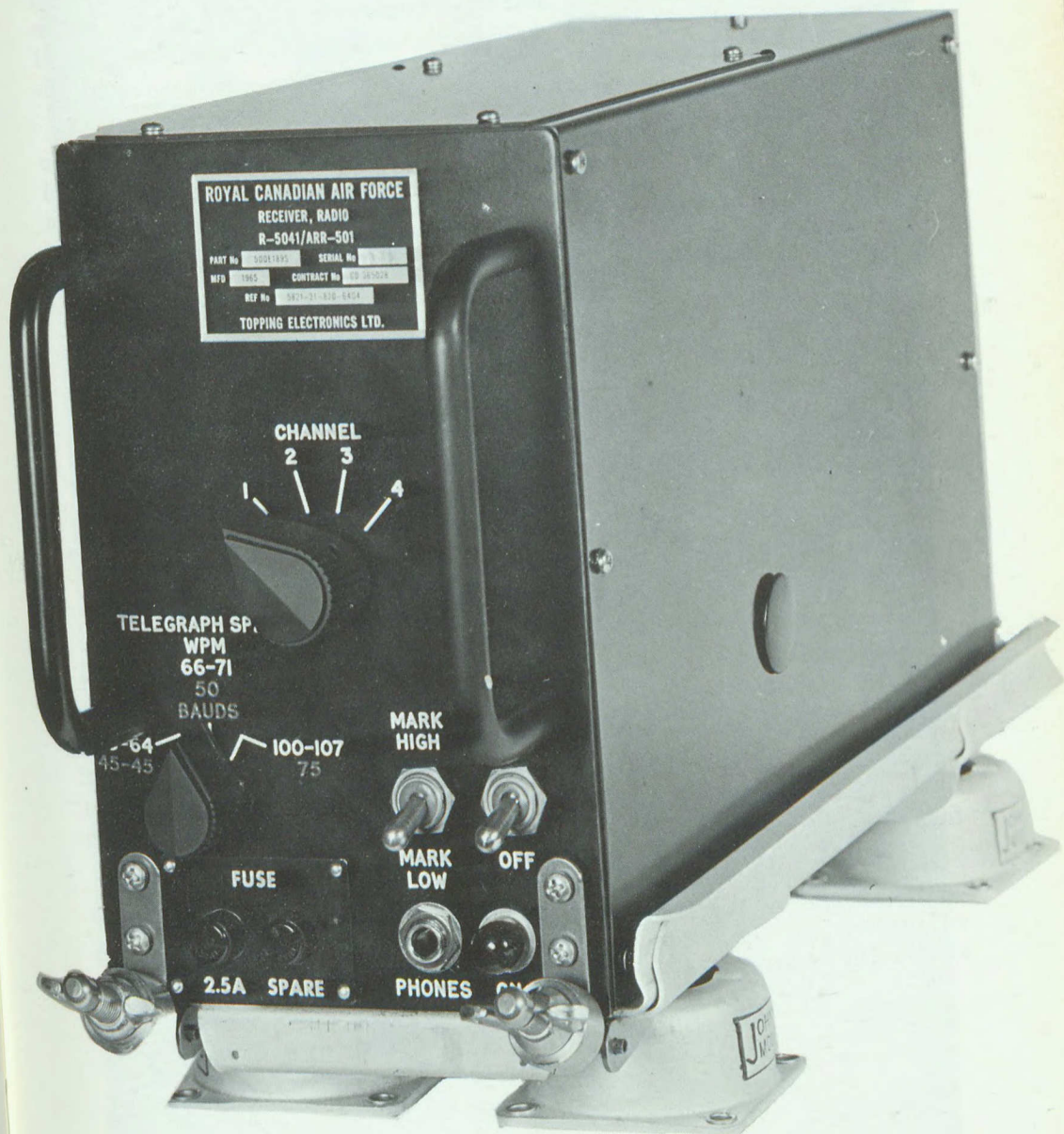
Radio Receiver AN/ARR-501 is an extremely reliable equipment and is presently in service with the Royal Canadian Air Force.

Reliability is achieved, in the main, by employing components that are in accordance with Military Specifications and by applying special reliability tests to all phases of design. Such reliability tests were conducted to Military Specifications and no failures occurred during double-life testing of the equipment (3 failures are permitted by MIL SPECS).

Another outstanding feature of the Receiver is its sensitivity. Good readable copy is obtainable with a signal strength of 2 microvolts per metre using a low-profile, flush-mounted loop antenna. Using a special low-profile, flush-mounted loop antenna, readable copy is obtainable with 0.07 microvolts per metre.

### Characteristics

FREQUENCY RANGE:	70 to 150 Kc/s
NUMBER OF PRESET FREQUENCIES:	Four.
SENSITIVITY:	With an input of 0.5 v. (measured across a 5 ohm resistor connected in series with the antenna and antenna input terminal) the output is actuated with an error rate not greater than $1 \times 10^{-5}$ when connected to the keyed direct current output of the receiver.
SELECTIVITY:	Bandwidth of IF output at 3 db points not less than 120 c/s and at 60 db points not more than 1000 c/s.
OSCILLATOR CONTROL:	Crystal — 100B2132 for 85 Kc/s to 100 Kc/s tolerance $\pm 0.02\%$ . CR37/U for 90 Kc/s to 165 Kc/s tolerance $\pm 0.02\%$ . Temperature maintained at $15 \pm 1^\circ\text{C}$ ( $59 \pm 1.8^\circ\text{F}$ ) by thermostat controlled heater when ambient falls below $15^\circ\text{C}$ ( $59^\circ\text{F}$ ).
OUTPUT:	3 Speeds — 60 to 64, 66 to 75, 100 to 107 words per minute.
OPERATING TEMPERATURE:	$-40^\circ\text{C}$ to $+55^\circ\text{C}$ ( $-40^\circ\text{F}$ to $+131^\circ\text{F}$ ).
ALTITUDE:	Sea Level to 30,000 feet (9,144 m).
OVERLOAD PROTECTION:	Fuse, current rating 2.5A.
INPUT VOLTAGE AND POWER:	28 VDC, 35 Watts Maximum.



ROYAL CANADIAN AIR FORCE  
RECEIVER, RADIO  
R-5041/ARR-501  
PART No. 5001995 SERIAL No. [blank]  
MFD 1945 CONTRACT No. 100 00000  
REF No. 1071-31-830-6404  
TOPPING ELECTRONICS LTD.

CHANNEL

2 3 4

TELEGRAPH SP.  
WPM  
66-71  
50  
BAUDS

64  
45-45

100-107  
75

MARK  
HIGH

MARK  
LOW

OFF

FUSE

2.5A SPARE

PHONES

CN

JON



## HIGH POWER TRANSMITTER AMPLIFIERS

The Northern Electric Company Limited has designed and manufactured several types of high power amplifiers for use in scatter radio systems, single sideband HF communication, radar and satellite ground stations. The illustration on the opposite page shows a 3 kilowatt, 9 GHz liquid-cooled klystron amplifier, designed for use in radio propagation work. Similar transmitters have been designed specifically for application to satellite ground stations.

A typical equipment configuration is to mount the power amplifier in a separate package on the antenna; the power supply and the heat exchanger are designed for remote placement, and a performance monitor panel is provided for inclusion in an operator's control console.

### Typical Characteristics and Performance

Power amplifier tube — klystron, Model VA-925C

Operating frequency — 7.90 to 8.40 GHz (one klystron)

Nominal output power — 10 KW (C.W.)

Drive output for full output — 20 mW

Bandwidth — 30 MHz (at power levels from 100 watts to 10 kW)

Phase linearity —  $\pm 10$  degrees (over  $\pm 10$  MHz band at power levels from 100 watts to 10 kW)

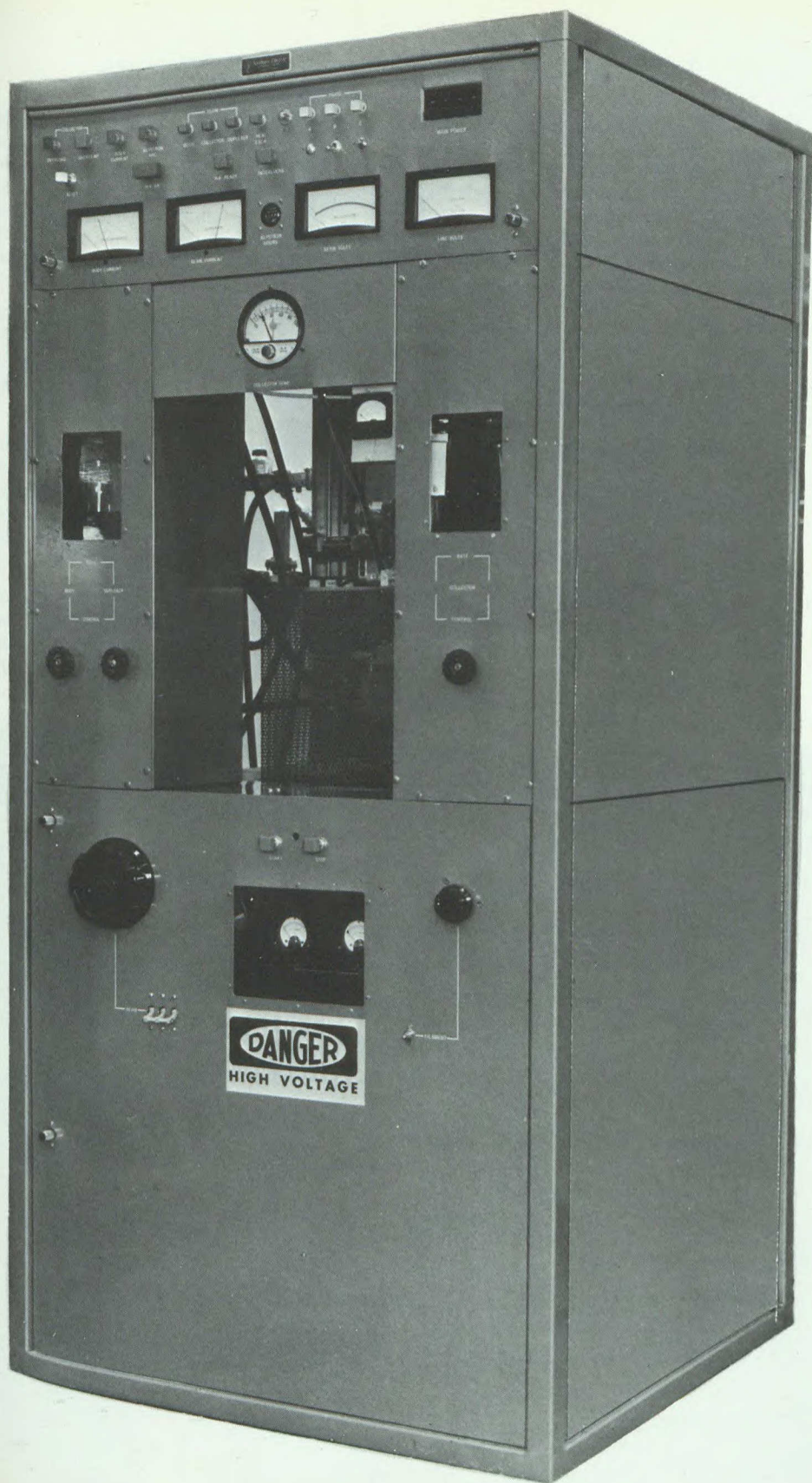
Unwanted phase modulation — less than 1 degree RMS

Harmonic output — more than 60 dB below carrier level

Spurious response — more than 60 dB below carrier level.

The amplifier will work into a load VSWR of 1.2:1 or less. The equipment is fully protected against arcs, overloads, failures or improper turn-on or turn-off sequences. The operator is provided with a monitor panel giving reverse and forward power output levels, equipment status indication, audible fault alarm, output power control and beam power ON-OFF.

Northern Electric's high power transmitter amplifiers are available as single units or in a dual redundant form complete with waveguide change-over switches and dummy loads. In the latter configuration they meet the extremely high availability requirements of military ground station equipment.



## LOW NOISE PARAMETRIC AMPLIFIERS

The Northern Electric Company, Limited has designed and developed a wide range of low noise parametric amplifiers for use in troposcatter communication systems, military search radars and satellite communications systems. Parametric amplifiers are used wherever a small signal is to be amplified with low noise contribution. Eight different types of amplifiers have been manufactured to date, accounting for over 1,000 units in use throughout the world. Northern's amplifiers have been used by USAF, NATO forces, CNT, A.T.&T., Bell Canada and the British Columbia Telephone Company.

Parametric amplifiers designed by Northern Electric are available in a variety of configurations and feature typical noise figures ranging from 1.8 to 2.5 dB depending on the type of amplifier. Operating frequencies of the various models cover the 755 MHz to 4.2 GHz range, with a bandwidth from 10 MHz to 500 MHz.

Mechanically, the amplifiers are completely self-contained and are available in a variety of configurations ranging from standard rack mounted models to pull-out rotatable drawer units. Simple temperature compensating circuits maintain stable amplifier performance over severe environmental conditions. All amplifiers are designed to meet very rigid military specifications and are unconditionally stable with any combination of source and load impedance.

One application is in search radars where the parametric amplifier is used to improve the range performance without increasing the transmitter power. The amplifier (shown in the upper photograph on the opposite page) was designed for the Royal Canadian Navy in conjunction with their ship-based search radar, SPS-12, and is installed as a modification kit.

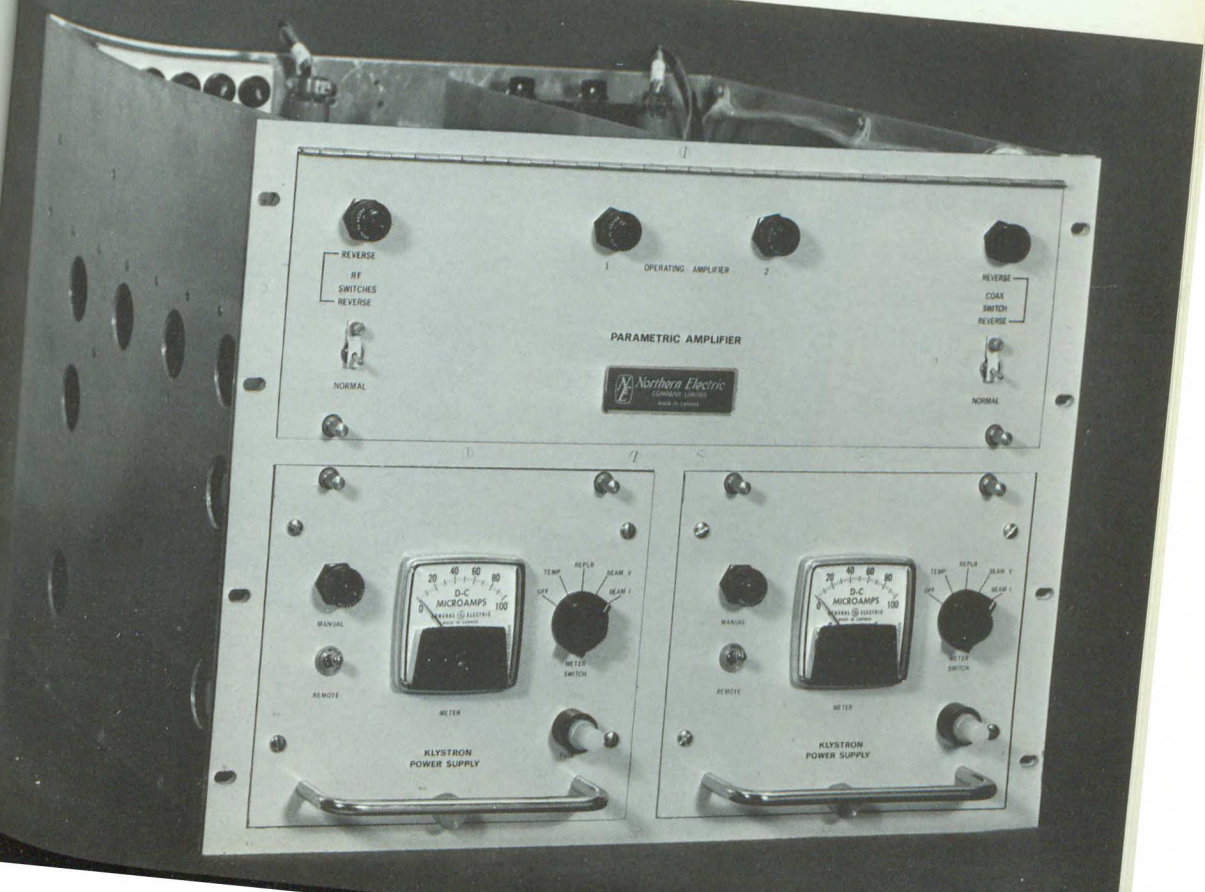
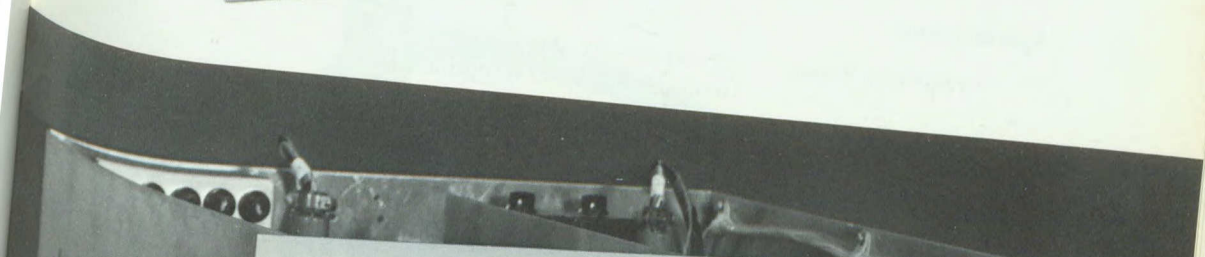
The latest model of parametric amplifier is a wideband version for use in unattended ground terminals of a satellite communications system. Operating at room temperature with high performance, the three-stage amplifier (shown in lower photograph on the opposite page) covers the complete band from 3.7 GHz to 4.2 GHz with 100 percent redundancy provided by automatic switching. No refrigeration is required to obtain a typical noise figure of  $150^{\circ}\text{K}$  (1.8 dB) pumped from a single 26 GHz klystron.

The QAL 1A parametric amplifier is completely self-contained and consists of two identical amplifiers, which include tunnel diode amplifiers, RF switches, automatic switching circuitry, indicators and manual controls. A failure of pump power causes the standby unit to be switched-in automatically. Provision is made for remote switching to override the automatic system. Modular construction has been used throughout. Parametric amplifiers can be supplied without redundant configuration, two-stage tunnel diodes, or automatic switching.

**SPECIFICATIONS:** *Model: R22800. Typical noise figure: 1.8 dB. Gain:  $18\text{ dB} \pm 2\text{ dB}$ . Bandwidth: 10 MHz (3 dB). Operating Frequency: 1.250 to 1.350 KMHZ. Input-Output VSWR: Linearity:  $-35\text{ dBm}$ . Klystron Frequency: 10.6 KMHZ. Power Supply: Regulated Solid State Silicon. Primary Power:  $115\text{V} \pm 10\%$ . Operating Environmental Temperature:  $0^{\circ}$  to  $50^{\circ}\text{C}$ . Military Specification: MIL-E-16400. Weight: 50 lbs. (22.7 kg).*

*Model: QAL 1A. Typical noise figure: 1.8 dB. Overall Gain:  $51\text{ dB} \pm 2\text{ dB}$ . Parametric amplifier gain:  $28\text{ dB} \pm 2\text{ dB}$ . Tunnel diode amplifier gain:  $23\text{ dB} \pm 1\text{ dB}$ . Bandwidth: 500 MHz (2 dB). Operating Frequency: 3.7 GHz to 4.2 GHz. Input-Output VSWR: 1.25:1. Klystron Frequency: 26 GHz. Power Supply: 117V, single phase, 50 or 60 Hz. Operating Environmental Temperature:  $32^{\circ}$  to  $104^{\circ}\text{F}$  ( $0^{\circ}\text{C}$  to  $40^{\circ}\text{C}$ ). Weight: 70 lbs. (31.7 kg).*





## UHF TRANSCEIVER AN/PRC-66

The AN/PRC-66 is a small portable transceiver that provides AM communication on any one of 3500 channels in the frequency range from 225.00 to 399.95 MHz. It offers considerable improvement in weight, size, performance and reliability over any equipment of its type in use today. It can be handheld during use, or operated as a packset, vehicular or airborne unit.

Special design emphasis has been placed on mechanical simplicity, electrical shielding and proper heat transfer.

The radio is modularized for easy maintenance. Each of the functional modules plug into a main chassis, which also forms part of the external case.

Low power consumption and high efficiency have resulted in maximum battery life. Either rechargeable nickel cadmium or throw-away alkaline cell batteries are available.

Accessories include the flexible fixed length antenna which can be tilted in any direction to provide vertical polarization, H250 handset, back mounted carrying harness and transit case. Battery charger and module fixtures are also available for easy maintenance.

### Specifications

Frequency Range	225.00-399.95 MHz Guard channel 243.0 (optional)
Channels	3500 spaced 50 kHz
Tx Power Output	2 watts average
Transmit Fidelity	Narrow band $\pm 6$ db, 300 to 2700 Hz
Rx Sensitivity	Wideband $\pm 3$ db, 300 to 23000 Hz
Rx Selectivity	3 uv for S+N/N of 10 db 3 db, 60 kHz minimum 60 db 120 kHz maximum
Audio Output	10 milliwatts, 500 ohm load
Audio Fidelity	Narrow band $\pm 6$ db, 300 to 2700 Hz Wideband $\pm 3$ db, 300 to 23000 Hz
Squelch	Carrier squelch adjustable
Sidetone	Detected RF 10 milliwatts
Size	9" $\times$ 5" excluding knobs $\times$ 1 $\frac{5}{8}$ " (22.86 $\times$ 12.7 $\times$ 4.13 cm)
Weight	5.5 lbs. (2.49 kg) excluding battery

The AN/PRC-66 has been developed under Rome Air Development Centre USAF by Collins Radio Company of Canada Limited and is now in production for Military requirements.





## UHF TRANSCEIVER AN/PRC-75

The AN/PRC-75 is a hand-held UHF transceiver that provides AM communications on any one of 3500 channels in the 225.00 to 399.95 MHz frequency range. Weighing only 3.9 pounds (excluding battery) this all solid-state radio produces an average output of one watt. All 3500 channels are readily available through the incorporation of a frequency synthesizer referenced to a single crystal standard oscillator.

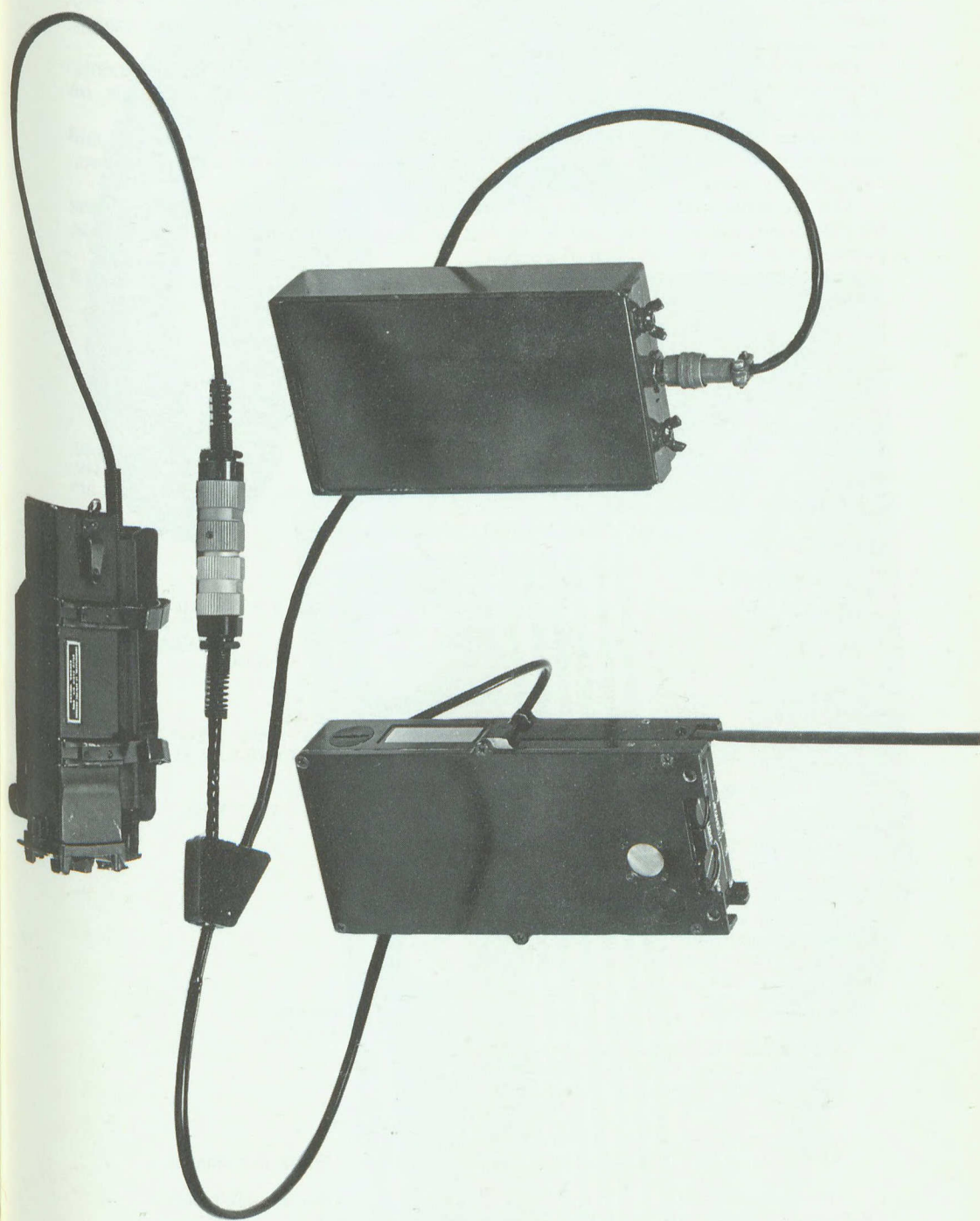
Comprising the AN/PRC-75 are the UHF receiver-transmitter, a battery power supply, helmet speaker, lanyard, carrying harness, accessory cables and transit case. The antenna can be removed and an adapter connected for a coaxial cable to a separate antenna or external power amplifier.

The R/T unit incorporates a push-to-talk button and transducer microphone as well as connector for battery and wideband operation.

### Specifications

Frequency Range	225.0-399.95 MHz
Channels	3500 at 50 kHz spacing
Tx Power Output	1 watt average
Rx Sensitivity	2.6 uvolts for 10 db S/N
Audio Output	8 milliwatts into 600 ohms
Audio Response	Voice $\pm 2/-6$ db 300 to 2700 Hz Wideband $\pm 3$ db 300 to 2500 Hz
Size	4½" wide $\times$ 8" high $\times$ 1½" (10.48 $\times$ 20.32 $\times$ 3.81 cm)
Weight	3.9 lb. (1.77 kg)
Power Input	24 VDC Battery 5.9 watts receive 17.6 watts transmit

The AN/PRC-75 was developed by Collins Radio Company of Canada Limited under a Rome Air Development Centre contract and is now in production for the U.S.M.C.



## FM 2-WAY MOBILE RADIOS

Designed to operate on various frequency ranges, the Canadian Marconi Company models DT77, DT82, DT83, DT84 and DT87 are compact, lightweight FM 2-way radios for mobile or control station use. High efficiency circuitry permits sealed-case packaging without external heat sinks.

Particular attention has been paid to meet EIA, DOT and FCC requirements. Simplified modulator construction, placing receiver and transmitter circuits on individual printed circuit boards, permits simplified maintenance.

In some units, the "Minit Miser", a combination of stabilized crystal and oscillator module, provides precision transmitter frequency control without heaters, extra battery drain or warm-up delay.

Also in some units, "Amp Miser" circuitry permits monitoring with the least battery drain, allowing the unit to be left on indefinitely, while full transmission power is achieved in a fraction of a second.

Latest state-of-the-art design concepts, including integrated circuits, provides a reliability of operation previously unattainable.

### General Specifications

	DT77	DT82	DT83	DT84	DT87
USE:	Mobile	Mobile	Mobile/ Control	Mobile	Mobile
FREQUENCY RANGE:	138-174 MHz	406-420 MHz 450-470 MHz	406-420 MHz 450-470 MHz	406-420 MHz 450-470 MHz	25-35 MHz 35-50 MHz
RF CHANNELS:	1 to 6	1 to 8	1 or 2	1 to 8	1 to 8
POWER OUTPUT:	25W	10W	10W	70W	25-45 MHz 50W 40-50 MHz 45W

The Technical Specifications that are noted below are applicable to the DT77 and are representative of the other models.

### DT77 TECHNICAL SPECIFICATIONS

#### General

Frequency Range:	138-174 MHz.
R.F. Channels:	1 to 6, in any 1 MHz.
Battery Drain:	Receive: 13.8 VDC Amp Miser On .12A Amp Miser Off 1.76A Transmit: 13.6 VDC 6.5A
Dimensions:	L W H Front Mount: 11 $\frac{3}{8}$ " x 9 $\frac{1}{8}$ " x 4" (29 x 23 x 10.2 cm) Trunk-Mount Control Unit: 6 $\frac{5}{8}$ " x 6 $\frac{1}{2}$ " x 2 $\frac{1}{2}$ " (16.8 x 16.5 x 6.35 cm)
Weight:	10 lbs. (4.5 Kg.)
DOT Type Approval No.:	100264196 — 150.8 — 174 MHz. Acceptable for licensing: 138.0 — 150.8 MHz.

#### Transmitter

Power Output:	25 Watts.
Modulation:	± 5 KHz.
Distortion:	Less than 4%.*
Frequency Stability:	(-30° to +60°C) ± 0.001%
Frequency Multiplication:	24 times.
Spurious Emissions:	-75 db.
Hum & Noise Level:	-50 db.*

#### Receiver

Sensitivity:	(12 db SINAD) 0.30 $\mu$ V.
EIA Selectivity:	(± 30 KHz) -85 db (12 db SINAD) -120 db (20 db quieting)
EIA Modulation Acceptance:	16 KHz.
Spurious & Image Rejection:	-90 db.
EIA Intermodulation:	(SINAD) -60 db.
Frequency Stability:	(Measured with AFC Applied) (-30° to +60°C) ± 0.0005%.
Squelch Sensitivity:	(For 80% output) 0.25 $\mu$ V.
AF Output:	(less than 10% distortion) 5 Watts, front-mount -60 db.*
Hum & Noise Level:	4 Watts, trunk-mount

\*Reference: 1000 Hz tone, at 3.5 KHz deviation or 4 Watts output.





## PORTABLE HF-SSB TRANSCEIVER

Designed by Canadian Marconi Co. as a rugged portable for remote-location field communications, the light-weight, compactness, and minimal power requirements of the CP24 make it ideal for a wide range of applications.

The special mobile mounting bracket provides antenna and power supply connections for instant conversion from portable to mobile operation.

Two whip antennas are available for portable use. A collapsible sectional model, held rigid in use by a tension cable core, occupies a minimum of space when broken down. The cable core prevents sections from being lost. An ultra-flexible model may be coiled into a special tubular container that attaches to the carrying bag.

For semi-permanent use — either a centre-fed dipole or long-wire antenna may be used for additional operating range. For mobile use, an extra-rugged, 8 foot, stainless-steel whip is available.

When the portable whips or long-wire antennas are used, the unique CP24 Adjustable Antenna Tuner provides simplified transmitter tune up to give an optimum match between the transceiver and its antenna for superior communications efficiency.

The CP24 may be used in private, commercial or public communications, systems, and is compatible with other SSB equipment. A full range of options and accessories gives the CP24 a flexibility of operation previously unattainable in SSB portable transceiver.

### GENERAL SPECIFICATIONS

FREQUENCY RANGE:	1.6 to 15 MHz
CHANNELS:	2
POWER OUTPUT:	10 Watts P.E.P.
POWER SOURCES:	Zinc-Carbon, Alkaline or Nicad, "D" size (total 9) or from vehicle battery or from 115 VHC with accessory.
DIMENSIONS:	Height 4", Width 9", Depth 12". (10.2 cm, 22.9 cm, 30.5 cm)
WEIGHT:	10 lbs (4.5 kg) including battery.





## SINGLE SIDEBAND COMMUNICATIONS RECEIVERS

The Canadian Marconi Company's XH13A receiver system consists of four independent receivers plus a power unit and audio amplifier with built-in monitor speaker. Modulator construction plus a range of models for AM, SSB or switched AM/SSB reception provide extreme flexibility of system design.

All solid-state design allows the installation of the four receivers and its associated power supply and monitor speaker in a panel area of only  $8\frac{3}{4}$ " (22.2 cm) on a 19" (48.2 cm) rack. Transistorization also permits extremely low power consumption — 7 watts per receiver, average.

Five tuned circuits, ceramic IF filters and an electromechanical SSB filter provide outstanding selectivity. Optional meter reads signal or AF line levels. AF is available on phone jack and balanced line connection. IF-derived AGC maintains audio level over a signal range of 120 db.

Solid state power supplies, with complete voltage regulation, are available for 115 or 230 volts AC and 12 volts DC.

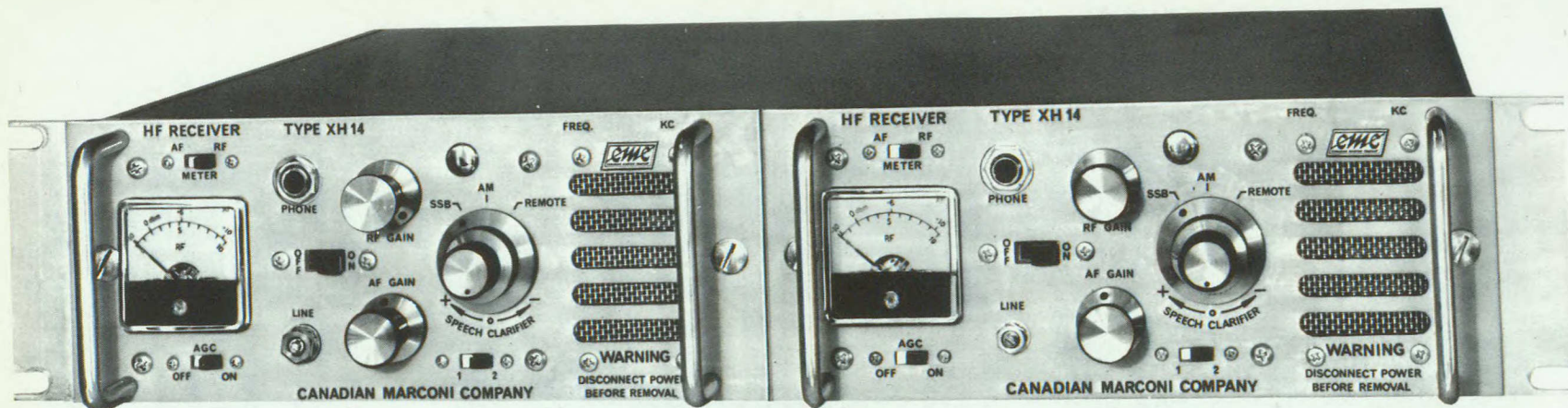
### Specifications:

Frequency range; 1.6 to 24 mc. RF channels; 1 per receiver module. Sensitivity: SSB — 1 microvolt for 12 db S+N/N. AM — 1 microvolt for 6 db S+N/N. Selectivity: SSM — 2.1 kc at less than 6 db down, 6 kc at more than 60 db down. AM — 6 kc at less than 6 db down, 30 kc at more than 60 db down.

The above electrical specifications are also available in Canadian Marconi Company's XH14 Receiver. Although identical in electrical design concept and operational facilities, the XH14 is presented as a completely self contained receiver module. As opposed to the XH13A system which operates up to four receiver modules from a common power supply/audio monitor unit, each XH14 module has its own power supply and audio facilities.

Two XH14 receivers may be mounted side by side on a standard 19" rack in  $3\frac{1}{2}$ " of panel space ( $48.2 \times 8.9$  cm).

Both XH13A and XH14 receivers are provided with ample remote control facilities.



## HF SINGLE SIDEBAND TRANSCEIVER AND TRANSMITTER

The Canadian Marconi Company's CH25 transceiver is the first single sideband unit readily usable for mobile installation. Transistorized design has permitted a 100 watt PEP unit weighing less than 22 lbs (10 kg) in one compact package suitable for underdash mounting.

Six simplified controls perform all operating functions. The transmitter is monitored by automatic load control and the receiver by automatic gain control. These features, plus the outstanding frequency stability, ensure easy operation by non-technical personnel.

The compatible AM feature of the CH25 permits it to be used in conjunction with regular AM systems. A Constant Percentage clarifier control allows fine tuning of the receiver for best signal reception.

Designed to handle 1 to 6 channels, the use of plug-in channel elements permits rapid on-location changing of channel frequencies. An internal 1000 cps signal may be employed for testing or signalling.

The CH25 may operate on completely independent transmit and receive frequencies with a choice of upper or lower sideband. This unit is also adaptable to frequency-shift or CW keying systems.

### **Specifications:**

Frequency range: 1.6 to 15 mc. Channels: 1 to 6. Sensitivity: AM (6 db SINAD) 0.7 microvolts. SSB (12 db SINAD) 0.5 microvolts. Power output: 100 watts PEP (SSB or compatible AM). Power requirements: 115 or 230 VAC, 50-60 cycles — 15 to 180 VA. 12, 24 or 32 VDC, 0.15 to 16 A. Weight: 22 lbs. (10 kg). Dimensions: 13 $\frac{3}{4}$ " x 10 $\frac{3}{4}$ " x 7" (35 x 27.3 x 17.8 cm).

For those cases which require the use of an independent HF/SSB Transmitter, as opposed to a Transmitter/Receiver Unit, Canadian Marconi Company can supply the PH17 100W PEP Single Sideband Transmitter equipment.

This unit is identical in specification and physical dimensions to the CH25 but provides only the transmitting facility.

Such an arrangement would prove useful in the case of a full duplex installation where transmitter and receiver should operate simultaneously and independently.

A 12 channel version, the CH26, is available with identical electrical specifications and performance. The unit is wider to accommodate the additional channels.





## SOLID STATE SSB PORTABLE TRANSCEIVER

The Canadian Marconi Company's CP24 SSM transceiver is completely solid-state consequently current drain is low.

Ordinary flashlight batteries, universally available, can be used to power the unit. Alternatively, any standard D cell zinc carbon alkaline or nicad can be used. A charging unit which will permit 50 hours between charges on NICAD cells is available for use with an AC or DC source.

A mobile shockmount and several antenna and microphone variations are offered.

The abnormally low weight (10 lbs including batteries) is achieved by a weight saving aluminum casting.

The CP24 was designed for use in environments ranging from the arctic to the tropics. The sealed interior which completely excludes moisture and dust resists fungus and provides flotation should the unit inadvertently be immersed. A microphone is not a necessity since the built-in loudspeaker can also perform this function.

### SPECIFICATIONS

FREQUENCY RANGE:	1.6 to 15 MHz
CHANNELS:	1 to 2
MODES:	10 watts P.E.P. USB (standard) LSB USB/LSB CW
TEMPERATURE RANGE:	Operational; $-40^{\circ}\text{C}$ to $+60^{\circ}\text{C}$ ( $-40^{\circ}\text{F}$ to $140^{\circ}\text{F}$ )
ANTENNA OPTIONS:	Dipole whip or long wire
BATTERIES:	9 "D" (or U 11) cells
WEIGHT:	10 lbs. (4.5 Kgs)
DIMENSIONS:	Height 4", Width 9", Depth 12" (approximately 10 x 23 x 31 cm.)
ACCESSORIES:	Canvas carrying bag and strap Vehicular mounting









## COAXIAL CABLE TRANSMISSION SYSTEM—46C

The type 46C coaxial cable transmission system, designed and manufactured by Lenkurt Electric Co. of Canada, Ltd., provides a secure transmission medium for 300 or 600 high grade multiplex communications channels utilising a wide variety of standard, twin-tube coaxial cables with two loaded interstitial pairs. The system has been designed expressly to meet the seasonal extremes of Canadian climate. All active circuits can be protected by duplicate plug-in units and dual, protected amplifiers reduce the possibility of failure to a very low order even when hostile surface conditions make it difficult or hazardous to service repeater installations.

For rapid installation of point to point communications systems the coaxial cable can be plowed directly into place at speeds of approximately four miles per hour where soil conditions permit. Installations may be hardened by burying cable and repeaters to depths dictated by the degree of protection required. The lack of conspicuous surface structures makes coaxial cable transmission facilities less liable to attack and acts of sabotage.

The interface with standard multiplex equipment is the same as a microwave system making it simple and economical to engineer and procure communications facilities where both methods of transmission are employed.

The 46C coaxial transmission system permits circuit lengths of up to 20 repeater sections (typically 5 to 120 miles — 8 to 193 km) with a loaded noise performance not exceeding 3 pw/km. The completely solid-state system utilises plug-in mechanics for rapid replacement of defective units. Where applicable duplicate plug-in units are used in both the terminal and dependent repeater units, thereby minimizing spare parts requirements.

Up to ten dependent repeaters may be powered by 400 Hz, 440 V ac power feed (generated within the equipment) from a terminal or intermediate location via the centre conductors of the coaxial tubes. The dependent repeaters are mounted in pressurized, water tight cabinets suitable for use in underground man-holes. Repeaters may be regulated to compensate for cable losses due to temperature, the regulation being controlled by a pilot above the baseband which is attenuated at the system output prior to transmission into multiplex or radio circuits.

The 46C system includes its own supervisory and service channel circuits using two loaded intersitital pairs. The system is continuously supervised and an alarm is initiated, sensed, confirmed and reported in less than five seconds. Up to 30 separate alarm conditions are scanned consecutively per tone and fault conditions present for two scans are reported. Additional tones increase the alarm reporting capacity by multiples of 30. Pulsed tones above the service channel frequency are used to signal the status of terminal and dependent repeater installations.

Terminal equipment for the 46C system is mounted on standard 19 inch relay racks.

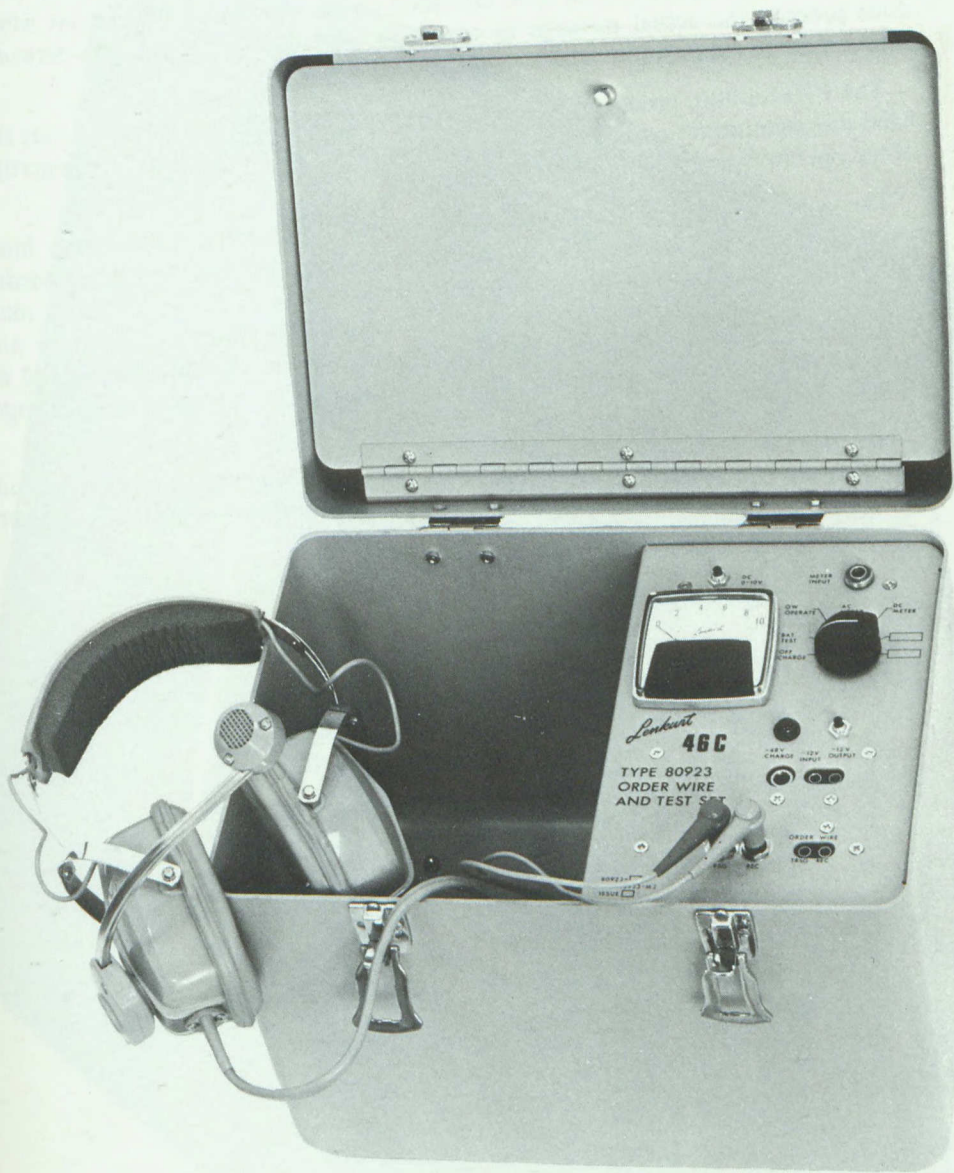
The 46C coaxial cable transmission system is offered in three basic capacity/bandwidth arrangements:—

300 channel capacity, 60 to 1300 kHz for use with 0.174, 0.246 and 0.375 inch coaxial tubes. Regulating pilot frequency, 1.34 MHz.

600 channel capacity, 60 to 2540 kHz for use with CA-N-63 cable. Regulating pilot frequency, 2.6 MHz.

600 channel capacity, 60 to 3084 kHz for use with 0.174, 0.246 and 0.375 inch coaxial tubes. Regulating pilot frequency, 3.17 MHz.

A portable service channel and test set provides communication from a dependent repeater to terminals or other dependent repeaters. The unit includes a telephone set, power pack and meter for pilot level, ac and dc measurements. It is provided in a rugged, steel sling pack.



## MESSAGE-FORMAT GENERATING EQUIPMENT

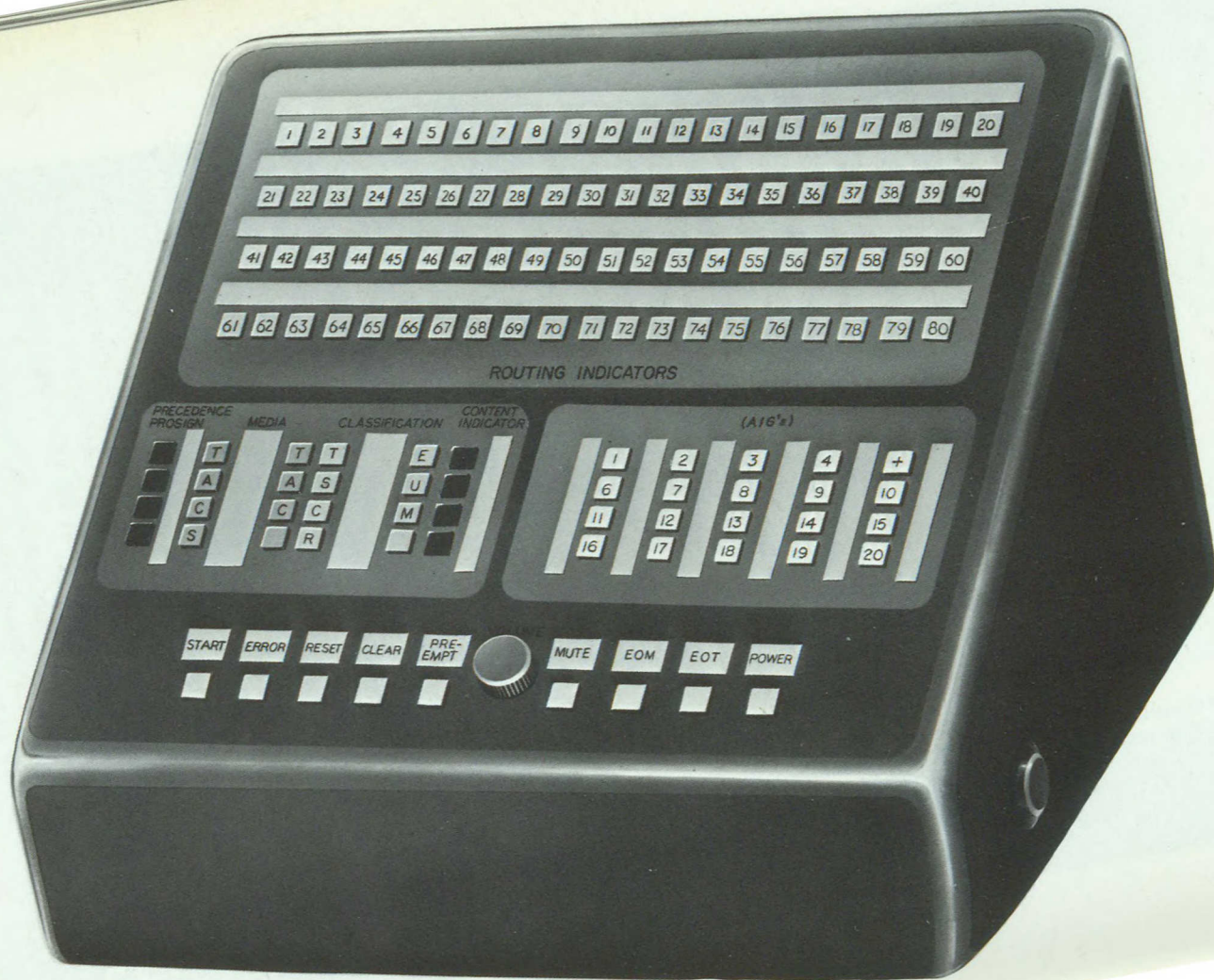
Modern-day automatic and semi-automatic communications systems have greatly increased both message capacity and transmission rate. The complexity of communications networks have, in turn, increased the complexity of instructions which must precede the actual message to ensure proper routing through the network, from sender to recipient.

The PHI-tel 300, produced by Computing Devices of Canada Limited, puts the fixed message format required by the communication system right at the fingertips of the operator, resulting in error free addressing.

The equipment stores Routing Indicators (RI), combinations of routing indicators (Addressee Indicator Groups, AIG), Precedence Prosign, Language Media and Format, Classifications and Content Indicator Codes and any other that may be required. When the appropriate pushbuttons on the Operator's Console are selected, the equipment transfers to the teletypewriter an error-free data signal in the correct format. The equipment automatically inserts time, date and message number into the format.

The PHI-tel 300 is programmed for a military network using Baudot codes and Janap format, however, it can be programmed to any format or procedure either military or commercial.





## TELEPATH COMMUNICATIONS AND DATA CONTROL EQUIPMENT

TELEPATH is the trade name for a line of solid state communications and data handling equipment designed and produced by CAE Industries Ltd. for the telegraph and digital communications industry.

The product line covers the range of selectors, for controlling terminal on-line equipment such as teleprinters, card punches, tape readers, etc. In addition, a line of code translation equipment is available, enabling any of the normal communication and data codes to be translated to common telegraph language forms.

TELEPATH selector units provide facilities for the control and coupling of teleprinter equipment to tape, card-punch, and "on-line" computer processing systems. Selectors are also used as part of message switching networks to supply station control and supervision from a central processor.

All equipment is designed to provide an Operating Time Between Failure of better than two years.

Security and parity checking facilities are available if required.

The TELEPATH line of products has been sold for application in military and commercial flight control, and reservations systems using computer processing equipment, with units in service throughout the world with a number of major airlines and other common carriers, such as the railroads, and with telephone and telecommunications companies.

A new product recently developed by the Telepath group in CAE is the "Keenscope" weather satellite photo receiver which receives FM signals from a variety of orbiting and stationary satellites, automatically switching as the satellites come into view and disappear over the earth's horizon, and prints out the photos. The Keenscope can also receive photo signals from reconnaissance aircraft, permitting instant assessment of photographs transmitted from the aircraft back to field stations. It has application in transmitting and receiving photographs over standard landlines to provide a news wirephoto service or to transmit fingerprints and other photographic information between security forces.

REQUEST



ALARM

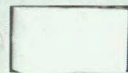


POWER ON



.50 AMP  
115 VAC

ON



OFF

**cae** 



## MICRO-ELECTRONIC SITUATION DISPLAY

A key element in its advanced Tactical Data Systems, Litton Systems (Canada) Limited manufacture micro-electronic Situation Display Consoles (SDC). These Displays are designed for use in any tactical role where an efficient man-machine interface is necessary to release the operators from routine tasks and allow them to concentrate on decision-making functions.

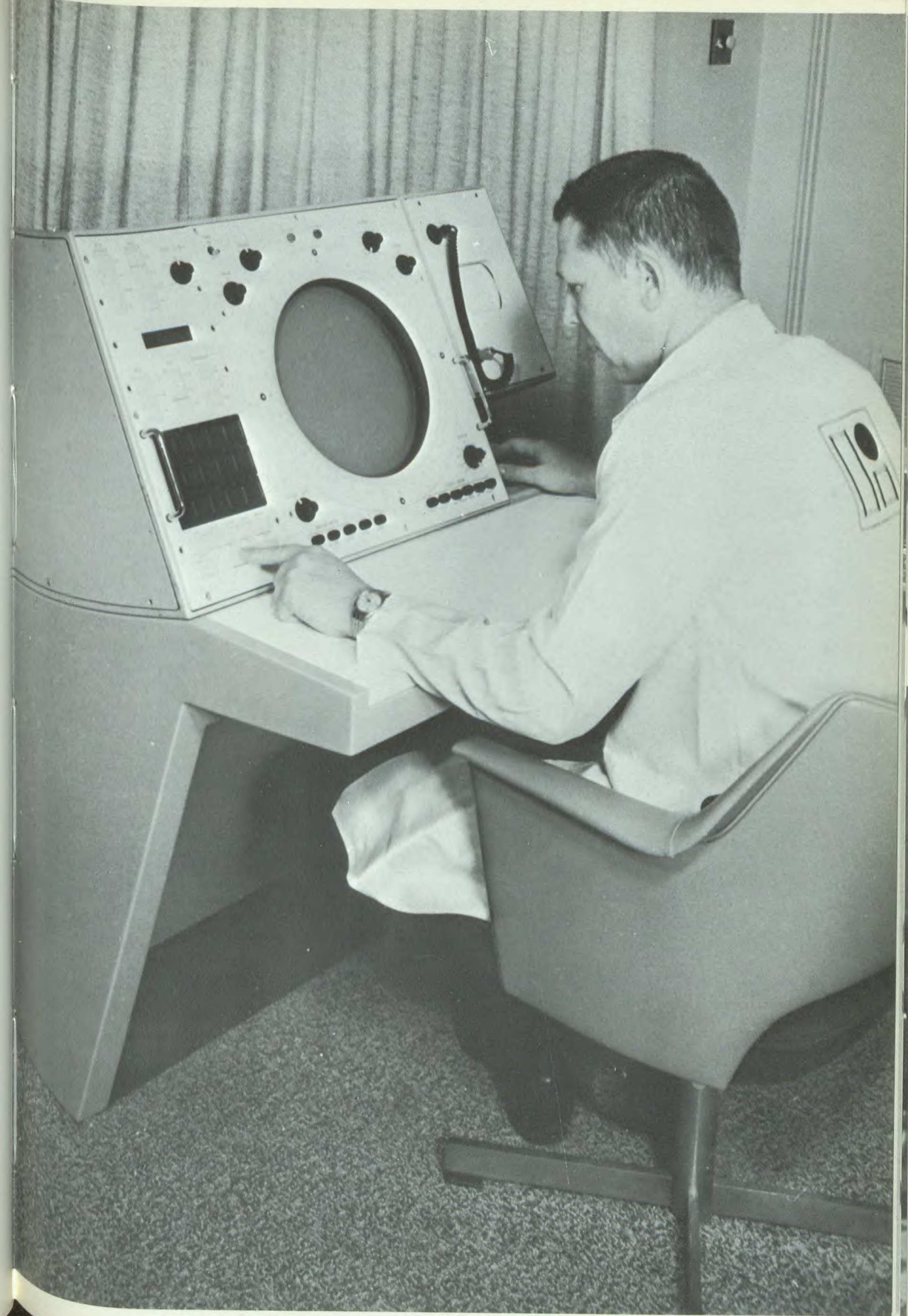
They offer a combination of programmable control flexibility radar/symbolic display, modular design and state-of-the-art micro-electronic construction. The Litton SDC can present radar or sonar video data and provides the operator with various techniques for computer data storage and retrieval. A small CRT Data Information Display provides auxiliary alpha-numeric data and a voice communications panel allows the operator to talk to other operators for switching and patching functions. Because it functions under program control, the Litton SDC has the flexibility to meet a wide range of specified tasks.

The front panel of the Litton Situation Display Console consists of three basic sections:

1. Operational Keyset — contains keyset matrix for data entry, operational task pushbuttons, symbol-select pushbuttons, and alert readouts.
2. Situation Information Display — contains a 12-inch PPI for displaying tactical and surveillance information (track data, video reports, etc.), and various CRT controls.
3. Digital Information Display — contains a 5-inch CRT for displaying and entering into the computer, alphanumeric data of an operational nature; light pen and track ball for data entry and call-up.

The versatility and adaptability of the Litton Digital Display is exemplified by:

1. The number and variety of operating modes and target categories available to the operator.
2. The flexibility achieved through provision of 5 multi-function operational task buttons and 15 momentary action function switches in the keyset matrix. As many as 360 unique actions can be performed by the operator with the multi-function capability.



## ALPHA-NUMERIC DISPLAY—WAND 600

The WAND 600 — Westinghouse Alpha-Numeric Display — represents a new concept in visual readout of digital information developed by Canadian Westinghouse.

Data sources utilized by the system include teletype, data link, computer, ticker and keyboard. WAND 600 accepts this digital information and converts it to alpha-numeric form at speeds up to 300 characters per second for readout on one or more standard television monitors. The system stores all input data permanently until it is up-dated or erased.

The WAND 600 system combines the delay line memory with the raster scan deflection system operating at standard NTSC 525 line TV rates. This makes possible the use of standard television monitors and broadcast receivers as display terminals and results in a low-cost, highly versatile system.

A number of auxiliary features are available for additional versatility. These include keyboards plus various edit and flashing functions often required in military and commercial displays. The system can also be integrated with closed circuit television facilities in many instances.

The basic functions of the system have been modularized to accommodate special configurations. This modular concept also permits time sharing of certain display functions in multiple display systems, reducing the cost per display terminal to a very economical level.

### Additional Specifications

1. SYMBOL FORMAT: 5 x 7 dot matrix.
2. SYMBOL REPERTOIRE: 64 symbols standard — up to 128 if required.
3. SYMBOL CAPACITY: up to 21 rows of 50 characters.
4. INPUT ADDRESSING: Sequential input. Editing facilities available with keyboard operation.
5. INPUT CODES: A variety of codes including 8-level ASCII and 5-level Baudot.
6. OUTPUT FACILITIES: Hard copy may be provided with standard peripherals (e.g. typewriter, paper punch tape).





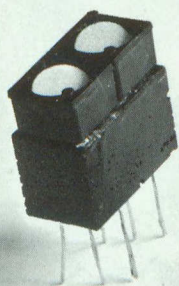
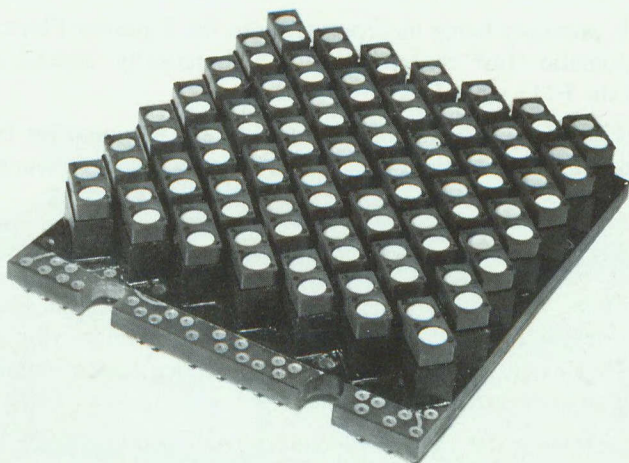
## MOBILE RADAR SYSTEM

Ferranti-Packard Electronics Division are supplying electromagnetic Status Indicator Displays for a highly mobile radar system under development by Sanders Associates Inc. for the U.S. Army. The system can detect high-speed aircraft flying at tree top level, and relay target information to nearby anti-aircraft batteries. Known as Forward Area Alerting Radar (FAAR), it includes identification equipment that distinguishes between friendly and enemy aircraft, and a VHF radio link for transmitting target information to the AA batteries. The FAAR system is housed in a transportable shelter and can be vehicle mounted for transportation to the battle area. The radar, which operates in the L band, can be remotely controlled from distances up to 130 feet (39.6 m).

The air defence batteries are equipped with a miniature display box. The display comprises a matrix of status indicators, which receive information from the FAAR and indicate visually the precise sector in which the enemy aircraft are located.

Features of the Ferranti-Packard status indicator which made it particularly suited to this application were its size and weight. Each indicator measures only .45 in. x .45 in. x .775 in. deep (11 x 11 x 19.7 mm). A single indicator has a weight of 4.5 grams, i.e. 0.16 oz. The indicators are rugged, and have a projected life of better than 20 million operations per indicator. The indicators can be set by a 1 ms to 100 ms pulse of 4.2 volts 250 milliamps (with diodes); without diodes the voltage is only 3.1 volts. No power is required to maintain status, which means that power loss will not cause loss of indication. The indicators have an inherent memory; the magnetic remanence in the pole pieces is the latching force which holds the indication, eliminating the need for memory circuits or holding current.

Being light reflecting, good visibility is possible under both poor ambient light conditions and direct sunlight; a distinct advantage over light bulbs which are difficult to see in direct sunlight. Reliability is a key characteristic of these indicators; there are no mechanical linkages to wear and no bulbs to burn out. The only moving part is the indicator element disc which is driven by magnetic coupling. The encapsulated coil is moistureproof and rugged. Printed circuit board mounting allows any number of indicators to be mounted in an array with minimal wiring. The indicator will operate over the temperature range  $-40^{\circ}\text{F}$  to  $+198^{\circ}\text{F}$  ( $-40^{\circ}\text{C}$  to  $92^{\circ}\text{C}$ ), and at a humidity of up to 95%.



.75"  
(19 mm)



## MILITARY PUNCHED TAPE READER

A recent addition to the comprehensive range of punched paper tape readers made by Ferranti-Packard is the Type 4040. Designed to meet the requirements of MIL-T-21200, Class II equipment, this unit is completely modular, constructed for maintainability and reliability.

This unit is presently being incorporated into the Emerson Electric Inc. General Purpose Automatic Test System, which automatically checks electronic sub-assemblies in the F111 aircraft.

The tape reading and handling mechanisms are mounted on the front of the panel and the chassis containing the electronic circuitry is mounted on the rear of the panel.

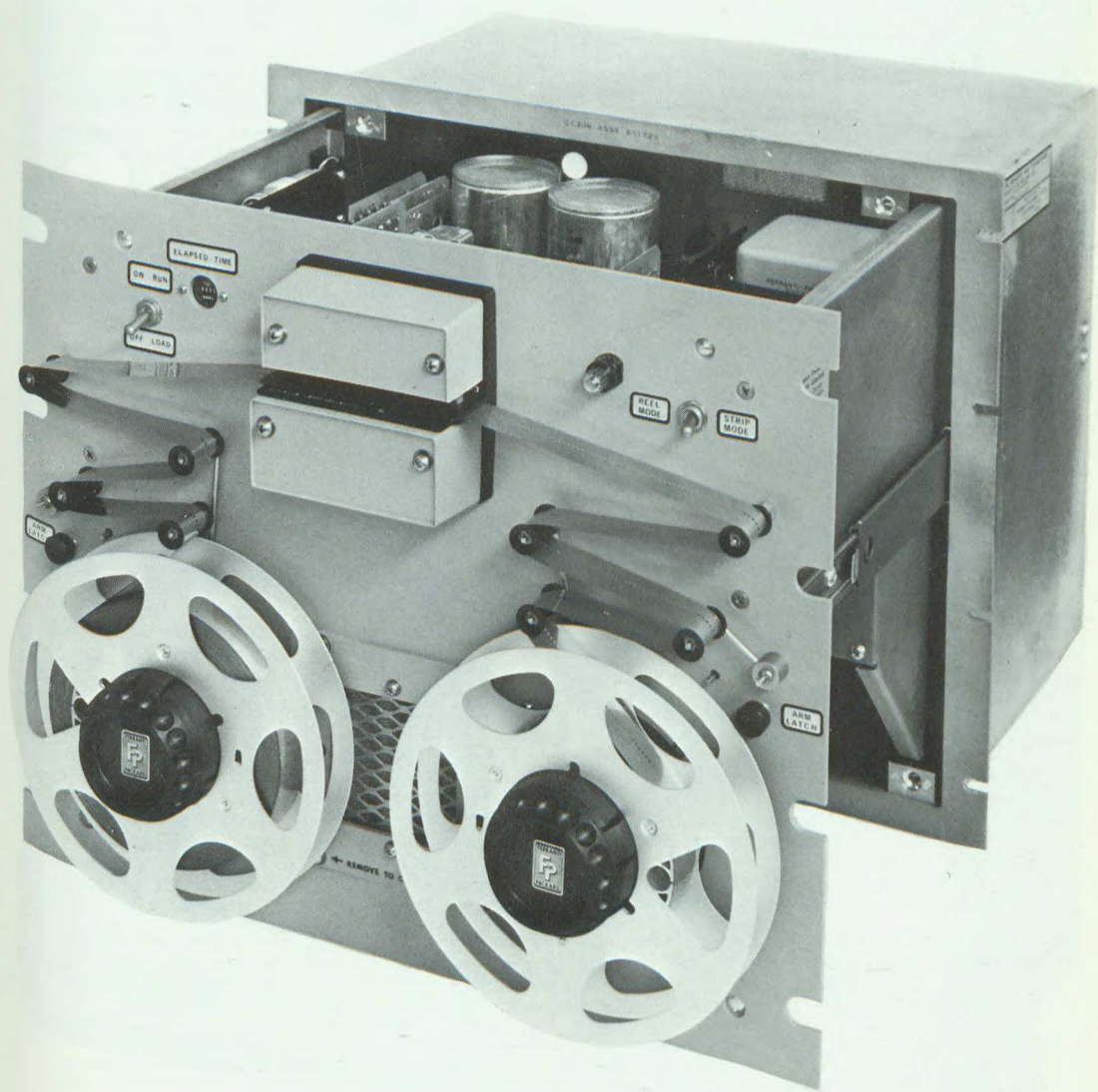
The chassis and panel as a unit are mounted with slides inside the enclosure. The enclosure flanges mount directly to a standard 19-inch rack. Access to the chassis and to the rear of the panel is gained by operating the four quick-release (slot-head) fasteners at the corner of the panel and withdrawing the chassis and panel to the full extent of the slides. Looped service cables within the enclosure permit operation at all extended positions.

For bench service, the cables disconnect from inside the enclosure, the unit releases from its slides and free-stands upright on a bench top in a fully operable condition.

### Specifications

SPEED:	420 characters per second, stop on character, bi-directional.
LOGIC LEVELS:	Hole +12V (+2, -2) No Hole OV (+1.0, -0)
REMOTE INPUT CONTROLS:	Stop/Start Rev/Fwd Read/Rewind
POWER:	115 VRMS, 400 Hz.
REELS:	8" NAB Hub.
TEMPERATURE:	0°C to 55°C operating.
SHOCK:	Designed to meet MIL-STD-810A, method 516 procedure VI.
RFI:	Designed to meet MIL-I-26600, Class II.
DOCUMENTATION:	MIL-D-1000, Form II, Category E.

Since the unit is of modular design, changes in logic levels power, speed, etc. will involve changes in the respective sub-assemblies only, and hence minimum non recurring costs.



## RADIO RELAY EQUIPMENT—AN/GRC-103

The AN/GRC-103 radio relay equipment, designed and manufactured by the Canadian Marconi Company is a light-weight, portable, general purpose radio relay set designed primarily for use in conjunction with pulse code modulation (pcm) multiplex equipment to transmit up to 24 voice channels. An optional Applique Unit permits its ready adaptation to operation with frequency division multiplex equipment. The radio relay set operates in the UHF frequency band and is intended for service in Military Tactical communications at the Command or Battalion Headquarters level and essential links between field switchboards. It will also find applications with Civil Defence and emergency service communications. The equipment is easily transportable by air, is designed for mounting in either a  $\frac{1}{4}$  ton (226.8 kg) jeep having a trailer or in a  $\frac{3}{4}$  ton (680.4 kg) truck. The individual units of the equipment are each of the size that is easily carried by one man. The equipment fully meets military environmental and construction specifications for this class.

The radio relay set uses a directional antenna system which is also easily transportable and can be rapidly erected and oriented. The whole system is designed for continuous operation with special design considerations providing practical features which ensure easy installation and simple operational procedures under difficult field conditions.

The AN/GRC-103, operating with normal antenna systems, will provide good performance over line-of-sight paths in excess of 50 miles (80.46 Km). The set has reserve power permitting satisfactory operation to a remarkable degree over paths containing obstructions. A system having two terminals and seven relay stations, operating over normal paths provides 'Via Trunk' quality of performance. Reliability analysis predicts a mean time to failure in excess of 3500 hours.

The AN/GRC-103 is fully transistorized (with the exception of the final r-f amplifiers) and operates in the 220 to 1,000 mc frequency range. The transmitter delivers 25 watts to the antenna in any of 1,560 r-f channels. These channels are selectable in 0.5 mc increments throughout the frequency range of the equipment. Other channel separations are available. The receiver and Transmitter each have removable r-f assemblies to cover 3 operating bands, 220 to 405 mc, 395 to 705 mc and 695 to 1,000 mc. Channel changing can be accomplished within 30 seconds. Band changing however, requires that the r-f assembly be changed and the antenna be altered. Band changing may be carried out within 5 minutes.

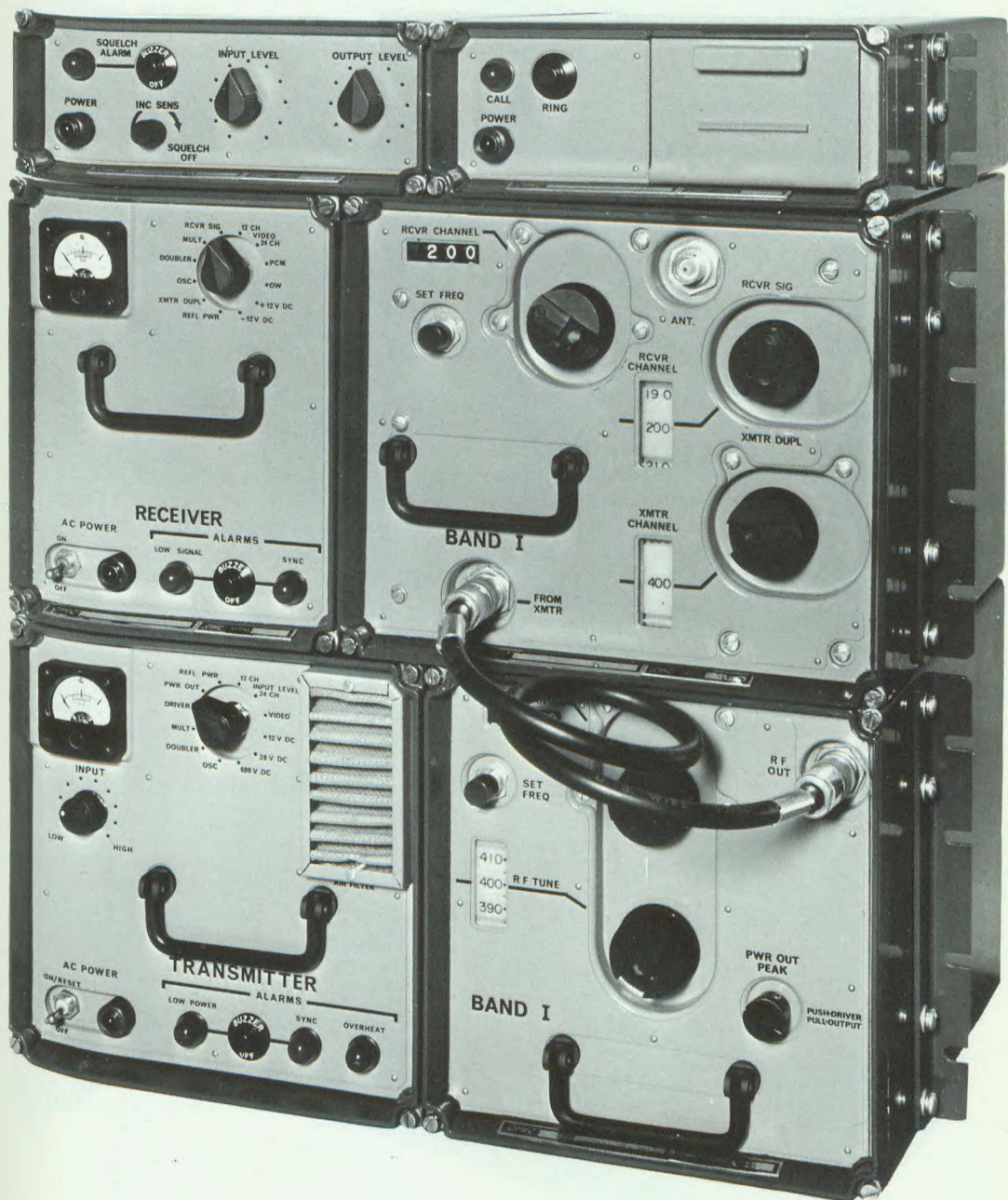
The equipment is normally employed with a corner reflector antenna or a high gain log periodic antenna. These, together with a light-weight portable mast are specifically designed for easy transportation and rapid erection. The log periodic or corner reflector antenna together with a 30 or 50 foot (9 or 15 meters) antenna support tower, can be erected within 15 minutes by one or two men. The antenna support tower is completely portable, the longest item is five feet (1.5 meters) in length to ensure simple stowage and easy transportation.

The equipment has two major units, the Transmitter and Receiver. Each of these units contains its own power supply, operating from 115 vac, 47 to 420 cps, or, optionally, from 24 vdc. Each of these units is contained in a case 8.5 inches high, 12 inches deep and 17.25 inches wide (21.59 cm x 30.48 cm x 43.81 cm) and each weighs approximately 60 pounds (27.2 kg). These cases are suitable for separate transportation; they may be mounted in a standard 19 inch (48.3 cm) relay rack, or may be stacked, one on top of the other. All controls, indicators and r-f connections are on the front panel, while all other cable connections are to recessed receptacles in the rear of the units. The units have been designed for field use. The individual units are moisture resistant, and have been designed to operate over a very wide range of temperature and environmental conditions.

Each major unit has three replaceable r-f heads, each covering one of the frequency bands 220 to 405; 395 to 705, or 695 to 1,000 mc. The r-f heads are of plug-in form and are easily replaced from the front of the equipment and contain frequency sensitive r-f components together with frequency selection circuitry.

In addition to the two major units of equipment, two ancillary units, the Order Wire Unit and the FDM Applique Unit are available. Each is in a case 3.5 inches high, 12 inches deep, and 8.56 inches wide (8.9 cm x 30.5 cm x 21.7 cm) and each weighs less than 8 pounds (3.6 kg).





## INTEGRATED TELECOMMUNICATION SYSTEM—MCS 6900

The Canadian Marconi Company has designed and developed the MCS 6900, a microwave radio relay communications system which comprises radio equipment operating in the 12 GHz band and a PCM multiplex facility which will provide up to 120 telephone channels.

As a standard terminal housed in an existing central office, the MCS 6900 equipment required to provide a communications facility for 48 voice channels can be contained in one ground unit console. The units which will be installed in this console are: radio ground unit, service telephone unit, system control unit, power supply unit and 48 channel units. A cable run will connect the radio ground unit to the mast-head radio mounted above the two-foot parabolic reflector.

Expanding the facility to a double terminal will only require the addition of a mast-head radio and antenna to the existing mast-head assembly and the addition to the existing ground console of a radio ground unit and service telephone unit. The functions of the system control unit will be expanded by adding sub-assemblies.

Further expansion of the facility to 120 channels will be accomplished by simply installing an additional 72-channel unit console with its own power supply, without additional common equipment.

The mast-head assembly of a standard repeater will be identical to the double terminal described above. The ground unit would consist of a 15 x 24 x 12-inch weather-proof metal case, enclosing two radio ground units, a service telephone unit, a system control unit, and a power supply unit. The equipment will operate over temperature ranges from  $-20^{\circ}\text{F}$  to  $130^{\circ}\text{F}$  and in tropical and sea mist humidity, without the need for heating, air conditioning or cable pressurizing and with only rudimentary shelter. If primary power from mains is not available, an inexpensive shelter to house power generating equipment will be required.

System configurations are available to meet any order of system reliability. Conventional single frequency space diversity systems can be provided as well as dual path working and alternative-frequency hot standby. Single frequency hot standby systems are preferred in order to conserve the frequency spectrum.

### Specifications

Radio group: Two section transceiver, mast-head and ground unit.

Frequency range  
12 GHz Band

Modulation  
Frequency modulation  
Gaussian response

Repeater type  
Demodulates to regenerated pcm  
Unlimited drop and insert facilities

Traffic capacity options

120 pcm telephone channels  
120 pcm telephone channels and 1 colour television channel  
38.4 Kbits/sec data channels  
Custom designed telemetry, high speed data, and program channels.

Built-In Test Equipment  
Power output: 150 mw  
Frequency control:  $\pm 0.003\%$   
Noise figure: 9 db

PCM multiplex equipment:

PCM characteristics  
Compatible with WECO D1 channel bank.

Voice channels  
Group: up to 24  
System: up to 120

Voice frequency characteristics  
Input level, 2 wire: 0 dbm, nominal  
Output level, 2 wire:  $-5$  to  $+3$  dbm, adjustable

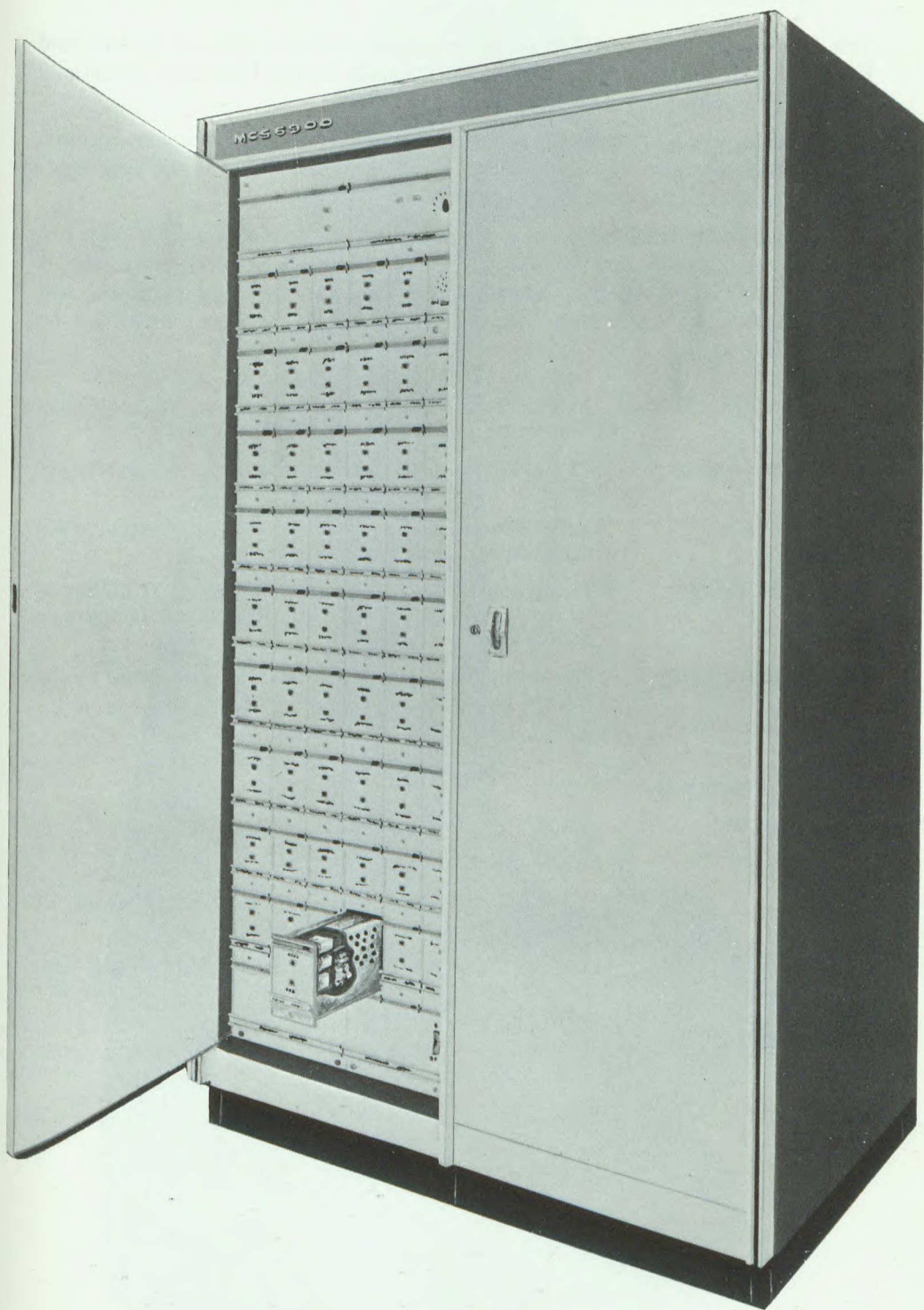
Impedance: 600 ohms  
Frequency response from 300 to 3400 Hz (Ref. 1 Kz):  $+1$ ,  $-3$  db

Signalling: one way subscriber loop E & M, 2 or 4 wire

Signal to distortion ratio  
"C" message weighted

Test tone 1000 Hz	Level	Signal/Distortion Ratio
	-40 dbm	22 db
	0 dbm	30 db
	+3 dbm	30 db







## FIELD TELEPHONE SET M262A (TA 5012/TTC)

This lightweight, self-contained, telephone system has been designed by Marsland Engineering in collaboration with Canadian Armed Forces Engineers, specifically for front line combat use in all climatic conditions.

Housed in a rugged shell of polycarbonate resin is a complete communication system requiring only attachment to standard telephone lines or the new lightweight assault cable to become fully operational.

Included in the handphone are a micro-circuit microphone amplifier with two levels of amplification, (one for normal voice and one for whisper), power supply for the amplifier, a squeeze operated generator for signalling purposes, and audible and visual indicator for incoming signals and a muting system for the annunciator.

COMMUNICATION RANGE:	In excess of 2 miles with lightweight Assault Cable, 5 miles on standard cable. (3.2 & 8 km)
AMPLIFIER OUTPUT:	1 mw, Power gain 53 db normal mode, 68 db whisper mode.
POWER SOURCE:	1.5V Battery. Life proportional to use. Current drain varies from 0.6 ma to 2.5 ma.
SIGNALLING POWER:	Hand operated AC generator delivers 200 milliwatts to the line at 15-25 Hz. Voltage duration is approximately 200 MS.
CABLE CONNECTION:	By means of two spring loaded binding posts in the base of phone.
WEIGHT:	1.5 pounds. (.68 kg.)

### Operating Conditions:

TEMPERATURE:	-40°F to +150°F (-40°C to 66°C)
ALTITUDE:	Up to 10,000 feet (3048 m) above sea level.
SHOCK:	Five foot drops to concrete and thermal shock of 50°F/minute.
MOISTURE:	Up to 100 percent relative humidity at varying temperatures, exposure to driving rain or snow, and immersion in shallow water for sustained periods.
HOSTILE ENVIRONMENT:	Resistance to particle entry, attack by insects, rodents, fungus and salt atmosphere.



## TELEPHONE AND TELEGRAPH MULTIPLEX TERMINAL

Radio Engineering Products have developed and produced this militarized multiplex terminal which provides 1 order-wire channel, 4 telephone message channels, and 4 voice-frequency telegraph channels on a 4-wire line or radio circuit. The transmission band is 0.3 to 19.7 kHz. The terminal includes hybrids with 2/4-wire switching, signalling converters and companders on the telephone message channels, test and line-up facilities, and automatic transmission regulator. It requires only 12 watts of power at 12/24 volts dc.

The terminal is immersion-proof and meets all requirements for operation under tactical military environmental conditions. It weighs 22 lb (10 kg), and has a volume of 0.33 cu. ft. (9400 cc). The average period of trouble-free operation under conditions of tactical operation is presently measured in years.

The stability of transmission performance, with variations in temperature, humidity, line voltage and aging, surpasses that of any previously available equipment.

Telephone message loops may be switched either 2 or 4 wire. In the 2-wire position a high-accuracy compressor-expander and a 20/1600 Hz signalling circuit are connected in each channel. The compandor reduces a total volume range of 50 dB at the transmitting terminal to a total range of 25 dB in the transmission path, and at the receiving terminal this is expanded again to 50 dB. A large reduction in noise, of the order of 25 dB, is obtained. These channels are suitable for 2400 baud data transmission.

The order-wire channel has a bandwidth of 0.3 to 2.8 Hz. It permits signalling and talking to all attended points in the multiplex system and to the switchboards and also monitoring of the four telephone message channels and the four vf telegraph channels. The operator signals over the order-wire channel to the operator at the remote multiplex terminal at 1600 Hz and over a local loop, if connected, at 20 Hz.

Four vf fs 100-wpm telegraph channels are provided. Loops are 2-wire full or half-duplex. A miniaturized solid-state dc to ac converter is used at each teletypewriter; this converter also provides the loop currents.

The reduction brought about by the channel companders, of crosstalk and noise introduced in the radio or wire path between the multiplex terminals, permits multiplex operation over radio sets such as the AN/VRC-12 or AN/PRC-25 which have ordinarily been used for a single voice circuit only. A 4 kHz automatic regulator holds the channel vf receive levels within 0.5 dB for changes in attenuation between the two multiplex terminals of as much as 12 dB, and visual and audible alarms are given for a greater change. These features improve transmission by such a large factor that on long vhf radio systems the performance of each of the five multiplex channels is generally superior to that of a single voice circuit operating over the radio system.

This multiplex terminal has been assigned standard nomenclature Terminal, Telegraph-Telephone TH-81/GCC. It forms the principal component of the following equipments:

Terminal Set AN/PCC-1 (1 plus 4 plus 4 channels, used with AN/PRC-25 Radio Set).

Terminal Set AN/VCC-1 (1 plus 4 plus 4 channels, used with AN/VRC-12 Radio Set).

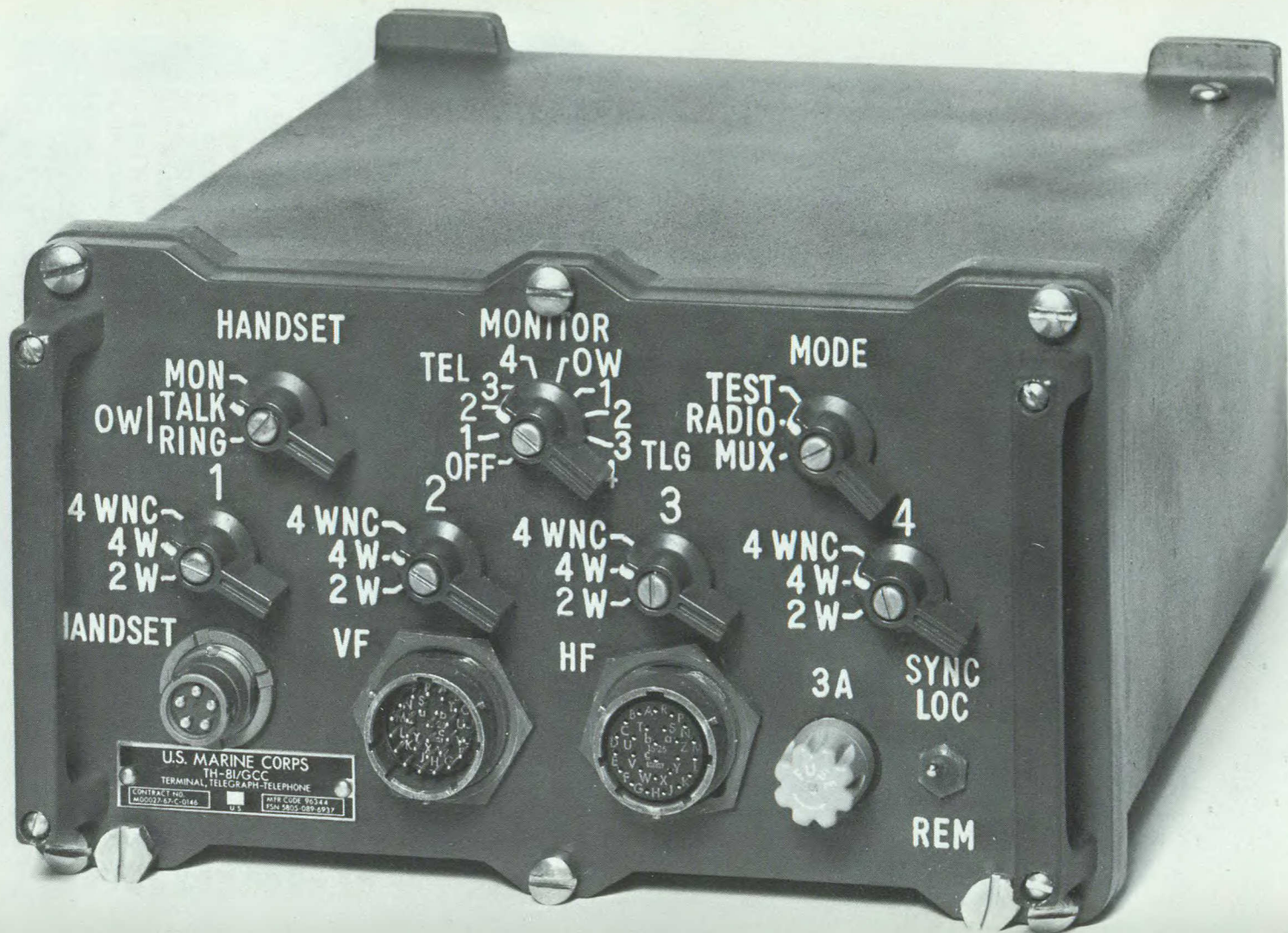
Terminal Set AN/VCC-2 (2 plus 8 plus 8 channels, used with AN/VRC-12 Radio Set).

Terminal Set AN/VCC-3 (3 plus 12 plus 12 channels, used with AN/VRC-12 Radio Set).

Terminal Set AN/GCC-14 (10 plus 40 plus 60 channels, used with AN/GRC-50, AN/GRC-103 or AN/TRC-97 Radio Sets).

A modified version of this terminal, with 2 in place of 4 telegraph channels, has been assigned standard nomenclature Multiplexer, Telegraph-Telephone TD-856(P)/TCC. This forms the principal component of Multiplexer Set AN/TCC-70, which is used with the AN/VRC-12 Radio Set to form the AN/GRC-163 Radio Set.





## TEST SET, TELETYPEWRITER TS-5082/UGM

The Test Set Teletypewriter TS-5082/UGM, supplied to the Royal Canadian Air Force, is used to obtain a complete quantitative check on the performance of the LF/RTT system, including the Topping AN/ARR-501 Airborne Receiver with its associated loop antenna and teleprinter. In simple terms, the first function of the Test Set is to provide a "go-no go" pre-flight check of the teletype receiver located in the aircraft. The second function of the Test Set is more sophisticated in that, acting as a signal generator, it will enable detailed aspects of the receiver to be checked. The Test Set provides fixed frequency signals suitable for matching the antenna and antenna cables to the Receiver and for alignment of RF circuits and in addition, a frequency-shift keyed signal is available for an over-all receiving system checkout and calibration. One of four test frequencies of the Receiver may be selected by a panel switch. This signal is controlled in amplitude (metered) and supplied to a Dummy Antenna and through a 3-foot Antenna Cable directly to the Receiver, or to a Radiating Coil mounted on a pole to induce a signal in the Loop Antenna mounted on the aircraft. The equipment is readily portable and operates from either built-in rechargeable nickel-cadmium batteries or 115 volt 60 cps line.

This equipment is produced by Topping Electronics.

### Performance

MEAN-TIME BETWEEN FAILURES: MTBF of 200 hours.

WARM-UP TIME: The equipment performs as specified herein not later than 10 minutes after being switched "ON".

SPEED: The equipment is capable of generating an output signal at 60, 66 and 100 words per minute as selected.

OUTPUTS: The equipment is provided with 3 outputs:

*Relay contact* An on-off keyed, one side grounded relay, capable of keying a non inductive circuit at up to 45 volts and up to 10 milliamps supplied from an external source.

*Radiation Loop* The output from a radiation loop is capable of coupling a signal between 70 Kcs — 150 Kcs to the Marconi AD 4488c antenna.

*Dummy Antenna* A dummy antenna is provided which enables the signal to be connected directly to the ARR501 input without re-alignment.

OUTPUT LEVELS: There are two output levels into the dummy antenna or radiation loop as follows:

*High Level* approximately 1 mv at receiver input.

*Low Level* approximately 1 uv at receiver input.

OUTPUT FREQUENCIES: The four pre-set frequencies in the band between 70 Kcs and 150 Kcs are as follows:

Channel 1 73.6 Kcs  $\pm$  3 cps      Channel 3 133.15 Kcs  $\pm$  3 cps

Channel 2 121.6 Kcs  $\pm$  3 cps      Channel 4 146.1 Kcs  $\pm$  3 cps

FREQUENCY SHIFT: The output frequency shift from the dummy antenna and radiation loop is between 50 and 85 cps.

INPUT: The equipment is capable of accepting the 1000 cps output from the ARR 501 and keying the UGC 502 teleprinter.





# INSTRUCTIONS FOR FIRST LINE TESTS OF RECEIVING SET, RADIO AIRCRAFT AND SYSTEM

## A. SYSTEM PREPARATION

1. Place airtight test set in aircraft antenna.
2. Connect antenna cable connector to panel socket marked ANTENNA.
3. Connect antenna cable connector to panel socket marked ANTENNA.
4. Ensure that the test set antenna is about 3 feet below the aircraft antenna and located within 1 foot of the perpendicular line from the aircraft antenna center.
5. Set test set controls as follows:  
SPEED as desired (100 RPM)  
MODULATION to ST-MADE, HIGH  
OUTPUT set appropriate  
CHANNEL as desired (CHANNEL D)
6. Turn BAT. power ON.
7. Observe that the RF METER indicates approximately 35  $\mu$ A, indicating RF drive to the output attenuator.
8. Position test set antenna cable to RF from line of the aircraft.
9. The system should now indicate satisfactory performance by printing continuous lines of ST, separated by test set and carriage return.

## B. RECEIVER TESTS

1. Locate the test set adjacent to the AIRCRAFT Receiver.
2. Disconnect the antenna plug P401 from the AIRCRAFT receiver socket J401.
3. By means of the supplied dummy antenna cable, part number 2795, connect the test set OUTPUT TO AIRCRAFT connector to J401 of the AIRCRAFT Receiver.
4. Ensure that the test set OUTPUT is connected to the test set D. ANT INPUT via a short coaxial jumper.
5. Set test set controls as follows:  
CHANNEL as desired (CHANNEL D)  
MODULATION to ST-MADE, HIGH  
SPEED as desired (100 RPM)
6. Switch BAT. power ON.
7. Observe that the RF METER indicates RF output by reading approximately 35  $\mu$ A.
8. Test system performance by switching LOOP 1 and LOOP 2 switches ON, and observing ST printouts at the teleprinter.
9. The two individual AIRCRAFT antenna loop amplifiers may be tested by switching LOOP 1 and LOOP 2 signals ON alternately.
10. In the event that printouts are not obtainable, proceed as follows:  
a) Disconnect the AIRCRAFT output connector P401 and, by means of the supplied 1 K $\Omega$  cable part number 2401, connect the AIRCRAFT output P401 to the test set 1 K $\Omega$  INPUT.

- b) Connect the test set OUTPUT TO T401 at the teleprinter via the extra cable and connector provided in the aircraft.

- c) Set the test set PUNTER switch to RFV and proceed as described in paragraph D, 1 to 8 above. Failure to print will indicate failure of the T401.
- d) Set the test set PUNTER switch to 1 K $\Omega$ . Failure to print will indicate failure of the AIRCRAFT Receiver.

## C. ANTENNA PERFORMANCE

1. At the AIRCRAFT Receiver:  
a) Remove the test cover and disable the receiver AGC local oscillator and output by grounding test point T701.  
b) Connect a sensitive RF VTVM between the RF output test point and ground (see 100-346-1-1 Figure 1-4).
2. CAUTION  
TO KNOW MINIMUM LOSS, BOTH CHANNELS REFERRED TO ABOVE MUST BE MADE ADJACENT TO T401 OR IF TRANSFORMER BRACKET, 200CHS.
3. Locate the test set beneath the aircraft antenna and proceed as described in paragraph A, 1 to 7 above.
4. With the receiver on, the RF output from the receiver should read approximately 1.5 millivolts at the VTVM.
5. Horizontal rotation of the test set antenna by 180° should produce a variation of RF output of not more than 3 db, as indicated by the VTVM.

## D. ANTENNA ALIGNMENT

1. Proceed as in paragraph C, 1 to 3 above.
2. Turn the RF scale of the AIRCRAFT receiver and, observing the VTVM, adjust tuning in accordance with the following table:

DESCRIPTION	CHANNEL	INSTRUCTION
LOOP 2 ANTENNA	T401 T401 T401 T401	PEAK TUNE
LOOP 1 AMP	T401 T401 T401 T401	DETUNE CC WBE-3.45
ADDER	T401 T401 T401 T401	PEAK TUNE
LOOP 1 AMP	T401 T401 T401 T401	DETUNE C WBE-3.45
LOOP 2 ANTENNA	T401 T401 T401 T401	PEAK TUNE

## NOTE

Loop 2 adjustments are to be made with the test set antenna in line with the axis of the aircraft.

Loop 1 adjustments are to be made with the test set antenna at right angles to the axis of the aircraft.



## SOUND RANGING CENTRAL—AN/GYK-501

The Sound Ranging Central, as produced by Computing Devices, is the data processing component of a Sound Ranging System. It accepts acoustic signals by radio link or by land line from an array of three to seven microphones deployed on a 1,000 - 20,000 metre base. The system also has the capability of providing 360° surveillance when these microphones are arranged in a cross configuration.

Sound Ranging is a means of locating a sound source be it a gun, howitzer, mortar or shell-burst. The Sound Ranging theory is based on the assumption that sound travels uniformly at a known velocity. From a knowledge of the time taken for a sound wave to travel between two microphones and the distance between these microphones a hyperbole may be computed which will pass through the sound source. The intersection of any two hyperbolae gives the location of the sound source.

The acoustic signals are recorded on magnetic tape and under operator control are played back, sampled, digitized and stored in a digital computer. The stored data signals are displayed on a cathode ray tube so that the operators can mark the relative arrival times at the microphones of the sounds from a single event. With this operator input plus the stored locations of the microphone and the prevailing meteorological conditions the computer calculates the location of the sound source and causes a print out of the results.



# ANTENNA CONTROL SYSTEM

Designed, manufactured, tested and installed in Canada, the system demonstrates the capabilities of the electronics industry to supply complex equipment and to support Canadian Defence requirements. The system is a product of TMC (Canada) Limited, in Ottawa and was designed by their Engineering Staff, working in close co-operation with the Military Design Authority.

Basically, the system is required to provide forty outputs from each of 20 high frequency antennas. Future growth potential (more antennas and, more outputs) is a "built-in" feature. To reduce degradation of received signals, the system was carefully engineered to meet certain over-all performance standards. The operational specifications were outlined by the Military, and completely met by the manufacturer. Some of the major characteristics of the system are:—

- (i) Input and output impedance is 50 ohms with an over-all frequency response of  $\pm 2$  db from 2.0 to 32.0 mc.
- (ii) Insertion loss from any input to any associated output at any point within this frequency range does not exceed 2 db.
- (iii) A means is provided to attenuate "Broadcast-band" signals below 1.8 mc so that high level signals of this type do not enter vital circuitry and cause intermodulation products.
- (iv) All intermodulation products are held at least 60 db below either of two 250 millivolt signals applied simultaneously at the antenna input and measured at the receiver output connection.
- (v) The input VSWR (looking into the system from any antenna) is better than 1.3:1.
- (vi) The output VSWR (looking back into the system from any receiver) circuit output connection is better than 1.2:1.
- (vii) Isolation between receiver-circuit output connections is at least 50 db at the worst point in the frequency range (30 mc) and 70-80 db at the lower frequencies (2-10 mc).
- (viii) Back-to-front isolation from any receiver output connection to any antenna input is 90-100 db at any frequency.

The heart of the system is TMC's Antenna Multicoupler. This particular unit is one of a series conceived and developed independently to meet a foreseeable requirement for new commercial/military markets.

The system was designed to work with an antenna field consisting of twenty antennas; twelve of which are oriented as six uni-directional pairs; the remaining eight as four omni-directional pairs. This antenna field configuration is fully accommodated by new switching and routing techniques to numerous operating positions. Switches can be remotely operated from a control panel mounted near the receivers so that immediate selection of the best pair of antennas, is made at any time. As this switching is virtually instantaneous, rapid comparison of the signal strength available on all antennas is possible.

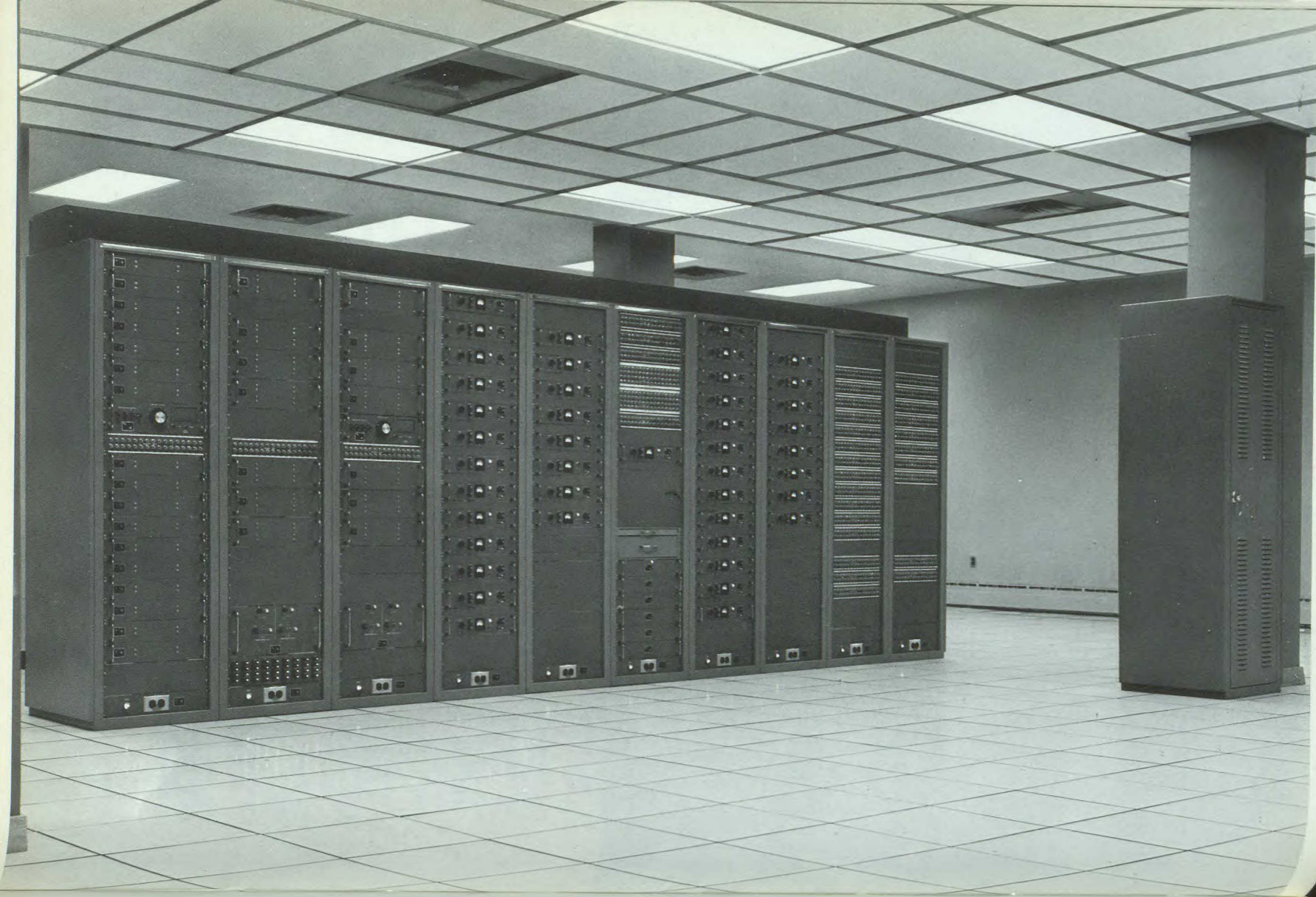
A further feature of the Antenna Control Group is the coaxial switch used in the system. New techniques of a recently available vacuum switch were used and arranged in a 1 x 12 matrix type of configuration. The packaging of these switches provides an exceptionally high isolation between connectors. Individual switches provide an exceptionally high isolation between connectors. Individual switches were life-tested to 500,000 operations.

All antenna switching functions are capable of remote control, which is of two types; a standard 19-inch panel mounting for use in receiver racks and a small desk-mounted, sloping-front cabinet for use at the control consoles and operator positions.

A Low-frequency multicoupler is used in the system to provide outputs from one LF antenna. This multicoupler is similar in design to the high-frequency multicouplers, differing only in filters and the use of low-frequency transformers at the input and output of the pre-amplifier. With this "companion type" of unit in the system, the logistics of support in the field is minimized.

The entire Antenna Control Group system is housed in ten identical cabinets. Each cabinet is protected by a separate AC circuit breaker with a front-panel indicator lamp and the load is evenly distributed between the three phases of a 120/208-volt supply. Utility outlets at the front and rear of each cabinet are provided for technician accessibility and are fused on separate AC circuits. The system uses approximately 1,000 coaxial cables with connectors on each end for the internal RF distribution. The total length of RF cables used to make all RF connections is approximately four miles and 108 cabling charts were required to identify these cabling connections.



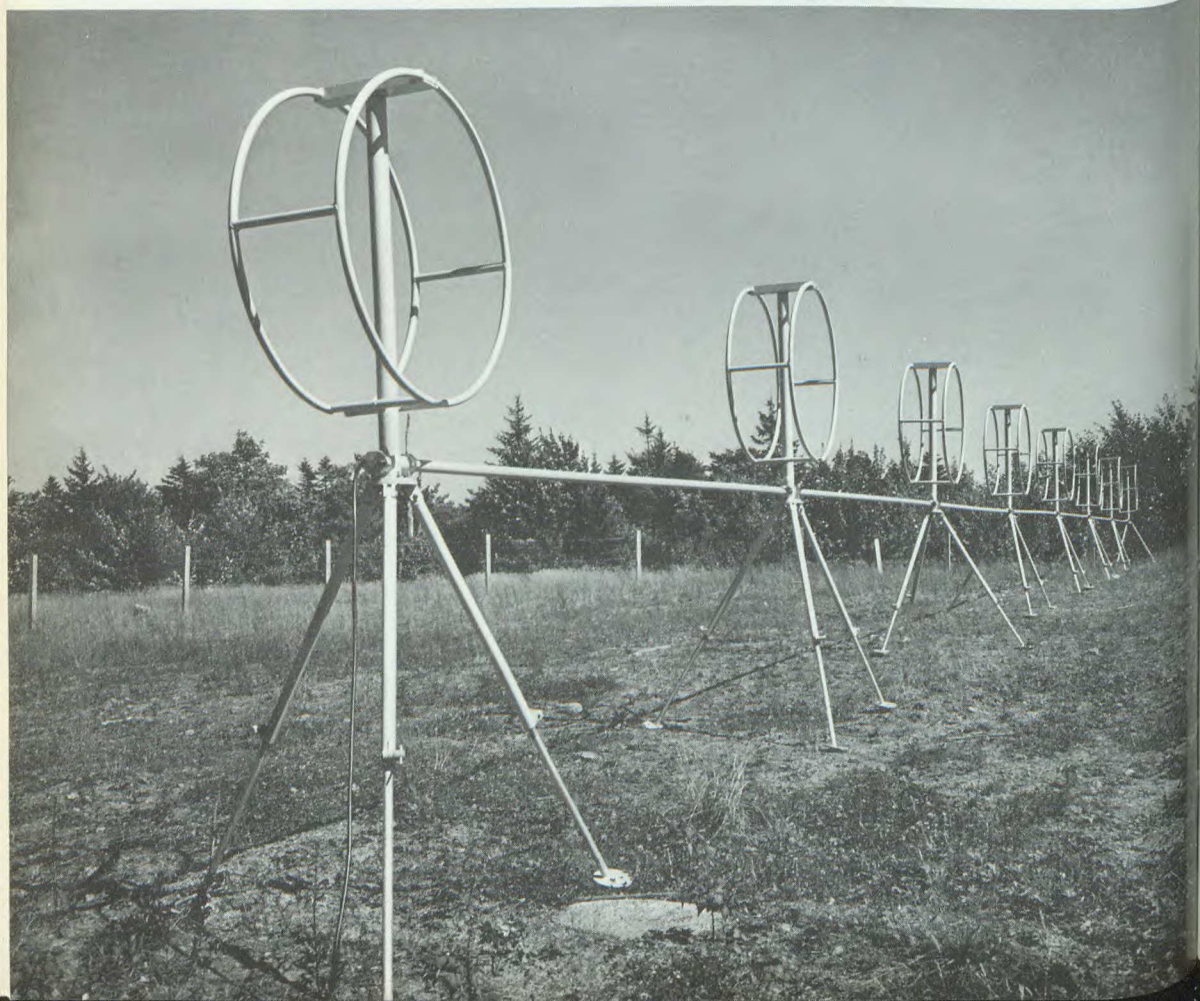




## ACTIVE APERIODIC LOOP RECEIVING ANTENNA ARRAY

These highly efficient receiving elements, designed and built by E.M.I. Electronics Canada Ltd., combine to form arrays with significant advantages over conventional antennae. The arrays cover 4 octaves (2-32MHz) and polar diagrams can be tailored to specific requirements. Other features of these arrays include:

- Small site requirements.
- Minimum site preparation.
- Minimum installation time.
- Maintenance without ladders or climbing.
- Low profile.
- No masts or guy wires.
- Independent and simultaneous operation of up to 4 receivers on one array.





## SIGNAL PROCESSING APPLIED RESEARCH PROGRAM

Since late 1962, the Canadian General Electric Company has been engaged in a continuing program of applied research in the field of signal processing. This effort is jointly funded by the Company and the Defence Research Board of the Department of National Defence of Canada.

The objective of the program is to undertake studies aimed at improving the detection and resolution capabilities of target locating systems operating in non-ideal environments that occur in space, atmospheric and undersea media. This involves extensive investigation into analytic, technological, and system aspects of signal processing applied to specific problem areas encountered by radar, sonar, and communications equipments.

With the aid of a programmable electronic matched filter and a perspective display device both of which were developed by the techniques group at Canadian General Electric, the characteristics of a large number of coded waveforms have been portrayed and catalogued. This effort has produced significant contributions to waveform design some of which are referenced in a recently published text book on signal processing. Current laboratory studies are aimed at expanding the information capacity of correlator devices through the exploitation of digital matched filters and the development of improved real time optical processing techniques.

In recent months, a portion of the applied research activities has been devoted to a field demonstration of the effectiveness of pulse compression when used to enhance target location in a range-extended clutter background. This test program involved the physical coupling of the experimental matched filter with an operational surveillance radar in the Air Defence network, and subjecting the modified system to a series of flight trials. The results obtained in this exercise are in close agreement with those predicted by theory.

Future program activities will be devoted to further demonstrations of effectiveness aimed at similar problem areas in other defence electronic systems. This will be carried out in parallel with the aforementioned laboratory investigations into advanced digital and optical signal processing techniques.





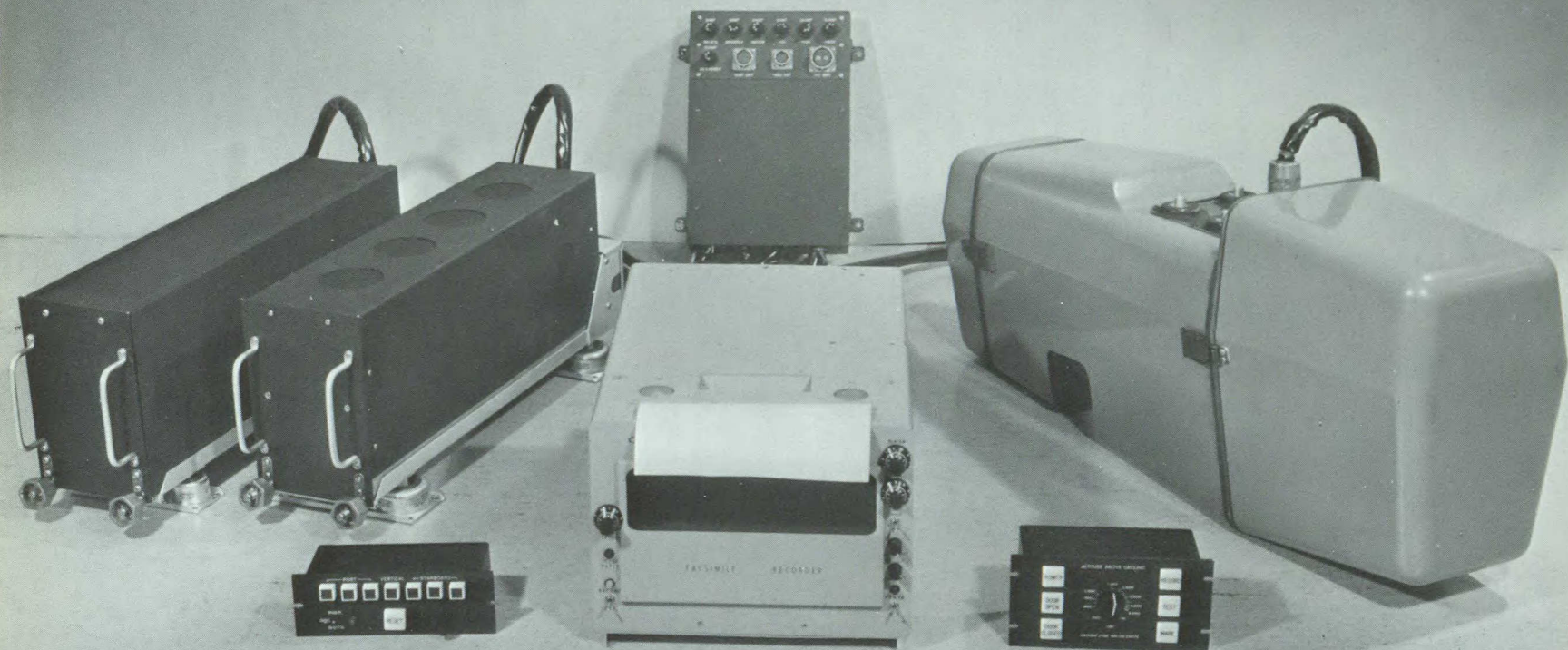
## **AIRBORNE IR FOREST FIRE MAPPING AND DETECTION SYSTEM**

The ability of infra-red devices to detect small differences in "heat" radiation has been exploited for many years in specific fields. Only recently, however, has the technique been applied to mapping and detection from the air of going or incipient forest fires, day or night, whether smoke-obscured or under light to heavy foliage. Such IR scanning equipment also provides terrain information necessary for geographic location; a method for early determination of fire rate-of-spread, effects of weather and fire control measures; an efficient direction and monitoring facility for post-fire mop-up activities; an aid in the location of lost or trespassing parties; a method of locating stream pollutants.

Computing Devices for several years has conducted a successful program resulting in the Firemapper, a system developed expressly for application by Forest Protection organizations. The sound basic design philosophies, acquired by the company through recent design, manufacture and installation of electro-mechanical avionics equipment on more than 4000 aircraft throughout the world, have been applied to the Firemapper to provide reliability and flexibility in concert with simplicity of operation and maintenance.

The system comprises a Power Unit which accepts aircraft generator output and distributes to all components, regulated and fused, and an Electronics Unit housing the bulk of the circuitry. Both units may be remotely stowed. The system is operated from a selected operator/observer station. A Control Unit provides for the operation of all airborne functions and a Display Unit contains an audio alarm capability and visual indicator panel. The Scanning and Film Recording Pod is mounted externally. A near-instantaneous In-cabin Recorder provides an optional, big-image facility. All system units conform to operational avionic configurations.

In operation, IR energy is received from the terrain below the aircraft and is focussed on the detector. The detector, cooled by liquid nitrogen, generates an output electronic signal proportional to the amount of IR energy received. The varying signal related to the IR output from the ground being scanned is amplified and applied to the various system outputs. An instantaneous audio alarm is sounded to notify the operator of high energy "hot" sources detected. The general ground area from which the source originated is also indicated. In the Recorders, a pinpoint of light of proportional varying intensity is scanned at the same rate as the ground below the aircraft. Hence, IR terrain images are permanently recorded. Location, shape and relative fire activity data is then conveyed to ground and air crews.



## ORIENTED CAESIUM MAGNETOMETER (AN/ASQ-501)

The Electronics Division of CAE Industries Ltd. has recently developed a high sensitivity airborne magnetometer system suitable for both ASW and geophysical exploration applications. This development follows a series of successful equipments produced by CAE in the general area of MAD and particularly in the field of ASW aircraft compensation, where CAE has attained a position of world leadership.

In addition to having a basic sensitivity of 0.01 gamma, the CAE oriented caesium magnetometer, which is an optically pumped system, combines several important concepts which together make it very desirable for all airborne applications.

The system eliminates heading error effects commonly present in optically pumped magnetometers by orienting the single caesium cell on a mechanical gimbal system, unlike most other systems which attempt to minimize the undesirable rotational or heading error effects by a complex multi-cell approach.

This simple orienting approach, which was developed by The National Aeronautical Establishment (NAE) of the National Research Council of Canada, when combined with an inherently stable self-oscillator caesium sensor loop and a unique low noise level, infinite dynamic range, frequency to voltage converter provides the most sensitive airborne magnetometer available.

Earlier versions of this magnetometer have been flying in the NAE experimental North Star aircraft for over two years. The present developmental model, (photo opposite page), which was built for the Department of National Defence of Canada, is presently flying in a Royal Canadian Navy CHSS-2 MAD equipped helicopter undergoing operational evaluation tests.

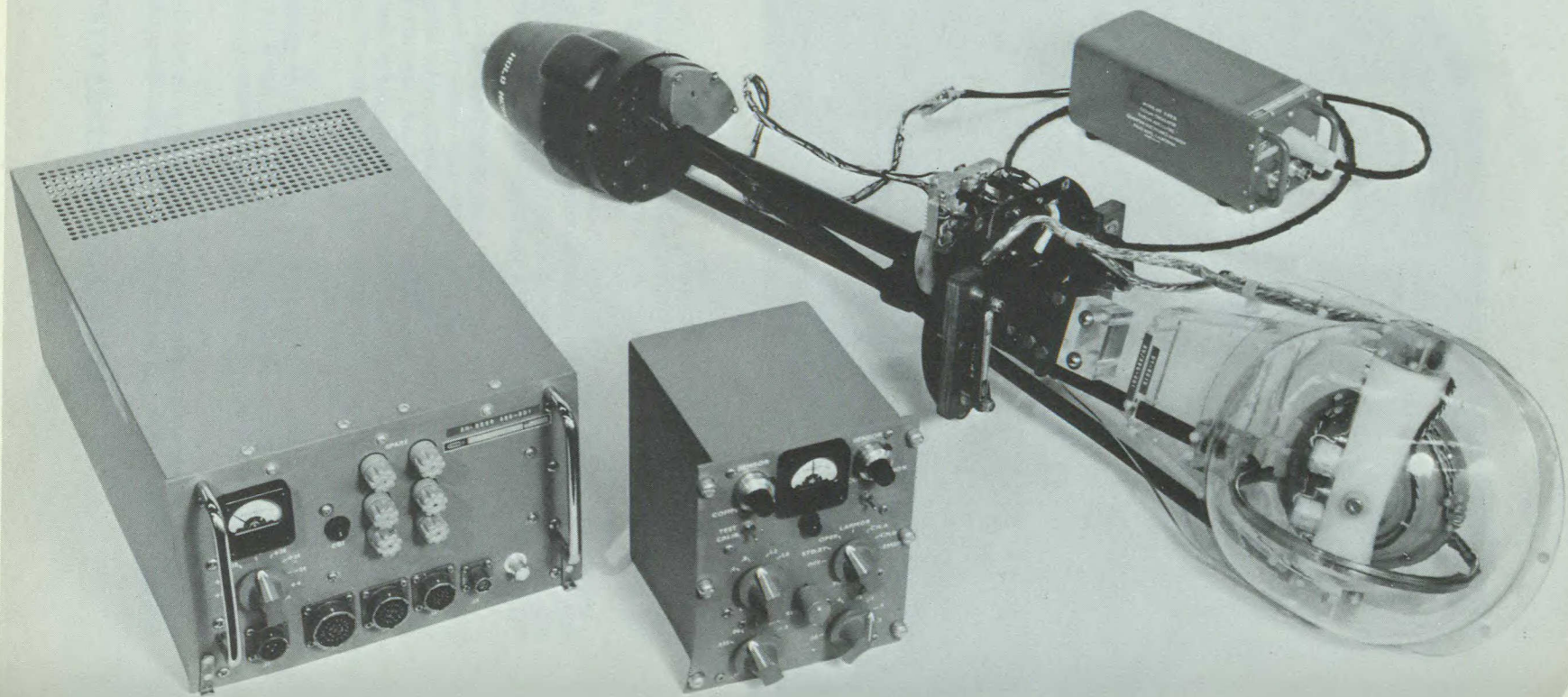
A simpler version of the same magnetometer is presently being flown in a small geophysical survey aircraft for magnetic mapping purposes.

It is presently planned to build a number of Service Test models of the magnetometer which will be designed and tested to satisfy the requirements of the applicable airborne military specifications.

This system, in addition to being greatly simplified with respect to the developmental model, will, through the widespread use of microminiature circuiting, have a total system weight of only 40 lbs. (18.2 Kg.)

The oriented caesium magnetometer is compatible with the requirements of both fixed and rotary wing aircraft and is unaffected by either magnetic field gradients or AC power field levels.





## FLUID VELOCITY METER

This instrument is now being manufactured by Champlain Power Products Limited for a number of applications where the measurement of low Fluid Velocities is of importance.

Using a unique fluid jet sensor, the instrument is able to measure fluid velocities in a range where the accuracy of comparable devices tends to fall off. For example, measurement of velocities as low as 0.15 FT/Second in air and 0.015 FT/Second in water is possible.

The Fluid Jet Sensor provides an all-pneumatic high gain signal directly proportional to the velocity of the fluid being measured. The sensor consists of a high velocity fluid jet which impinges on two pressure receiver tubes symmetrically spaced in the Jet. Cross Flow velocity of the Fluid causes the Jet to deflect and unbalance the pressure between the receiver tubes. This pressure difference is used as a measure of the fluid velocity.

Applications to date have been mainly in scientific and industrial areas. The instrument shows great promise for use as a low range airspeed indicator for helicopter and VTOL Aircraft use. Other possible applications include the study of ocean and lake currents and the monitoring of explosive gas mixtures.

In addition to the Fluid Velocity Meter, the Company manufactures other environmental instruments and high quality mechanical shaft seals. The shaft seals, based on a hydrostatic principle, have found acceptance on Nuclear Power Reactors.





## CUSTANCE SUDORIMETER

This new instrument developed by Canada's Defence Research Chemical, Radiation and Biological Laboratories and named after its inventor, Dr A. C. Custance is now being produced by Canadian Research Institute.

The instrument, finds wide use in physiological and psychological research, monitoring during anaesthesia, lie detection, human factors work, etc, etc. The instrument comprises a sensor which is applied to the human subject, capable of measuring small humidity changes. This variation with perspiration actuates a servo mechanism, driving a valve admitting dry air until a pre-established balance is again regained. The digital read-out is in linear relationship to the rate of flow of the restoring air. A sensitive panel indicator shows the degree and direction of unbalance, so that interesting psychological correlations are possible. Provision is made for external recording of results, and available models include single and dual-channel instruments, the latter permitting the use on two subjects simultaneously, or on two locations on the same subject.

A wide application of this instrument to operating room procedures, as a replacement or an extension of oximetry is anticipated. Because the time of response is less than one second, it will provide valuable supporting evidence in forensic lie detection.





## H.F. SOUNDING SYSTEM

Long distance radio communication is dependent upon the ability of the Ionosphere to reflect the transmitted signal. To be able to guarantee communication between two stations at all times, a close watch must be kept on the reflecting properties of the Ionosphere so that the frequency giving optimum reflection can be selected for use. The Ionospheric measuring equipment was manufactured under Navy contract according to the requirements of 'Oblique Ionospheric Sounding System Standard' issued by the United States Defence Communication Agency and is only one of many complex equipments researched, designed, engineered and produced by EMI Electronics.

The Transmitter produces a binary-coded pulse train of 30KW p.e.p., 1, 2 or 3 milli-seconds long. Frequency coverage is from 2 Mc/s to 32 Mc/s in four octave bands, each octave having twenty spot frequencies linearly distributed. The pulse train consists of 100 micro-second pulses, each having a Gaussian profile. Ten, twenty or thirty pulses are used according to the pulse-train length, and the pulses are phase-reversal modulated. A train of thirty pulses at 30 KW gives a receiver signal, using pulse addition, equivalent to a single pulse transmitted at 900KW p.e.p., while the binary code enables the signal to be identified.

The Receiver sweeps through the eighty frequencies in synchronism with the transmitter. This is achieved by using highly stable oscillator and timing units, and by further synchronizing both units to time standard signals.

One receiver is capable of operation with any number of transmitters up to a maximum of ten. When a transmitted pulse train is received it is demodulated to provide a binary code, and the separate code elements are added to provide a signal pulse to the display.

Using the pulse-compression technique the power gain by a 30-bit pulse train over a single pulse is 14.8db, while retaining the resolution of a single pulse. The receiver display provides instantaneous information on the state of the Ionosphere as an Ionogram on a c.r.t. display. The Ionogram has an *X* axis of frequency from 2 Mc/s to 32 Mc/s in eighty steps, and a *Y* axis of elapsed time. The reflection from the Ionosphere modulates the *Z* axis to provide a bright-up signal. The low weight and minimal power consumption of the receiver means that it may be fitted into any truck, ship or aircraft having sufficient space.

A Paper Recorder connected to the receiver provides a continuous reference to past conditions. The paper record has eighty channels, one for each frequency, arranged across the paper at sixteen channels to the inch. Elapsed time is recorded along the length of the paper at the rate of one inch per hour, with unique marks at noon and midnight. Each channel records a signal received as a mark on the paper, so that the paper record does not give detailed information, just the fact that a signal was received on a particular frequency at a specified time.

A specially designed, rugged Camera uses standard 100 ft 35 mm daylight-loading spools of film to automatically record Ionograms. The camera has a Wollensak f 1.9 to f 22 Raptar lens, and a flat-field non-distorting optical system. A data chamber provides three types of data: time, date, and exposure number.

The Remote Display c.r.t. provides an Ionogram similar to the one shown at the receiver unit. Either of these Ionograms may be photographed by using the special camera. It should be noted that a photographic record provides complete information concerning a signal, i.e. frequencies reflected, number of hops, etc.

### TRANSMITTER

<i>Frequency response:</i>	Output power within 1 db below and 2 db above nominal.
<i>Output power:</i>	30 KW p.e.p.
<i>Duty cycle:</i>	6 per cent max.
<i>PRF:</i>	20 pulse trains per second.
<i>Pulse train:</i>	2 at each frequency per transmission cycle, each consisting of 10, 20 or 30 pulses.
<i>Pulses:</i>	100 $\mu$ Sec. duration, phase reversal modulated, Gaussian profile.
<i>Stability:</i>	One part in $10^6$ per day.
<i>Accuracy:</i>	One part in $10^6$ .
<i>Power Supply variation:</i>	10 per cent change causes less than one part in $10^6$ frequency change.
<i>Spurious and harmonic levels:</i>	50 db minimum below the output signal level.

### RECEIVER

<i>Sensitivity:</i>	$3 \mu V$ for $\frac{S+N}{N}$ ratio of 20 db.
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*Overload recovery time:*

Less than 500  $\mu$  Sec.

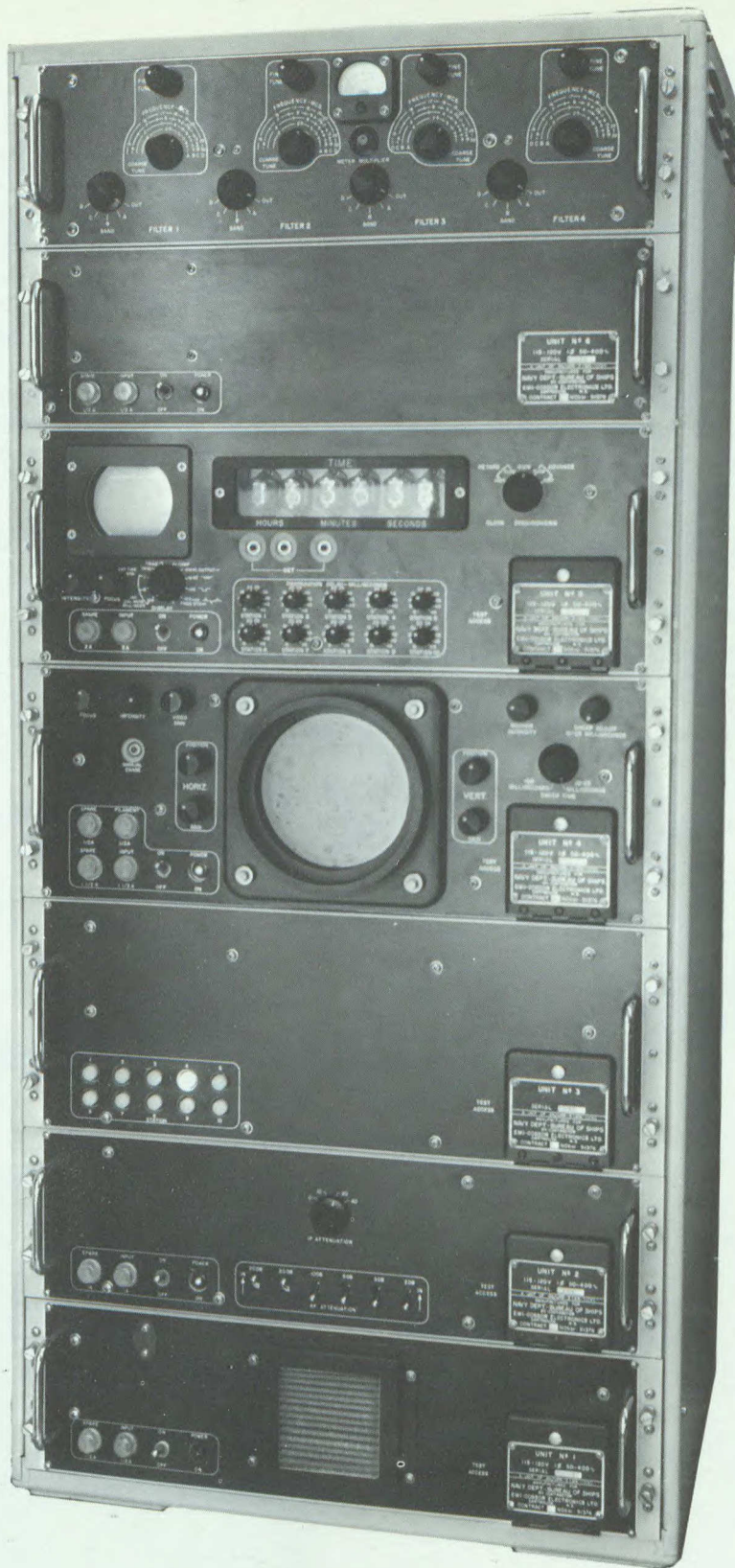
*Selectivity—*

adjacent channel rejection: 20 db minimum

beyond adjacent channel rejection: 60 db minimum

### POWER SUPPLIES REQUIRED

<i>Transmitter:</i>	208V 3 phase 50 or 60 c/s.
<i>Receiver:</i>	115V or 120V at 2 amps single phase 50 to 400 c/s.
<i>Frequency coverage:</i>	2 Mc/s to 32 Mc/s by eighty spot frequencies.



## INFRA-RED SPOTTING DEVICE

This infra-red measuring device compares the object radiance to a reference radiance level. The reference level may be varied to meet varying conditions. It is designed to use as a reference signal any other object or background such as a wall in a building or the ground when outdoors. Calibration is carried out by aiming the equipment at the background and then adjusting the threshold control until the audio tone is just extinguished. When the gun is now aimed at an object which emits more radiance than the background an audio tone will be emitted from the speaker. An earphone is available for high noise level environments.

The range of applications is limitless covering such obvious applications as stores or hangars surveillance, electrical checks for overheated ballasts or connections as well as the location of the fire source in smoke filled areas or between walls and ceilings.

This is another development and production by Spar Aerospace Products.

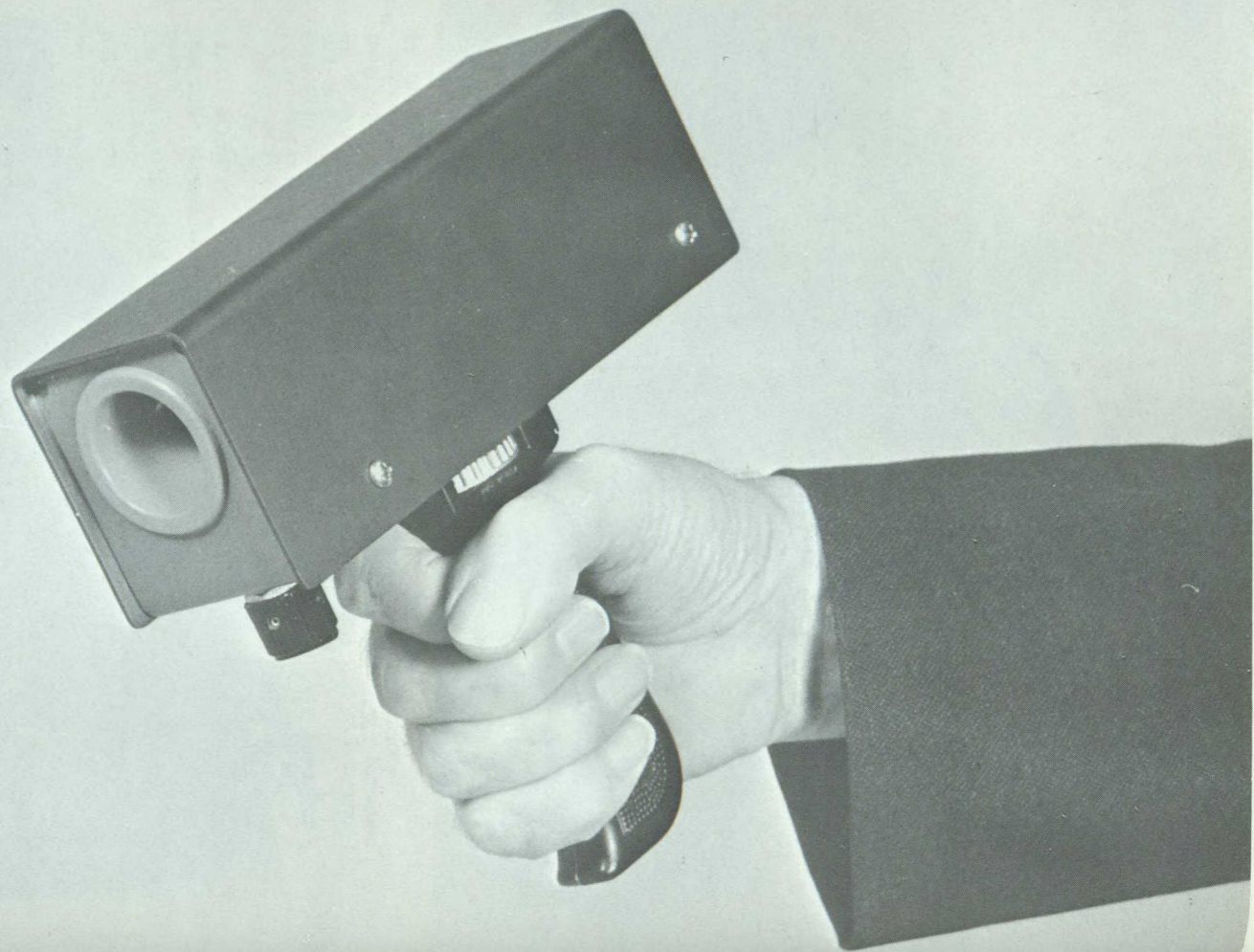
### PERFORMANCE

#### Minimum Detectable Temperature Difference.

(Minimum temperature of the object above ambient which is just detectable depends on ambient temperature).

<i>Object Temp.</i>	<i>Ambient Temp.</i>	<i>MDTD</i>
95°F (35C)	75°F (24C)	20°F (7C)
<i>Field View</i>	6° x 6° angle	
<i>Distance to Size</i>	Area covered at 10 ft. (3.04m) is 1 ft. x 1 ft. (.3 x .3m)	
<i>Ratio</i>	Area covered at 20 ft. (6m) is 2 ft. x 2 ft. (.6 x .6m)	
<i>Spectral Response</i>	2.5 - 2.7 microns.	
<i>Response Time</i>	Less than .25 seconds i.e. for a surface at 10 ft. (3.04m) away, scanning rate should not exceed 4 ft. (1.2m) at 20 ft., 8 ft. (6m, 2.4m) per second etc.	
<i>Dynamic Range</i>	Approx. 95°F. to 500°F. 356 - 260°C.)	
<i>Operating Temp. Range</i>	-10°F. to +130°F. (-23 - +55°C.)	
<i>Range</i>	The range of the equipment is virtually unlimited. It can see a cigarette at 50 feet, (15m), a barbecue fire at 1,000 feet (304m), or the sun at 93,000,000 miles (149,665.000km).	





## SOLID STATE POWER CONDITIONING DEVICES

Spar Aerospace Products Ltd. has over ten years of experience in the design, development and manufacture of many types of solid state power conversion of equipment for aerospace, marine and land vehicle applications. The group is supported by manufacturing and quality control facilities experienced in the volume fabrication of such equipment, thus ensuring that all aspects of the power conversion field from conceptual studies through manufacturing to field support can be implemented to meet the full requirements of customers.

The SPS 44 solid state, 2.5 kva frequency converter is designed to meet the needs for aircraft, vehicular and marine electrical power conversion. Primary application: converting variable-frequency input power to frequency regulated 400 Hz output power. This power converter is used in power systems where conventional engine driven alternators are directly coupled to the accessory pad, and a medium level power source with constant frequency is necessary for frequency sensitive electrical equipment. Complex and weighty CSU drives may be eliminated where bulk of power is used for heating, lighting and rectifier loads. It is fully qualified to MIL-E-5272.

### INPUT POWER

106 - 120 volt rms, line-to-neutral: 300 -  
550 Hz 3-phase: 4-wire  
190 volt transients for 100 ms line-to-  
neutral  
2000 volt transients for 0.5  $\mu$ s line-to-line

### OUTPUT POWER

112.5 - 118 volt rms line-to-neutral: 400 Hz  
 $\pm 2\%$  3-phase: 4-wire  
2.5 kva continuous: 3.25 kva for 5 minutes  
0.75 lag to 0.9 lead power factor  
300 va of 115 v 3-phase delta output  
200 va of 26 v single-phase output  
300% short circuit current for 5 seconds,  
any configuration  
4% total voltage waveform harmonic con-  
tent  
120°  $\pm 1.5^\circ$  phase displacement for bal-  
anced loads  
75% efficiency at full load.

The SPS 45 is a compact, solid-state, remotely controlled light dimming device designed to provide simultaneous, efficient brightness control of both 5.5-v and 28-v instrument lamps without additional transformers or resistors. Developed to meet the needs of one particular type of aircraft, the SPS 45 is readily adaptable to a wide variety of aircraft, vehicular or marine applications.

The SPS 45 operates from any 115-v, single-phase, 300Hz-550Hz supply. It meets the requirements of MIL-E-5272 and MIL-E-5400. Its high reliability design provides many advantages for dimming rugged, low-voltage lamps in both new aircraft and retrofit applications. It is short circuit proof and has a design MTBF of 7,000 hours.

### INPUT POWER

106 - 120 volt rms  
300 - 550 Hz  
MIL-STD-704 transients

### OUTPUT POWER

5.0 to 28 volts rms; 200 VA @ 28 v  
1.15 to 5.5 volts rms; 75 VA @ 5.5 v  
Outputs combined: 100 VA @ 28 v plus  
50 VA @ 5.5 v  
Short circuit: 5 seconds without damage.

### MECHANICAL

Weight: 37 lbs. (16.8 kg)  
Size:  $\frac{3}{4}$  ATR, full 22.5" x 7.5" x 7.5"  
(57 x 19 x 19 cm)  
Self-cooled.

### ENVIRONMENTAL SPECIFICATIONS

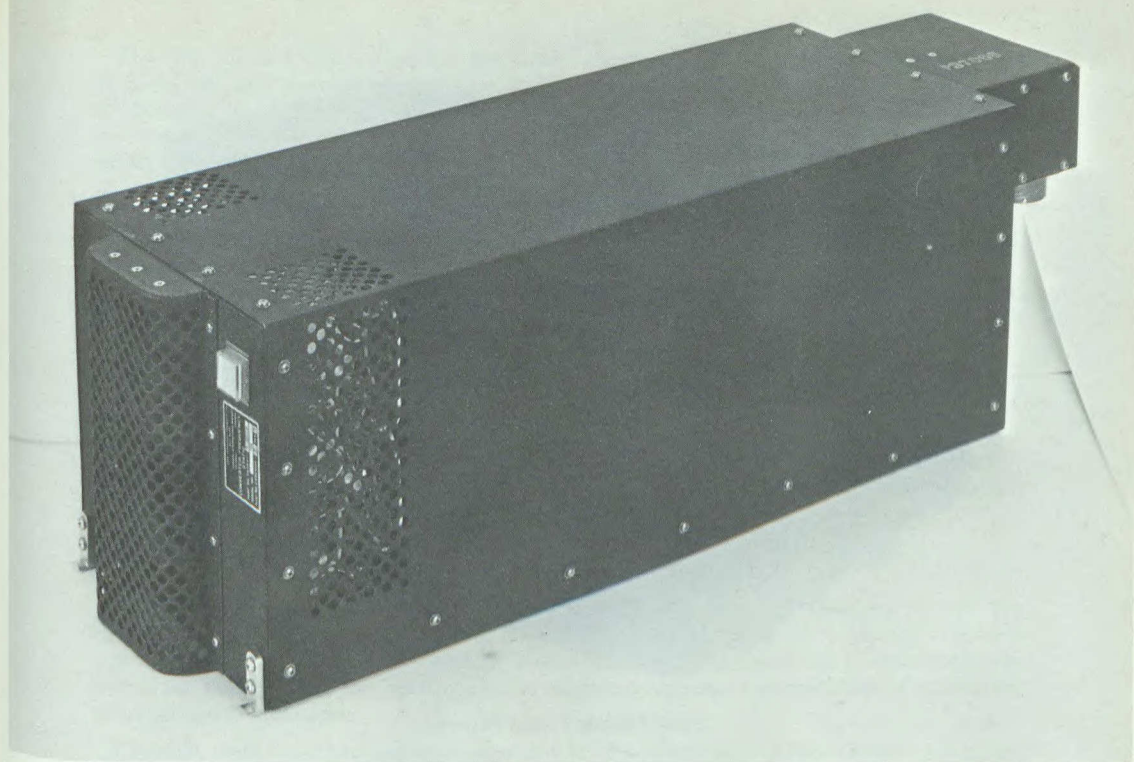
Temperature: -54° to 71°C (-62° to  
160°F), 85°C (185°F) for 5 minutes  
Altitude: 36,000 ft. (11,000 m)  
Vibration: MIL-E-5272, procedure V  
EMI: MIL-I-6181  
Salt spray: MIL-E-5272, procedure I  
Sand & dust: MIL-E-5272, procedure I  
Fungus: CAM 4b, appendix I

### MECHANICAL

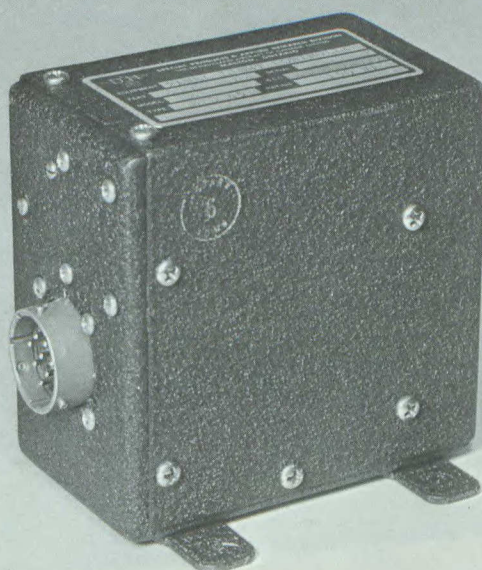
Weight: 36 ounces (1 kg)  
Size: 4 x 2½ x 4 ins.  
(10.2 x 6.3 x 10.2 cm)

### ENVIRONMENTAL SPECIFICATIONS

Temperature: -54°C to +71°C, 85°C for  
5 minutes  
Altitude: 36,000 feet (11,000 m)  
Vibration: MIL-E-5272, procedure XII  
Shock: MIL-E-5272, procedure V  
EMI: MIL-I-6181  
Salt spray: MIL-E-5272, procedure I  
Fungus: CAM 4b, appendix I  
Humidity: 240 hours, 95% RH  
Acceleration: 15 g, 3 axes.



SPS-44 Power Frequency Converter

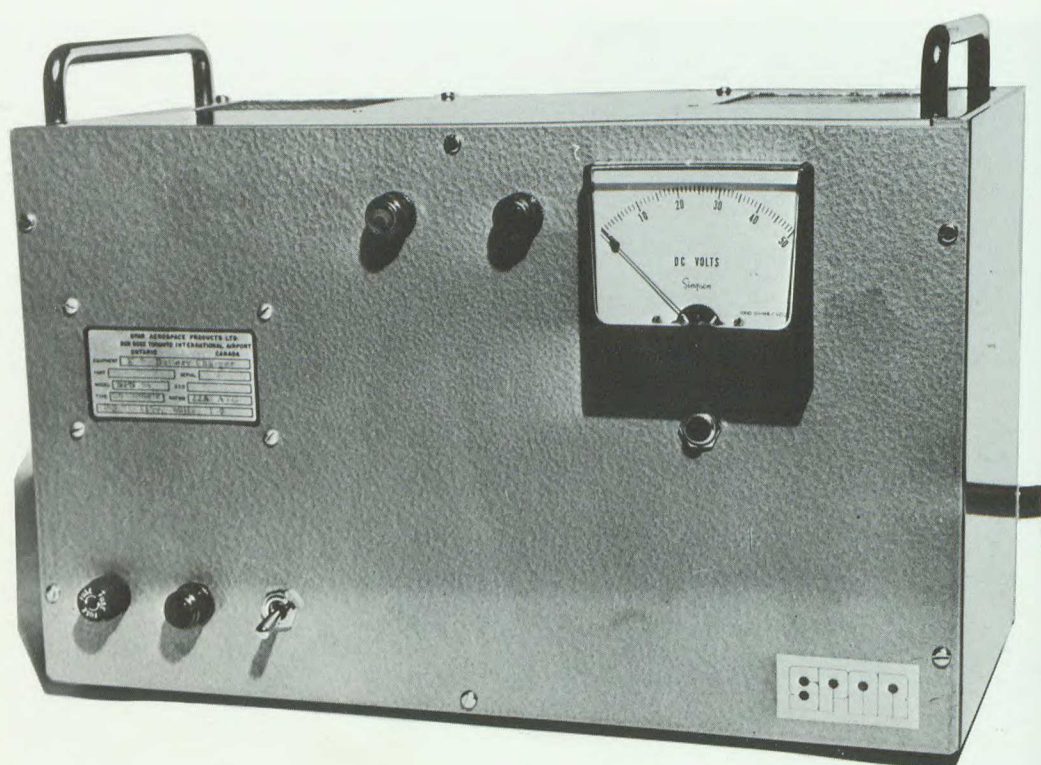


SPS-45 Panel Light Controller





SPS-48 Static Power Inverter



Bench Charger for Coulometer Batteries

The SPS 48 is a solid state, 65 VA single phase inverter that operates from an input of 20-30 vdc and provides single phase 400 Hz output at either 26 or 115 volts rms or a combination of both. The unit is used in airborne and ground applications where 400 Hz instrument power is required. Through Spar engineering, the inverter can be applied to all military and civilian aircraft and to vehicular and marine applications.

#### INPUT POWER

20 - 30 vdc  
80 volt transient MIL-STD-704  
Reverse polarity protected

#### OUTPUT POWER

115 volt rms or 26 volt rms (or combination)  
Single phase  
400 Hz  $\pm 1\%$   
 $\pm 2\%$  voltage regulation (line, load and temperature)  
65 VA  
0.7 pf lag to 0.9 pf lead  
200% short circuit current  
150% power overload for 5 min.  
5% total harmonic distortion  
65% efficiency

#### MECHANICAL

4.7 in. x 6.7 in. x 3.4 in. (12 x 17 x 8.6 cm)  
overall including connectors and base plate  
3.25 lb. (1.48 kg) (If unit required to operate fully immersed in water, add 1 lb. 11 oz. (.79 kg))

#### ENVIRONMENTAL SPECIFICATIONS

Designed to the requirements of TSO-C73  
Temperature:  $-55^{\circ}\text{C}$  to  $+71^{\circ}\text{C}$   
Altitude: to 50,000 ft.  
Humidity: 48 hours at 95% RH at  $50^{\circ}\text{C}$   
Shock: 6G for 10 ms/plus crash safety 15G  
Vibration: 5G max.  
RFI: MIL-I-6181D

A recent development at Spar is the Coulometer Controlled Battery Charging System. The Spar Battery Charger forms the base of a sophisticated system designed to provide regulated, maximum-efficiency charging of modern Ni-Cd batteries. Controlled by a coulometer unit within the battery pack, the charger ensures high-rate-of-charge replenishment in accordance with the battery application.

Constant, high-current charging is provided in the initial part of the charge cycle, after which an automatic pulsed overcharge is supplied; this ensures optimum charging with improved battery performance and extended life, assists in cell equalization and reduces field maintenance.

The Coulometer cell measures the quantity of charge removed from the battery during operation, and controls the charging circuit replenishing the battery with an equal amount of charge during the charging cycle. The significant advantages of this system over the presently used constant-potential or constant-current systems are:

- In-service batteries are maintained at a full-charge condition, even with repeated discharge and charge cycles.
- Batteries with unknown past history can be put on charge and most efficiently brought to their full capacity.
- Variable charge rates to suit operating conditions are simple and practical.
- Thermal run-away problems with present Ni-Cd battery charging systems are overcome.
- Equalization of cell voltages is accomplished during the initial operation period with a new battery, and subsequently maintained in service.
- Battery maintenance is reduced; field failures due to gassing and thermal problems are eliminated.
- System efficiency and reliability are improved.
- Provision is made for primary rather than secondary charge control.
- Designs are available for virtually all current ratings and battery capacities for any application.

## STATIC INVERTERS

A research and development programme now going into its sixth year at Garrett Manufacturing Limited has produced static inverters as a logical follow-up for this company's work in solid state controls. After evaluating several inverter techniques Garrett has now developed a line of low power single phase sine wave static inverters mainly for aircraft and ground vehicle use. The following are typical units now available:

### 75VA Static Inverter for Land Navigation Systems

Input — 20-30 VDC

75 VA 26 VRMS  $\pm 1.5V$  400 Hz  $\pm 2\%$

Output —

15 VA 38  $\pm 2\%$  VAC 800 Hz  $\pm 2\%$

Weight — 10 pounds (4.5 kg)

Can be supplied with phase adapter to operate three phase gyro.

This unit is designed to provide A.C. power for the Army's Land Navigation Systems and serves either the LN 101 (Gyro Compass) or the LN 102 (Magnetic Compass). For further association see pages 264-267.

### 150VA Static Inverter for U.S. Army P/N 10516412

Frequency — 400  $\pm 4$  cycles

Input — 24 volts  $\pm 6$  volts

Output —

115 volts  $\pm 5\%$  single phase A.C.

Convection Cooled — no fan.

Dimensions — 7.5" W. x 10.25" L. x 6.0" H.  
(19 x 26 x 15 cm)

Weight — 16 pounds (7.25 kg)

Waterproof.

This unit has been qualified to Specification MIL-1-60166 (MU) and is on the Qualified Products List.

### 250VA Static Inverter for Light Aircraft and Helicopters

This unit has been designed to replace existing rotary inverters. Physically interchangeable with rotary inverters, MS 21983. The unit is lighter and has higher efficiency at a comparable cost. It will be supplied with FAA TSO C73 certification.

Dimensions — 4.75" W. x 6.25" H. x 9.25" L.

Dimensions — (12 x 16 x 23 cm)

Input — 20-30 VDC

Output —

115  $\pm 5$  volts 400  $\pm 1\%$  single phase AC.

26  $\pm 1\frac{1}{2}$  volts 400  $\pm 1\%$  single phase AC.

Convection Cooling — no fans.

Overload — 150% for five minutes

Weight — 10 pounds (4.5 kg)

Maximum Ambient — 71°C

Efficiency — 70%

Reverse polarity protection included.

Short Circuit — Will withstand an output short circuit indefinitely without incurring damage and will provide a minimum of 25% of the rated current to clear a fault (by tripping fault-load circuit breaker).

Basic 250VA units can be connected in parallel to form 500, 750 or 1000VA single phase power, or alternately three units can be connected as 750VA three phase unit.

### 500VA Static Inverter

Size —  $\frac{3}{4}$  ATR Short — Rack Mount

Input — 21.5 V — 27.5 VDC

Output —

115 + 4.5 V, 400  $\pm 1\%$  HZ Single Phase AC

- 2.5

Convection Cooling — No Fan.

Efficiency — 80% Minimum

Weight — 17 pounds (7.7 kg)

150% for five minutes

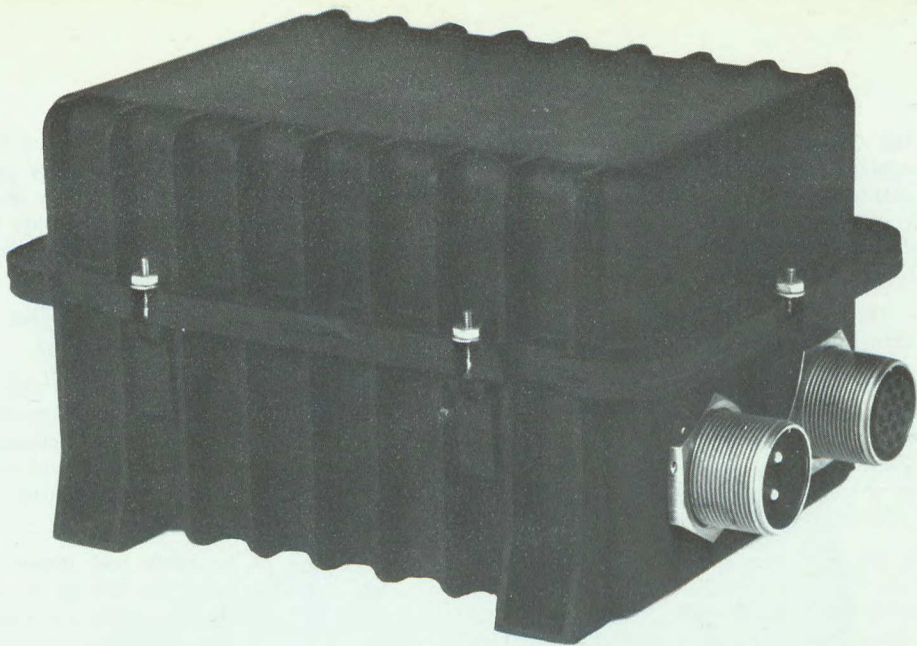
Overload —

200% for five seconds

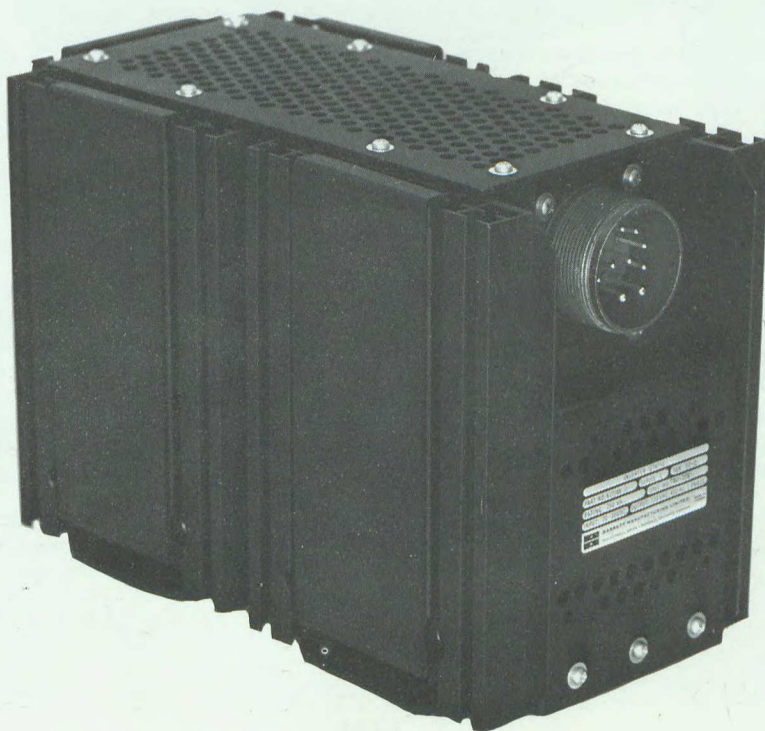
Short Circuit Capability — Will provide a minimum of 250% rated current for 10 seconds into a short circuit placed on its output. In the event of the short existing for longer than ten seconds (i.e. hang-up of fault load breaker) the unit will then self protect until the fault is removed.

Maximum Ambient Temperature — +71°C.





A E L — 75 VA Static Inverter for Land Navigation System.



250 VA Static Inverter for Light Aircraft & Helicopters.

## REFLECTION METER—CG-6

The Canadian Research Institute Model CG-6 Reflection Meter is basically a device for shining a standardized light on the sample under study and measuring the quantity and quality of light reflected back on a photo-electric cell. To do this in an easily utilizable way, a simple computer circuit drives a sensitive galvanometer. Depending on the direction of the incident light and the reflected light selected for analysis, the instrument may be used for diffuse reflection, colour, whiteness, brightness, opacity, gloss or sheen.

The Model CG-6 Reflection Meter finds applications in so many fields that its use is virtually limited only by the ingenuity of the operator.

The Model CG-6 can be used without alteration with a wide variety of standard search units or "heads" as well as custom built heads for special applications, all of which plug in to the instrument proper. For diffuse reflection, including several modes of measuring colour, the light strikes the test surface normally and is measured in a conical segment with an average angle of reflection of  $45^\circ$ . Since measurement is taken in all meridian planes, the reflection from surfaces showing directional texture is averaged over  $360^\circ$ .

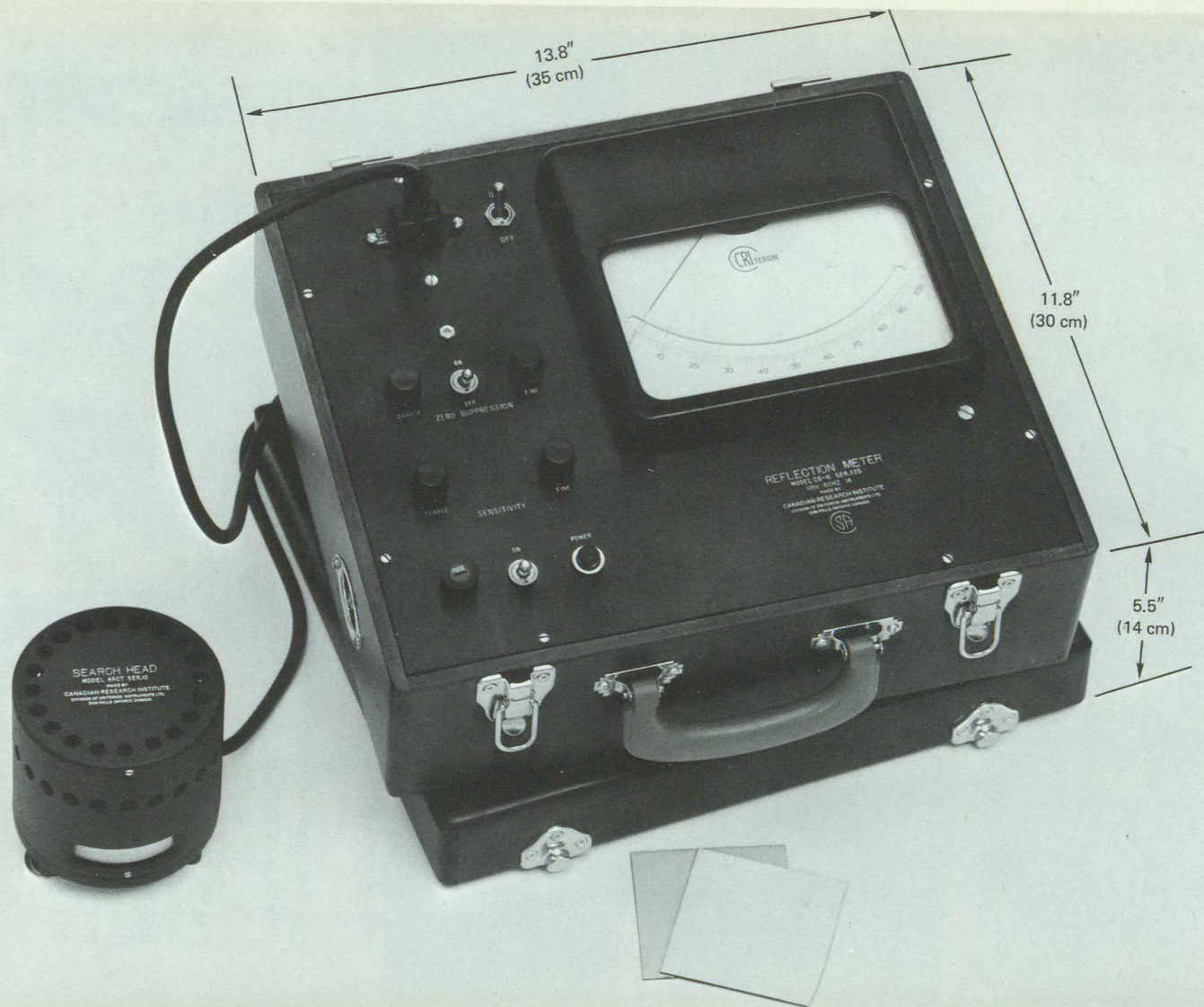
For gloss measurement, the search units provide angles of incidence and inspection which are the same but diametrically opposed. Gloss heads are available for all of the commonly used incident angles as required in the paint, plastic, ceramic, metal and paper industries.

The Model CG-6 is also an extremely sensitive and accurate Colour Difference Meter, having even wider scope than some instruments specifically offered to measure colour difference. A combination of scale expansion and scale suppression features built into the instrument, permit the user to utilize the 155 mm scale normally showing 0 to 100% reflection as, say, 0 to 25% for very dark samples with a 4 X scale magnification, or 55 to 80% for light samples, again with 4 X expansion. These features, completely at the expression of the operator (within the ultimate sensitivity of the meter) solve the problem of matching dark colours in textiles and of matching whites in the appliance trade.

For the measurement of colour and colour difference, the Model ARCT Search Unit covers a 16 mm diameter portion of the sample, and is for use with up to 4 optical filters 25 mm diameter in a turret for immediate use of any one filter. Any system of Wratten-type (gelatin) or glass filters may be used, but the instrument reaches its peak of utility when the three tristimulus filters are used. Results of measurements made with the CG-6 and tristimulus filters are in close agreement with CIE readings, and permit impersonal and international identification of colour. Values may be converted to reflectance, dominant wavelength and purity or brilliance, hue and saturation, or value, hue and chroma — all alternative modes of expression of colour or left as CIE — X, Y, Z.

For the measurement of gloss, no such international agreement has been reached as applies to colour. Several different industries have their own conventions regarding the expression of gloss. Specular gloss is determined by shining a pencil of light on to the surface to be measured at a specified incident angle, and measuring the light reflected at an equal but opposite angle. Calibration is in reference to polished black glass standards. Available search units utilize angles of  $45^\circ$ ,  $60^\circ$ ,  $75^\circ$  and  $85^\circ$  with a universal model in preparation. Most measurements are made at a  $60^\circ$  angle. (See the special application notes below).

While the Model CG-6 Reflection Meter finds wide usage for the more obvious measurement of colour and gloss, it is also invaluable for many less direct tests used in science, industry and medicine.





## PRECISION TRACKING CONTROLS

The Slewstick Control, designed and built in Canada by Bourns (Canada) Ltd., is used to manually control elevation and azimuth, on parabolic dish, precision tracking antennae.

The control consists of a handle supported on a ball, by virtue of which, two Precision Potentiometers are controlled. The ball is in a teflon socket, with freedom of plus or minus 30 degrees in two axis at right angles to each other. The ball and socket arrangement is let into a plate which forms part of the instrument housing and serves also as the top of the instrument. The handle is installed in such a manner — by means of a spring and roller — that it will return to a central position in the 'hands-off' mode.

Extending through the top of the handle is a shaft with a push button. Depressing this push button, allows the operator to actuate a pair of micro switches and thereby engage the control mechanism.

Employment of the Slewstick Control produces rotation of the Precision Potentiometers which is directly proportional to the angle of displacement in the two axes, which in turn controls the antenna tracking.

The unit has been tested across a temperature range from 0° to 50°C and operation is satisfactory throughout.

Bourns (Canada) Ltd. is active in the design and manufacture of unique electro mechanical and electronic devices, and has an enviable background of experience and 'know-how' at its command.



# STEPPER MOTORS

## Size 18VR — 15° Step Angle

Novatronics Ltd. 18M34A1 VR stepper motors have a multi-toothed soft iron rotor. When DC pulses are appropriately applied to the stator windings the resulting magnetic field causes the nearest rotor tooth to line up for minimum magnetic reluctance (smallest air gap). By energizing the stator windings sequentially the stator field is made to rotate in steps either clockwise or counterclockwise. Rotation of the stator field will cause the rotor to follow.

The 18M34A1 stepper motor has a rotor inertia of only 3.66 g cm<sup>2</sup>. A stable air gap is maintained by bonding the stator to the housing and using material with compatible temperature coefficients.

### • General Specifications

#### Mechanical Data

Weight .....	12.8 oz.
Rotor Inertia .....	.020 oz. in. <sup>2</sup>
Holding Torque .....	10 oz. in.
Pull-in Torque at 200 Steps/sec	4.3 oz. in.
Step Angle .....	15°
Pull-out Rate (no load) .....	520 steps/sec.
Pull-in Rate (no load) .....	500 steps/sec.
All tests performed after thermal stability with instrument mounted on standard heat sink and in ambient of 25° C.	

#### Electrical Data

Stator Winding .....	4 phase
Supply Voltage .....	28 volts D.C.
Resistance (R) per Phase .....	52 ohms.

### Switching Mode

Terminal	Yel.	Red	White	Black
CW	—	—	+	+
CCW	+	—	—	+
	+	+	—	—
	—	+	+	—

Green connected to positive. Motor rotation as viewed from shaft end.

### • Options Available

- Special windings
- Special torque/speed characteristics
- Terminals instead of leads
- Different shaft lengths
- Pinion shaft ends

## Size 08PM — 45° Step Angle

Novatronics Ltd. type 08M30K3 four-phase motor have a permanent magnet rotor. The rotor lines up with the stator magnetic field produced when DC pulses are applied to the stator windings. By switching the polarity of the DC voltages in a particular way the stator field is made to rotate in steps either clockwise or counterclockwise. The rotor and shaft will follow.

The 08M30K3 stepper motor uses a special patented magnet to insure maximum energy retention over a long service life. A stable air gap is maintained by bonding the stator to the housing and using materials with compatible temperature coefficients.

### • General Specifications

#### Mechanical Data

Weight .....	1.6 oz.
Rotor Inertia .....	.004 oz. in. <sup>2</sup>
Holding Torque .....	.40 oz. in. (min.)
Pull-out Torque at 160 steps/sec	.3 oz. in.
Operating Temperature Range .....	-55°C to +100°C
Pull-out Rate (no load) .....	800 steps/sec. (min.)
Pull-in Rate (no load) .....	235 steps/sec. (min.)
Normal Step Angle .....	45°
All tests performed after thermal stability with instrument mounted on standard heat sink and in ambient of 25°C.	

#### Electrical Data

Stator Winding .....	4 phase, 4 pole
Supply Voltage .....	28 volts D.C.
Resistance (R) Per Phase .....	200 ohms.
Rotor .....	permanent magnet

### Switching Mode (180° Rotation)

Terminal Step	Yel.	Red	White	Black
CW 1	—	—	+	+
2	+	—	—	+
3 CCW	+	+	—	—
4	—	+	+	—

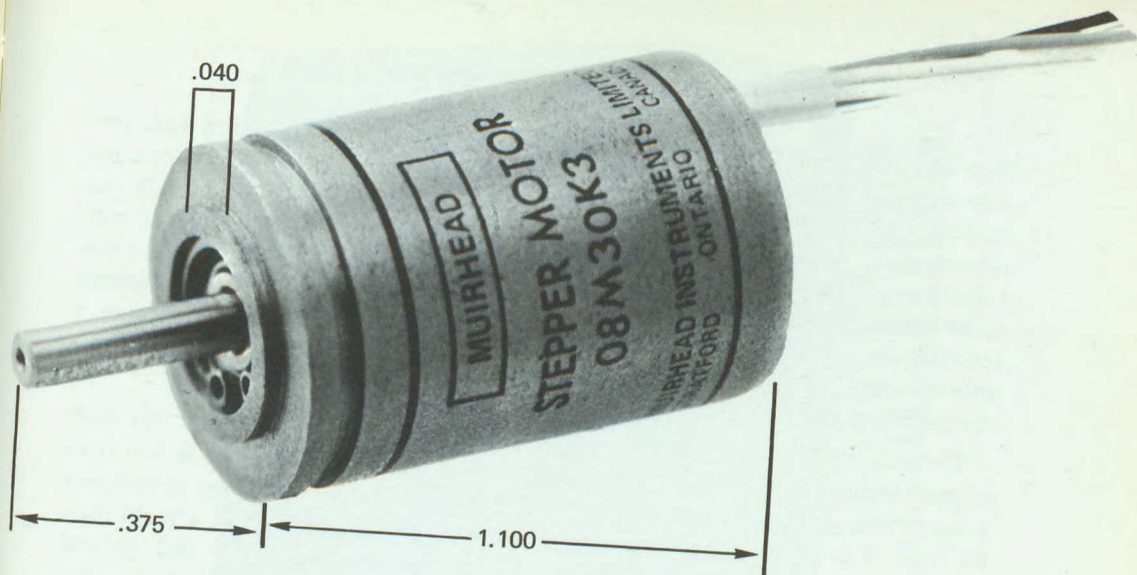
Terminals Red/Black & Green connected to positive. Motor rotation as viewed from shaft end.

### • Options Available

- Special windings
- Special torque/speed characteristics
- Terminals instead of leads
- Different shaft lengths
- Pinion shaft ends

Novatronics Ltd. also produce a range of logic drivers, stepping transmitters, gearheads in sizes 08, 10 & 11, servomotors in 08, 10, 11, 15 & 18, tandem synchros and tandem motor/gearhead/synchros as well as custom gyro motor staters.





## ELECTROMAGNETIC INDICATORS

New electromagnetic indicators now in full production at Novatronics Ltd. provide a remarkably versatile display concept. The H2100 electromagnetic indicator module operates from DC pulses applied to its stator coils. There is only one moving part — permanent magnet rotor with indicator drum — mounted on self-lubricating bearing. Exceptionally long life is insured by flotation of the rotor assembly in the stator magnetic field. A special magnet insures maximum energy retention for long service life in adverse conditions. The stator is attached to a military grade PCB. Random access to display character permits direct instantaneous readout.

The indicators, even in direct sunlight, are readable at 12 ft. (3.6m). For dark or poor lighting conditions internal illumination is available. Weight is less than 1 ounce and design exceeds MIL-E-5400 Class 2. The H2100 series is designed for front-of-panel mounting and can be supplied as a module or as a multi-digit assembly. Typical applications are; airborne displays, shipboard and ground test equipment, computer readouts, instrumentation and control systems, and communications information display.

### • General Specifications

Typical specifications for Series H2000 and H2100 Indicators are shown below.

No. of Positions ..... 11

Standard Characters ..... 0 to 9 with blank

Character Size ..... 0.26" high x 0.19" wide  
(6.6 x 4.8 mm)

Colors ..... White characters on matte black background

Viewing Angle ..... 45°

Input Voltage ..... 6 volts DC

Input Power ..... 0.9 watts

Duty Cycle ..... continuous at 77°F. (25°C)

Minimum Pulse Duration for random entry ..... 0.5 sec at 77°F. (25°C)

Minimum Pulse Duration for switching adjacent characters ..... 0.1 sec. at 77°F. (25°C)

Electrical Connections ..... 12 (plus 2 if internal lighting required)

MIL Design Specs ..... Mil-E-5400 Class 2

*Character Alignment* ..... When energized no part of a character is cut off by the upper or lower edge of the window. The vertical centre line of each character is aligned with centre line of the window within  $\pm .020$ .

Weight ..... less than 1 oz.

Operating (continuous duty cycle)

Temperature Range ..... -4°F to 158°F  
(-20°C to 70°C)

Storage Temperature

Range ..... -85°F to 212°F  
(-65°C to 100°C)

Case ..... high impact resistant plastic with dull black finish.

### • Options Available

Number of Positions ..... 0 to 12

Characters ..... Other sizes and colors available

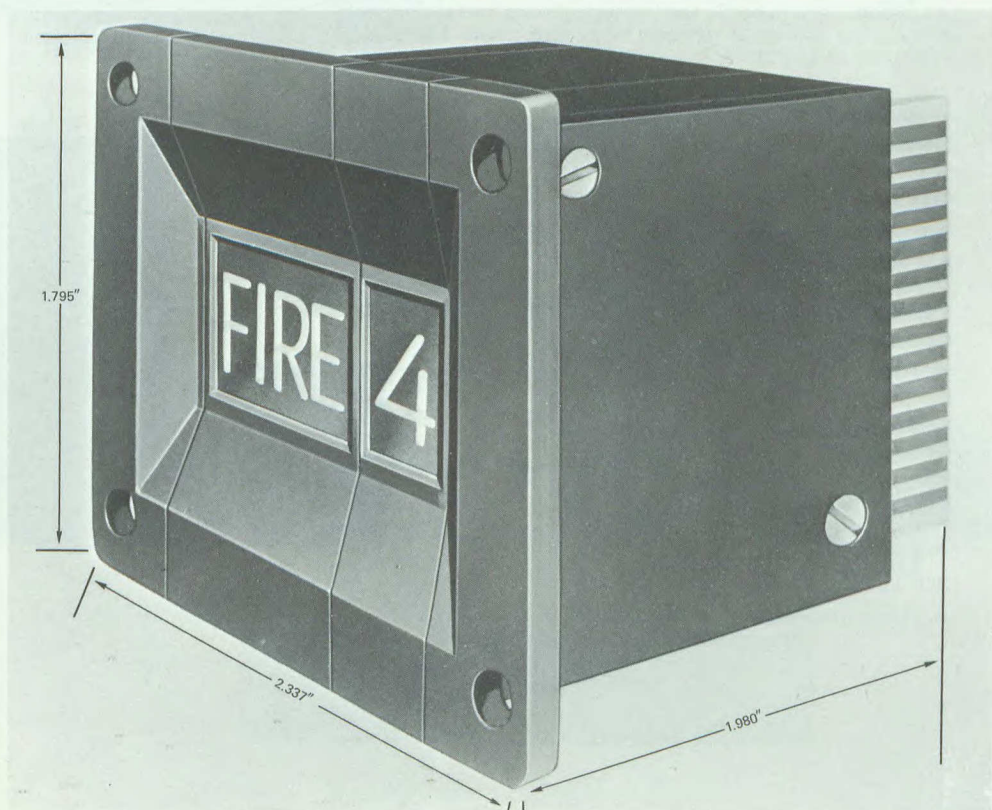
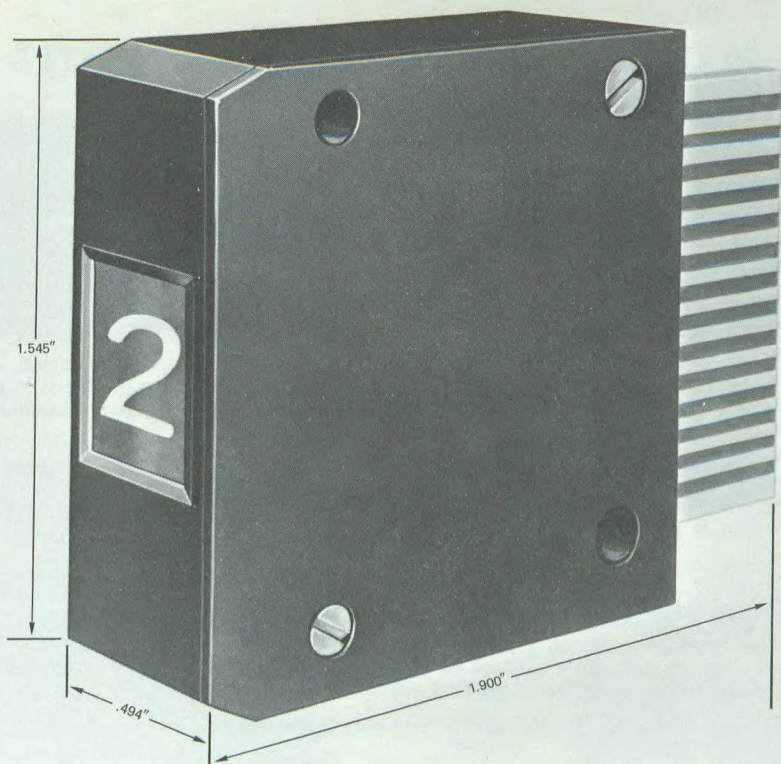
Terminations ..... Lead wires or terminals

Sealing ..... Cases can be sealed

Input Voltage ..... 5, 12, 24 or 28 volts DC

Connection Table ..... Other stator windings permit other switching modes; e.g., a six coil stator can be provided to give 12 positions with only 7 connections.

Internal Lighting ..... Two unbased T-1 Size —(MS24367) connected in parallel. Lamps may be colour coated to MIL-L-25467 RED or MIL-L-27160 BLUE-WHITE. Lamp voltages may be 5.0, 12.0, 28.0.





## PRINTED CIRCUIT BOARDS, MULTI-LAYER

The Specialized Components Division of the Canadian Marconi Company offers a complete modern facility for the production of complex multilayer circuit boards, to Military and rigid commercial specifications.

Multi-layer boards containing up to fourteen layers are in regular production and experimental boards up to twenty-four layers are being developed. Tolerances are maintained to Military and IPC-ML-925 standards. The etch back process is used on all plated through holes and finished hole sizes range down to .0135" (.34mm) diameter. Pattern plating is utilized to minimize under-cutting of circuitry. Circuit finishes available include nickel, gold, copper, rhodium, electroless tin, electro-deposited or fused tin lead. Other finishes are available upon request.

Single and double-sided boards with plated through holes and edges if required, are given the same attention to detail and tolerances. Chemically milled parts are produced in prototype and production quantities in a variety of metals including stainless steel, phosphor bronze and brass.

The facility is complete in every respect and is equipped to handle all requirements from the reduction of the master negative or chronoflex through to the finished product with terminals, jacks, connectors and angles installed and component stencilling applied. The finished item is packed in individually-sealed packages or to customers requirements.

The Divisional Quality Program, which conforms to accepted Canadian and United States Standards, assures continual compliance with applicable drawings and specifications and special customer requirements.

Constant monitoring of the plating processes by a Chemical Control Laboratory under a qualified Chemist and close control of all manufacturing operations by experienced personnel, ensures uniform quality in the final product.

Professional assistance is available to potential customers to assist in design, layout and production problems.

Delivery schedules are constantly monitored by means of a modern Data Collection system working into an IBM computer. This provides Production Control with up dated daily records of all jobs in process.

All boards illustrated in the photograph are fabricated to Military Specifications and represent a cross section of the type of printed circuit boards which are presently being produced in production quantities.

### TOP RIGHT:

A 6-layer board, .062" (1.6mm)  $\pm$  .003" (.076mm) thick, plated gold over nickel. It has 1107 holes, 896 of which are in 28-hole, flat-pack configuration with finished diameters of .018" (.46mm) after plating.

### TOP LEFT:

A standard single sided .062" (1.6mm) thick, tin lead plated.

### CENTER RIGHT:

This is a single sided indicator lamp board of irregular shape.

### CENTER LEFT:

A 5-layer board .062" (1.6mm)  $\pm$  .003" (.076mm) thick with 675 holes most of which are .021" (.53mm) diameter after plating.

### BOTTOM RIGHT:

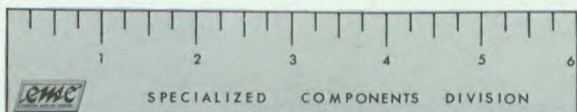
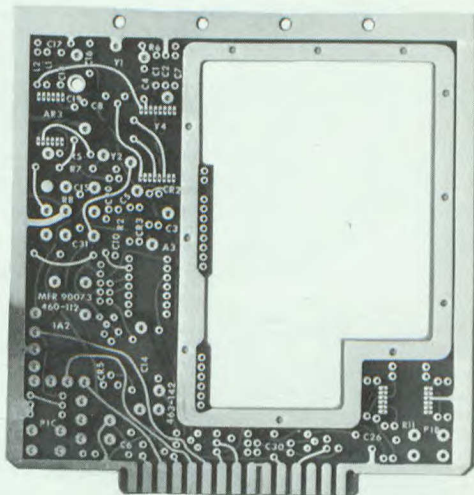
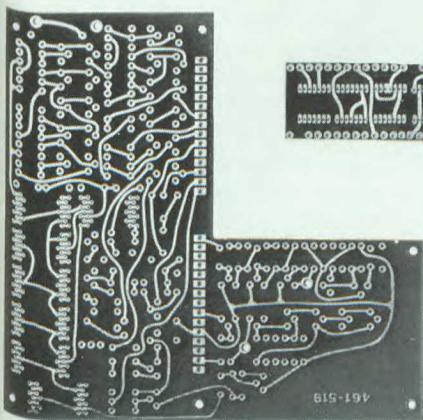
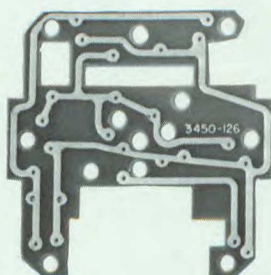
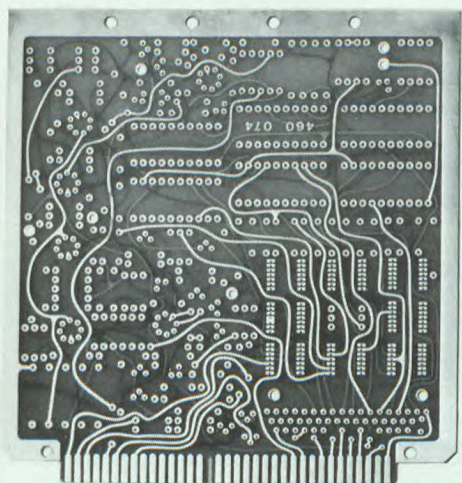
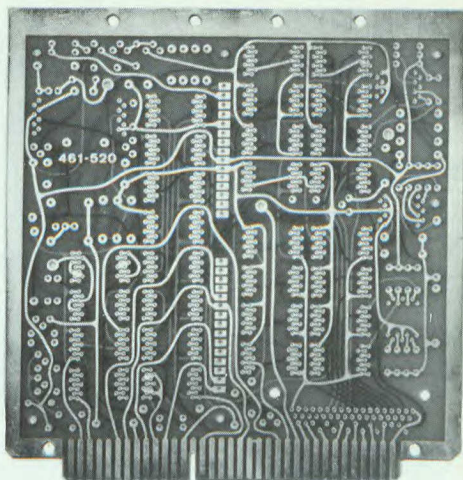
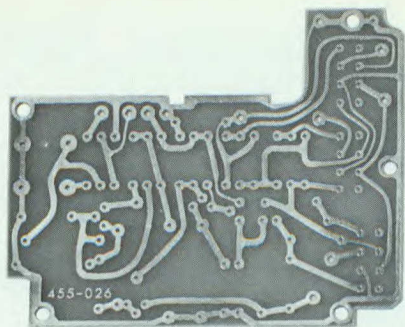
A 5-layer board with a milled center cut-out with plated edges on the cut-out.

### BOTTOM LEFT:

A conventional 4-layer board .062" (1.6mm) thick, designed to mate with the board shown on the top right.

### BOTTOM CENTER:

A 3-layer module board, .030" (.76mm) thick  $\pm$  .003" (.076mm) tolerance.



## PRINTED CIRCUIT BOARDS AND EDGE-LIGHTED PANELS

The exacting demands on to-day's technology in such fields as supersonic Aircraft and Aerospace vehicles are producing not only a range of new equipments to futuristic requirements but also facilities which will design, develop, and produce these equipments to to-morrow's standards.

O. & W. Electronics Limited is one of those sources which has been active in the Aerospace field for over fifteen years and which has clearly demonstrated a leading role in Printed Circuitry and Edge-Lighted panels.

Applications range from the Automotive field with flexible mylar printed circuit boards to the rigid boards and panels used in radio and television sets, mobile radio, aircraft radio and instruments as well as in space satellite applications. The Boards are produced from a variety of materials which include single and double sided copper paper-based phenolics, glass epoxies, glass melamines, flexible mylars, etc. From these materials both single and double sided printed circuit boards with or without plated-through holes are produced together with flush bonded circuits for commutator or switch applications.

A variety of finishes are available such as flux-cote, melamine solder resist, nickel-gold, tin-nickel, silver, rhodium and tin-lead with the latter five finishes being electro-plated. These Boards are produced in accordance with MIL-P-55110A and related specifications.

O. & W. Electronics have supplied Printed Circuits for the F-104 programme, the VRC12 and Autodin communication equipments as well as car radio boards for Philco and "flexible instrument cluster boards" for the Falcon and F85 Oldsmobile.

Edge-Lighted panels are designed and produced to the latest revision of MIL-P-7788. The Lackon process is employed in the photo marking of panels giving sharper detail and accuracy of graduations or markings to .001" and angular tolerances of 5' of arc. The process will register in black and white or colour. Certificates of approval from both United States and Canadian military authorities are held covering the quality assurance of both Boards and Panels.

O. & W. Edge-Lighted panels may be found throughout the following aircraft; CL-44, CL-41, F104, F5, F-4 (Phantom), Caribou, Buffalo, Twin Otter and such equipments as the ASN30 Navigation Set in the Grumman.

This same production source maintains the following "in-house" facilities so as to ensure the high quality and reliability demanded of such equipment:

- Engineering: engineering assistance is available to help solve any illumination layout or functional problems which might arise during the design stages.
- Art Department: to work from customer blueprints and specifications to make the necessary photographic master.
- Machine Shop: to maintain the consistent quality of panels, dials and scales.
- Processing and Inspection: over and above the normal to be expected equipment is a Light Laboratory. A DND Inspector is also in residence.

This same facility also produces a wide range of photo-processed custom metal panels, scales and dials for electronic equipment as well as chemically milled parts. Naturally the assembly of hardware to Boards as well as the assembly of electronic circuitry is standard work to custom requirements.

O. & W. Electronics have substantial export markets to such highly technical and competitive areas as U.S.A., England, Holland, West Germany, Italy and Japan.





## MILLIMETER REFLEX KLYSTRONS

In 1959, Varian Associates of Canada Ltd. initiated the development of a 70 GHz reflex klystron. At that time, the millimeter radio spectrum, 30-300 GHz corresponding to wavelengths of 10-1 millimeters, was practically unexploited for any practical use and few, if any, tubes or hardware were available for experimental work.

The invention of the laser in 1960 and the possibilities which this device suggested at optical frequencies, caused a general slackening of interest at millimeter frequencies. Varian Associates of Canada Ltd., however, pursued the development programme already underway and by 1962, had developed the VA-250 series of reliable and rugged reflex klystrons covering the frequency band 50-80 GHz as well as reflex klystrons covering the millimeter spectrum from 50 GHz to 220 GHz. Laboratory prototype tubes have been built as high as 245 GHz.

Two cavity klystron amplifiers operating at 60 GHz have been built with a small signal gain of 6 db. When used as an oscillator, over 10 watts of power was delivered to an external load, with an efficiency of 2.5%. The bandwidth, however, was very small. To improve the gain, efficiency, power output and bandwidth, a three-cavity amplifier is now under development.

Prototype Extended Interaction Oscillators operating at 60 GHz produce output powers of 50 W.C.W. at 8% efficiency and have a dynamic bandwidth of 180 MHz. The development of a mechanically tunable Extended Interaction Oscillator with greater power output, improved bandwidth and efficiency is under development.

### HIGH POWER SERIES 50 - 170 GHz.

In this series of tubes the tuning range has been sacrificed for power output. 500 mw with 1 GHz tuning or 350 mw with 2 GHz tuning is guaranteed at one end of the series and 75 mw with 2 GHz at the high frequency end of the series.

These tubes find application in microwave spectroscopy, communication transmitters, parametric amplifier pump sources, and maser pumps, where hundreds of milliwatts of power are required and tunability can be sacrificed to obtain more power.

### MEDIUM POWER SERIES 50 - 170 GHz.

The tubes in this series are each mechanically tunable over 6 GHz. Tubes above 110 GHz will tune 8 GHz. Featuring somewhat lower guaranteed power, (150 mw at 50 GHz, 50 mw at 170 GHz), these tubes find application where high power is required but tunability cannot be sacrificed.

### LOW POWER SERIES, 50 - 170 GHz.

Where the need exists for only a few milliwatts of power, this series can be used with a saving in tube cost and power supply requirements. These tubes tune 6 GHz and give 10 mw at reduced beam voltages. A new tube recently developed by Varian of Canada in the 70-100 GHz range, with a 2 GHz tuning range, will give 50 mw at 900 volts on the beam or 8 mw with 500 V on the beam. These tubes find application in radiometers, radar receivers and communication receivers.

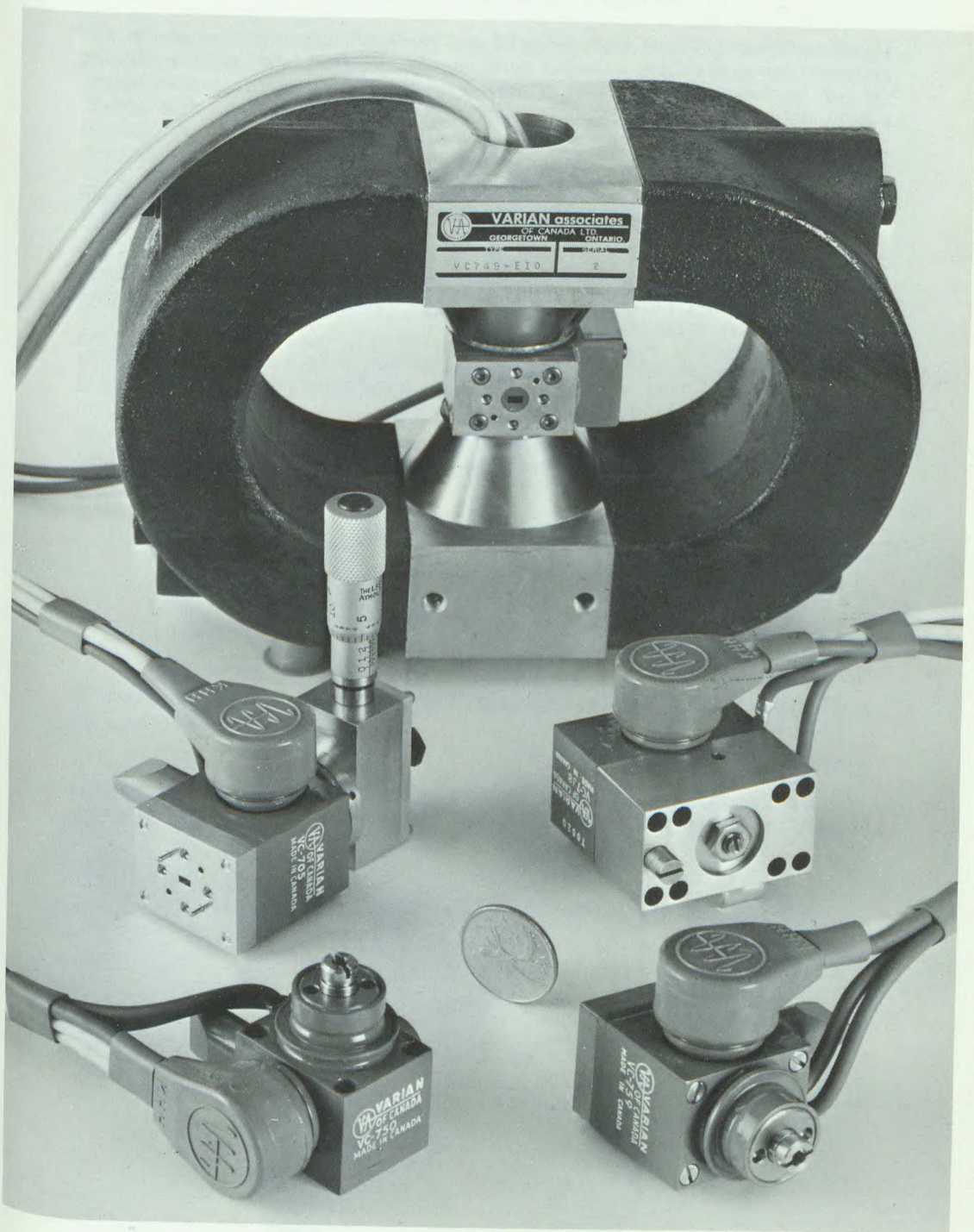
### HIGH FREQUENCY SERIES, 170 - 220 GHz.

These tubes have a tuning range of 2 GHz and a guaranteed output of 10 mw. Higher frequencies, up to 240 GHz, are available as laboratory models.

The tubes in all series will survive 50 g shock and are rugged enough to be used in airborne and missile applications.

New techniques needed by our aerospace programmes, by defence and by basic research, ensure that the millimeter spectrum will not be left as a technological vacuum but will, with the advent of practical millimeter klystrons and other components, be much more fully utilized than was thought possible a year or two ago.







## TOWER LIGHTING TRANSFORMER

Hammond Manufacturing have designed and produced these transformers for applications for where there is a need to isolate the electrical lamp of other circuits on and insulated antenna tower system from the regular electrical distribution system and to minimize the capacity reactance to ground of the tower light circuit.

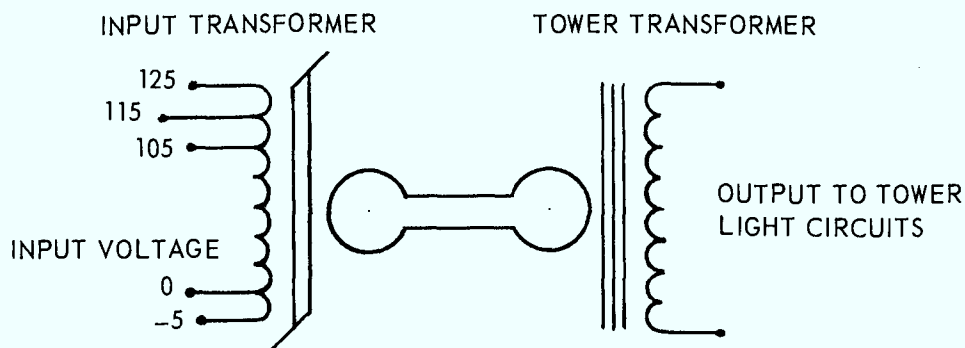
### Features

- System consists of a toroidally constructed Input Transformer with a single turn secondary coupled to an epoxy filled Tower Transformer by means of a one turn primary.
- Low capacitive coupling between input and output is achieved by the large diameter of the 1 turn secondary of the input transformer and its large spacing to the primary of the tower transformer.
- High reliability is achieved by excluding moisture with a special sheath treatment of the primary winding of the input transformer and the epoxy filling of the matching tower transformer.
- Physical alignment of the primary and secondary circuit devices although important is not critical, greatly simplifying installation on tower and insulators.

### Technical Characteristics

- VA 700 (Hammond Design #80390)
- Frequency 60 Hz
- System Input — 115 volts with taps at 105, 125, and —5 volts.
- Systems Output — 115 volts  $\pm 3\%$  at 700 VA.
- Minimum isolation spacing between primary toroid and 1 turn secondary is 3" (7.62 cm).
- Weight 200 pounds (90.7 kg.)

Other VA ratings for 60 Hz, units designed for 50 Hz, units with other primary voltages or units fully tropicalized and available on special order.



## PHOTO-ELECTRIC CELLS

The **Cadmium Sulphide** photocells manufactured by National Semiconductors Limited are sensitive in the visible part of the spectrum and, in fact, their spectral response closely resembles the human eye. They can be used in high voltage circuits (one type has a rating of 2,000 v.) or they can be used in low voltage transistor circuitry. A typical application would involve controlling a relay or a transistor directly in the presence of light to perform some control function. A large application of these cells involves the automatic turning on of outdoor lights at dusk and off at dawn.

The **Cadmium Selenide** photocells are similar to the Sulphide variety except that they are sensitive in the red part of the visible spectrum and have a faster speed of response. They are mainly used in automatic sensing devices such as elevator controls and production counting of objects.

**Silicon** photovoltaic cells peak in the near infrared part of the spectrum and exhibit extremely high speed of response in the order of 1 microsecond. They can be fabricated in a variety of shapes to suit particular requirements; applications involve sensing of punched computer tape, photo-electric encoders and optical sound track detection in cinema projectors. National Semiconductors Limited has a research facility where special photo-electric transducers can be developed to meet special requirements. The techniques employed in the production of its devices include:

Thin film facilities.

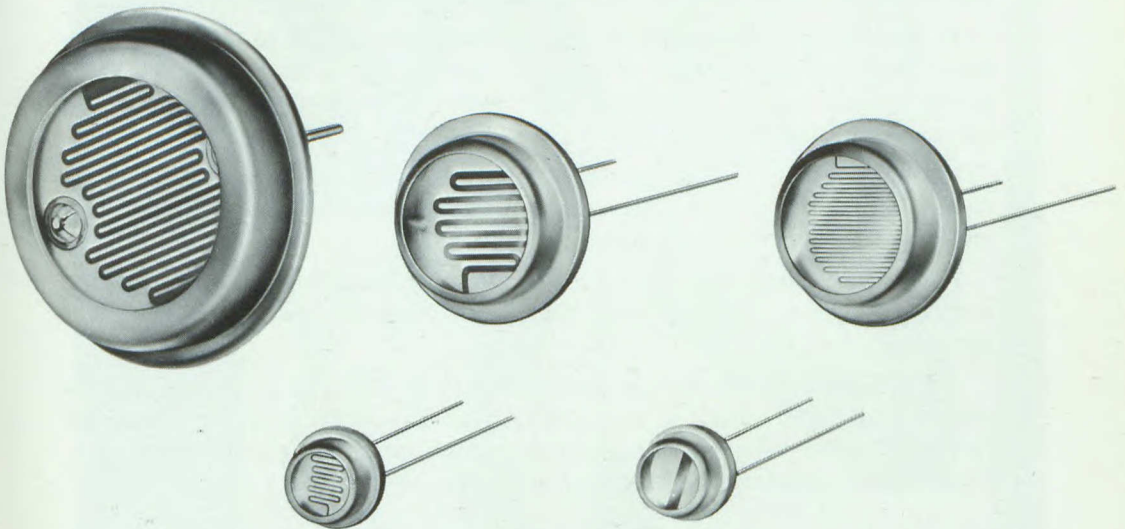
High vacuum production techniques.

Silicon diffusion techniques.

Hermetic sealing and leak detection facilities for semi-conductor devices.

Photometric standard laboratory.

The company also undertakes the development of circuits associated with photo-electric cell applications.



## STERILIZATION PLANT—COBALT 60

This Cobalt 60 Sterilization Plant was designed by Atomic Energy of Canada as a high efficiency irradiator for sterilizing medical supplies. Throughputs range up to 48 units per hour equivalent to 162 cu. ft. (4.29 cu. m) per hour.

The plant consists of an irradiator building of composite construction of block and concrete which serves as a biological (protective) shield. Cobalt 60 is the source of radiation; the system comprises a flat vertical plaque carrying the Cobalt 60 source, a source raising and lowering device, the source pass mechanism and a water storage pool to shield the source when not in use.

Operation of the plant is centered in a main console — the console also houses the controls for the maintenance system.

Nominal plant capacity is 300,000 curies of Cobalt 60. The plant may be modified to increase the capacity.

Materials to be irradiated are pre-packaged in corrugated cartons. The cartons are then moved by a power input conveyor to the load position where they are fed automatically onto a monorail carrier and conveyed into the irradiation room — the cartons are then fed automatically from the carrier into the source pass mechanism where they are indexed through different positions about the exposed Cobalt 60 source.

The monorail carrier has two product box positions. An upper position which receives un-irradiated product boxes at the load/unload station from the input storage conveyor and a lower position which receives an irradiated box at the source pass mechanism.

Loading and unloading of the product boxes is done automatically at their respective stations; at the load/unload station the irradiated product box is discharged onto the outlet storage conveyor into the sterile area while an un-irradiated product box is loaded into the upper position from the input storage conveyor.

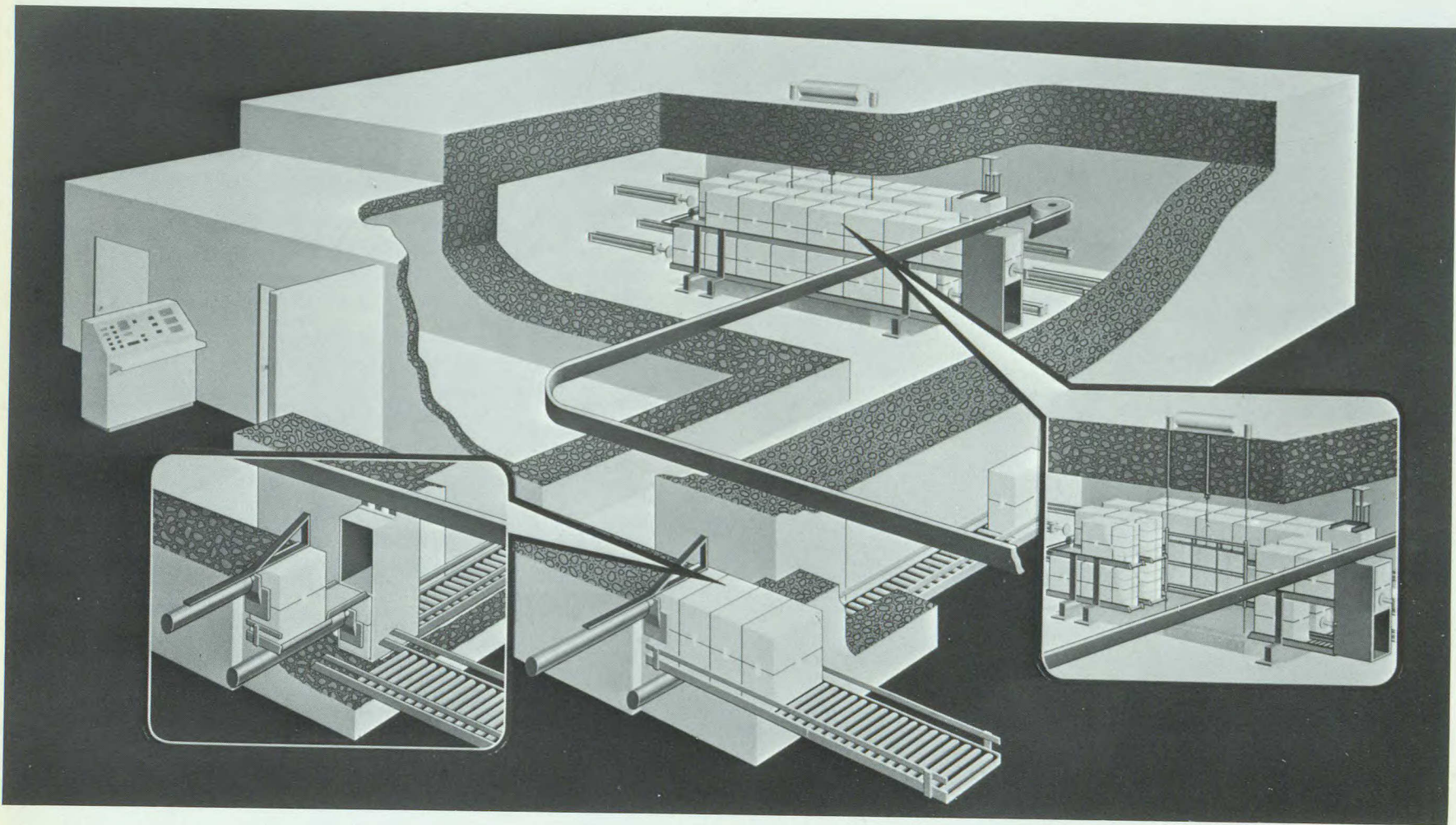
At the source pass mechanism the un-irradiated product is loaded into the source pass mechanism, while an irradiated product box is loaded into the lower position of the carrier. The carrier then returns to the load/unload station and the sequence is repeated.

The exposure time of the cartons in the irradiation room is pre-set on the control console. Irradiation time is basically determined by product density-dose required and the activity of the source.

This Medical Supplies Sterilization Plant is a fully automated facility, when the source pass mechanism is loaded, the system maintains a constant day-in-out throughput.

The input and output storage conveyors may be designed to accommodate a sufficient supply of cartons to maintain an input and output volume for a desired number of hours; this means that complete plant operation may be carried on — requiring only the presence of one qualified technician.





## THE GAMMABEAM 650

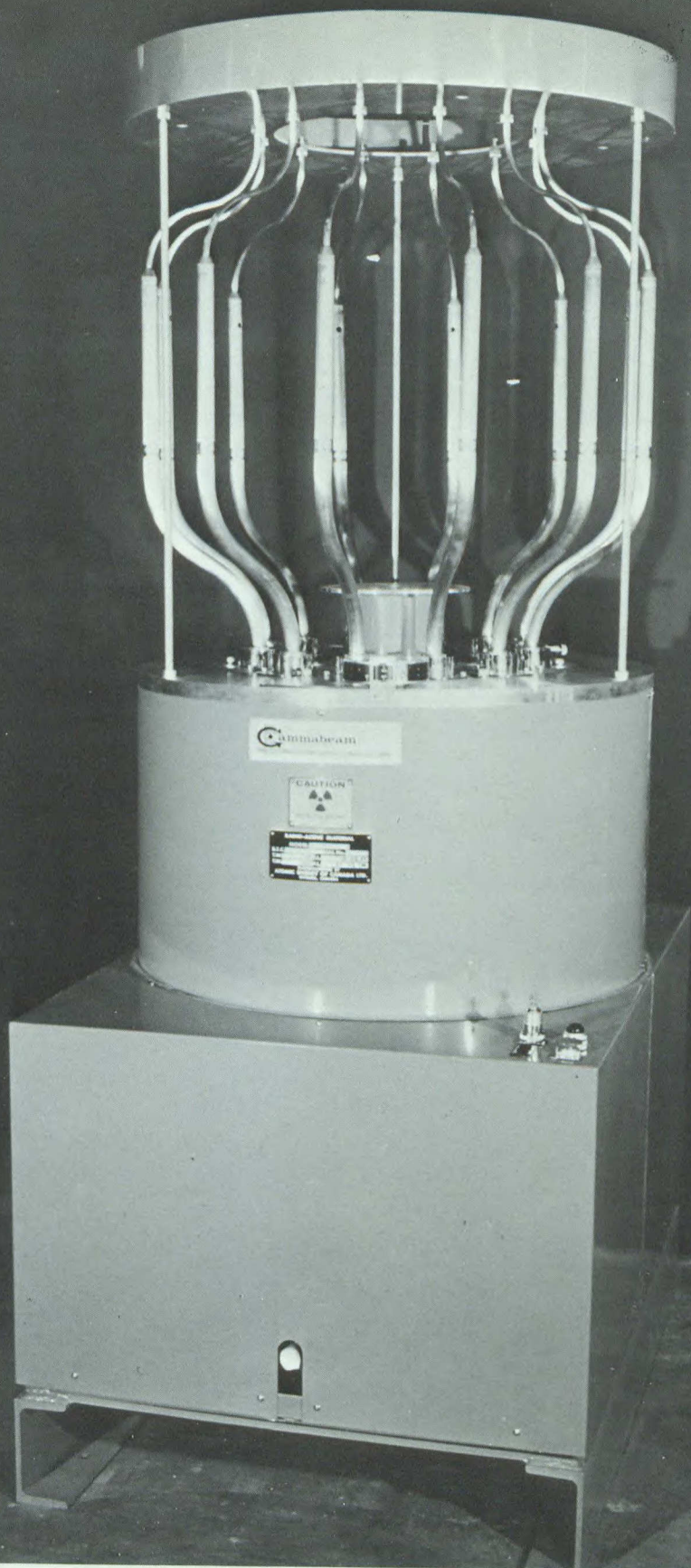
The Gammabeam 650 Irradiator is a variable dose rate cavity and panoramic irradiator, designed for use in a fully shielded room. Its source capacity is 30,000 curies Cobalt 60 which will produce a maximum central dose rate of  $5.4 \times 10^6$  roentgens per hour without exceeding tolerance levels or radiation about the source housing as established by the International Commission on Radiological Protection and the United States National Committee on Radiation Protection.

The source is exposed in twelve vertical tubes which are arranged in a cylindrical pattern, and which can provide a variable pitch diameter. Variation in dose rate in the source cavity, or panoramically, can be achieved by preselection of the source pitch diameter and/or the number of active source tubes exposed.

The Cobalt 60 sources are housed in tubes and shielded in a lead container that forms the body of the unit — the sources are moved pneumatically from the stored position to the irradiate position by compressed air — continuous air-flow from the compressor holds the sources in the irradiate position — release of pressure returns the sources by gravity to the stored position. Individual groups of sources are moved up or down to form the irradiation pattern desired. The unit is remotely controlled from a Control Console.

The equipment was designed and produced by Atomic Energy of Canada.







## IRRADIATION EQUIPMENT

The atom is a potent factor in the political economy of the world today—in the near future its impact will be even greater. It will play a greater role in all the aspects of economics, particularly in the newly developing nations.

To understand and become familiar with the handling and potential of this new form of energy needs the use of laboratory equipment which permits the safe investigation of both peaceful and defensive applications.

The sterilization, by Gamma Rays, of medical supplies is one of the uses of irradiation equipment. This equipment, designed and produced by Atomic Energy of Canada Limited, has been used to ensure that rations, being shipped to distant outposts, arrive there in such condition that long-term storage is possible. This again is the process of irradiation in a sterilizing role. Such applications have been established and are being refined and extended continually in many laboratories, and a significant contribution from Canada to these advances is the supply of sophisticated laboratory equipment suitable for such investigations.

A.E.C.L. Cammacells are in use in twenty countries for laboratory work. Illustrated is the GAMMACELL 220, a completely self-contained and portable irradiator requiring no additional shielding and with a capacity up to  $2.0 \times 10^6$  rads/hr is basically for research purposes.

The CAMMABEAM 150, one of a new series may be used in a laboratory role or for batch processing and is capable of delivering an output of 1500 roentgens per hour at one meter from the source in any of three beam configurations from full panoramic to pre-determined beam shape.

The unit is completely portable and is delivered with the source already loaded so that no transfer of active material is necessary in the field. A shielded room or controlled area is required for operation and the unit can be moved to different facilities as required without radiation hazards to personnel concerned.

GAMMABEAMS, for batch or large scale experimental irradiations, are now entering service, and can be installed rapidly, in prepared concrete irradiation rooms, for the preservation and extended storage of local produce.

Large scale permanent Industrial Installations are being built now, but to realize the immense potential of irradiation, much additional laboratory work, for which GAMMACELLS and GAMMABEAMS are needed, still must be completed.

Since Cobalt 60 became available in ever-increasing quantities, scientists have used its high energy gamma emission to study radiation effects on materials of all kinds. Investigations are being carried out on such diversified products as foods, textiles, rubber, glass and chemicals. The range of radiation studies is limited only by the imagination of scientists and researchers the world over.



## NAVAL SHIP DESIGN AND CONSTRUCTION

Canadian industry and the Canadian Armed Forces — Maritime have a recognized capability for the design and construction of ships of the frigate and destroyer types (5000-2000 tons). This capability is demonstrated by the "St. Laurent" and "Annapolis" class destroyer now in Canadian Naval service. The latest Canadian ships under construction are the "DDH-280" class. An illustration of this class is on the facing page.

The DDH-280 class was primarily designed as an anti-submarine weapon system, but it has a flexible capability. The design allows the ship to perform effectively in area search, force or convoy protection, air defence, and amphibious support roles. The ships are as modern in concept and design as any contemporary destroyer and suited to provide a 20 to 25 year life for the vessels.

Hull particulars are — Overall Length 426'  
Midship Beam 50'  
Deep Draught 14'6"  
Displacement 4100 tons.

The propulsion system utilizes all gas turbine machinery (COGOG). The main propulsion machinery is a two-shaft arrangement of geared gas turbines, 50,000 total maximum shaft horsepower. Each shaft set consists of a main gas turbine of 25,000 SHP and a cruise turbine of 3,700 SHP, arranged side-by-side, driving a controllable pitch propeller through a common gearbox and clutches. The engines can be controlled from the Bridge or Machinery Control Room.

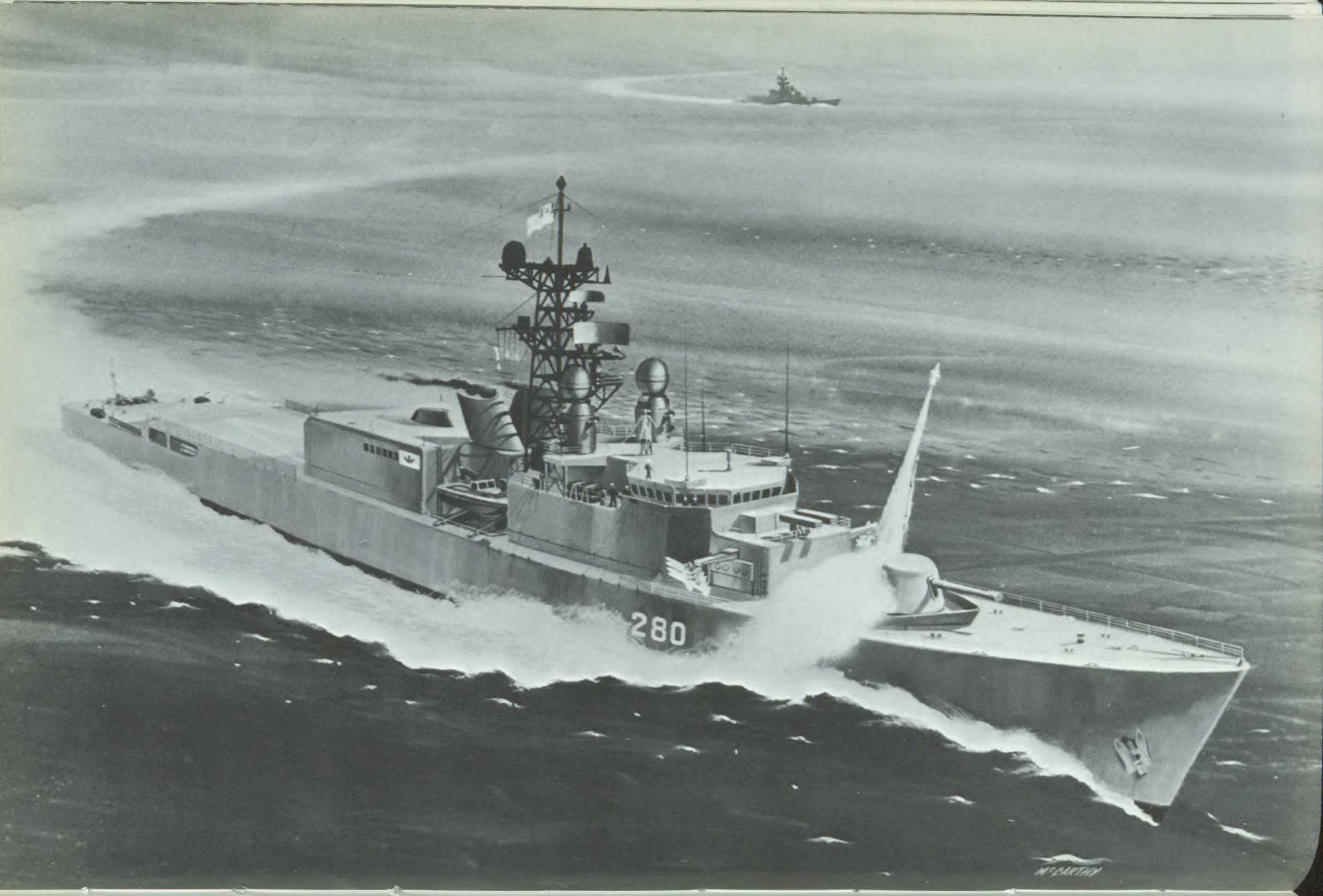
The remainder of the machinery and power plant design represent advanced engineering and are chosen for maximum performance, durability, and ease of maintenance.

The combat system suit, including sensors, weapons, electronic counter-measures, communications, and command and control systems is highly integrated and automated representing a completely new system taking advantage of the most advanced technical knowledge and fighting concepts. Use of digital computers for this system "core" has provided considerable flexibility for further up-dating in the early 1980's. The integrated weapons package consists of search and attack sonars, both hull mounted and variable depth; dual helicopter weapon system ("Sea King" — CHSS-2); point defence missile system; 5" surface guns; anti-submarine mortar mountings; and anti-submarine torpedoes.

The prime contractors for the DDH-280 ships are Marine Industries Limited, and Davie Shipbuilding Limited. The gas turbine propulsion system is supplied by United Aircraft of Canada. Command and Control System, by Litton Systems (Canada) Ltd.; Sonars by Canadian Westinghouse Ltd.; Helicopter hauldown and securing device by Fairey Aviation Ltd. Other Canadian shipyards and sub-contractors are providing specialized systems and hardware items. (Many of these items are individually described in this book).

The DDH-280 class ships are an example of the Canadian capability for the design and construction of modern naval vessels suited to the variety of roles required in ships by smaller navies. As well as destroyers, a series of composite supply and replenishment ships, patrol and other miscellaneous naval vessels made in Canada are now in operational service. The Canadian shipbuilding industry is experienced and prepared to respond to naval ship systems and hardware requirements in the international market.





McARTHUR

# HYDROFOIL SHIP DESIGN AND CONSTRUCTION

Canadian Industry, in conjunction with the Canadian Armed Forces has demonstrated its ability to design and produce a hydrofoil ship for all weather, ocean-going operation. HMCS BRAS D'OR, FHE 400, is a vessel of this type and her performance during initial trials this year, has equalled or exceeded the design predictions.

BRAS D'OR was designed and constructed to evaluate the effectiveness of ocean-going hydrofoils as alternatives for frigates and destroyers in anti-submarine warfare. With this in mind, her foil system has been designed to permit foil-borne cruising at up to 50 knots in Sea State 5. Hull-borne range is comparable to that of a destroyer. Foil-borne range is several hundred miles.

The foil system selected is of the surface piercing type considered to be advantageous primarily because of its inherent stability in the foil-borne mode but also, by virtue of the massive damping offered by the foils, providing all-important hull-borne stability in heavy seas. The foils are arranged in a "canard" configuration, the main lift occurring well aft. The superior sea-going performance of this configuration compared with the conventional or "aeroplane" arrangement has been firmly established.

Her normal maximum all up weight is 475,000 lbs. (215,460 kg) and of this, approximately 40% is disposable load.

Hull particulars — Length 150'9" (46 m)  
Breadth 21'6" (6.6 m)  
Depth 15'7" (4.8 m)

Foil particulars — Overall Span  
Main Foil 66'0" (20 m)  
Bow Foil 21'0" (6.4 m)

The displacement propulsion system utilizes a sixteen cylinder, high speed marine diesel, which produces 2000 bhp at 1500 rpm. This gives a hull-borne speed of approximately 14 knots obtained through controllable pitch propellers via a reduction gearbox and downshafts within the anhedral foils. A power takeoff from the displacement gear box can also drive the auxiliary gearbox for electrical power generation, etc.

For foil-borne propulsion, a marine gas turbine of 22,000 Shp at 3600 rpm is used. The free turbine is coupled to an inboard gearbox which splits and increases the speed of the twin shafts, down through each of the port and starboard struts to the outboard gearboxes. Here, the speed is reduced and power transmitted to the fixed pitch super-cavitating propellers which give the vessel a speed of 60 knots at 1800 rpm.

Control of either propulsion system is from the enclosed bridge or alternatively from the engineer's console in the operations room. The ship's heading is controlled by the bow foil which is steerable and also adjustable in rake to adjust ship's trim. Turns are fully or partially coordinated depending on speed by the variable incidence anhedral tips. These tips are also coupled to an autopilot and act as stabilisers to supplement the foil system's inherent roll resistance.

Three smaller gas turbines are used to drive the auxiliary gearbox (as an alternative to the power takeoff from the diesel), the emergency electrical and hydraulic power unit and the deck mounted fire pump.

After completion of her machinery and hydrodynamic trials which are intended to evaluate performance as a ship, and subject to the conclusions of the evaluation, a fighting equipment package is available for fitting and evaluation of performance together with the ship as a weapons system. This fighting equipment package was especially designed for her and like her machinery and equipment generally, had to meet the requirement of compactness and low weight. The fighting equipment consists of a variable depth sonar including hoist and high speed body, an associated computer based action information system and an advanced intercommunication system. Two of a possible four sets of triple A.S.W. torpedo tubes would be fitted.

The Prime Contractor and Design Agent for the BRAS D'OR is the DeHavilland Aircraft of Canada Limited, who subcontracted the construction of the hull to Marine Industries, where the ship was assembled. The main and auxiliary gas turbines were supplied by United Aircraft of Canada and the propulsion transmission by General Electric. The V.D.S. hoist installation was subcontracted to Fleet Manufacturing, and the Interior Communications System to Marsland Engineering Limited.

The Prime Contractor for the design and production of the Weapons System was Canadian Westinghouse Company Limited, with Hawker Siddeley producing the high speed towed bodies.







## TOWING MACHINES

The Garrett Marine Model M-200 Towing Machine system has been designed to provide deep sea towing operators, salvage operators and oceanographic research agencies with a high capacity Towing Machine capable of trouble free operation.

The M-200 model consists of two basic components; a winch system mounted on the weather deck and a below deck 170 horsepower diesel drive engine. The diesel engine, transmission and air holding brake which are located below deck are connected to the winch by a multiple chain drive enclosed in a heavy trunk passing through the deck.

The deck mounted winch consists of an integrally welded structure into which is fitted a unique arrangement of fairlead, fleeting shaft, level wind and main drum assembly all of which are capable of withstanding the breaking strength of 2¼ inch (5.7 cm) wire rope. The drum has a capacity of 2,600 feet (792 m) of 2¼ (5.7 cm) — 6 x 37 wire rope with 1½ inch (3.8 cm) free flange. The drum clutch (set for 200,000 pounds) (91 metric tons) is a planetary type mounted on the low speed shaft with control at the winch and at the upper deck. A gypsy head, dogging device and footage counter are also fitted to the drum assembly. The gypsy head is suitable for 10 inch (25.4 cm) manila rope with a breaking strength of 77,000 pounds (30.4 metric tons).

The Towing Machine is operated from the winch console located on the boat deck immediately above the Towing Winch. While these controls operate the winch, they in effect control the diesel drive located below deck and are divided into two main groups — one group on pneumatic controls for a second group of 24 vDC controls covering permissives, start-up, shut-down, running and diesel brake release. The main control functions are regulated pneumatically by three levers on the winch console. The first is the direction-throttle lever, the second is the shift control (low or high) and the third lever controls air supply to the winch drum clutch brake for motivation of the drum.

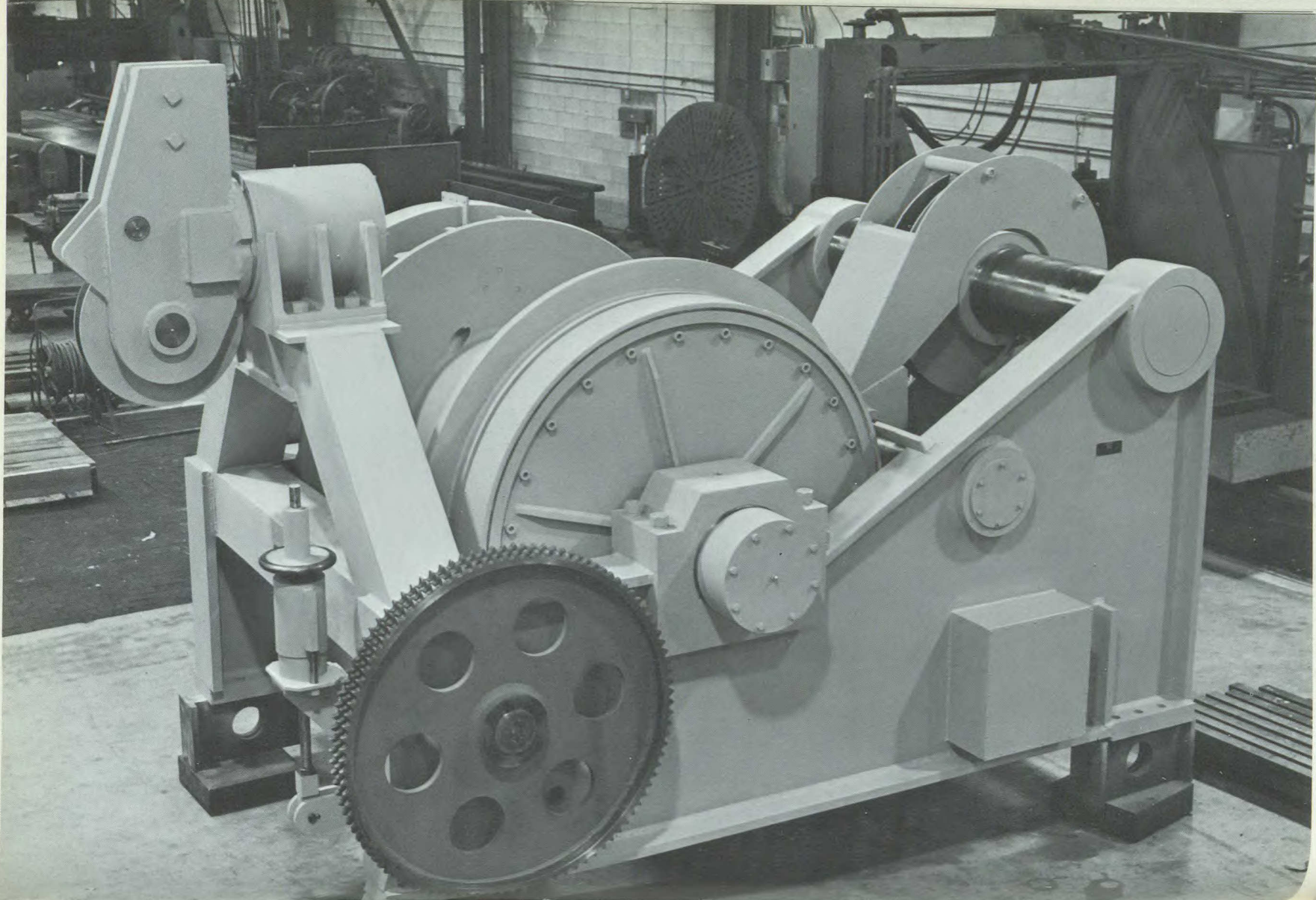
Cable payout is indicated both on the winch console and in the pilot house by a selsyn system driven from the winch. The lifting lever to engage the drum dogging device is a manual adjustment at the winch.

Maximum line pulls of 150,000 pounds (68 metric tons) is at 22 feet (6.7 m) per minute, while line speed is 100 feet (30.5 m) per minute.

The winch which is approximately 14 feet long, 10 feet wide and 9 feet high (4.3 x 3 x 2.7 m) weighs 50,000 pounds (22.7 metric tons). The drive system including transmission and convertor weighs 8,000 pounds (3.6 metric tons).

With the exception of the gypsy head and ring gear, no other cast materials are used. Self-aligning anti-friction bearings are used throughout except for the main frame bronze bushings. The complete winch, drive system and controls meet the performance and construction requirements of United States Coast Guard, American Bureau of Shipping and Lloyds Registry.

Design work on a variety of different types of winches for specific applications i.e. salvage work and anchoring of offshore drilling platforms is currently in progress and drive systems are either diesel, electric or electro-hydraulic.



## MARINE WINCHES

The Garrett Marine Model M-100 Mooring Winch has been designed, developed and manufactured to enable ships operators to stop and moor vessels in canal locks, seaway mooring stations and at loading and unloading docks quickly, efficiently and with a minimum of operators.

The all-electric (440/550 V) AC automatic self-tensioning mooring winch requires no hydraulics or motor generator sets. In size it is 6 feet long, 4 feet 6 inches wide and 4 feet 6 inches high (1.8 x 1.4 x 1.4 m) and weighs 7,500 pounds (3402 kg). The winch with integral 40 horsepower motor is suitable for weather deck mounting. Separate master switches, also suitable for weather deck mounting, permit manual or automatic control of the winch from remote stations. The manual control permits slow or fast heave and slow or fast payout and drift. The characteristics of the two speed gear change provide 65 feet (19.8 m) per minute at 20 - 24,000 pounds (9072 - 10,886 kg) and 275 feet (83.8 m) per minute at 8,000 pounds (3629 kg). The electric motor brake is set for 35,000 pounds (15,876 kg).

In the automatic mode line tensions can be selected at 13,000 or 20,000 pounds (5897 or 9072 kg) and be maintained within 10 per cent. The automatic tensioning device is built into the drum assembly.

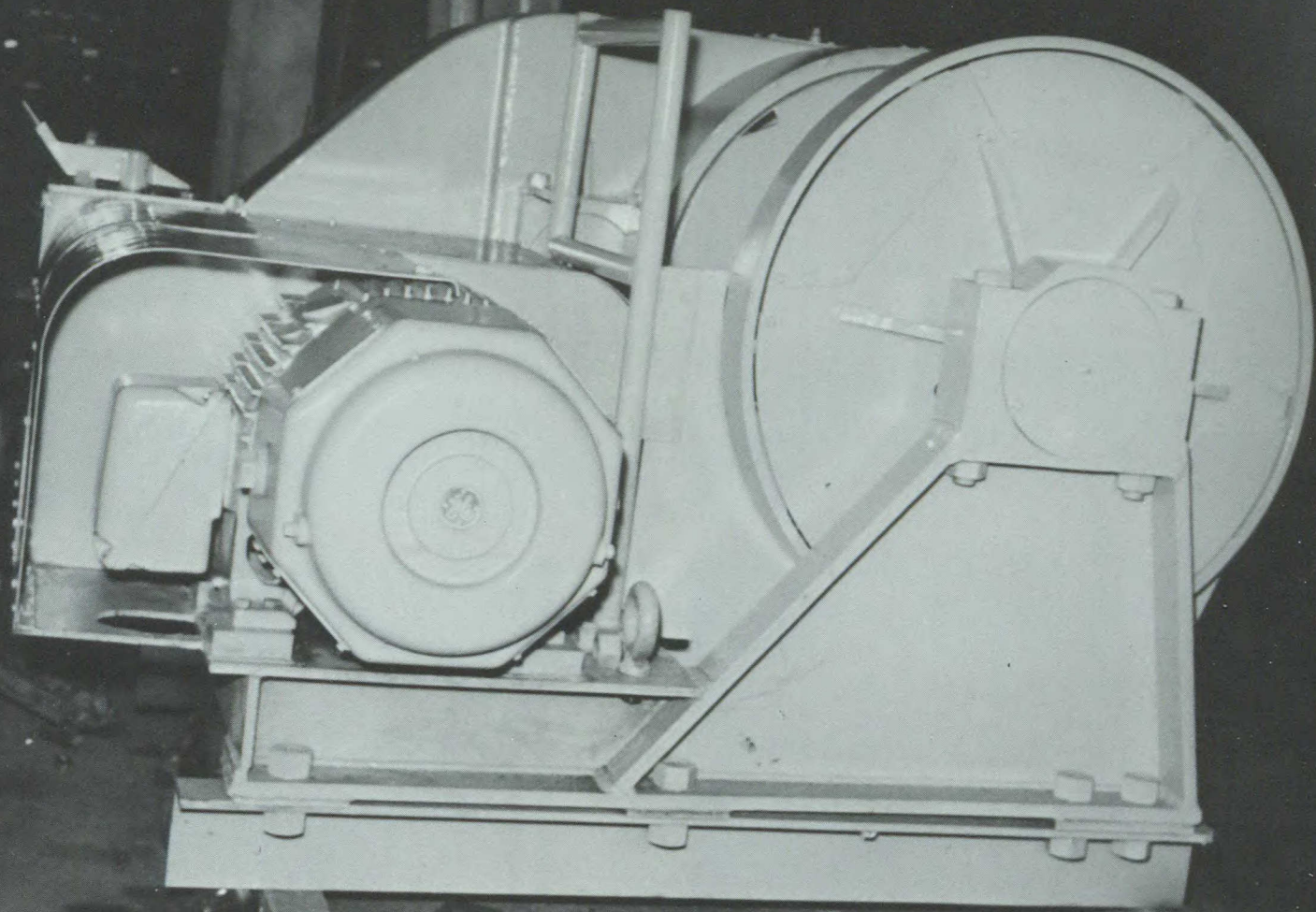
The winch base, drum and main shafts are designed to withstand the breaking strength of 1½ (2.9 cm) diameter 6 x 25 cable. The drum capacity is 600 feet (272 m) of 1½ inch (3.8 cm) cable with 2½ inches (6.4 cm) of drum flange clear of the top layer. The main control apparatus and resistors are suitable for below deck mounting.

All gearing is machine cut to AGMS standards. Anti friction bearings, with only one exception, are used throughout.

All electrical devices, including the motor and brake are of the marine type built to the standards specified for this type of service. The equipment is also built in accordance with the regulations of the appropriate approval agencies for intended service.

An all-electric highline winch for use with replenishment systems is currently in design and feature in-drum gearing to reduce weight and conserve space.





## WINCH SYSTEMS

Since 1937 Swann winches have been performing various duties in Canada and throughout the world. Fishing, oceanographic, towing, anchor, cargo and utility winches, capstans and windlasses are just some of the winches in operation. Recently, in co-operation with the Canadian Government, Swann has developed many specialized winches for the fields of oceanography, defence and research.

The ocean is a relatively untapped source of wealth for ourselves and other nations. Only a decade ago did Canada begin to really embark upon oceanography. Over this short period of time Swann Winches has designed, developed and perfected more than two dozen specialized oceanographic winches aiding Canada's research team. These winches are not merely a means to raise a heavy load. They are also a medium of communication from the depths of the sea to man. Bathythermograph winches for relating water temperatures and salinity, sound source winches for detecting vibrations, coring winches for taking samples of the ocean's floor, even television winches for a first hand view of depths man alone cannot reach. Another assistance winches provide is that scientists are able to communicate with the depths from the laboratory by means of telemetry, etc.

A look into the future will show an ever increasing use by oceanographers of micro equipment, circuitry and hardware borrowed from the space engineers. Swann Winches will be supplying these and winches for their use.

Swann offers a wide range of towing winches, the largest of which was built in 1966 and installed on the "MV" Haida Brave. To envision the size of this winch, the uppermost portion stands almost seven feet high. It carries 2,500 feet of 2¼" diameter wire rope and weighs twenty-three ton. The winch tows a large modern log barge along the coast of British Columbia.

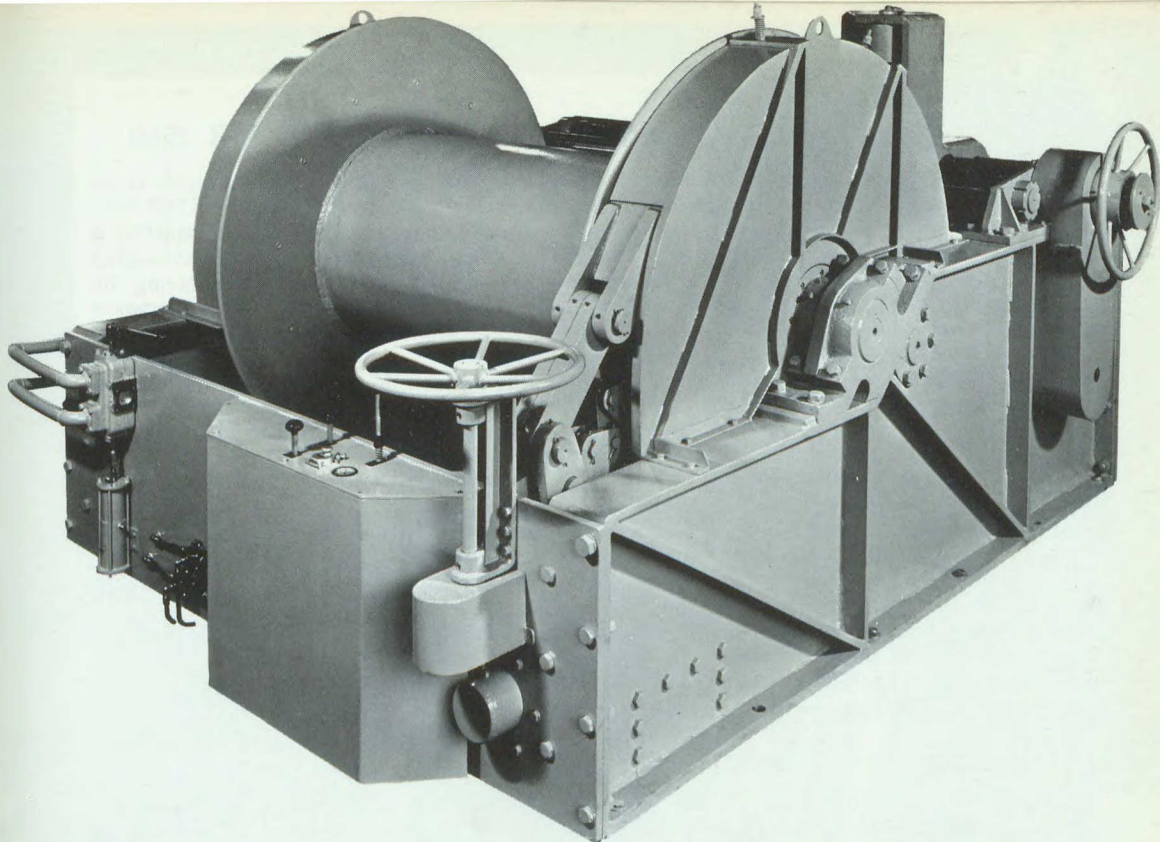
Being Canada's third largest resource, the fishing industry uses winches entirely as a method of harvesting. Swann Winches are in use along both Pacific, Atlantic coasts and in many other areas of the world. Numerous types of winches for trolling, gillnetting, seining, trawling, dragging, longlining, Swann has met them all with aptly designed winches.

Windlasses have a standard design and are fitted with a custom wildcat governed by chain dimensions. At present the windlasses range from ¼" diameter to 1⅞" diameter (6 to 47 mm) chain. Interesting modifications can and have been made such as the Series 357 windlass/winch installed on Canada's famous Bluenose II.

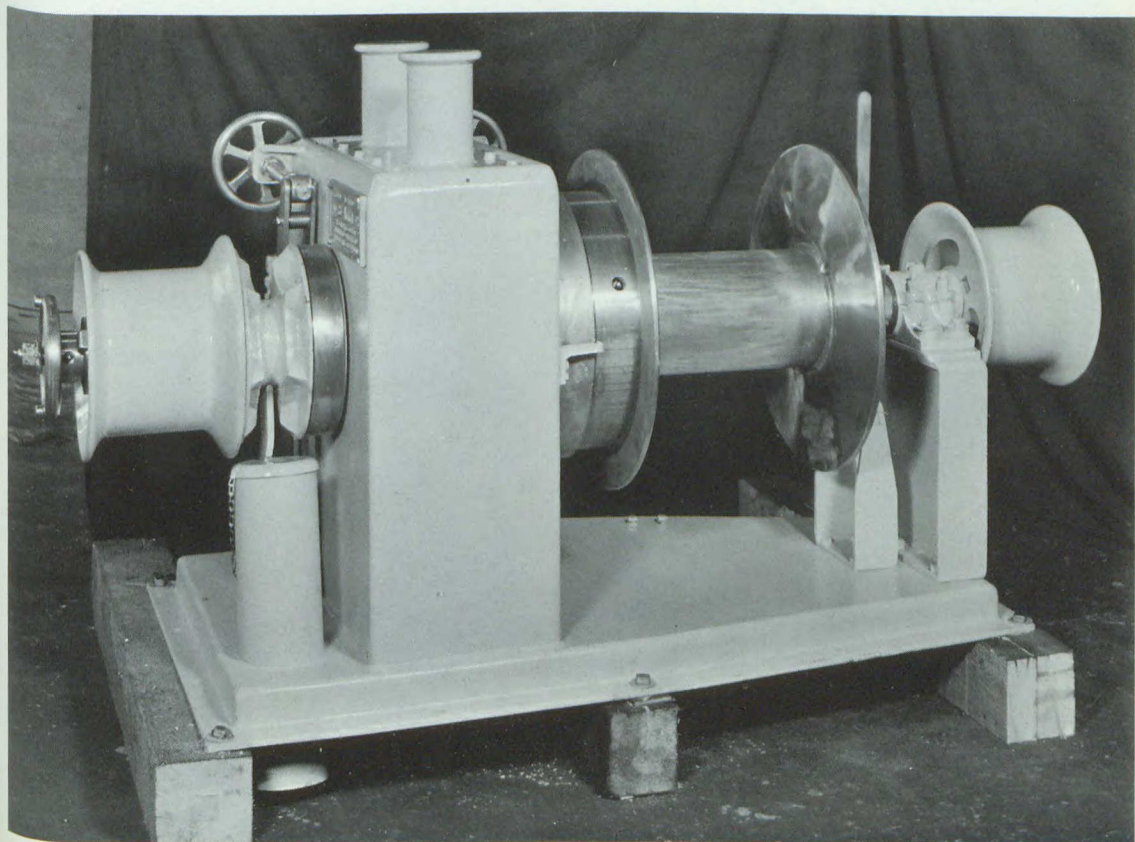
Another feature of the company is the Hydraulic Services Department which can design systems, rebuild or repair hydraulic components and provide field service for any hydraulic system.

We welcome the opportunity of producing designs to meet the precise requirements of a particular application, whether it is for lightweight oceanographic winches designed to handle delicate instruments or a massive towing winch to haul an ocean going barge.





Two Speed Hydraulic Towing Winch — Series T — 408 as installed on the "Haida Brave".



Hydraulic Windlass/Winch Series 315 M as installed on Blue Nose 11.



## AUTOMATICALLY MOORED BUOY—TYPE MB 2500

This medium weight deep sea buoy designed and produced by EMI Electronics, is an automatic two-stage system capable of mooring itself in sea depths down to 18,000 feet.

The moored system consists of a surface buoy connected via a slack cable to a subsurface float which in turn is connected via a taut lower mooring cable to a dead weight anchor. A number of variations are offered to the basic buoy system giving the equipment a considerable degree of versatility in payload distribution, system location in the sea, recovery, etc. Typically, the surface buoy and subfloat can support payloads of up to 50 lb. and 100 lb. (22.7 and 45 kg) respectively.

The maximum current conditions in which the surface buoy will remain on the sea surface are defined by the "limiting" profile curves. If these conditions are exceeded the buoy will submerge and reappear when conditions are again less than the "limiting" profile. The maximum depth to which the buoy (and, similarly, the subsurface float) may descend without damage is such that the system will survive under almost all conditions to be expected in the oceans.

The total weight of the system in air depends upon individual customer requirements but will normally be less than 3000 lb. (1361 kg). The complete system is supplied in a wooden packing case approximately 40 inches square and 16 feet long (258 cm<sup>2</sup> x 4.9 m).

Launching preparations are simple and once completed the system may be launched from a small ship by dropping in the sea where it will automatically deploy and moor itself without further attendance.

### TECHNICAL PERFORMANCE SPECIFICATION

**MOORING DEPTH.** The system will moor in any sea depth between 500 feet and 18,000 feet (1524 to 5486 m).

**SUB-SURFACE FLOAT DEPTH.** The implantation depth is readily adjustable and normally deployed set to 300 feet (91 m). This depth,  $\pm 20$  feet (6 m) will be achieved in zero current conditions, but the actual depth of the subfloat will vary with current.

**LIMITING CURRENTS.** In currents up to the limit the *surface buoy* will remain on the ocean surface. If the current exceeds the profile value the buoy will submerge and the subfloat descend by a corresponding amount. The maximum design depth of the surface buoy is 300 feet, and of the subfloat 1000 feet. This should be suitable for practically all conditions encountered except, possibly, the strong deep current areas of the world. With the limiting depth values given, the safety factor is approximately 1.5.

**LIMITING ENVIRONMENTAL CONDITIONS.** The system tends to protect itself by submergence in excessively bad weather; that is, weather in the storm or hurricane range. When it does not submerge the system will however survive sea state 8 and associated winds in the range 41 to 47 knots.

**MOORING LIFE.** The moored system has a statistical half-life of six months within the limits defined by the limiting current and environmental conditions.

**AUTOMATIC MOORING SEQUENCE.** Once dropped into the sea the system will moor itself automatically. The sequence of events is as follows:

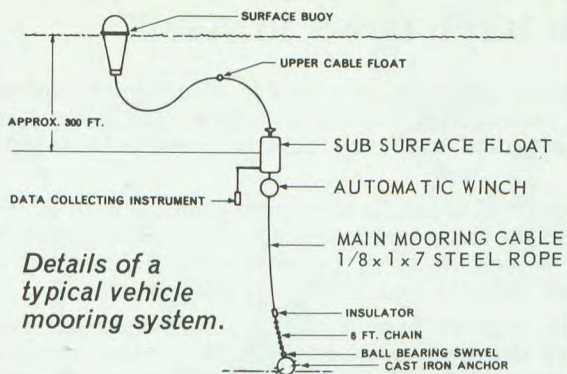
The sub-surface float, winch and anchor assemblies descend in the sea at a velocity of approximately 10 ft./s (3 m/s).

At a depth of approximately 200 feet the anchor manacle assembly releases freeing the anchor from the winch frame.

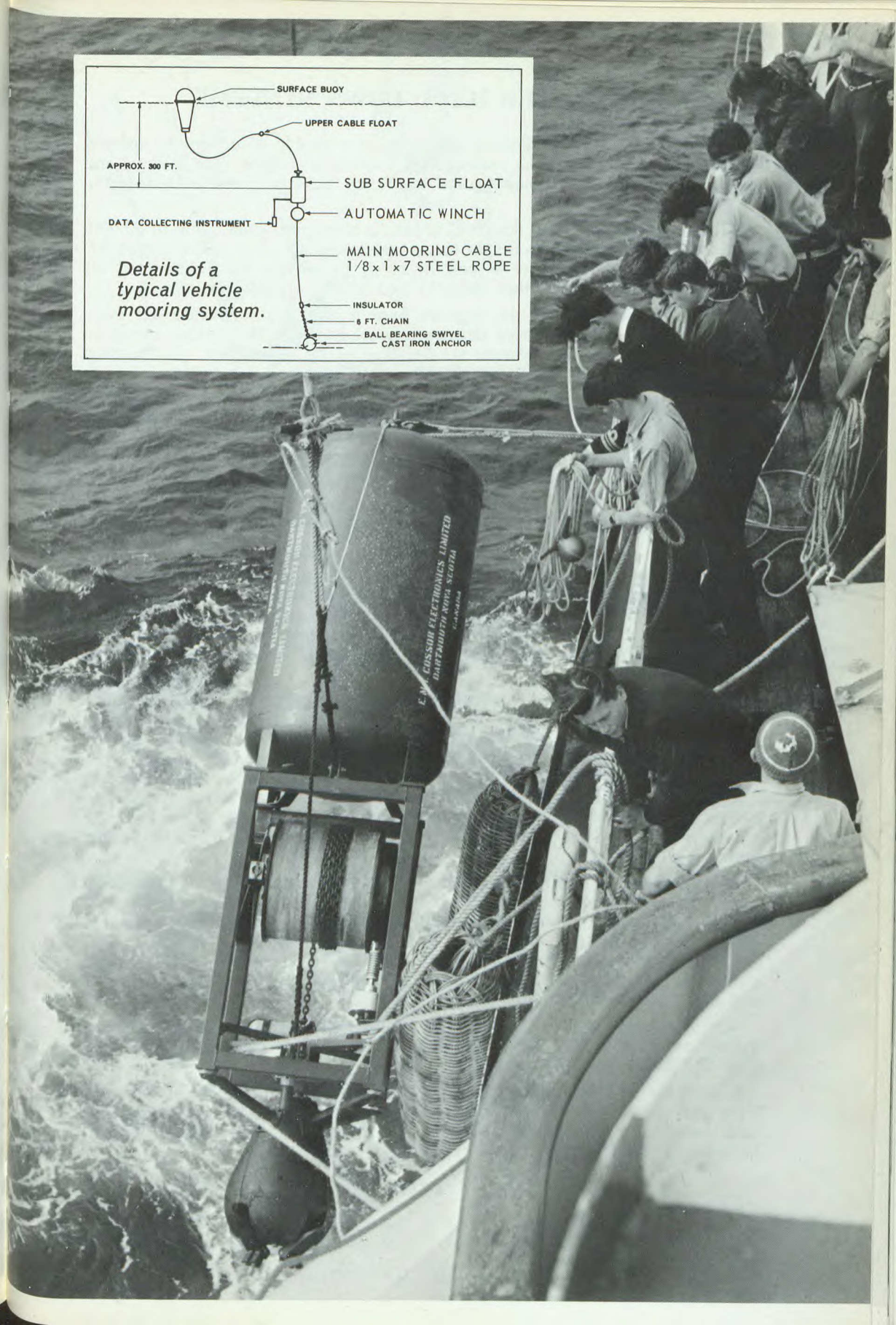
At approximately a depth of 320 feet (97 m) the brake securing the winch relaxes and allows the anchor to descend at a rate of some 14 ft./s (4 m/s).

About two minutes after the anchor reaches the ocean bed a lock located at the winch fires and permanently locks the winch drum.

The modular construction of the basic buoy system allows a variety of optional features to be incorporated to meet the requirements of individual users.



*Details of a typical vehicle mooring system.*



## HELICOPTER HAUL DOWN SYSTEMS

The Helicopter Haul Down Systems are designed to enable helicopters to operate at sea from small flight decks under rough weather conditions. The systems are engineered, designed and manufactured by Fairey Canada Limited, Dartmouth, Nova Scotia.

Various systems have been designed, to handle helicopters from 8,000 to 20,000 lbs. (3629 to 9072 kg) gross weight in sea states causing a roll of  $31^{\circ}$ , pitch  $8^{\circ}$  and heave up to 20 feet per second (6 m/s); to provide for either fixed or traversible securing device either single or two-helicopter configuration.

The system illustrated on the opposite page is the latest two-helicopter configuration designed for advanced destroyer escort concept. The system operation may be considered in four phases: (1) Landing on the flight deck. (2) Securing immediately upon landing. (3) Straightening. (4) Traversing into hangar.

A landing operation is carried out as follows: A line is lowered from the hovering helicopter and connected to the haul down cable end fitting, which is then winched up and locked in a probe in the helicopter bottom fuselage. The haul down cable is reeved around a drum in the winch compartment of the ship, and this drum, powered by a hydrostatic transmission, is operated to winch the helicopter under a selected and controlled tension, to the flight deck. Tension selected at the control console will remain constant regardless of ship motion. At a "null" period in the ship's motion the helicopter will be drawn smoothly down to the flight deck. This constant tension feature is achieved through the use of a servo system which compares cable tension, measured by a load cell, with a command signal or tension selection at the control console. The resultant error signal is used to control the output of a variable displacement pump, causing the haul down cable to be reeled in or out and to maintain the required cable tension. Rate of descent can be controlled by increasing or decreasing the tension selected.

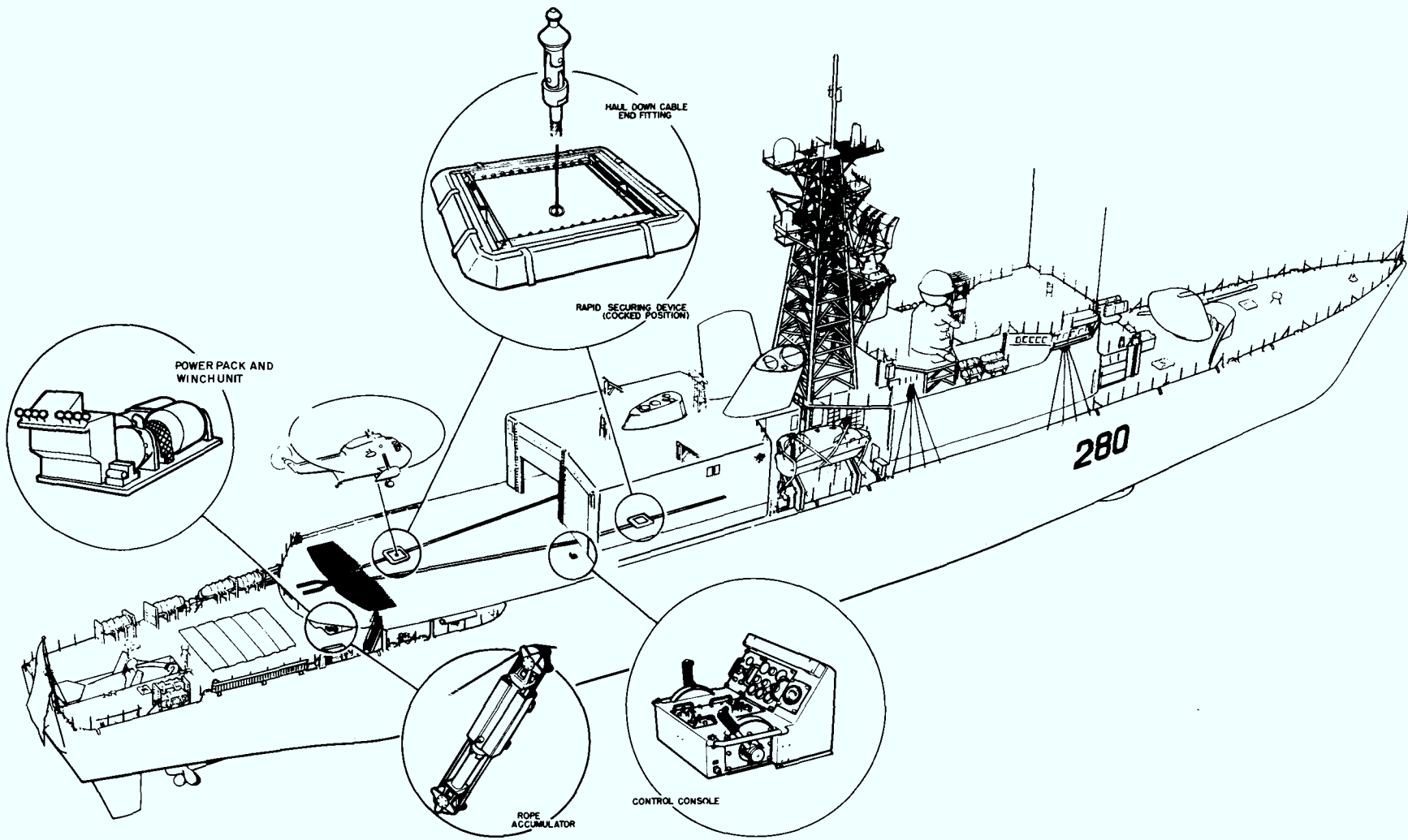
As soon as the helicopter has landed, the Rapid Securing Device, known colloquially as the "Beartrap", is actuated. The securing device is a steel structure about six feet square and eight inches high, which contains two mutually opposed parallel Arresting Beams. These beams are remotely closed and opened from the control console by the securing device hydraulic system. In the closed position, both beams lock together and secure the helicopter probe protruding from the bottom fuselage. When the beams have locked together on the probe, and the helicopter tail probe is lowered, the helicopter is restrained on deck against motion in all directions.

The operation is completed by straightening the helicopter on deck by traversing the securing device aft, with the helicopter attached. A tail guiding winch system can be installed which assists in straightening the helicopter under severe weather conditions. The securing device and helicopter may then be traversed forward into the hangar. In the installation shown, use of a "swinging bellmouth" permits a common haul down system to be used with independent traversing systems for port and starboard hangars.

Alternate systems (not shown) provide for different configurations of traversing feature; single helicopter configurations with or without traversing feature; and simplified fixed securing systems.

In addition to being operationally approved for use with the Royal Canadian Navy and incorporated in the latest destroyers, the "Bear Trap" systems have been installed, evaluated and accepted by the United States Navy and the Japanese defence forces.





## TELESCOPIC HANGARS

With the Dominion Aluminum patented telescopic helicopter hangar, it is possible to house and service the aircraft in the same area as that used for landing. In most installation, only two helicopters are carried, and, particularly under difficult weather conditions, both aircraft should be operational, either in the air or ready to fly. Only the telescopic hangar allows this co-use of space for both storage and flight operations. Extended, it is a hangar—retracted, it frees its own deck space for take-off and landing, making it possible for the smallest ships to provide hangar facilities.

The hangar operates on the principle of a telescope, and is installed on the flight deck. Coaxial sections constructed of arched aluminum frames and sheeting retract within each other to expose the flight deck for use. The structure forms an inverted “U” in cross section and with the use of high-strength low-weight aluminum, minimizes the ship’s top weight. The hangar usually employs one fixed section forward and one or more moving sections aft that extend out over the flight deck. The forward fixed section is the largest and contains the power supply, operating control panel, heating units, and maintenance gear.

The moving sections travel on steel tracks recessed in the flight deck. Retraction and extension is accomplished by electric drives with provision for manual operation in the event of power failure. Electric brakes automatically engage the track when not operating to prevent hangar movement caused by the ship’s motion. Grounding of the moving sections eliminates the build-up of static electricity. The hangars have now been designed in sizes ranging from 12 feet wide by 25 feet long and 12 feet high (8.6 x 7.6 x 3.6 m) to 80 feet wide by 300 feet long and 60 feet high (24 x 91 x 18 m).

In the fully extended position, the telescopic hangar is designed to withstand winds up to 130 MPH from any direction. Watertight seals are incorporated throughout, to maintain a suitable environment in the roughest weather. The hangar is designed to withstand maximum pitch and roll of the ship and to operate under heavy sea conditions if necessary.

Special lighting, heating, ventilating and fire-fighting equipment has been developed as an integral part of the DAF telescopic hangar system. In this regard, the DAF hangar possibly is superior to many land-based multi-purpose hangars. Servicing can be carried out under hangar conditions and the helicopter can receive periodic repair and maintenance within feet of where it lands.

Over 50 of the hangars are now at sea with the Canadian, United States and Italian navies as well as with the Canadian and U.S. Coast Guards.

The same type of structure has now found employment in two new roles. The covered docking of submarines for repair and maintenance has always been desirable but usually prohibitively expensive. With the telescopic building both the requirement for cover and the budget are satisfied. The other use is for dockside cover for quality cargos and yet not interfere with the working of winches or cranes.



Sikorsky HH-52A landing on U.S.C.G.C. "Eastwind" with the hangar retracted. Retracted length 18'9½" (5.7m).



U.S.C.G.C. "Edisto". Extended length 56'9" (17.3m) Width 30'4" (9.3m) Height 17'2" (5.2m)



## UNDERWAY REPLENISHMENT OF SHIPS

Garrett Marine has developed and produced for the Canadian Navy a unique system which allows the safe transfer of heavy equipment between ships at sea, without interfering with their operational readiness. Conventional methods using inhaul/outhaul techniques have long been used but these methods are very restricted due to problems of co-ordinating three independent winches (inhaul, outhaul and highline) in anything other than calm seas.

The Garrett Marine concept employs a Self-Propelled Vehicle (SPV) operating on a tensioned highline between the supply vessel and a receiving ship. Drive is by an electric motor carried on the vehicle which is controlled from the supply ship via a trailing cable. Self-Propelled Vehicle systems are capable of being used for either liquids or solids transfer and it is envisaged that to achieve optimum cost/effectiveness, equipment will be integrated to the extent of having each station capable of transferring either solids or liquids. Various systems offered by Garrett Marine are as follows:

a. *Single Highline*

Utilizes a conventional highline winch and ram tensioner with the highline dead ended on the receiving ship. A latch assembly incorporating a shock absorber and a means of automatically disengaging the vehicle drive clutch so that the highline may pass back and forward whilst the vehicle is docked in the latch provided at the supply ships. Maximum shock during docking with full payload is 5g.

b. *Double Highline*

Again utilizes the standard highline winch and ram tensioner but with the line passed to the receiving vessel through a flounder plate and sheave and back to the supply vessel where it is dead ended. In this configuration, the vehicle drive is operated on the lower dead ended line whilst the top line is passed through an extra idler sheave in the top of the vehicle so that the vehicle is supported by both lines. Thus for a given payload, it is possible to use lower line tensions than required by the single highline system. Use of the doubled highline imparts greater stability to the vehicle travelling on the line. The docking arrangement is reversed with this method in that the latch assembly is situated on the receiving vessel. Again maximum shock of 5g is seen by the payload during docking.

c. *Three-Drum System*

This is the most advanced of the systems offered in which a doubled highline is carried by two interconnected highline drums. These drums are driven by, and mounted co-axially with, another drum which is connected to the highline winch and ram tensioner. As before, the vehicle is supported by both lines and drives on only one line. In operation truly shockless docking at either the receiving or the supply vessels is achieved by a brake operating on one of the highline drums. Thus with the brake released both highline drums are driven by the winch drum and there is no passage of highline around the tension sheave at the receiving vessel. In this mode, the SPV can approach the receiving vessel as if the highline were dead ended there. On the return, the highline drum brake is operated stopping the line which the vehicle uses for traction. Thus, the vehicle can now approach the supply vessel without regard to ships motion. Ships motion is accommodated by continuing to drive the other highline drum and maintain the line tension.

All systems are designed to operate on a standard 1 inch diameter highline and can be furnished with dual speed drive and automatic control. The automatic control allows the change speed and stop distances to be preset at both ends of the transfer and facilitates operation in poor visibility or at night. Systems are supplied complete with 400 Hz motor generator set and automatic powered cable reel including trailing cable to the vehicle. Principal operational characteristics are as follows: (a) Transfer speeds are 75 feet per minute and 300 feet per minute (22.9 x 91.4 m). (b) Payload capability at present to 5,000 pounds (2268 kg) at 300 foot (91 m) ship separation. (c) Operational in Sea State 5.

A number of accessories for use with the system is also offered and these include:

- a. *Powered Hoist*—This is carried on the vehicle and permits the load to be raised and lowered during the loading.
- b. *Variable Frequency Power Supply*—For use in place of the fixed frequency source giving variable speed drive and providing fast speed return (450 feet (137 m) per minute). Size and weight of the supply would be less than the motor generator set it replaces.
- c. *Telephone Communication and Distance Measuring System*—Provides communication between loading crews and ships bridges as well as ship separation readout on the bridges for station keeping purposes.



## OCEANOGRAPHIC MAGNETOMETER SYSTEMS

The Barringer Oceanographic Magnetometer System was developed for the Oceanographic Office of the United States Navy. The system consists of two main parts; an on board instrument console and a marine towing system. The instrument console houses the OM104 Oceanographic Magnetometer, a monitor oscilloscope, a strip chart recorder and a power supply which provides the polarizing and magnetometer power requirements. The marine towing system consists of 750 ft. of special tow cable, an under water connector and a sensor or "fish".

The OM104 Magnetometer was developed to meet the U.S.N.O.O. requirements which called for a direct reading nuclear precession magnetometer with a accuracy of  $\pm 1$  gamma over a range of 20,000 to 100,000 gamma. The requirements included digital and analog outputs and a maximum cycling rate of 2 seconds to be initiated automatically, remotely or manually.

As a totally new design concept the equipment carries many interesting innovations but to personnel concerned with the streaming and recovery of such equipment the connector is of special interest.

The cable-fish connector was specifically designed for underwater towing. The techniques employed in the connector have been proved in military designs and were tailored to the magnetometer application. The connector is of the screw-connect type and contains three #12 standard pin type contacts. The shell is made entirely of non-magnetic brass and transmits the towing strain from the pigtail to the strain member of the tow cable. All seals in the connector are mechanical and therefore either half can be replaced in the field with simple hand tools.

Use of a connector near the "fish" provides the system with flexibility that some systems do not have:

- (a) Damaged fish can be removed and replaced in a matter of minutes with minimal delay to a survey.
- (b) A tow cable may be used with various sensors using the standard connector.
- (c) Field repair of the connector does not occur at a critical area where contamination could affect the system performance.
- (d) Sensor can be readily removed from cable for continuity check of cable and sensor.

One final provision in the connector assembly is for the insertion of an instrument package between the male and female halves. This could be required for signal preamplification in deep towing applications. The unit is merely screwed into place between male and female connector halves.

### Specifications

*Resolution:* 1 gamma

*Accuracy:*  $\pm 1$  gamma

*Range:* 20,000 to 100,000 gamma in sixteen overlapping ranges, selected by front panel switch

*Cycling Mode:* Automatic, manual or remote

*Maximum Cycling Rate:* 2 seconds

*Automatic Cycling Rate:* 2 seconds to 3 minutes, adjustable through hard wiring

*Display:* 5 numerical indicator tubes showing the field directly in gamma units

*Outputs:* Digital — 5 figure 1-2-4-8 BCD and Print Command

Analog-current output and voltage output

The analog output represents 0-99 gamma and 0-990 gamma on separate channels

*Power Requirements:* Magnetometer — 22v to 32v DC @ 1.5 amps max

Polarizing — 22v to 45v DC, 4 amps @ 28v (typical)

Optional power supply available to provide magnetometer and polarizing power requirements 115v, 220v, 240v AC 50/60HZ

*Temperature Range:* 0-50°C

*Size:* Width 19", height 3½", depth 10" (48 x 9 x 25 cm) designed for front panel mounting in standard 19" (48 cm) rack

*Weight:* 10.6 lbs. (4.9 kg)

*Sensor:* Barringer Marine Towing System Type C1041.





## VDS—VARIABLE DEPTH SONAR (504)

A type of sonar that is one of the most significant developments in the science of submarine detection in recent years has been in use by the Royal Canadian Navy since 1960 and is also in use with the Royal Navy, the Royal Australian Navy, and the Royal Indian Navy.

Called Variable Depth Sonar (VDS), the new system enables warships to lower sonar gear through the ocean's thermal layers, thereby overcoming the submarine's ability to escape detection in or below these temperature strata.

Variable Depth Sonar was the result of more than ten years' research and development by Defence Research Board scientists of the Naval Research Establishment, Halifax and specialists of the Royal Canadian Navy.

The need for a layer-probing sonar first became apparent when enemy submarines, both by accident and design, made tactical use of thermal layers during the Second World War.

The upper levels of oceans usually contain layers of varying temperature which form a horizontally uniform patterns many miles in extent. These layers may impede or completely resist penetration by sonar transmissions from hull-mounted sets.

The problem was of particular concern to the RCN because of such water conditions off Canada's coasts.

DRB scientists and RCN anti-submarine specialists, working together, discovered the problem could be substantially overcome by placing transducers in or below the layers of varying temperatures.

Applied research and development followed. The result is essentially a transducer which can be towed at varying depths. The towing cable houses a core of electrical conductors for carrying signals to the sonar displays and electrical power to the transducer.

The concept that led to the development of VDS was initiated almost simultaneously in Canada and the United States. Close liaison was maintained with the United States Navy and Royal Navy, which also sought improved detection methods along similar lines. Information was shared throughout with Canada concentrating on specified possible methods as the other countries explored allied techniques.

**HMCS New Liskeard** (coastal escort) was the first ship to be used for experimental trials. Repeated testing and modification resulted in improvement in the equipment's performance, and an improved version of VDS, built by Canadian firms, was installed in **HMCS Crusader** (destroyer escort). Intensive evaluation produced effective results and the equipment was accepted for service in the RCN.

While it is most obvious that these are older equipments it should be realized that development in this field has continued and newer equipments have been evolved.







# TRANSISTORIZED MARINE RADIO—LN55

This compact Canadian Marconi Company marine navigational radar was designed to bring the benefits of radar navigation to small craft operators without the high cost, high power consumption and the need for technically competent operators associated with previous radars.

The set is available with either 5-inch or 10-inch (12.7 or 25.4 cm) display units which may be bulkhead or chart-table mounted or free standing on a pedestal. The use of all solid-state circuitry (except the CRT) and fixed coil deflection system eliminate the need for ventilation of the display cabinet permitting closed cabinet design for weather protection. The fixed coil deflection system also eliminates motor noise usually found in moving-coil systems and the display units are completely noise-free. An edge-lit panel enhances night-time operation as all functions and major control positions are visible without glare.

Two precision slotted-waveguide antennas are available. The smaller, 3-foot (.9 m) antenna is enclosed in a glass-epoxy radome which provides complete protection from wind, water and icing conditions, eliminating wind drag and ice loading to keep power drain to a minimum. The rotating mechanism is extremely quiet.

For larger vessels or where space and other conditions permit, a conventional 4-foot (1.2 m) tabular rotating antenna provides improved angular discrimination.

Either antenna may be used with either display unit, allowing complete flexibility in meeting operational and environmental requirements.

The separate transmitter/receiver unit can be installed in any convenient location to simplify the running of waveguide. This unit contains the completely solid-state receiver and regulated DC power supplies as well as the 7.5 kilowatt transmitter. Plug-in power adaptors permit efficient operation from 13.6, 26.4 and 36.0 UDC as well as 115/230 VAC power sources. The circuitry is protected by fast-acting primary and extensive secondary fusing. Installation and maintenance have been simplified by the use of a comprehensive system of test points and controls.

Sales of the LN-55 radar have exceeded 1,000 sets, including some for use in U.S. Navy helicopters.

## Specifications

### RECEIVER

I.F. Bandwidth: 5MHz  
I.F. Center: 30MHz  
Tuning: Synchronous  
Noise Figure: 12db (overall)

### TRANSMITTER

Peak Power Output: 7.5KW  
Frequency: 9375  $\pm$ 30MHz  
Modulator: Line & Thyatron  
Pulse Length: 0.18 micro seconds  
P.R.F.: 1500 pps.

### ANTENNAS

	3-foot (.9 m)	4-foot (1.2 m)
Rotation Speed	22 RPM	22 RPM
Horizontal Beamwidth (−3db points)	2.5°	1.8°
Vertical Beamwidth	22°	25°
Side Lobe Suppression	24db+	26db+
Type	Precision Slotted Waveguide	Precision Slotted Waveguide
Polarization	Horizontal	Horizontal
Wind Load @ Rated RPM	80 Knots	80 Knots

### GENERAL

Power Requirements: Approximately 160 watts at 13.6, 26.4, 36 VDC or 115/20 VAC

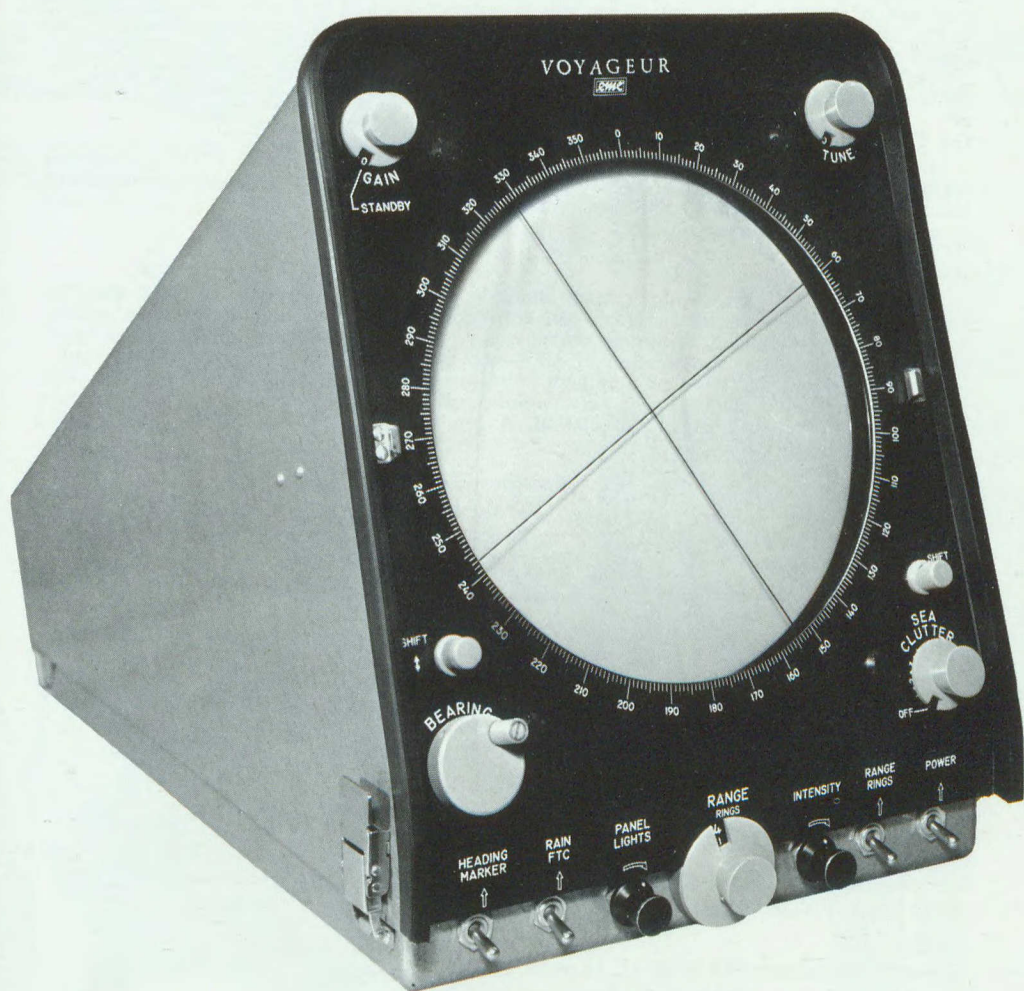
Ranges: 10" (2.54 cm) Display — 1,4,8 and 16 nautical miles  
5" (12.7 cm) Display — 1/2,2,8 and 16 nautical miles

Calibration:  $\pm$ 2% of range

Range Discrimination: 35 yards (32 m) or better

Bearing Accuracy:  $\pm$ 1°

Weights: Transmitter/Receiver	37 lbs. (16.8 kg)
3' (.9 m) Antenna with Radome	50 lbs. (22.9 kg)
4' (1.2 m) Antenna	65 lbs. (29.5 kg)
5" (12.7 cm) Display Unit	28 lbs. (12.7 kg)
10" (25.4 cm) Display Unit	32 lbs. (14.5 kg)



# TRANSISTORIZED MARINE RADAR—LN66

The LN66 marine navigational radar set represents an evolutionary development of this equipment line and features commonality of many parts with the LN55 previously described. It differs mainly in increased power, increased range and improved range resolution with these improvements being the result of continuing development by Canadian Marconi in this field. The three major units of equipment in each LN66 system are:

## Antenna Group

A 4-foot slotted waveguide antenna is enclosed in a tubular radome and mounted on a gear box or antenna drive unit. This unit is connected via a rotary joint in the gear box to the Transmitter/Receiver unit by means of elliptical waveguide. A smaller, 3-foot (.9 m) slotted waveguide antenna is available. The entire antenna and drive unit is enclosed in a glass-epoxy radome which provides complete protection from wind, water and icing condition eliminating wind dray and ice loading to keep power drain to a minimum.

## The Transmitter/Receiver Unit

This contains the regulator for the D.C. voltages required for both the T/R unit and the display unit. The T/R unit contains the modulator, magnetron, duplexer, klystron, local oscillator, mixer and I.F. amplifiers. Warm up time is restricted to 180 seconds by a built-in thermal delay unit.

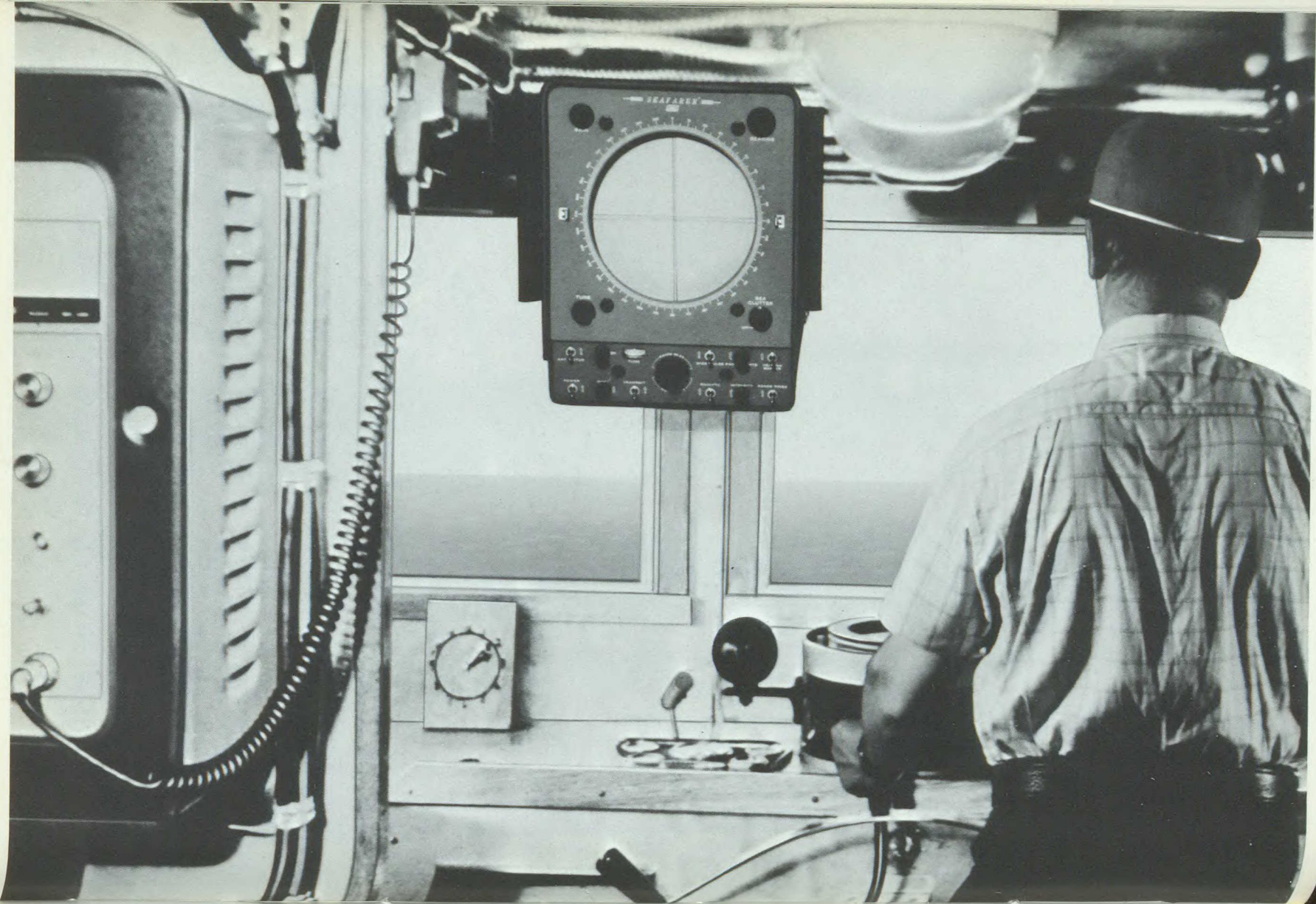
## The Display Unit

This contains no power supply other than the HV supply for the CRT, and combined with the solid-state circuitry and fixed-coil deflection system, eliminates the need for ventilation of the display cabinet permitting closed cabinet design for weather protection. An edgelit panel provides uniform illumination of all switch and control positions. The display unit is equipped with a 10" (25.4 cm) cathode ray tube utilizing a P33 phosphor giving long persistence and good contrast. The short pulse length sub FTC provide for effective resolution during periods of heavy precipitation. A smaller version of the display unit using a 7" (17.9 cm) CRT is available.

## Specifications

<b>RECEIVER</b>	<b>TRANSMITTER</b>	
I.F. Bandwidth: 14MHz	Peak Power Output: 10KW	
I.F. Center: 45MHz	Frequency: 9375 ±30MHz	
Tuning: Synchronous	Modulator: Hard Tube Type	
Noise Figure: 12 db (overall)	Pulse Lengths: .05 and .25 micro seconds	
	P.R.F. 2500 and 1250 pps	
	<b>ANTENNAS</b>	
	3-foot (.9 m)	4-foot (1.2 m)
Rotation Speed:	22 RPM	22 RPM
Horizontal Beamwidth (-3 db Points)	2.5°	1.8°
Vertical Beamwidth	22°	25°
Side Lobe Suppression	24 db+	26 db+
Type	Precision Slotted Waveguide	Precision Slotted Waveguide
Polarization	Horizontal	Horizontal
Wind Load @ Rated RPM:	80 Knots	80 Knots
<b>GENERAL</b>		
Power Requirements: 180 W @ 12, 24 or 36 VDC		
	Separate Converter provided for use or 115/230 VAC.	
Ranges: ½, 1½, 3, 6, 12 and 24 nautical miles		
Calibration: ±1%		
Range Discrimination: ±20 yards (18.3 m)		
Bearing Accuracy: ±1%		
Weights: Transmitter/Receiver	37 lbs. (16.8 kg)	
3' (.9 m) Antenna with Radome	50 lbs. (22.9 kg)	
4' (1.2 m)	65 lbs. (29.5 kg)	
10" (25.4 cm) Display Unit	35 lbs. (15.9 kg)	





## SUBMARINE SIGNAL SIMULATOR (SSS)

As a result of CAE's leadership in the field of ASW aircraft compensation, further developments in the general scope of MAD (Magnetic Anomaly Detection) have resulted. Due to the limited use of signal processing in MAD, operator training can significantly improve MAD detection capability. To this end the Electronics Division of CAE Industries Ltd. has developed the SSS, an electronic device which generates submarine-like signals, simulating the actual submarine magnetic signature, which may be injected directly into the MAD system. The SSS may be used either while airborne, on the ground, or in a simulated system trainer or bench test set-up.

The SSS, by means of rotary controls on the front face, can be made to simulate 3 different submarine magnetic moments (from small to nuclear size), aircraft speeds from 50 to 300 knots, and aircraft-to-submarine separations from 500 to 3000 feet (152 to 914 m). Each of the above conditions can be simulated for 5 different representative submarine signal shapes corresponding to the various combinations of aircraft and submarine headings.

The simulator is very simple to operate. Once the various controls have been set to select the desired conditions with respect to separation, airspeed, etc., the simulated signal is then started by means of a toggle switch. When the simulated signal reaches the point where the "aircraft" has passed closest (or over) the "submarine" an "ON TOP" lamp lights thus allowing the operator (or instructor) to determine how "late" he was in recognizing the submarine signal.

Since the simulator generates an electrical analog of the submarine signal, it may be used either in the air with actual background geological and geomagnetic noise or on the ground with simulated background noises. The CAE SSS is compatible with all existing MAD magnetometers (ASQ-8, ASQ-10A) as well as new 0.01 Gamma Magnetometers (ASQ-81, CSF Caesium MAD, and the CAE Optically Pumped Oriented Magnetomer (ASQ-501)).

For realistic MAD operator training the SSS is usually operated by someone other than the MAD operator (possibly the co-pilot) so that true operator training and performance evaluation may be effected.

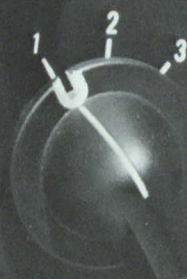
The SSS is also a very useful tool in evaluating and grading overall MAD performance since it provides a stable signal reference with which detection range capability may be evaluated.

The most significant aspect of the SSS is that it eliminates the necessity of tying up a submarine for MAD training purposes. With the SSS, MAD training with simulated submarine signals can be done on each and every MAD flight if desired.



SUB  
SIGNAL  
SIMULATOR

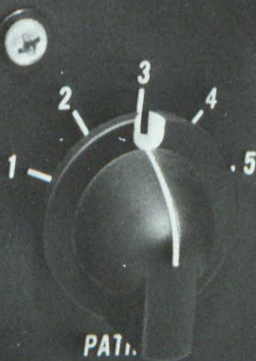
ON TOP



SUB SIZE



SEPARATION



PAT.



AIRSPEED

PWR

START

OFF



## X-Y PLOTTING TABLE, SUBMARINE (Model M450A)

The Marsland Engineering Limited model M450A plotting table is an electro-mechanical-optical display device of a size suitable for installation in submarine vessels, consisting of a plotter display unit, mounted on top of and hinged to an electronics unit. Own Ship's Motion (OSM) data in the form of AC voltages proportional to the North-South (Y) and East-West (X) components of speed are converted into scaled movement of a projector which displays a circular image of Own Ship Position on the plotting surface. Also displayed on the control panel are Own Ship's Position in degrees, and minutes of latitude and longitude. Target bearing data (true) is accepted in the form of 360°/revolution synchro transmission and displayed as an arrow cursor, concentric to the Own Ship Position on the plotting surface.

The plotter display unit (M464A) is a cast frame containing the projector carriage, the mechanical drive assembly, the control panel and the plotting surface. The projector carriage is a platform, positioned in X and Y co-ordinates by a cable drive, and carrying the projector assembly which consists of a blower cooled tungsteniodine lamp, a lens system, a rotary reticle, the target bearing servo-mechanism, and a solenoid actuated shutter to blank out the bearing cursor. The mechanical drive assembly is a step motor driven cable and pulley system which moves the projector carriage in response to digitized increments of own ship's motion from the electronics unit. The plotting surface is a laminated plastic rear-projection screen which may be marked on with a grease pencil or crayon, or which may be covered with transparent drawing paper or a transparent chart.

The control panel is recessed into the top of the plotter display unit and is hinged for ready access for maintenance and repairs. In addition to the various control functions, the control panel also contains the Ship's Position Indicator (SPI), a pair of step motor driven dial counters which display latitude and longitude of own ship.

The electronics unit M465A, is a reinforced sheet metal box containing the electronic packages, regulated power supplies and input cable connections. The electronics packages are all on plug-in printed circuit cards. The majority of the circuit functions are accomplished by means of integrated circuit modules, of the linear and digital logic types.

### Specification:

#### INPUTS:

1. East-West component of OSS (Sox) — 0.25/Kt at 400 Hz, North-South component of OSS (Soy) — 0.25/Kt at 400 Hz, to a maximum of 50 Knots (12.5 volts), referred to a 115V 400 Hz reference voltage (VR) derived from the plotter.
2. Target Bearing Data, 360°/Rev., 400 Hz 3 wire synchro referred to 115V 400 Hz (VR) derived from the plotter.
3. Target "In-Contact", a normally-open switch closure which actuates the bearing cursor shutter.

#### ACCURACIES:

1. Own Ship Position —  $\pm 1\%$  of distance travelled, all scales, all speeds from 5 knots to 40 knots. ( $\pm 3\%$  from 1 knot to 50 knots)
2. Target Bearing —  $\pm 0.5^\circ$  of ordered bearing up to 20°/sec. bearing rate.
3. Ship's Position Indicator
  - Latitude  $\pm 1\%$  of distance travelled
  - Longitude  $\pm 1\%$  to 60° Latitude
  - Longitude  $\pm 3\%$  to 85° Latitude

#### SLEWING RATES:

1. Own Ship's Position: East-West 2"/sec.  
North-South 2"/sec.
2. Target Bearing: 36°/second.
3. Ship's Position Indicator: Latitude 20 min./sec.  
Longitude 20 min./sec.

SCALES:  $\frac{1}{4}$ ,  $\frac{1}{2}$ , 1, 2, 5, 10 nautical miles per inch.

#### POWER REQUIREMENTS:

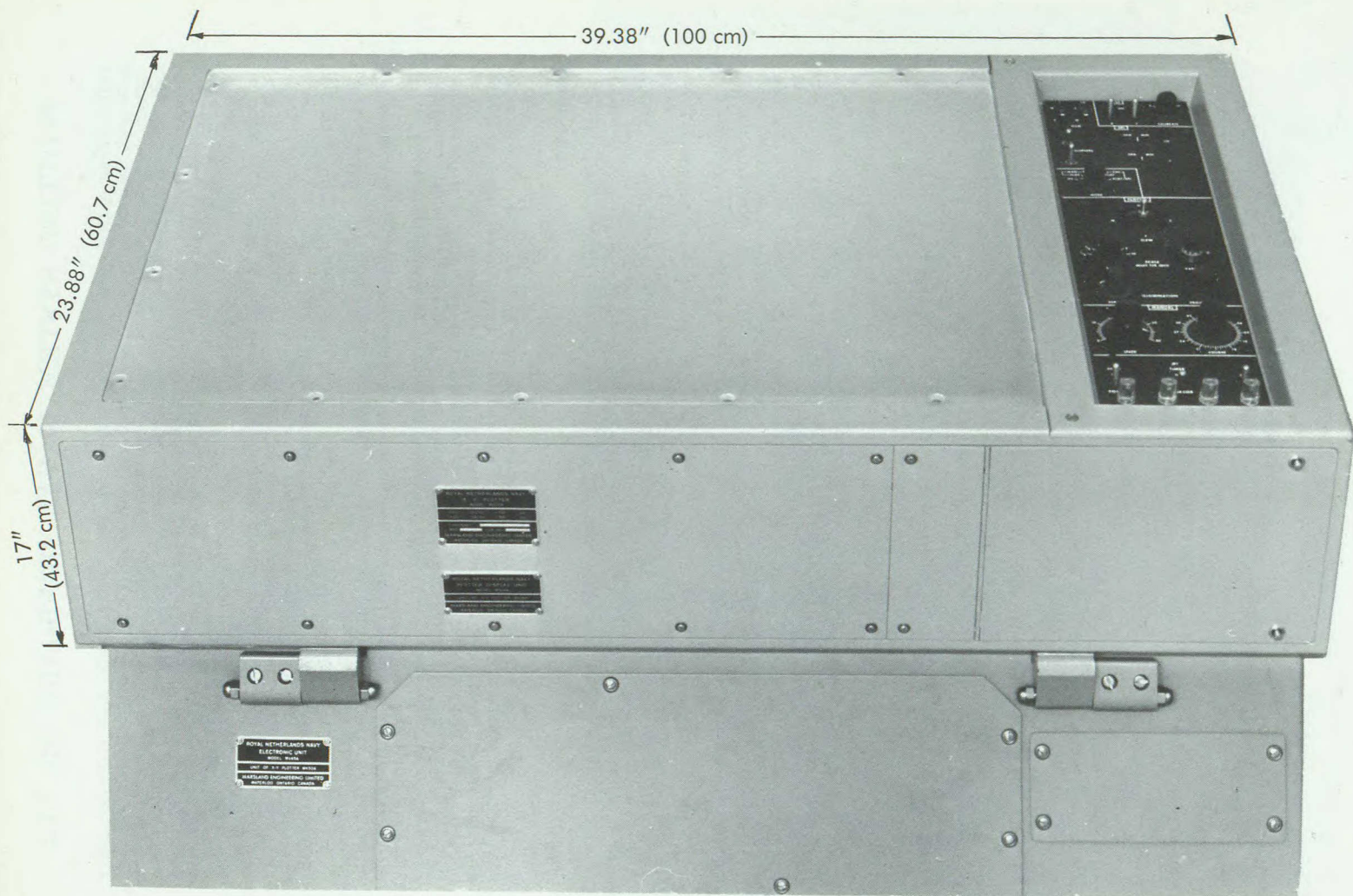
1. 115V  $\pm 10V$ , 400 Hz  $\pm 20$  Hz, 1 Phase, 4.0 Amp.
2. 115V  $\pm 10V$ , 60 Hz  $\pm 5$  Hz, 1 Phase, 2.0 Amp.

#### DIMENSION: (complete plotter)

17" H x 23.88" W x 39.38" L. (43.2 cm H x 60.7 cm W x 100 cm L).

#### WEIGHTS:

- |                          |                   |
|--------------------------|-------------------|
| 1. Plotter Display Unit: | 132 lbs. (60 Kg)  |
| 2. Electronics Unit:     | 103 lbs. (47 Kg)  |
| Total:                   | 235 lbs. (107 Kg) |



## PLOTTING SYSTEM, NAVAL SHIPBOARD, Mk NC2

Following an extensive development program in close collaboration with Canadian Navy personnel, Marsland engineers developed the Analogue Plotting Computer Mk NC2 or "automatic plotting system". The system automatically displays accurate continuous location data of two targets on a large horizontal translucent screen. Over 200 installations have been made on Royal Canadian Navy, Royal Netherlands Navy, and United States Navy vessels equipments in use have been well received by navy personnel and have proven their operational value.

Target range and bearing data is fed into the electro-mechanical computing and drive circuits in the Plotting Table, with the range data passing through the Data Converter where it is modified for use by the plotting system. In a typical operation one target could be a submarine under attack (being tracked by sonar), and the second target an attacking helicopter (being tracked by radar).

"Own ship" speed and course data from the speed log and gyro compass is also fed to the computing and drive circuits, with the speed data passing through the Data Converter.

The computing and drive circuits automatically process the received data, and drive a mechanical-optical assembly (including Main Projector and Target Plot Attachments), which projects on to a translucent screen a compass rose polar diagram with "own ship" position at the centre, and two colored spots of light (one red and one green) representing the targets. A scale Selector Switch provides for seven scales from 0.25 nautical mile per inch (500 yards per inch) up to 10 nautical miles per inch.

### Equipment

PLOTTING TABLE has the form of a large office desk, the top of which is a heavy armor plate glass projection screen, overlaid with a plastic sheet for track plotting. The table frame is ruggedly built and the whole unit shock mounted. The Plotting Table contains the electro-mechanical computing and drive circuits; and the mechanical-optical projection units (Main Projector and Target Plot Attachments) which are mounted on a movable carriage and bridge assembly.

TARGET PLOT ATTACHMENTS are ruggedly constructed, automatic mechanical-optical projection units located in the Plotting Table. Each unit comprises a movable projector which projects a light spot on the display screen, and associated driving mechanism. Systems can be supplied with one or two units as required. In a typical two-unit system one unit would project a red spot to indicate the target under attack, and the other a green spot to indicate a supporting attack weapon (e.g. helicopter or other vessel). The Target Plot Attachments are mounted on the same movable carriage and bridge assembly as the main projector (which projects the compass rose and "own ship" position), so that the target spots accurately show the location of the targets relative to "own ship".

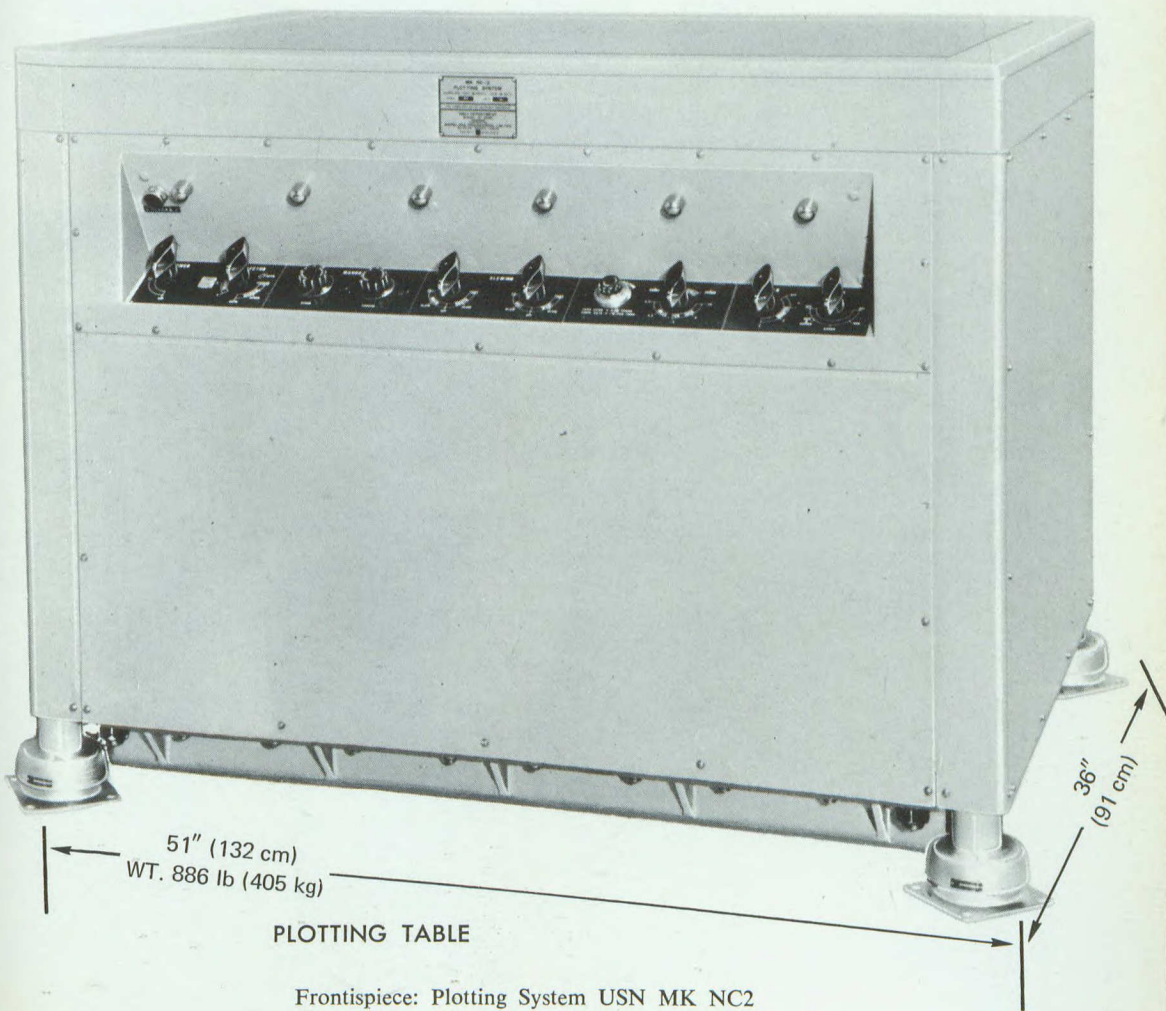
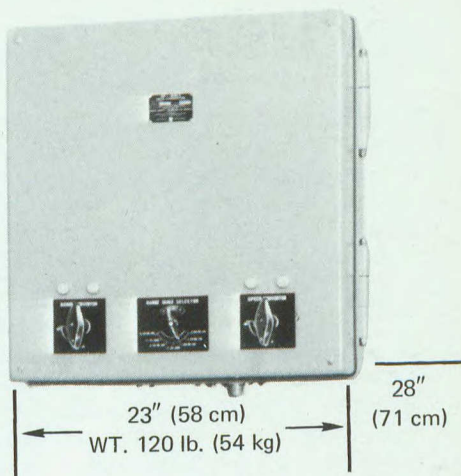
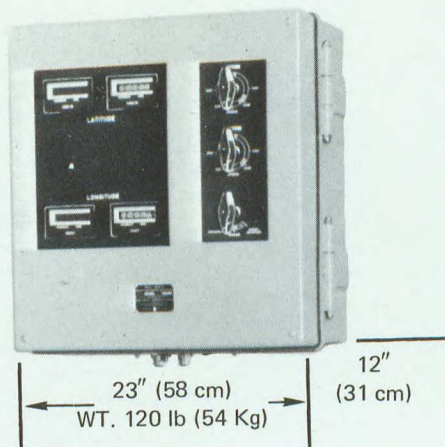
DATA CONVERTER is a strong cast alloy box mounted separately from the Plotting Table, containing electronic and mechanical equipment for converting target range and "own ship" speed data into a form suitable for use by the Plotting Table electro-mechanical computing and drive circuits. It also contains circuits for providing the seven different range scales available for selection by the operator.

DEAD RECKONING INDICATOR is a piece of ancilliary equipment available for use with the basic plotting system if required. It is a cast alloy box mounted separately from the other equipment, containing an electro-mechanical computer. This unit displays the calculated position of "own ship" in angles of latitude and longitude, which can be read from drum type indicators through front cover windows. Necessary resetting controls are provided.



DEAD RECKONING INDICATOR

DATA CONVERTER



## EMERGENCY RADIO BEACON

The RESCU/99 Emergency Radio Beacon is designed and manufactured by Garrett Manufacturing Limited.

The Beacon is lightweight, compact, fully automatic device intended primarily for use at sea in conjunction with life-rafts. Operation is initiated automatically upon immersion in water. The radiated power is nominally 350 milliwatts average on either or both of the two output frequencies: civil emergency frequency 121.5 MHz and Military emergency frequency 243 MHz. Each channel is amplitude-modulated using chopped-carrier modulation. The modulation sweeps downward in frequency over the range 1500 to 600 Hz at a rate of approximately 2½ sweeps per second, in accordance with the latest ICAO recommendations.

A water-activated magnesium-silver chloride battery provides power to operate the Beacon. The battery is totally dry and inert until activated by immersion in water. While normally intended for use in sea-water, the battery can also be activated by fresh water and by other aqueous liquids. The operating life is in excess of 48 hours.

The transmitter and associated circuitry are fully solid state, with all components operating at conservative ratings. A hermetically-sealed cover encloses all electronic circuitry.

The Beacon can be packed in a stowed life-raft or may be bulkhead-mounted. For the latter application, a bulkhead-mounting bracket is provided.

### **Tabulated Specifications**

**Frequency:** 121.5 MHz and/or 243 MHz, 0.005% tolerance.

**RF Output:** 121.5 MHz — 350 milliwatts average power.

243 MHz — 350 milliwatts average power.

**Modulation:** Modulation in accordance with ICAO recommendations (100% swept tone modulation over 900 Hz range within the range 1500 to 600 Hz; Sweep rate 2 to 3 Hz).

**Dimensions:** Length (Stowed) 22.25" (56.5 cm)

Length (Operating, with Antenna erected) 38.75" (98.4 cm)

Diameter 2.75" (6.9 cm)

Weight 3.5 lbs. (1.6 kg)

**Operating Life:** 48 Hours

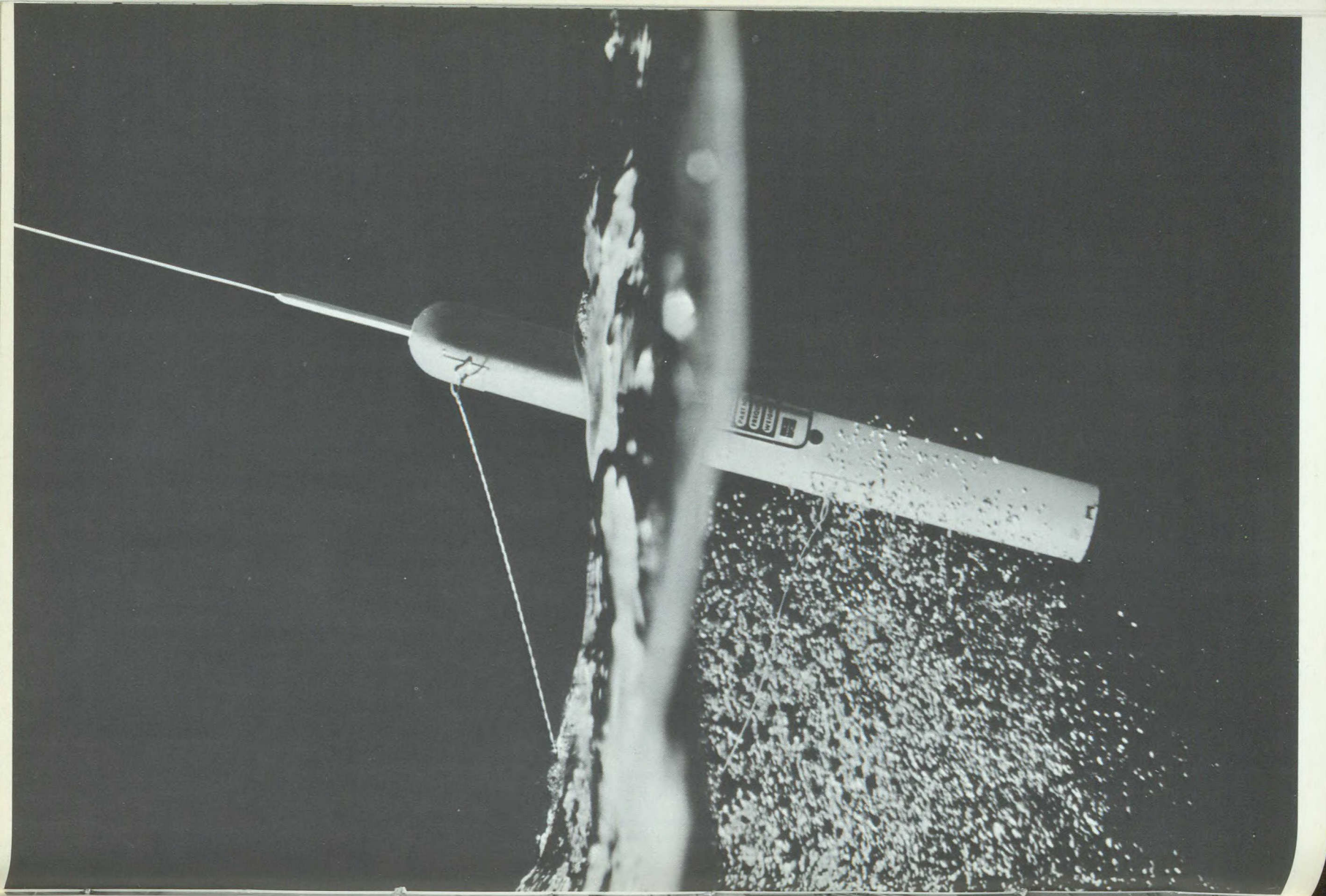
**Storage Life:** Indefinite

**Range:** Over 200 miles (322 Km) at jet altitudes.

Compliance requirements formulated for these Beacons by the U.S. Federal Aviation Agency and Federal Communications Commission as well as by the Canadian Department of Transport have been met by the RESCU/99. With this status achieved the equipment has now been adopted by more than fifty airlines such as: Air Canada, Pan American, TWA, Lufthansa, SAS, Air France and by such aircraft manufacturers as Boeing and Douglas.

These documents differ considerably in scope and content; GML therefore, produced a single combined test procedure which meets the intent of all three documents.







# TUL 30 RL LIFERAFT

## GENERAL DESCRIPTION

The Tul 30 RL liferaft (reversible type) consists of two, 14 sided, polygon shaped buoyancy chambers superimposed on a single floor tangent to both chambers.

A reversible canopy system is fitted to an aperture located on the center of the raft floor, and confined within removable water-tight protective covers located on each side of the floor aperture.

Removal of either canopy cover will expose the canopy system, and allow an occupant to erect the canopy as per instructions printed thereon.

In the event of a capsizing, the remaining canopy cover now in a topmost position can be removed, and the canopy system can be reversed through the raft floor aperture and re-erected upright by following given instructions.

Liferaft features such as: boarding ramps, life-line, rescue line, sea lights, buoyant safety knife, rain-water catchments, mechanical and manual inflation systems, deflation plugs, hand pump, sea anchor, and repair kit are standard equipment on the Tul 30 RL Liferaft.

An equipment bag, containing survival equipment and emergency rations, can be added to satisfy FAA or military regulations.

## INFLATION SYSTEMS

### (a) MECHANICAL INFLATION (30-35 Seconds) LIFE RAFT

Provided by a high pressure (3000 PSIG) Nitrogen cylinder, a regulator valve, two hi-pressure hoses and two miniature air aspirators equipped with positive-pressure seal non-return valves.

### (b) CANOPY SUPPORT STRUT MECHANICAL INFLATION

This is provided by a carbon dioxide cylinder. Release of CO<sub>2</sub> can be performed from any liferaft attitude. This system is used on initial canopy system erection.

### (c) MANUAL INFLATION/TOPPING-UP

This is achieved by using the hand pump provided. Both buoyancy chambers and canopy support strut may be inflated from any liferaft attitude.

## MATERIALS

Buoyancy tube fabric conforms to MIL-C-19002.

Canopy fabric conforms to MIL-C-7966, variety S.

## LIFERAFT BUOYANCY AND WEIGHT DATA

Outside dimensions of buoyancy chambers across flats .....	13'3¼" (204 cm)
Diameter of upper and lower chambers .....	14" (35.6 cm)
Total volume of upper and lower chambers .....	90.8 cu. ft. (2577 litres)
Buoyancy of main chambers only (fresh water) .....	5675 lbs. (2574 kg)
(salt water) .....	5847 lbs. (2652 kg)
Maximum effective buoyancy of liferaft .....	18380 lbs. (8337 kg)
Weight of liferaft (less inflation equipment) .....	approx. 55 lbs. (25 kg)

## EQUIPMENT WEIGHT DATA

Valise container .....	3 lbs. (1.36 kg)
Nitrogen cylinder c/w regulator & hoses .....	17 lbs. (7.7 kg)
Bellows bag .....	7 lbs. (3.2 kg)
Paddles (hand type) .....	1 lbs. (.45 kg)
Equipment bag .....	27 lbs. (12.5 kg)



This version of a 10 man raft differs from the one described in the article but serves to point out the variety of original designs offered by TUL. The boarding ramp may be seen together with the opened primary and secondary closure curtains. The water activated battery cell and emergency light are at the left of the canopy opening.

## CUSTOM MACHINE SHOPS

The picture on the facing page is an indication of the back-up type of service now considered to be an integral part of in-house quality control of any progressive shop now actively engaged in the aeronautical and space fields. This furnace which has an internal diameter of 5 feet can handle parts up to 20 feet in length and is specifically approved for aluminum alloys in the 7075 T 6 and T 73 as well as 2014 T 6 ranges where temperatures up to 1000°F with controls of  $\pm 3^\circ$  are required.

One of the lesser known strengths of Canadian industry is a small but select collection of custom machine shops that are capable of endeavours not normally found in a straight machine shop. Such firms add immeasurably to Canada's industrial make-up and the variety of products covered by some of them may be noted in this section offered by Universal Die & Tool Mfg. Ltd.

The "hard core" of machined parts for to-day's sub and supersonic aircraft continue to exert demands on production sources for the ultimate in skills, techniques and machine tools.

The picture on page 244 is representative of the type of structural component produced by this firm for the aircraft industry. They have produced such components for nearly all Canadian built aircraft since 1946. One of these, the Spar Caps for the DC9, 108" (274 cm) in length and starting off as a 350 lb. (158.8 kg) forging and finishing as a 75 lb. (34 kg) finished machine component, has been in quantity production for some 16 months and will remain so for quite some time to come. Below the Spar Cap is a structural member for the supersonic F 104 which incorporates a homogeneous continuous hinge.

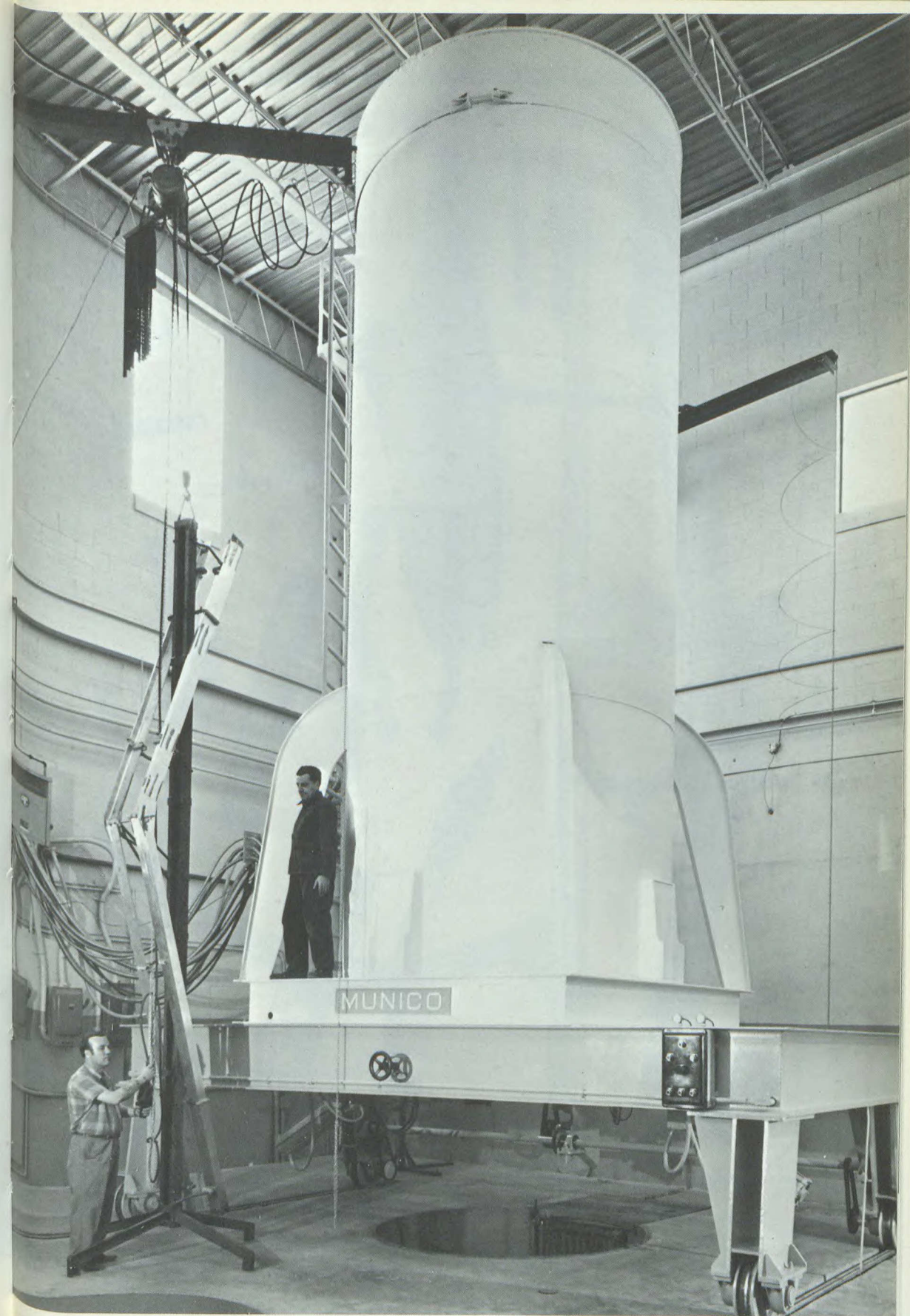
The photograph on page 245 is a sampling of the smaller range of ordnance items produced. They include a Small Arms Universal Cleaning Kit at "A", Blank Firing Attachments for rifles and sub-machine guns at "B", a Tension Bar for steam aircraft catapults at "C", a Maintenance Tool for automatic rifles and a gear toothed Sight Quadrant at "D". The 3 piece steel Cleaning Rod at "E" is one part of the larger kit in the inset.

These two Cleaning Kits are considered capable of cleaning and maintaining any equipment from a hand weapon (pistol) to a .5 machine gun, including shotguns, by merely changing the accessory brushes which screw onto the Pull-through or Cleaning Rod. The two kits have been designed as a family and common parts are used throughout with each and every weapon receiving its own individual attention. Due to these features ordnance spares are greatly reduced and at the same time the cost of the overall item is kept low as it is now used in quantity across a family of weapons as opposed to individual items for each separate weapon.

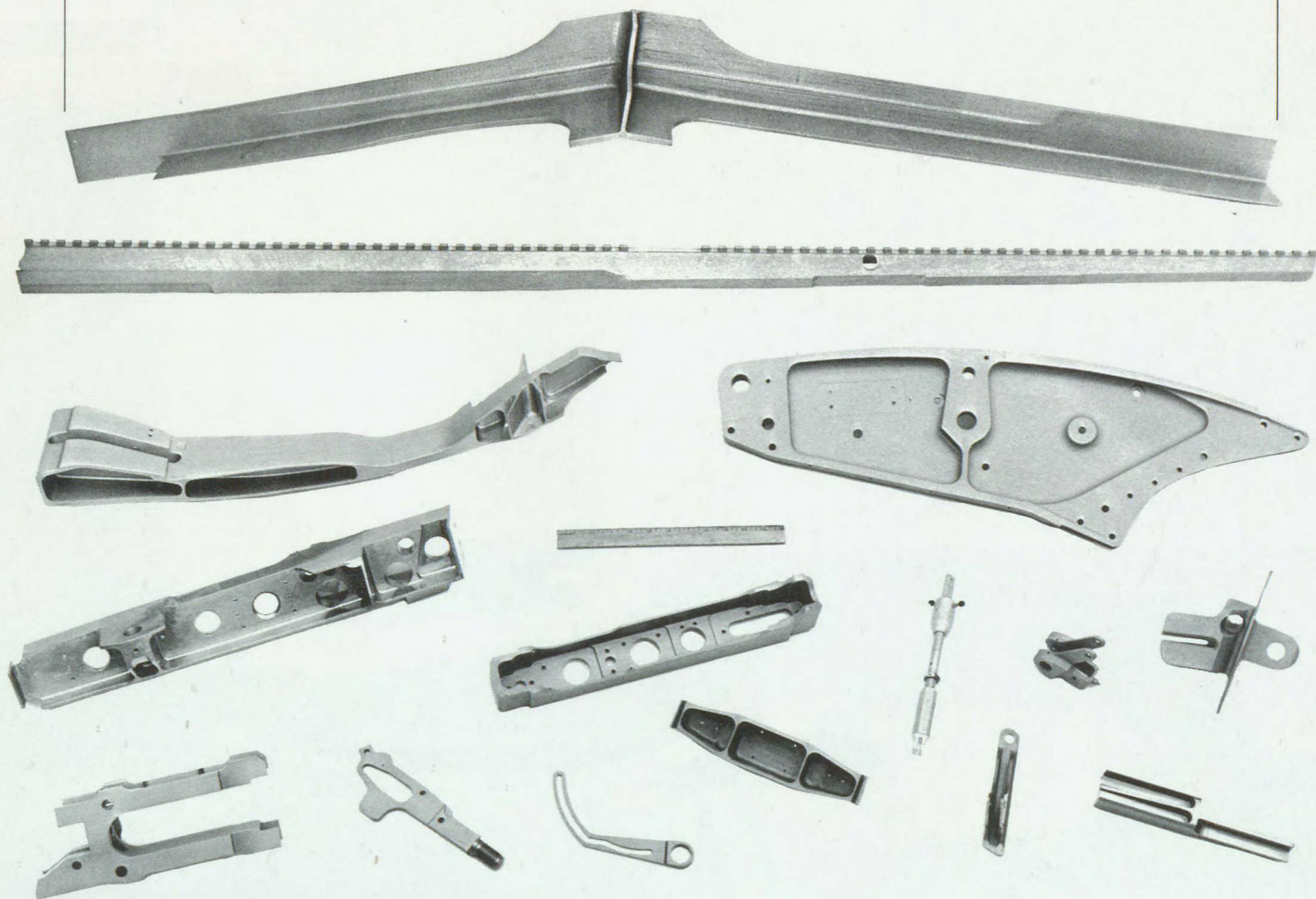
Universal Die & Tool have also produced Drill Rounds and Sub-calibre Devices for recoilless rifles, Rifle Grenade Launchers as well as Electro-Mechanical Target Devices for musketry training.

Firms of this type, in Canadian Industry, can usually be relied upon to provide a high degree of personal attention to an exacting production problem and yet, because of their smaller size, maintain reasonable and acceptable costs.





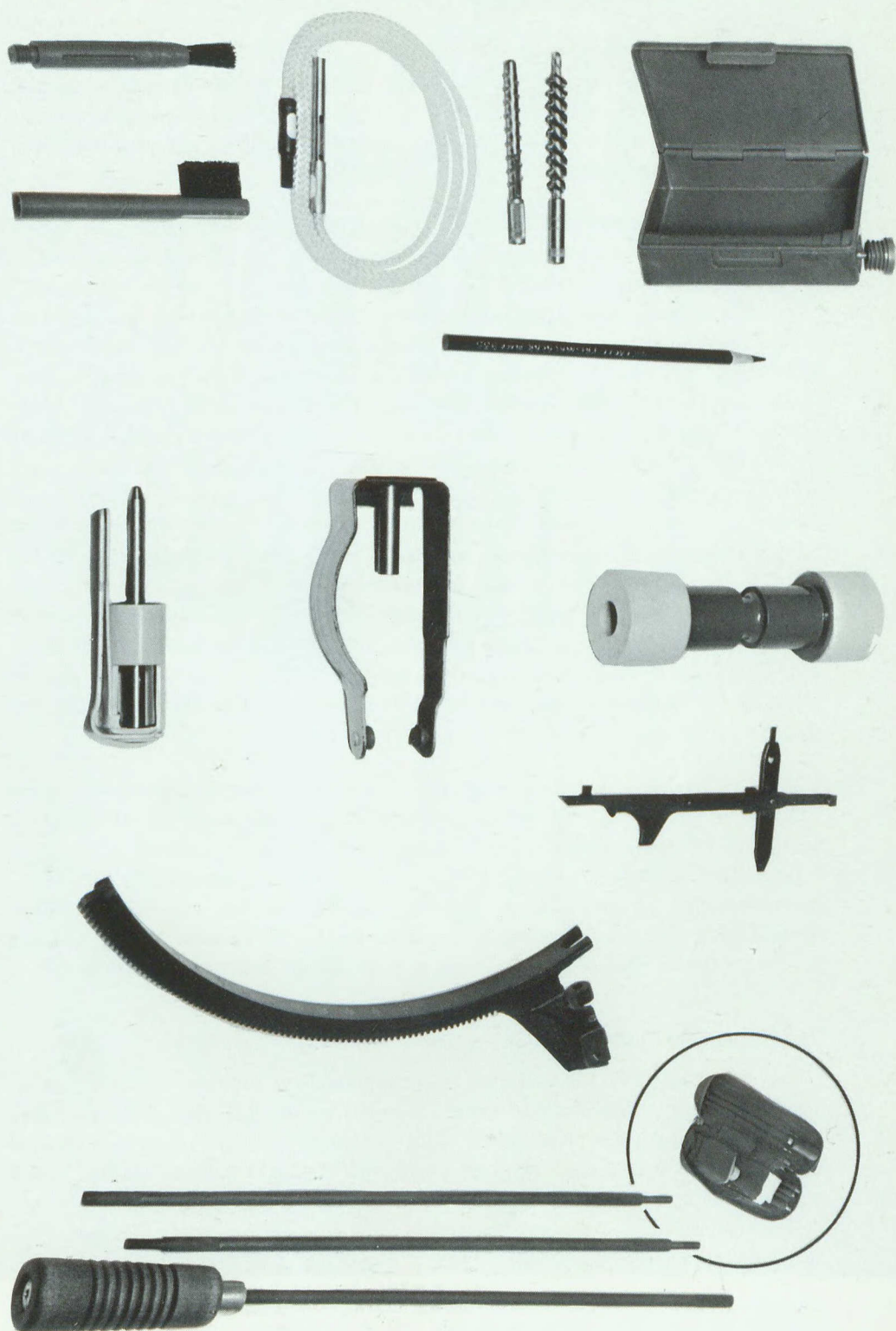
108" (274 cm)



### CUSTOM MACHINE SHOPS (cont'd)



## CUSTOM MACHINE SHOPS (cont'd)





## FLUIDIC DEVICES AND SYSTEMS

Aviation Electric Limited has been pursuing a program of Research and Development in the relatively new field of Fluidics since 1964. Today, the company's devices, recognized as among the most advanced and best performing ones on the market, are sold throughout the world. Complete engineering services are provided, from initial feasibility study through to complete systems design.

First generation elements (known as "LABMOUNT"), recommended for breadboarding and experimental use, are a monostable amplifier (type 1100 M 0 1) a bistable amplifier (type 1000 B 02) a trimmable proportional amplifier (type 1301 P 01) and a diode (type 1200 D 01). These devices, moulded from polycarbonate thermoplastic, include tri-serrated brass fittings suitable for conventional interconnecting with  $\frac{1}{8}$ " (3 mm) i.d. flexible tubing. All incorporate a unique vortex venting technique (patented) which completely eliminates impedance matching problems usually associated with such devices, and operate on the wall attachment principle (Coanda effect). The bistable and monostable amplifiers, like the diode, have been designed for use in digital and pulse processing fluidic circuits which may be built up in the same manner as electronic circuits. The proportional amplifier is used to perform analog computing functions in pneumatic systems. It is suitable for operation in analog control systems such as level, pressure and temperature controllers. It can also be used in digital controls, for example, in conjunction with the Bistable amplifier, to provide a pressure switch with an adjustable set point. This proportional amplifier is provided with a specially designed trimming feature (patent pending) which may be used to adjust the initial setting of the bias level or establish accurate nulling of the amplifier output differential.

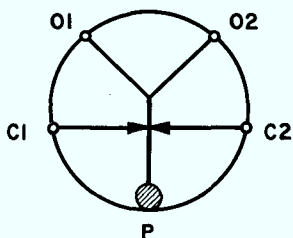
In 1968, Aviation Electric introduced its second generation fluidics, known as EDGEMOUNT. The heart of the Edgemount modular design concept consists of three basic elements that plug in to standard sockets which in turn are mounted on modules: a monostable amplifier, a bistable amplifier, and a trimmable proportional amplifier, all providing improved performance over the conventional first generation elements described previously. In addition, a composite element is available and is designed to provide special channel configurations to meet specific customer requirements.

### **The Edgemount Modular Plug-in System**

The EDGEMOUNT modular plug-in system has been designed with ease of assembly and neat system layout in mind. The mounting on their edge of the amplifiers reduces considerably the panel area required for a system. Moreover, element replacement or circuit modification offers no problem. The EDGEMOUNT concept allows mounting of systems in standard industrial or airborne enclosures thus solving the problem of practical, functional packaging for fluidic circuits, heretofore associated with conventional fluidic hardware.



An "Edgemount" fluidic industrial sequencer control panel, demonstrating the easy replacement of elements and/or circuit modification now made possible with Aviation Electric's new modular design concept. All elements are plugged in to standard sockets, thus eliminating the tangle of interconnecting tubing usually associated with fluidic circuits.



P = SUPPLY

C1 = LEFT CONTROL

C2 = RIGHT CONTROL

O1 = LEFT OUTPUT

O2 = RIGHT OUTPUT

### Rate Sensor Operating Specifications

Function: Angular Rate Sensing

Operating Medium: Gaseous Fluids

Operating Principle: Vortex Flow Phenomenon

Supply Pressure Range: 1.0 - 15 psig.

Characteristics with the set supply pressure of 5.0 psig

Flow Rate: 2.3 scfm

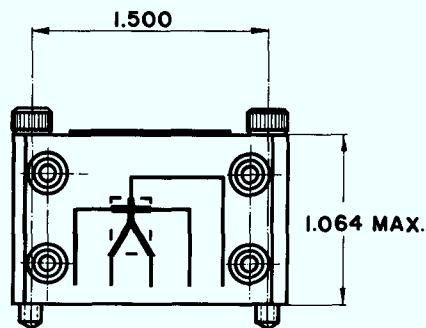
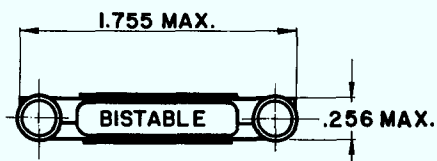
Maximum Range:  $\pm 300^\circ/\text{sec}$ .

Linearity:  $\pm 2\%$

Maximum Linear Range:  $\pm 150^\circ/\text{sec}$ .

Nominal Gain:  $K=0.0036 \text{ psi}/^\circ/\text{sec}$ .

(Blocked Output)



Threshold Limit:  $0.1^\circ/\text{sec}$ .

(10 cps bandpass)

Noise Level:  $0.1^\circ/\text{sec}$ .

Dynamic Range: 1500

Null Output:  $0 \pm 0.004 \text{ psid}$

Hysteresis:  $0^\circ/\text{sec}$ .

Delay Time: 10 msec

Transfer Function:  $G(s) =$

$K_e - 0.01S$

$(1 + 0.011S)$

Sensitivity to rotation about axes

orthogonal to axis of symmetry:

Below Threshold

### Operating Specifications (Bistable Amplifier)

Function: Two-Input Bistable Flip-Flop

Operating Medium: Gaseous Fluids

Operating Principle: Wall Attachment with vented vortex.

Temperature Range:  $-65^\circ\text{F}$  to  $+160^\circ\text{F}$

Element and Socket only.

Supply Pressure Range: 1.0 to 15 psig

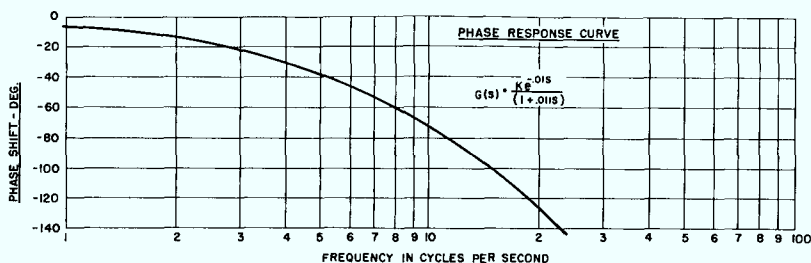
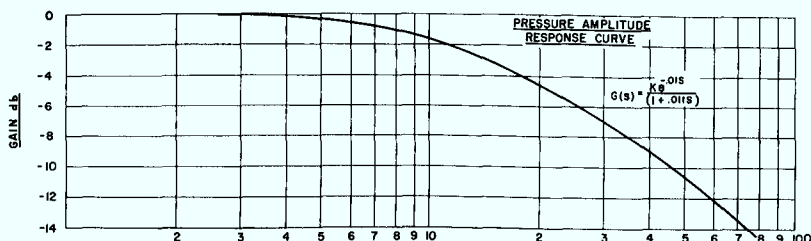
Frequency Response: 800 cps (element only)

Response Time: 0.0004 sec.

**Loading Capacity:** Element is stable from the fully opened to the fully blocked loading conditions.

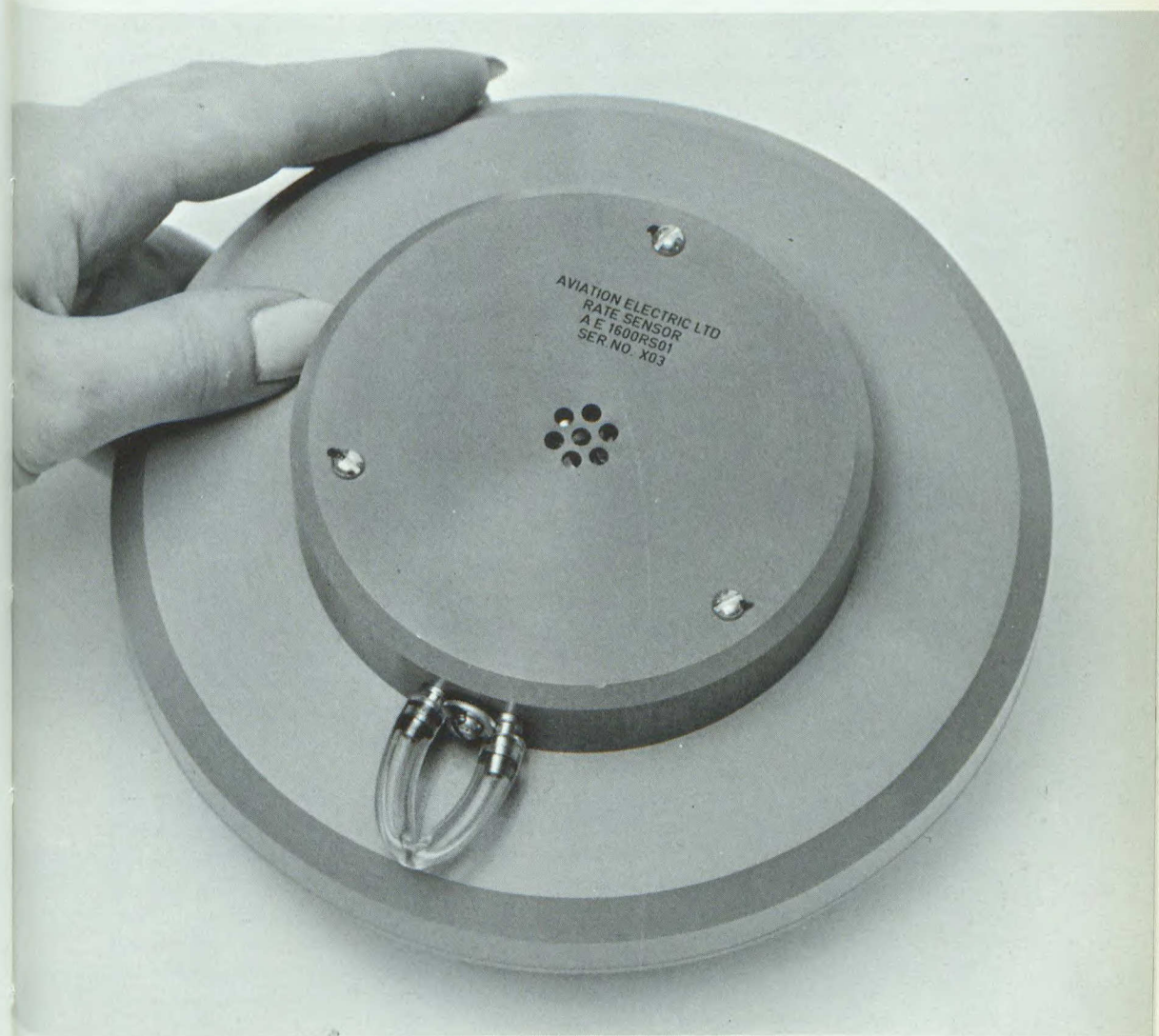
Nominal Operating Characteristics at the Indicated Supply Pressures:

Supply Pressure psig	1.0	2.5	5.0	15.0
Supply Flow scfm	0.09	0.15	0.21	0.37
Pressure	0.36	0.94	1.98	5.65
Recovery psig (Blocked)				
C1 Switching Pressure psig	0.06	0.20	0.35	1.17
C2 Switching Pressure psig	0.12	0.35	0.60	1.26





The Angular Vortex Rate Sensor, type AE 1600 RS 01, available from production, is a device capable of sensing angular velocity about its axis of sensitivity and provides a differential pressure signal proportional to that velocity. The fluidic equivalent of a conventional rate gyro, it is, due to the absence of moving parts, ideally suited for operation in extreme environmental conditions. It can be used in systems for missile and space vehicle stability augmentation, for aircraft autopilots and for torpedo guidance. The rate sensor output signals may be integrated to provide attitude information.



AE 1600 RS 01 Fluidic Angular Rate Sensor, the fluidic counterpart of a gyro.

## MICROWAVE FILM DRYER

Starting from a number of microwave application patents developed by the National Research Council in Ottawa, Devtek has developed and commercialized a range of microwave drying equipment. Included are units for the rapid drying of adhesives, paper and leather. Of particular interest for defence purposes is the development of a high speed photographic film dryer, a mock-up version of which is shown in the attached photograph.

The particular film dryer shown was developed for the drying of 9½" (24.1 cm) reconnaissance film. Microwave energy is used in this case to take advantage of the high microwave absorptive properties of water relative to film base materials. This enables the water to be evaporated rapidly without heating the base material. Using 2450 MHz microwave energy, the film can be dried to the required condition at speeds in excess of 100 f.p.m. (30.5 m.p.m.) in a 5 foot (1.5 m) chamber. This rate of drying is achieved without image degradation.

In microwave film drying the processed film is passed through a rapidly alternating electrical field. The dipolar molecules of water in the film emulsion are forced to reverse their orientation in step with the alternating field. The resultant inter-molecular friction produces the heat required for evaporation. This technique of direct energy transfer avoids the problems of thermal lag and temperature gradients inherent in conventional techniques of thermal transfer such as conduction, convection or radiation.

The Devtek film dryer uses a novel "parallel plate" application chamber. This design, a patented development of the National Research Council, is a significant improvement over standard microwave serpentine chambers, giving greater uniformity of drying of web materials such as film. In addition, the use of this parallel plate chamber, where the field is transmitted along the same direction as the web travel, also makes possible the use of a resonant system where a standing wave pattern is established. This leads to high power utilization efficiencies (about 95% RF energy utilization) in the 5 feet of chamber. Thus high output of a uniform high quality product is achieved within a small production space.

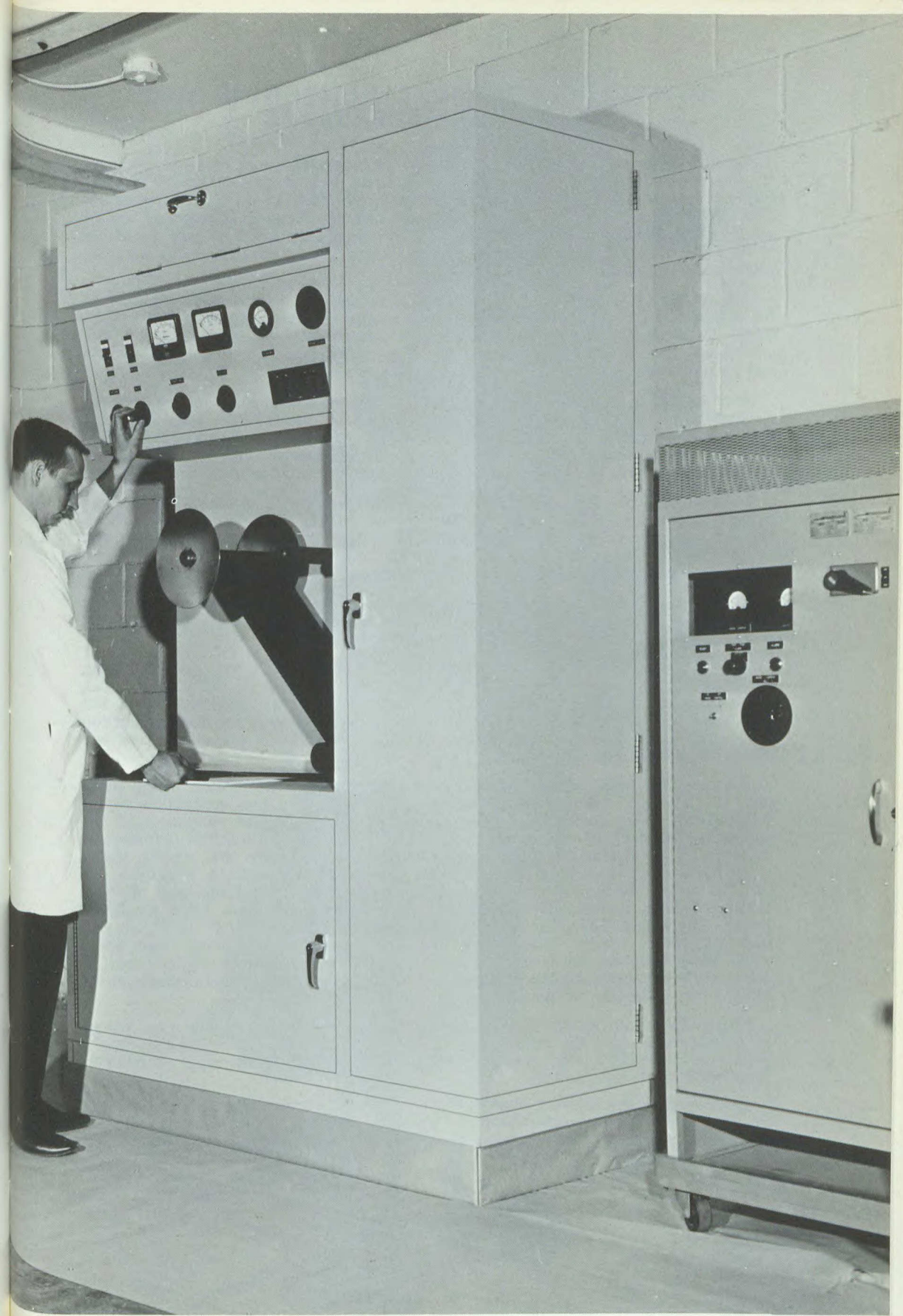
Devtek's experience in a variety of industrial applications of microwave energy has enabled the company to overcome a number of operating and maintenance problems previously associated with this technique of heating or drying. Prime among these is the problem of power source failure. With a number of the company's units now entering their third year of constant operation, Devtek has not experienced a single power source failure in the field. This performance results from careful design aimed to give maximum protection of the power source.

Also used to advantage in the film dryer is Devtek's experience in the development and design of film processing equipment. The principle of the Levitron Roll — an air support technique for handling webs without mechanical contact — is used for transporting the film where contact would cause damage to the image.

Additional features of this microwave drying system include rapid threading of the film, since the drying chamber can be opened for ready access, and use of automatic alarms and power cut-offs to protect the product and the equipment in the event of any malfunction of this or any associated equipment. Also, safety features are included to minimize the possibility of accidents due to mis-use of the equipment.

The above description refers primarily to the unit developed to meet one particular set of specifications. However this is not a standardized product and similar units can be designed to meet specific individual requirements. The same features of unique chamber design, product quality, efficient energy utilization and high speed drying would be applied to any Devtek drying system.







## AUTOMATIC STRAIGHT-LINE TINNING AND REFLOWING APPARATUS

Automated soldering is the most advanced mass production method for the joining of electronic components or integrated solid state packages to the parent printed wiring board, because of the reliability obtained with little or no hand preparation. The reliability and durability of the resulting soldered electrical connections are of prime interest. The most important factor which affects the success of these objectives is the solderability of the component lead and the printed wiring conductor surfaces which are to be joined.

The surface of the copper print is prone to tarnish and oxidize when exposed to the atmosphere for a duration exceeding several days and the removal of this surface oxide — a prerequisite to successful soldering — can be achieved only with the proper application of a very active flux. The use of a highly aggressive flux is undesirable and its use is often forbidden in soldering specifications.

Since solder has an extremely high affinity for solder, the reliability of the soldered electrical joint can be improved if the copper conductor surfaces have been pre-tinned with hot fused solder. If pre-tinning of the printed wire pattern is undertaken before oxidation has occurred, then aggressive fluxes can be avoided, and high speeds and low temperatures can be employed to perform the component soldering.

The development of the Electrovert ASTRA systems provide a means for applying a highly solderable fused coating to printed wiring boards. Pre-tinning of the printed surfaces using one of the Electrovert systems protects the printed pattern from oxidizing through the formation of a layer of intermetallic alloy of copper and tin, covered by a thin, uniform, continuous and shiny layer of solder.

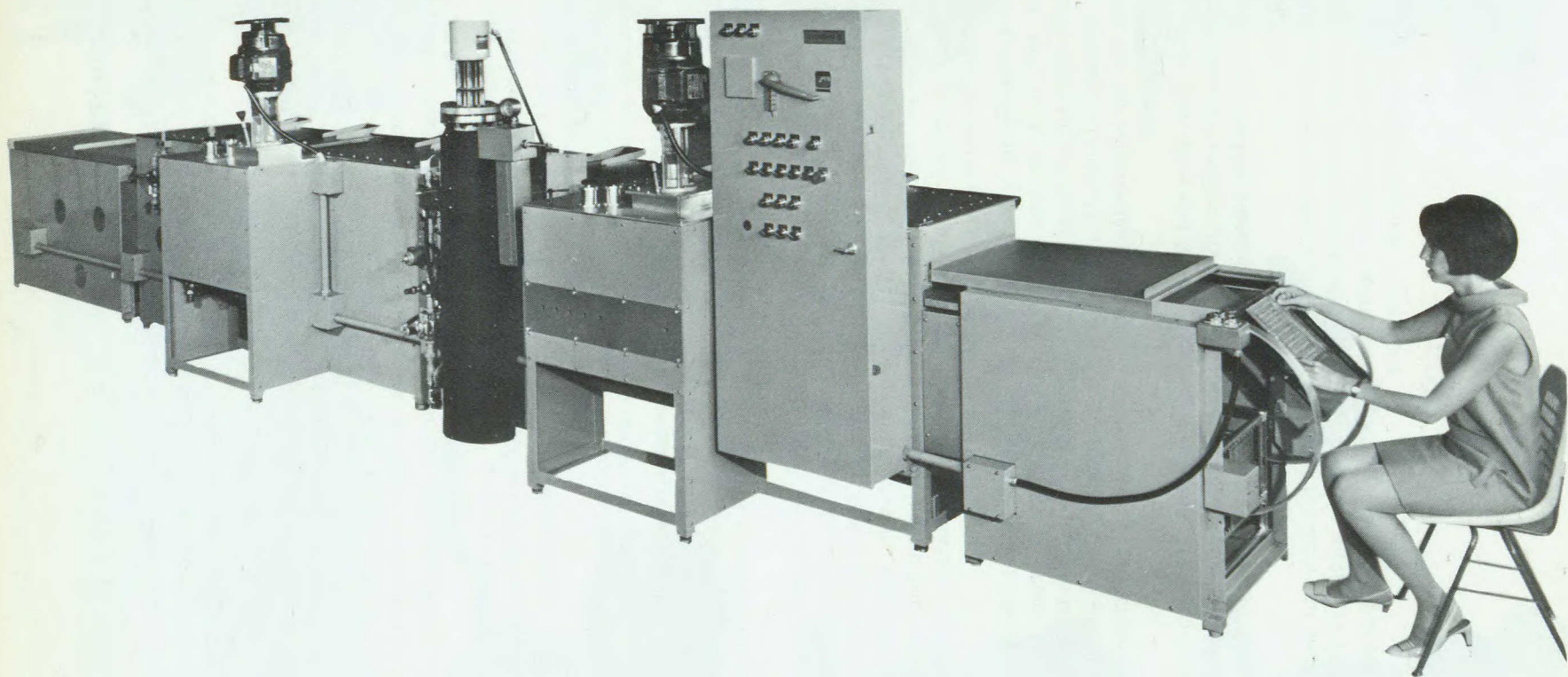
After a printed circuit board has been pre-tinned using one of the Electrovert systems, the shelf life is extended without a decrease in the solderability since the hot fused layer of solder on the printed pattern resists oxidation.

The ASTRA, Electrovert's new Automated Straight-line Tinning and Reflowing Apparatus processes printed wiring panels with dimensions up to 12" x 15" (300 x 375 mm). The machine is designed to accommodate not only individual boards but also large panels which may have several small repeated patterns for mass production processing. The processing speed of the ASTRA is 8' (2.5 m) per minute and will accept single or double sided boards.

The complete machine employs one operator who loads the printed wiring panel onto the conveyor system which takes the board through a flux application station followed by a hot solder coating operation. At this stage, the formation of the copper-tin boundary alloy layer is complete and is covered with a fairly uniform coat of solder. The pre-coated board is subsequently conveyed to the next position where a hot liquid spray is directed to the top and bottom side of the board, with the result that the excess solder coat is removed leaving a uniformly leveled thin coat of shiny solder. All holes are left solder-free except for plated-through holes which are intentionally left with a thin uniform solder coat. Holes as small as 0.010" (0.25 mm) in diameter will be opened. Subsequently the board passes to a cleaning stage where water spray dissolves any leveled agent which may have remained on the board. A return conveyor transports the pretinned and leveled board back to the operator at the loading end of the line where a visual inspection is performed.

The machine is available with or without fluxing and solder coating stage (single or double sided) and the return transport conveyor system. The ASTRA system is capable of achieving a uniform solder coating thickness in the range of .000050" to .000500" (1.3 - 12 microns).

Re-flowing of printed wire boards which have been electroplated with a coating of tin or tin-lead can be undertaken using the ACTA or ASTRA systems with the resulting formation of the intermetallic alloy covered with a thin uniform sealed layer of solderable metal.



## FORGED STEEL VALVES AND STEAM TRAPS

Velan Engineering Companies are manufacturers of one of the most comprehensive ranges of forged and cast steel valves and steam traps used throughout North American Industry as well as in Naval vessel and Military establishments.

The company's range of valves can be divided into eight categories:

- \* Small — ¼" to 2" (.6 - 5.1 cm) Forged Steel Bolted Bonnet Gate Globe and Check valves utilized in general industry from low through high pressure service. ASA Class 150 lb. to 1500 lb. (68 to 680 kg)
- \* ¼" to 3" (.6 - 7.6 cm) Forged Steel Bonnetless Gate, Globe and Check valves for power and high pressure service. ASA 600 class, 600 lb. to 1500 lb. (272 to 680 kg)
- \* Large Cast Steel valves from 2" to 24" (5.1 - 61 cm) ASA class 150 lb. to 600 lb. (68 to 272 kg)
- \* Large Forged Steel "Pressure Seal" valves from 2" to 18" (5.1 - 46.0 cm) for general industrial and high pressure power service. Class 900 lb. to 2500 lb. (408 to 1134 kg)
- \* Stainless Steel valves both cast and forged in the complete range from ¼" to 24" (.6 - 61 cm) for corrosive services.
- \* Complete line of forged carbon and stainless steel valves specially designed for nuclear applications in sizes ½" to 18". Class 150 lb. to 1500 lb. (68 to 680 kg)
- \* Top Entry and Side Entry Ball valves in the complete range from ¼" to 12" (.6 - 46.0 cm).
- \* Special service custom built valves designed and engineered by modifying existing designs; as well as completely custom built valves designed, engineered and manufactured from the ground up.

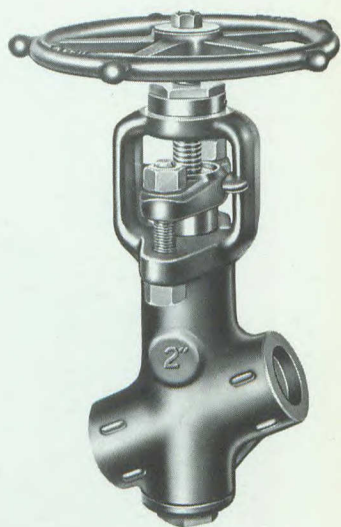
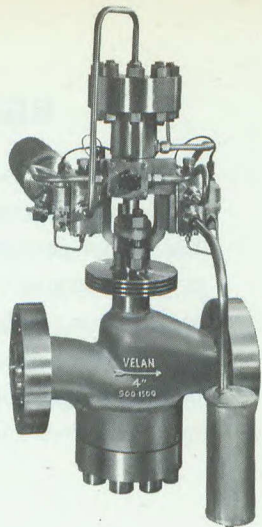
In this last category, valves for such exotic services as Nuclear Power, Cryogenic and Rocketry are manufactured. Typical examples of the company's products are shown on the accompanying page together with the first U.S.N. Nuclear Carrier "U.S.S. Enterprise" which was, along with its sister ship, equipped with Velan valves and steam traps. Bottom right is one of three custom built nuclear control valves built to special specifications for the NERVA nuclear rocket to be used for landing U.S. Astronauts on the moon.

Velan Engineering is located in Montreal. It has excellent raw material, manpower, rail, road, sea and air transportation facilities. To cater to its growing business in the United States, the company operates two independent U.S. Corporations located in Upper New York State and Houston, Texas which are supplemented by the engineering, designing and manufacturing facilities of its two plants in Montreal.

Excellent U.S. Sales and Service facilities are provided through the company's branch sales and service offices in New York City, Houston, Chicago and Los Angeles augmented by associated agents, distributors and representatives in major U.S. cities.

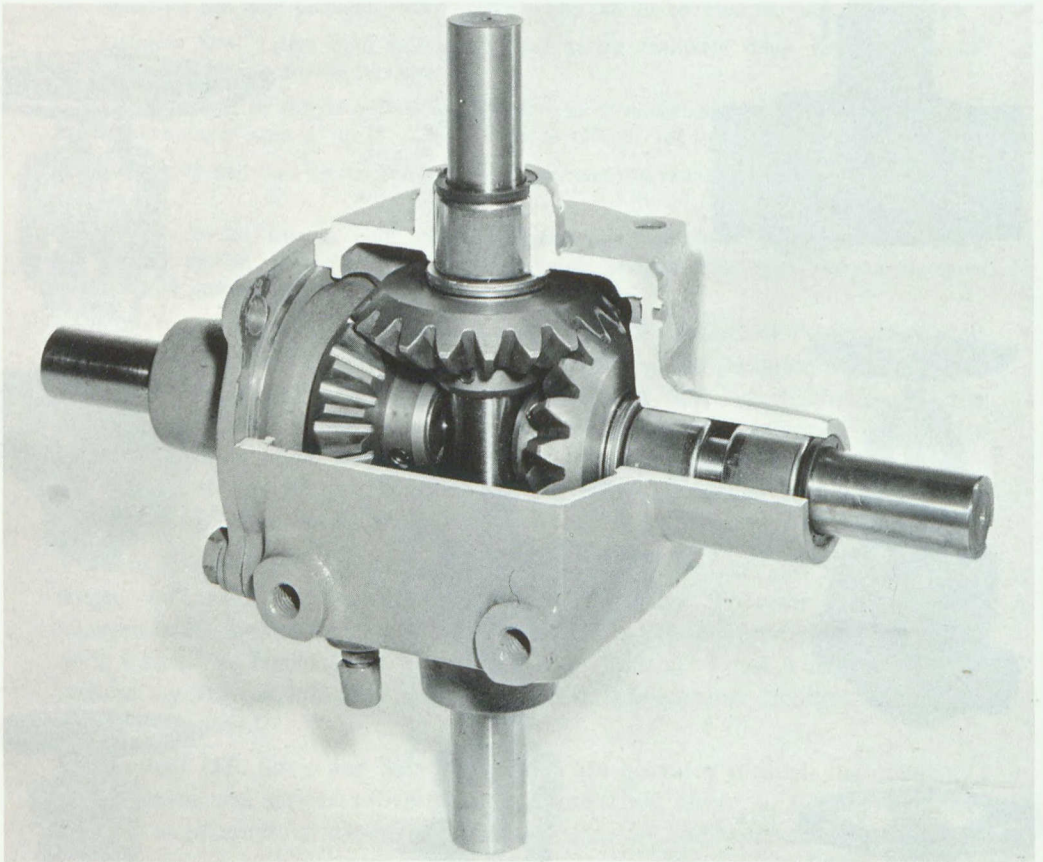
As the company operates a plant in England and has sales and service facilities throughout the world, these facilities are always at the service of Canadian and U.S. industrial and defence commitments abroad, offering replacements, spare parts and servicing in any part of the globe.





## RIGHT ANGLE DRIVE GEAR BOXES

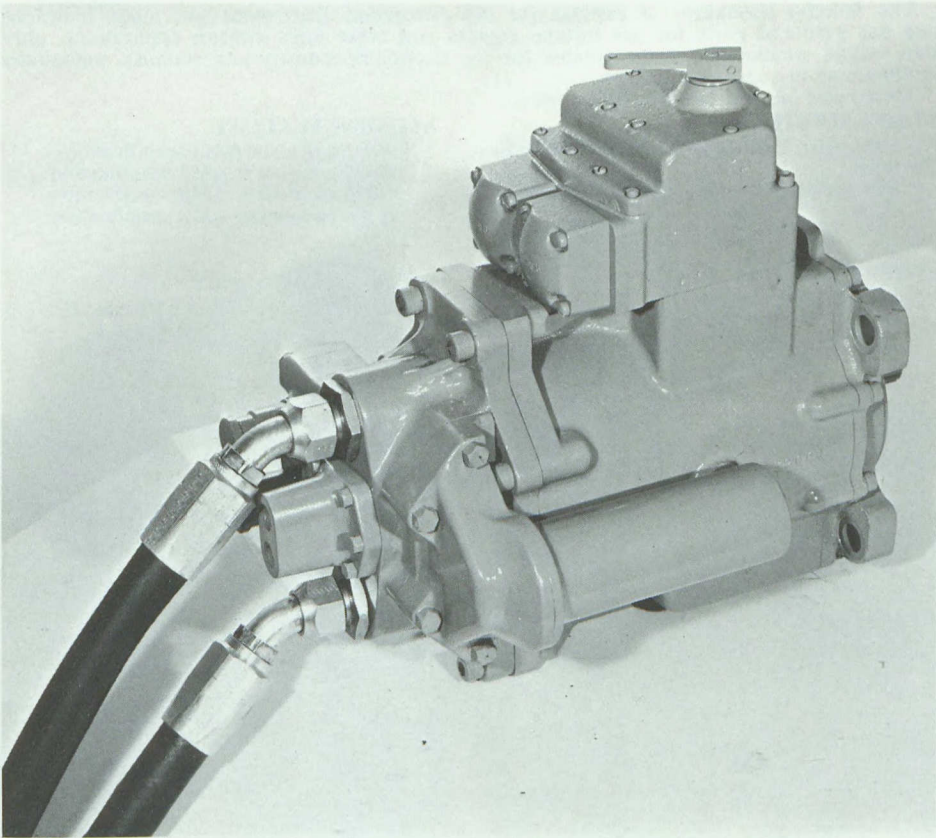
Versatile and compact right angle drive gear boxes custom designed and produced by Canadian Acme Screw & Gear are suitable for accessory and control drives. The design permits direct coupling and overhung belt or chain drive. The photograph illustrates a cross-drive but from a standard basic housing and common components, a simple right angle, a double shaft Tee, a triple shaft Tee, or cross-drives are possible. A choice of four mounting positions is provided in the housing. Gear ratios of 1.00/1 or 1.50/1 are available from production but optional ratios and shaft can be supplied upon request.





## HYDROSTATIC TRANSMISSIONS

Axial piston variable displacement hydrostatic transmissions with servo-control for use on mobile equipment are designed and produced by Canadian Acme Screw & Gear to meet custom requirements. The transmissions were completely designed and developed in Canada and have been in production for approximately six years. These units have been used extensively in many heavy-duty industrial applications demanding continuous 24-hour service. Their success in varied backgrounds has assured acceptance in both the United States and United Kingdom.





## PRECISION INVESTMENT CASTINGS

The Specialized Components Division of the Canadian Marconi Company manufactures Precision Castings in Ferrous and Non-Ferrous metals. Castings of corrosion resistant steels, nickel based alloys, copper based alloys and aluminum are manufactured by the lost wax method of investment casting.

Capabilities range from the production of castings with sectional thicknesses down to 0.050 inch (1.3 mm) in Ferrous and Nickel based alloys and 0.025 inch (.64 mm) in aluminum and copper based alloys to castings up to 16 inches (41 cm) in length. High strength Aluminum Alloy Castings are made in accordance with ASTM radiographic standards and AMS mechanical strength requirements.

Casting tolerances are maintained in accordance with the standards of the Investment Casting Institute. Closer tolerances can be achieved at customers request, depending upon individual application. Waveguides with tolerances in accordance with MIL-W-85 are a special feature of the foundry.

Strict adherence to customers specifications is ensured by the Divisional Quality Program, with trained personnel including a Radiographer and a Metallurgical Engineer monitoring all aspects of the process. Tensile test specimens and discs for chemical analysis are produced from the same melt as the castings, for customer testing when required. Foundry control is maintained by means of routine tensile and hardness tests as well as penetrant, x-ray and dimensional inspection.

The foundry specializes in castings for the Aerospace, Electronics and allied industries and has produced parts for gas turbine engines and other high strength applications, ultra thin section aluminum castings suitable for the electronics industry and complex waveguides in aluminum or copper base alloys.

Metals cast include, but are not limited to:

### STAINLESS STEEL

- 300 series and equivalent AMS specifications
- 400 series and equivalent AMS specifications
- 17/4 PH and equivalent AMS specifications

### ALUMINUM ALLOY

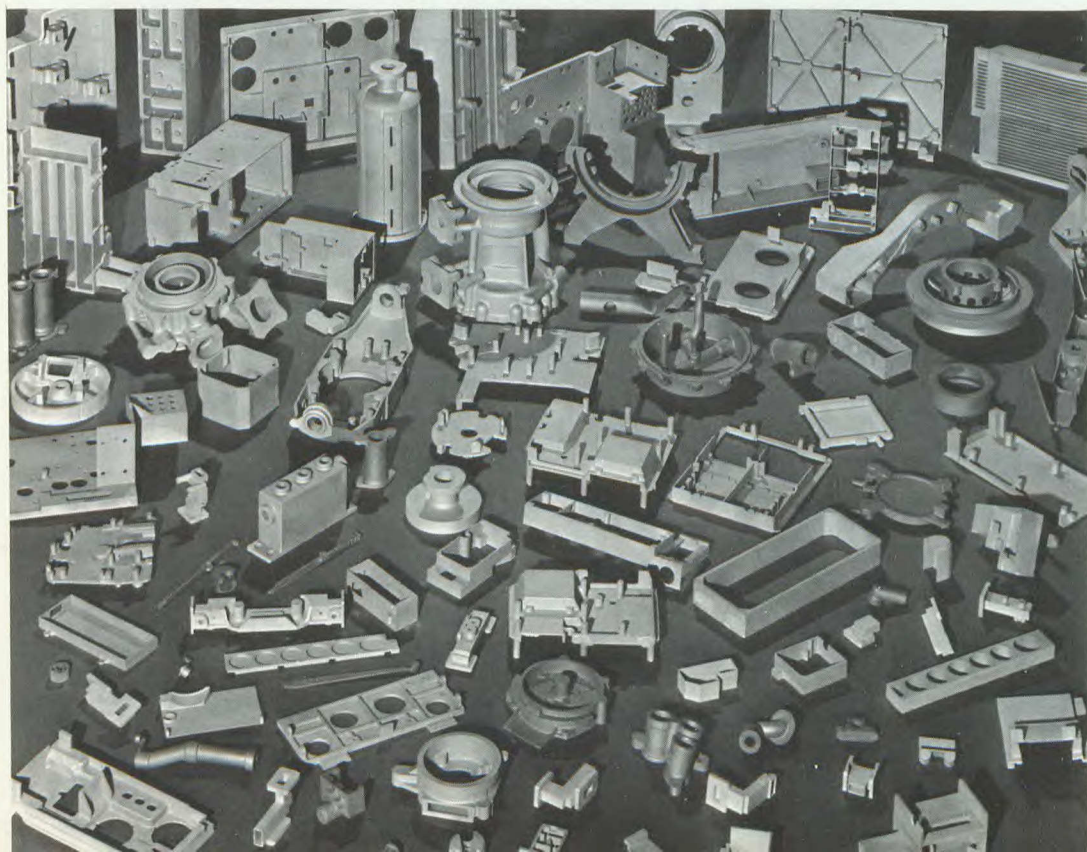
- 40E equivalent AMS specifications
- A320 equivalent AMS specification
- A355 equivalent AMS specification
- A356 equivalent AMS specification

### COPPER BASE ALLOY

- Silicon Bronze equivalent AMS specification
- Beryllium Copper equivalent AMS specifications

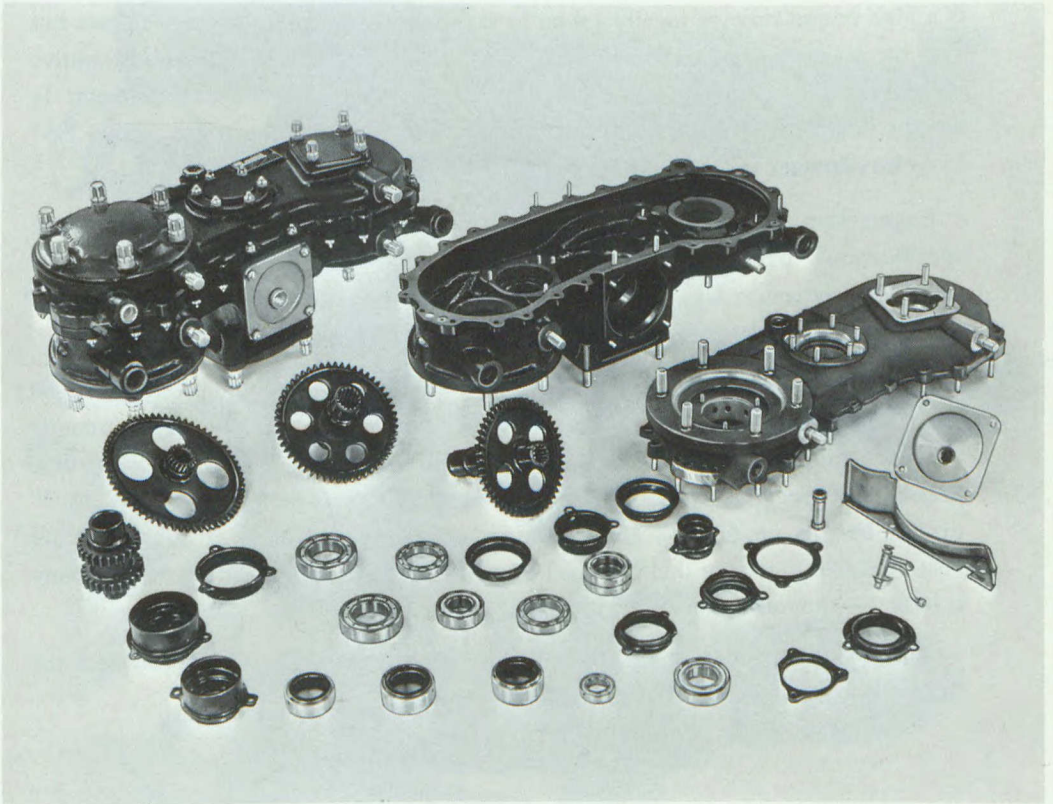
### NICKEL BASE ALLOY

- Hastelloy equivalent AMS specification



## GEARING

The products shown on the facing page are indicative of the type of work carried out by Spar Aerospace Products Ltd. who are manufacturers of power transmission systems, sub assemblies and precision parts for the aerospace industry. This firm on a production basis supplies Vertol CH 46 and Fairchild Hiller HU12 helicopter transmissions, gearboxes for J79, J85, CH 610 and CF 700 jet engines and various airframe actuator gearboxes, and a full range of precision gears including spur, helical, spiral bevel, and zerol types. Design, development, production engineering, and approved laboratory services are available for customer requirements. In addition, approved repair and overhaul facilities on gearboxes, actuators, transmissions and constant speed drives are maintained at the Spar premises in Toronto.





## IMPACT EXTRUSION COMPONENTS

General Impact Extrusions (Manufacturing) Ltd., Toronto, Ontario, specializes in plastic forming and impact extrusion of metals, primarily aluminum, copper, brass and magnesium. It is Canada's largest manufacturer of aluminum impact extrusions. The company's fabrication capabilities include collapsible tubes, vials, mailing containers and other lithographed parts for the packaging industry. The company also produces components for the appliance, automotive, electronics and atomic fields.

For many years General Impact Extrusions has produced parts and components for defence applications, such as pistons, ammunition shells, missile parts, rocket components, precision cold forgings, and tail fin assemblies. A competent engineering staff is available for component and part design.

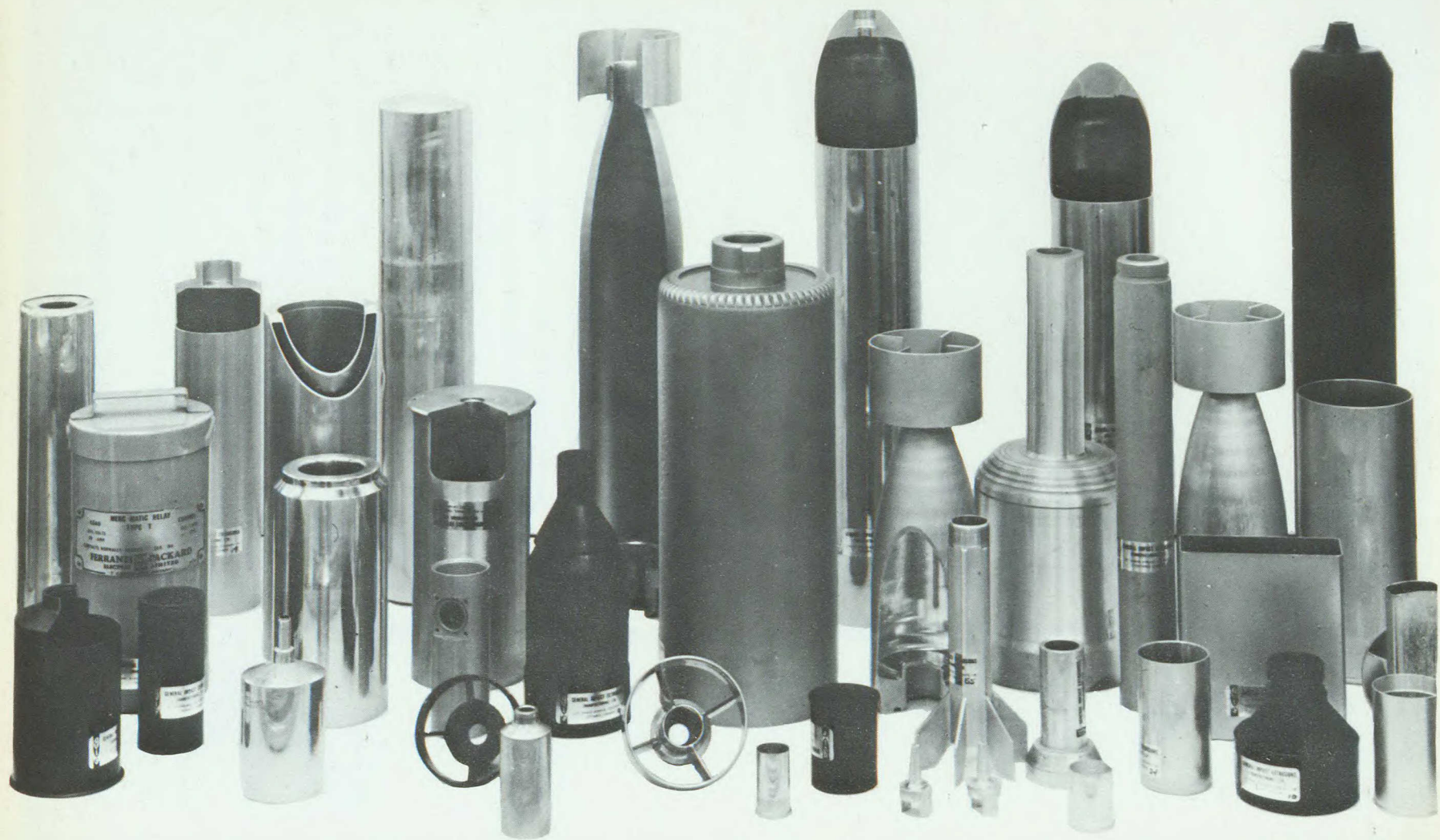
The impact extrusion process cold forms metals under high pressures. The method is a most efficient way to produce cans, shells and other hollow shapes. It is a high output process ideally suited to satisfy not only military requirements but also the high volume requirements of the packaging, electronics and automotive industries. Press capabilities for impacts are up to 6" (15.24 cm) diameter in lengths of up to 25" (63.5 cm) and for precision forward extrusions, up to 2.5" (6.4 cm) diameter in lengths of up to 120" (3.0 m) maximum.

Engineering services are available for alloy selection, strength and performance specifications, part design, and production engineering. Other services include small lot production for pre-production testing, evaluation and testing of physical properties and performance.

G.I.E. production facilities include 19 extrusion presses and well over 160 miscellaneous machine tools, draw presses, coining presses, lathes, automatic chuckers, multispindle chuckers, automatic drills, automatic screw machines, drill presses and special purpose machines to handle components from 1/4" dia. to 7" dia. in lengths up to 25". Heat treating, annealing and anodizing facilities are also available to ensure that the level of quality control demanded by the company is in fact maintained.

This same firm also maintains a facility in Buffalo, N.Y. which provides the same services and products as the parent company.





## DIFFUSION FURNACE ACTUATOR

The A-798 Actuator is a motorized single spool BI-STEM unit designed by Spar Aerospace Products specifically for use in the manufacture of semi-conductor devices.

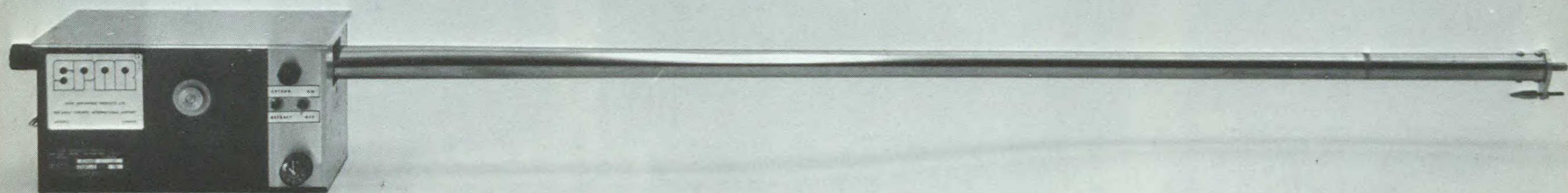
The Actuator is used to withdraw crucibles from a diffusion furnace at specific rates to obtain accurately controlled cooling.

The unit features a d-c stepper motor with integrally mounted step servo control. This allows the unit to be set at any extension rate from 0 to 1 in./sec. by adjusting the externally mounted control knob.

### FEATURES:

- Repeatable speed control allows programmed operation.
- Slip clutch in drive system protects motor in the event of overload.
- Automatic limit switches at both ends of travel.
- 2 amp fuse fitted as standard.

BI-STEM Length	42 in. max. (1.06 m)
BI-STEM Description	0.75 in. nominal dia. by 0.004 in. thick 301 stainless steel. (19 mm x .1 mm)
Actuation Capability	5 lb. (2.3 kg)
Size	5.6 in. x 4.0 in. x 8.87 in. (14 x 10 x 23 mm)
Weight	5 lb. (2.3 kg)
Drive Motor	IMC d-c stepper
Supply Voltage	28 volts dc $\pm$ 4 volts.





## NAVIGATION SYSTEMS LNS 101 AND LNS 102

Development of this equipment was originally undertaken by the Canadian Army and Aviation Electric Limited to meet conditions of modern warfare where units are required to move rapidly about the battlefield under cover of complete darkness or in fog or smoke, or when all hatch covers must be kept closed. Vehicles so equipped are also enabled to navigate accurately on terrain devoid of recognizable landmarks, where reliable maps are not available or in areas devoid of permanent topographical features such as desert or arctic regions.

The Land Navigation System (LNS 101 or LNS 102) accurately and continuously computes and displays the geographical location of the vehicle and the direction in which it is headed. The presentation is designed to let the commander use the information immediately without need for any manual plotting or calculating.

The LNS 101 set comprises a Plotter, Vehicle Position (PVP), an Indicator Heading and Position (IHP), a Computer, and is supplemented by a Power Inverter. The set works in conjunction with a Gyro-Compass when designed for use with heavily armoured vehicles such as tanks.

The LNS 102 set comprises a Plotter, Vehicle Position (PVP), an Indicator Heading and Position (IHP), a Computer, and is supplemented by its own Power Inverter. This system features a company developed Magnetic Heading Reference which eliminates the use of the more expensive Gyro-Compass. This navigation system will usually be found in thin-skinned steel or aluminum armored vehicles such as command or reconnaissance cars and personnel carriers.

A Heading Indicator can be supplied with either system, for use by the driver when he is separated from the vehicle commander and cannot see the Indicator, Heading and Position (IHP).

### **Characteristics Common to the LNS 101 and LNS 102**

- Indicates the exact heading and position of the vehicle in a way that can be immediately interpreted and used.
- No manual plotting, calculating or recording required.
- Four standard map scales: 1:25,000, 1:50,000, 1:100,000 and 1:250,000.
- Routes and directions do not have to be calculated in advance.
- Independent of radio transmission.
- Compact units — permit installation in crowded vehicle compartments.
- Dual capability computer enables system operation with either north seeking Gyro-Compass or Magnetic Heading Transmitter.

### **Principle of Operation**

The continuous computation and display of the present position of the vehicle is obtained by automatic dead-reckoning from a known starting point. The distance travelled by the vehicle is measured by the odometer drive, while the direction of travel of the vehicle is derived electrically from either a Gyro Compass or a Magnetic Heading Transmitter. These two inputs are fed to the COMPUTER which performs the trigonometrical calculations necessary to convert them to EAST/WEST and NORTH/SOUTH components of the vehicle movement. This information is transmitted in the form of electrical impulses to the display units, INDICATOR, HEADING AND POSITION (IHP) and PLOTTER, VEHICLE

Plotter, Vehicle Position (PVP)——



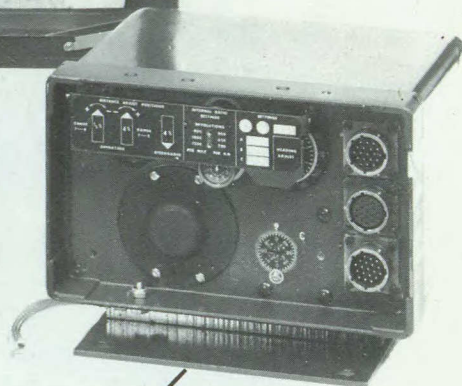
Power Inverter.



Indicator Heading & Position (IHP)



Gyro-Compass & Controls



Computer.

## NAVIGATION SYSTEMS LNS 101 AND LNS 102 (cont'd)

**POSITION (PVP).** The heading signal from the Gyro Compass or Magnetic Heading Transmitter is also indicated on the display units. Prior to moving off, the starting point co-ordinates, obtained from a standard military map grid, are set into the appropriate units. Any subsequent movement of the vehicle is continuously followed and displayed.

The Heading & Position Indicator unit displays two "4-digit" map references — one for Eastings and one for Northings. These are set to the map reference of the vehicle location before moving off and, in operation, continually record the position of the vehicle in terms of map co-ordinates.

The Vehicle Position Plotter provides a continuous pictorial presentation of the exact geographical location of the vehicle and the direction in which it is headed. This enables the navigator to steer the vehicle along any prescribed course without manual plotting or mental calculations. This is achieved by setting into a transparent holder on the Plotter the pertinent section of a standard military map. An illuminated image comprising a positional 'dot' and directional 'arrow' is projected on to the underside of the map. At the commencement of a run the image is set to the map co-ordinate position of the vehicle corresponding to the map references on the Heading & Position Indicator after which the vehicle location and heading will be both digitally and pictorially displayed.

Field trials in various countries have proven the stated operating characteristics of the equipment particularly with respect to reliability under rugged conditions as well as at extreme temperatures.

### **Power Requirements**

24 VDC. Obtained from vehicle battery.

Computer and all Display Units only . . . 2 amps max:

LNS 101 System: 5 amps-17 amps running depending on the Gyro-Compass in use.

LNS 102 System: 4 amps max:

### **Speed Range**

Zero to 95 Km./hr. (60 mph).

### **Accuracy**

Within 50 meters or an average of 1% of distance travelled, whichever is the greater, with Gyro-Compass. (LNS 101)

Within 50 meters or an average of 1½% of distance travelled, whichever is the greater, with the magnetic heading reference. (LNS 102)

Sets similar to the LNS 101 have been in operation with the Canadian Army for sometime, and both the British and United States Armies have acquired quantities of LNS 101 as well as LNS 102 systems.

### **Automatic Position Reporting (APR)**

Application of the basic navigation system concept and/or units to related field usage are constantly under study. A new development in this area is the Automatic Position Reporting system (APR) which provides the commander, when he is located in a remote command post, with the facility of being able to automatically interrogate vehicles under his command and have displayed in front of him the position of the vehicle interrogated in the form of a six digit readout, to the nearest 100 meters. Although the equipment uses the standard transmitting-receiving equipment, no voice communication of any sort is necessary. Space and mounting facilities have been provided in the Indicator, Heading and Position (IHP) for the incorporation of two modules to provide the necessary signals for the Automatic Position Reporting system. (APR).





## CANADAIR CL-89 (AN/USD-501)

The Canadair CL-89 has the service designation 'Drone System, Short-Range Reconnaissance XC1', and performs the functions of target acquisition, damage assessment and surveillance.

The CL-89/XC1 is a self-contained, mobile system which is based on the use of a simple, low-cost drone that carries sensor equipment and is recoverable. It is for day and night use by army formations in forward battle areas and is reuseable.

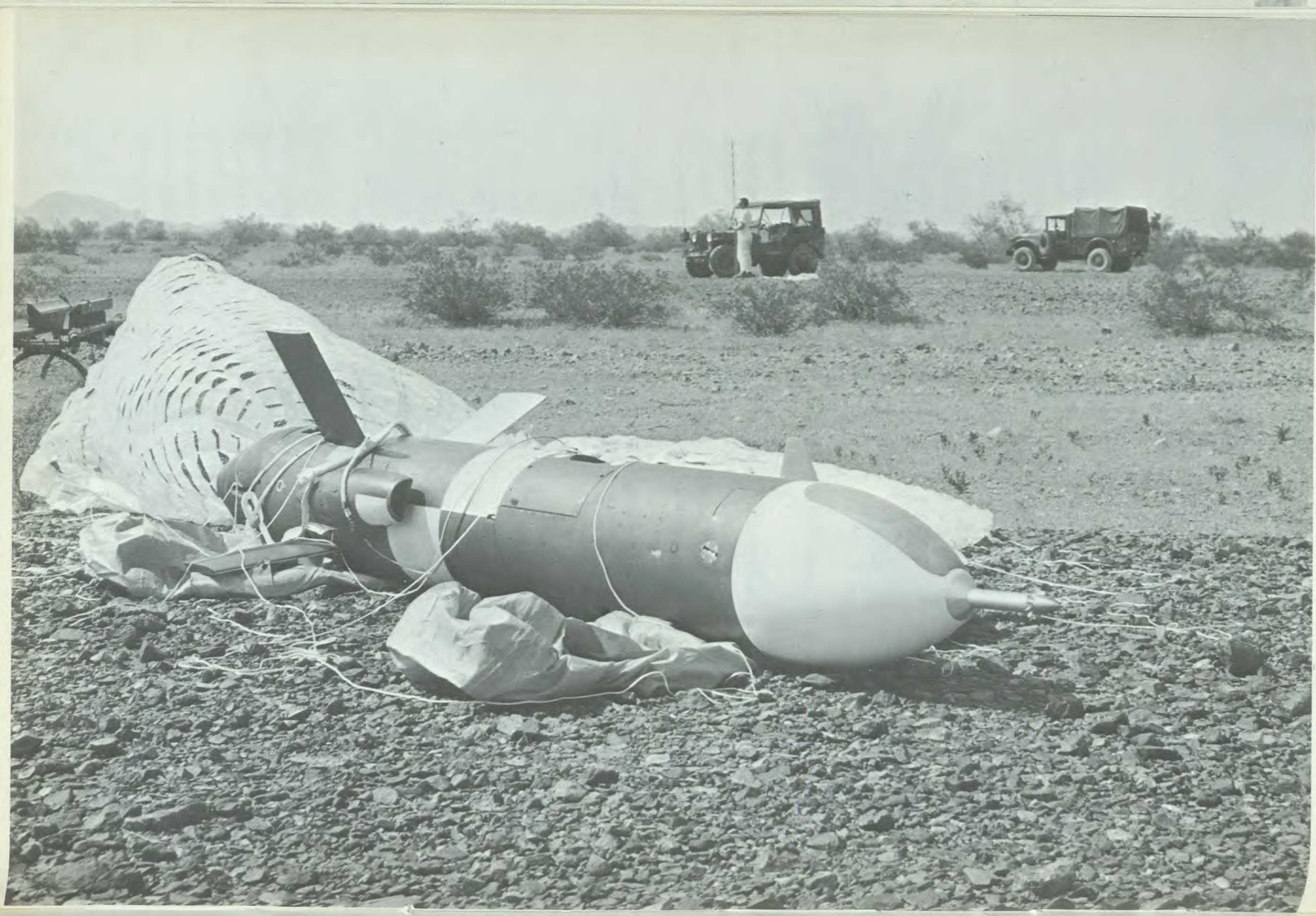
The drone is launched by booster rocket and has a turbojet sustainer engine. On completion of a reconnaissance mission, it returns and lands by parachute, with air bags to cushion ground impact. The drone is then available for further missions.

At present the sensors consist of cameras equipped for day and night operation but an infrared sensor is under development.

Development of the CL-89/XC1 system is funded jointly by the British, German and Canadian governments, with the U.S. Army providing firing-range facilities and technical support for the flight-test program.









## SURVEILLANCE SYSTEMS

Canadian Westinghouse has carried out development work in a versatile surveillance system for land, sea and air. Three of the individual equipments in this area which have been under development are: The Wesscam steered and stabilized camera mount for taking motion pictures (16, 35 and 65 mm) via remote control from a moving vehicle; Totem, a high-grade monochrome television system elevated on a slender extensible mast; and Periscope, a tethicopter carrying a remotely-controlled space stabilized monochrome television system.

These Westinghouse systems perform the following surveillance functions:

- |   |                           |
|---|---------------------------|
| 1. <i>Line-of-sight Stabilization</i><br>(including a stable reference from which to steer the line-of-sight and natural periods of the stabilizer from tenths of seconds to two minutes) | Totem, Periscope, Wesscam |
| 2. <i>Remote Control of line-of-sight and other functions</i>   | Totem, Periscope, Wesscam |
| 3. <i>Bearing Readout of line-of-sight</i><br>(relative to magnetic north $\pm 0.5^\circ$ )   | Totem, Periscope          |
| 4. <i>Elevation</i> — Ground extended member to 50 ft.<br>— Tethered flying platform to 600 ft. with position-keeping and wind compensation.  | Totem<br>Tethicopter      |
| 5. <i>Wide Band Secure Communications</i><br>(along the tether: 20 MHz band; multiple if desired; for video or direct radar I.F.)   | Tethicopter               |

It is considered that these systems and sub-systems would find a basic use in the following fields: air cushion vehicles, tracked land vehicles, tracked amphibious vehicles, wheeled land vehicles, buoyant ships, submarines, hydrofoil craft, autogyros, helicopters and fixed wing aircraft. They can also be used with a variety of unmanned vehicles.

Considered applications of the line-of-sight stabilization and elevating capabilities provided include the following:

### *Applications of Line-of-Sight Stabilization* (sensors, radiators and other functions)

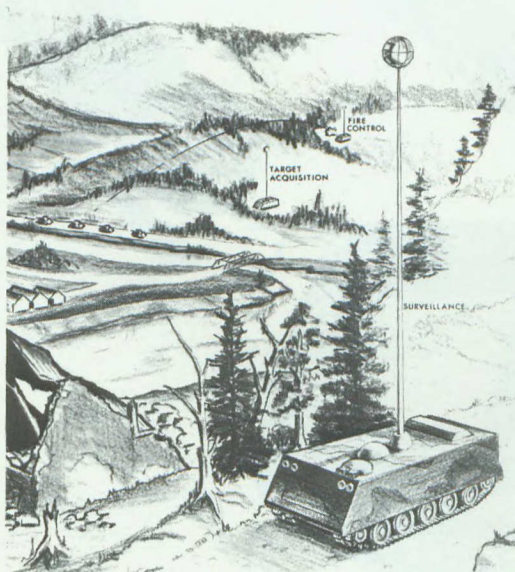
- Television cameras:  
    daylight, colour, low light-level
- Film cameras  
    cine, single frame
- I.R. imaging cameras
- Radar
- Line-of-sight microwave for secure communications and image transmission
- Laser rangefinders; illuminators
- Weapons control — indirect
- Weapons control — direct (pointing)

### *Applications of Elevating Systems* (sensors, radiators and other functions)

- Optical (real time)
- I.R. (remote)
- Radar (surveillance)
- Laser intervisibility
- Photographic imaging
- Line-of-Sight microwave
- Electronic warfare devices
- VHF and UHF line-of-sight devices
- VLF and LF antennae (masts)
- Meteorological equipment.



The Wesscam steered and stabilized camera mount provides vibration-free motion pictures. Operator is inside helicopter using remote camera control with television viewfinder. Camera pans through 360° and tilts from +15° to -75° from true horizontal side mounts and smaller housings are available for a variety of sensors.



The Periscope tethicopter elevates a 17 inch, 30 pound payload to 600 ft. on a tethered line. Functions are similar to the Totem with hover, position-offset and follow-along capability.

The Totem elevated television system rises to 50 ft. on a slender extensible mast. Camera has a stabilized 360° azimuth view with compass readout. Tilt of view is +15° to -15°.

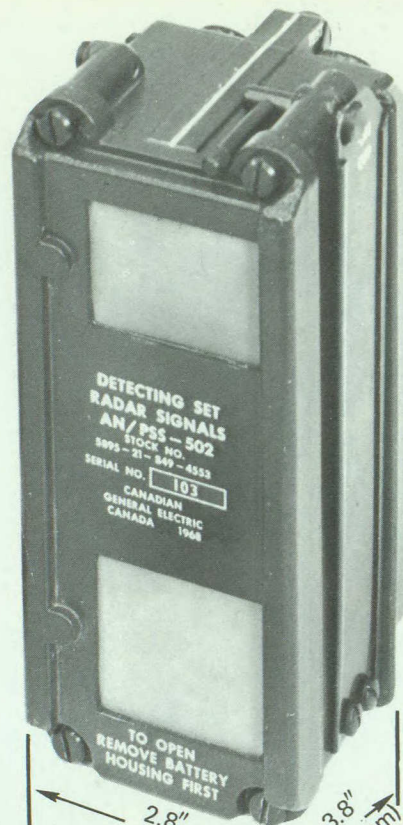
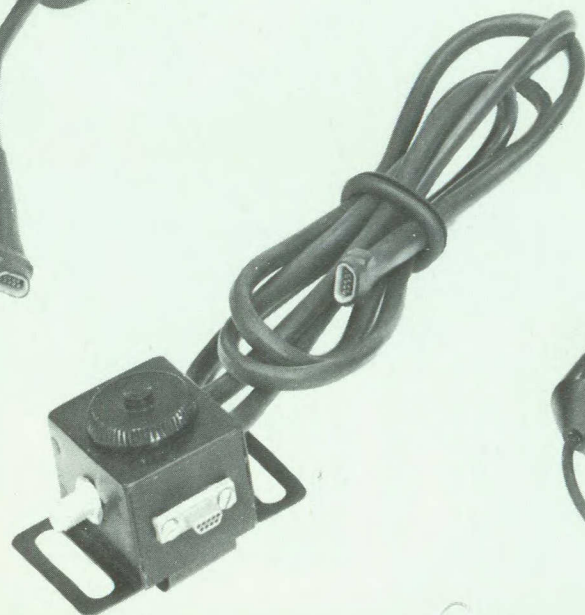
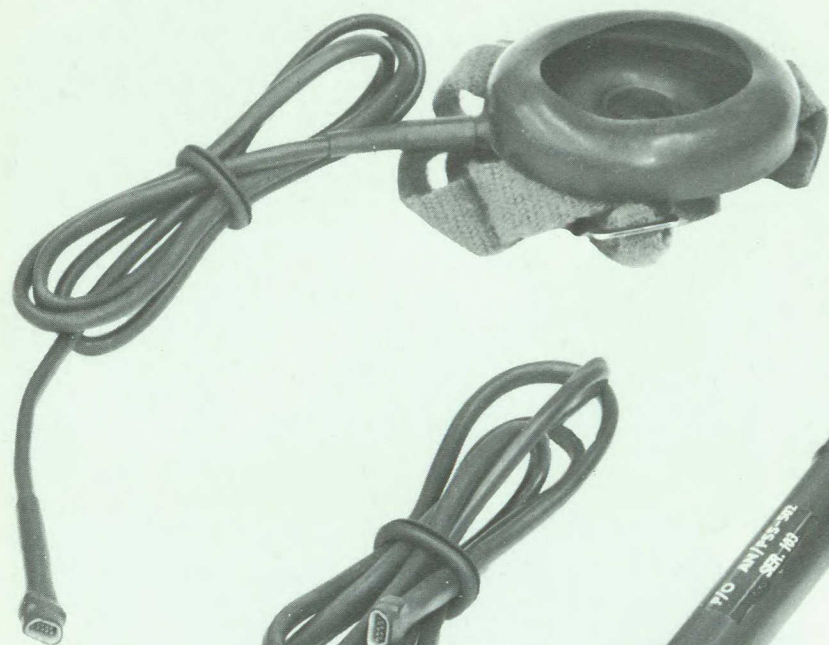
## **DETECTING SET, RADAR SIGNALS "MICRADET" AN/PSS-502**

The "Micradet" a rugged, hand held microwave receiver used to detect and determine the bearing of CW and pulse modulated radar signals was designed by Canadian General Electric, Information Systems and Defence Products Department.

It features two detection modules for 8 to 20 GHz and 20 to 40 GHz with 20 and 10 degree beam widths respectively. The unit can be procured with the low frequency detector only to which a high frequency module could be added when needed. It detects pulses as short as 50 nanoseconds and PRF's in excess of 100 KHz. Sensitivity is adequate to give warning at ranges in excess of the radars vehicle detection range. Signal indication is a tone in the headset with a pitch related to the PRF of a pulsed signal or the relative power of a CW signal. The internal battery will provide a minimum of 12 hours continuous operation.

Plug in printed circuit boards ensure ease of maintenance with a mean time to repair of 15 minutes and MTBF in excess of 2000 hours. The equipment is designed to withstand its predicted rough usage. It has been tested and meets the climatic and durability requirements of CAG-100 class G4 for fully exposed portable equipment.





DETECTING SET  
RADAR SIGNALS  
AN/PSS-502

STOCK NO. 5895-21-049-4553

SERIAL NO. 103

CANADIAN  
GENERAL ELECTRIC  
CANADA 1968

TO OPEN  
REMOVE BATTERY  
HOUSING FIRST

6.9"  
(17.5 cm)

2.8"  
(7 cm)

3.8"  
(9.6 cm)

# RADIATION DETECTION SYSTEM AIRBORNE

## AN/ADR 501

The AN/ADR 501 is a radiation detection system which measures and records gamma radiation over the range 0.1 to 100 R/hr. It is intended for use in light aircraft or helicopters for the rapid reconnaissance of gamma radiation dose rates due to contamination on the ground. The equipment measures the radiation dose rate at the aircraft and may be converted to dose rate near the ground by multiplying the aerial dose rate by a factor which depends upon the height above ground. The radiation dose rate is recorded automatically.

The AN/ADR 501 consists of the following main components:

The Detector Radiac is the radiation sensitive portion of the AN/ADR 501. It converts gamma radiation dose rate to an electrical signal. The detector is a sealed unit which should be placed so that it is not shielded from the ground by large or bulky objects. It may be mounted inside the aircraft provided that only the aircraft skin is between it and the ground. It may also be mounted outside the aircraft.

The Cable Assembly connects the detector to the amplifier. It provides power to the detector and also carries the electrical signal from the detector to the amplifier.

The Amplifier Assembly amplifies the small electrical signal from the detector and provides sufficient power to operate the recorder assembly. It also includes an alarm device which gives a flashing light whenever the dose rate reaches a preset level. The operator can set the preset level anywhere between 0.1 and 10 R/hr. The amplifier assembly also includes the detector and bias batteries, which have very long life and should only need replacement during periodic maintenance. All operating controls are on the amplifier.

The Recorder Assembly consists of a recording milliammeter calibrated in Roentgens/hour. The meter may be used with the motor OFF, as an indicating meter only, or it may be run as a recorder. The record is provided as a series of dots on a pressure sensitive strip chart. A window on the front opens to permit writing on the strip chart, which may be done either with a pencil or a metal scribe.

The Battery Assembly consists of three separate power supplies, all using mercury cells for high performance:

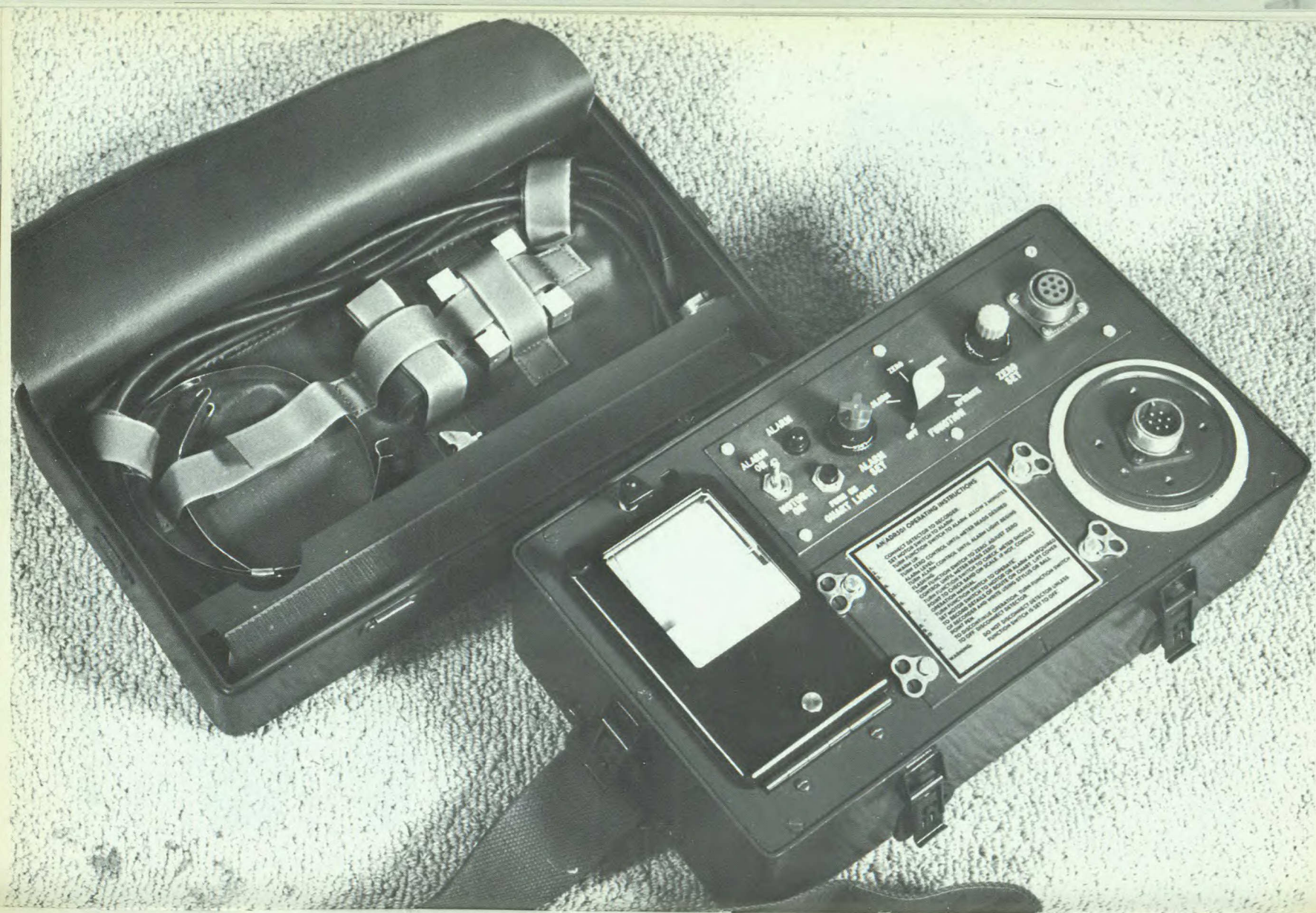
- (a) *Detector Filament*
- (b) *Amplifier*
- (c) *Recorder*

The Amplifier, Recorder and Battery Assemblies mount in the main case and may be removed for repair or replacement. The detector and cable are used outside the case but provision is made to carry them in the case for convenience in transportation.

Performance of the equipment is as follows:

- (a) *Range:* 0.1 to 100 R/hr. on one 3 decade quasi-logarithmic scale.
- (b) *Response Time:* 90% of correct reading within 3 seconds under adverse conditions, better under normal conditions.
- (c) *Chart Speed:* 60 in/hr or 6 in/hr (152.4 or 15.2 cm/hr), depending upon gear train used. Intermediate speeds may be obtained with special gear trains.
- (d) *Temperature Limits:* Detector, -40F (-40C) to 125F (52C)  
Recorder unit, -20F (-29C) to 125F (52C).
- (e) *Operating time:* Limited by batteries at low temperature extremes to 4 hrs. Much longer at normal temperatures. Chart time 12 hrs at max chart speed.
- (f) *Power Supplies:* Completely self-contained batteries.
- (g) *Radiation Sensitivity:* Gamma Radiation only, from 80 kev to over 3 mev. Essentially non-directional.
- (h) *Accuracy:*  $\pm 20\%$ .







## RADIATION SURVEY TRAINING SYSTEM RST 8500

This system enables civil and military personnel to exercise in the use of gamma radiation survey equipment under realistic field conditions without exposure to dangerous gamma radiation. The equipment described here meets this need and is in quantity production by EMI Electronics Canada Ltd., Gamma radiation is simulated by electromagnetic radiation (low power radio frequency signal). The transmitter output is radiated in an elliptical pattern 10 miles long and 4 miles wide. This radiation is detected and measured by portable receivers (gamma simulators) which duplicate an actual Radiacmeter IM/108B in weight, appearance, size and operation. Localized "hot-spots" are simulated by miniature self contained transmitters. The complete system meets full military specification.

To provide realistic training conditions the electromagnetic radiation generated by a continuous wave transmitter is programmed to vary with time to simulate the build-up and decay of the gamma radiation field resulting from a nuclear explosion. A rapid and linear rise from zero to full power can be adjusted to take place between  $\frac{1}{4}$  hour and 2 hours together with a slow exponential decay from full power to substantially zero over a time period from 2 to 8 hours in  $\frac{1}{2}$  hour steps.

Whilst an exercise is in progress the transmitter is programmed to emit an identifying call-sign at full power three times in succession each hour. The transmitter is designed to operate from a 12 volt storage battery.

The simulator receiver is built in to an IM/108B Radiac meter case and has been designed with a minimum number of alignment adjustments for ease of maintenance. A crystal controlled local oscillator provides adequate stability of operation in conjunction with a 2 kHz intermediate frequency amplifier which requires no tuning coils. Various types of primary or secondary batteries can be built into the case as desired. Other models of Radiacmeter can be simulated using standard receiver modules.

Brief equipment specifications are: —

### *Main Transmitter*

Frequency (typical) ..... 29.800 MHz  
Power output ..... 5 watts max.  
Spurious and harmonic radiation ..... 60 dB  
below fundamental  
Power Supply ..... 12 volts D.C.  
Dimensions ..... 12" x 13" x 7"  
(30.5 x 33 x 17.8 cm)

### *Antenna*

Height ..... 10 ft. (3.05 m)  
Length overall ..... 12 ft. (3.6 m)

### *Temperature*

(in service) ..... -20°C to +52°C.  
(in storage) ..... -54°C to +71°C.

Packaged for transport ..... 1 ft x 1 ft x 6 ft.  
(30.5 x 30.5 cm x 1.8 m)

### *Hot Spot Transmitter*

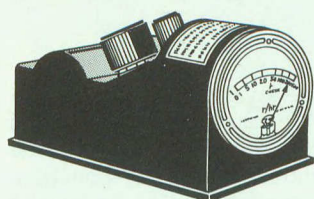
Frequency (typical) ..... 29.800 MHz.  
Power output ..... 75 milliwatts  
Spurious and harmonic radiation ..... 40 dB  
below fundamental  
Dimensions 7" x 4" x 2" (5 x 10 x 17 cm)

The equipment is designed to meet the following climatic conditions:

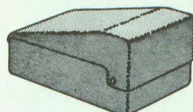
Altitude (in service) .... 5,000 ft. (1524 m)  
(in storage) .. 30,000 ft. (9144 m)

Humidity ..... 98% relative.

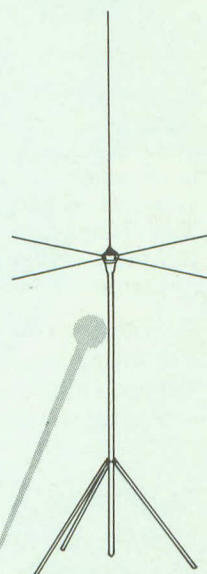
Radiation Pattern — 10 miles long x 4 miles  
wide (16 x 6.4 km)



RECEIVER



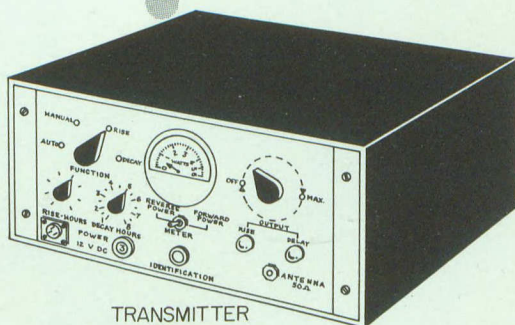
RECEIVER WITH  
COVER



TRANSMITTING  
ANTENNA



HOT SPOT  
TRANSMITTER



TRANSMITTER

## OPTICAL DESIGN

The product reputation enjoyed by Ernst Leitz Canada Limited, and described on pages 280 to 287 is not only the result of years of experience but also of a firm foundation in specialized areas some of which are noted below.

### *Modulation Transfer Function Analyzer*

Ernst Leitz Canada Limited is a company engaged in the development and manufacture of highly sophisticated optical systems. An essential part of the operation is of necessity, quality control. In recent years a new concept of testing optical systems was introduced, which is generally known as Modulation Transfer Function. This company is believed to have been the first in North America to have used this most complete and sophisticated equipment to take such measurements. This equipment is known as the EROS IV model, manufactured by Sira-Beck.

### *Optical Ray Tracing*

The major function in the development of optical systems is ray tracing. Modern computers have greatly facilitated the work of the designers and this facility also makes use of these modern tools. The picture shows part of the in-house equipment which also permits the designer to automatically plot correction curves as well as lens diagrams. For the design of large and complex systems, the company also employs bigger computers on a time sharing basis.

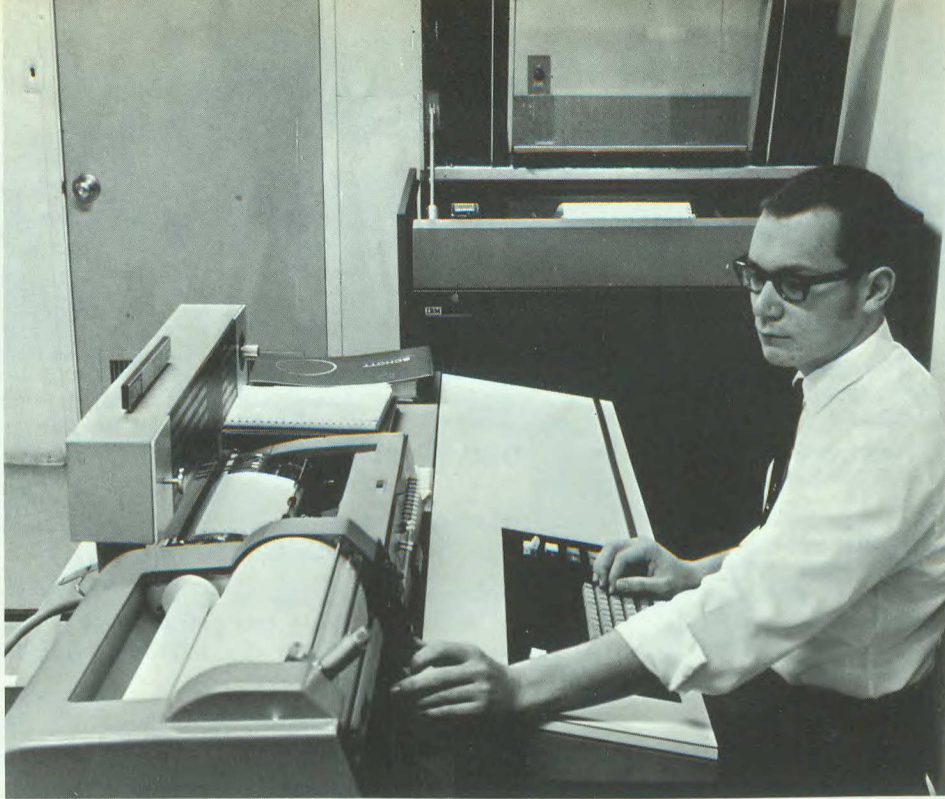
### *High Vacuum Department*

Almost without exception, optical components require some form of thin film deposition. The work in this department ranges from simple anti-reflection coatings of magnesium fluoride to as many as 50 layers for some types of interference filters. The use of an electron gun permits the evaporation of any known material suitable for thin film depositions.

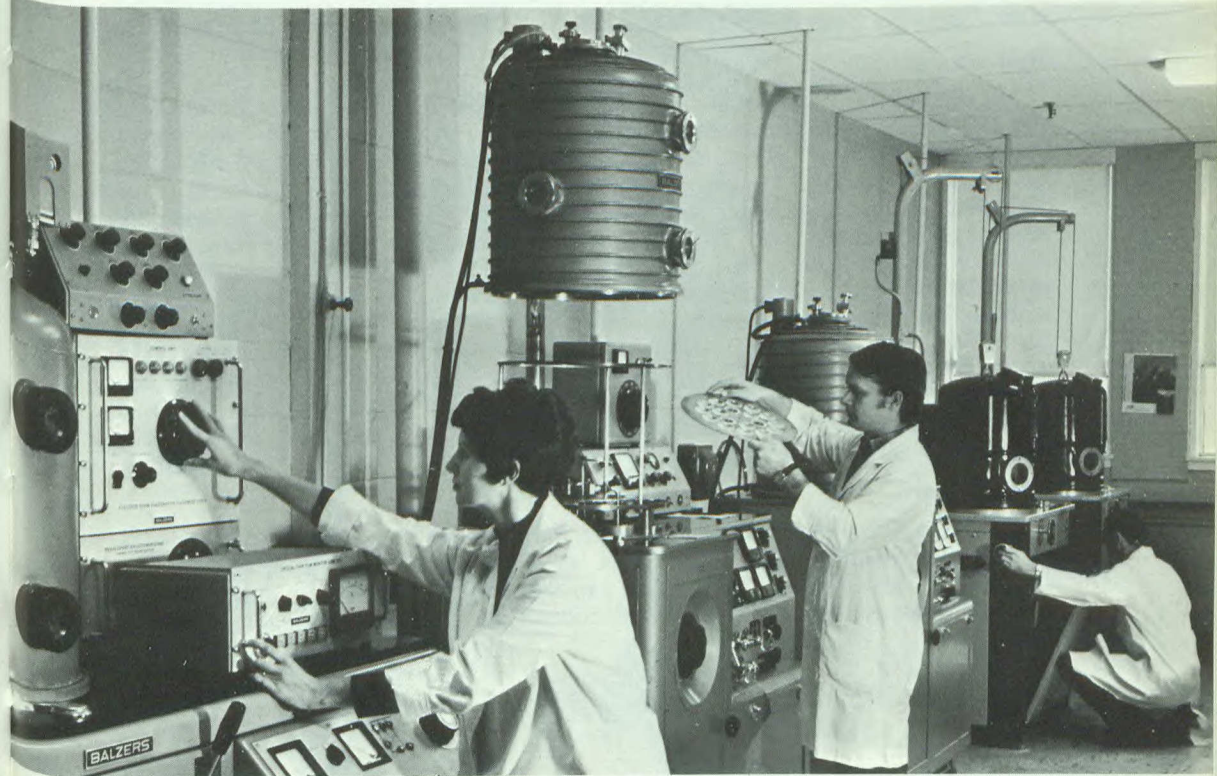


Modulation Transfer Function Analyzer





Optical Ray Tracing



High Vacuum Department

## OPTICAL-MECHANICAL FIRE CONTROL

The effectiveness of any weapon system can be denominated by the accuracy and simplicity of the fire control element. The reliability of the weaponry may be measured by the ruggedness designed into the precision instrument and the degree of ease associated with maintenance. Availability of the fire control element may be influenced by cost and excessive costs may well preclude the acquisition of an equipment which could take full advantage of the inherent capabilities of the weapon.

Canadian problems in this area were largely solved when Ernst Leitz Canada Ltd. was established in 1952. This firm has provided Canada and the Canadian Forces with a facility equal to any in North America and personnel with production and design backgrounds trained to the exacting standards demanded by their predominant product — the Leica Camera.

While these same comments were made in an earlier edition they still apply changed only by the further dependancy that time lends to a proven source.

Leitz equipments have found acceptance in allied nations around the world in commercial and military fields where both competition and performance requirements present a restricted field. Some of the more basic and interesting products are noted below.

### **Day-Night Sight**

To meet a requirement for an inexpensive Day-Night rifle sight Leitz has developed a light-weight unit power reflecting telescope type of day-night sight that, although short in length and simple in construction, is capable of projecting a reticle to infinity on which to align a target. This is accomplished by providing a real intermediate image of the target on a mirror in which a reticle is located. Night use becomes possible by illuminating this etched reticle with a Trilux light source thereby eliminating batteries. A control is provided for reticle illumination adjustment. This sight is on field trial in Canada, U.K., Sweden, Germany and Denmark.

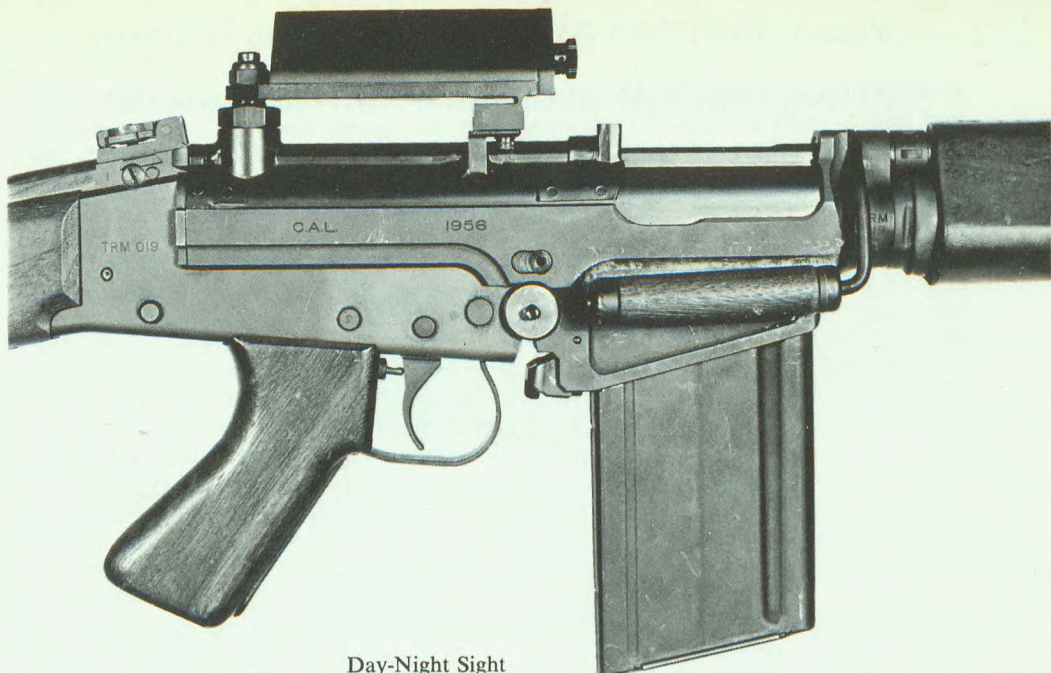
### **Sightunit C2**

The Sightunit C2 was designed to replace other older Sights such as the M4, M6 and M34A2 which did not meet user requirements. The new equipment had to serve improved fire control systems and procedures as well as be capable of taking the heavier shocks imposed by newer and more powerful mortars. At the same time the Sight had to provide greater accuracies than the older equipments to take full advantage of greater ranges. All Scales are in mils and the accuracy to lay is true in Azimuth and Elevation to within  $\pm 2$  mils. The Sight has been designed so that it is capable of being tested and adjusted by unit personnel to ensure proper alliance with the bore axis of the weapon. The Sight weighs only 2.8 lbs. (1.3 kg) and has passed all trials for shock, immersion, drop, temperature, etc. Ancillaries exist which permit an elevated line of sight as well as a light projection device for use with a paralleloscope when the weapon is employed in a deep pit or APC where an outside aiming post is not possible. This equipment has been adopted by U.K., Australia, New Zealand, India and Canada as well as in several other countries.

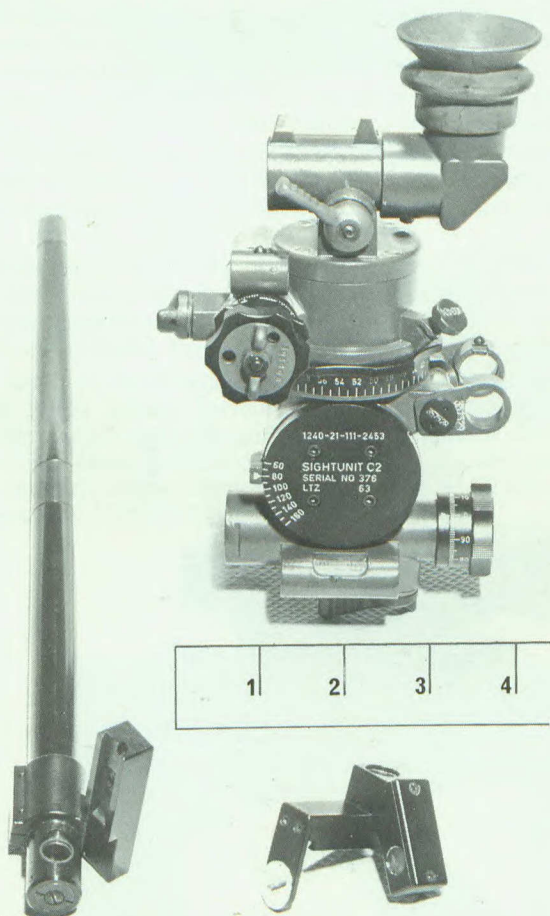
### **Sniper Sight**

When the Canadian Army adopted the FN Rifle they were left with the choice of accepting existing Sniper Telescopes, as is the usual practice, or providing a Scope which was designed for the rifle and that met the particular ballistics of that rifle. Fortunately they chose the latter course and Ernst Leitz Canada designed,



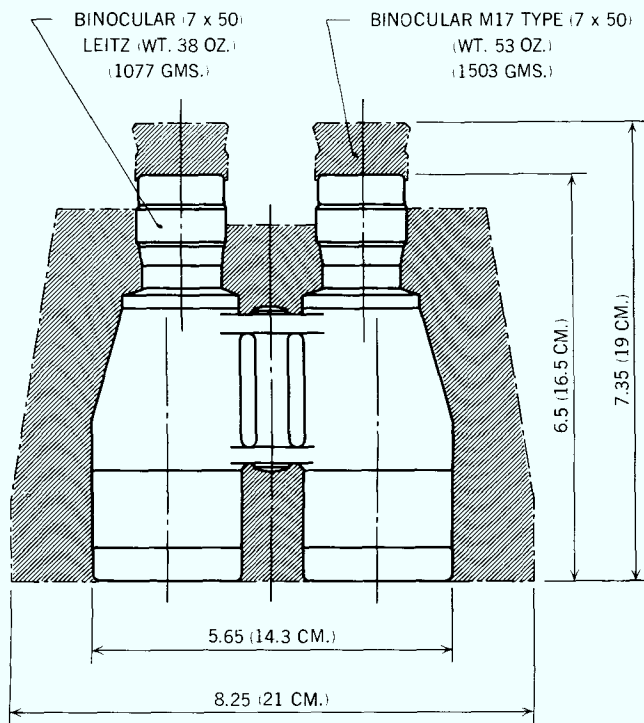
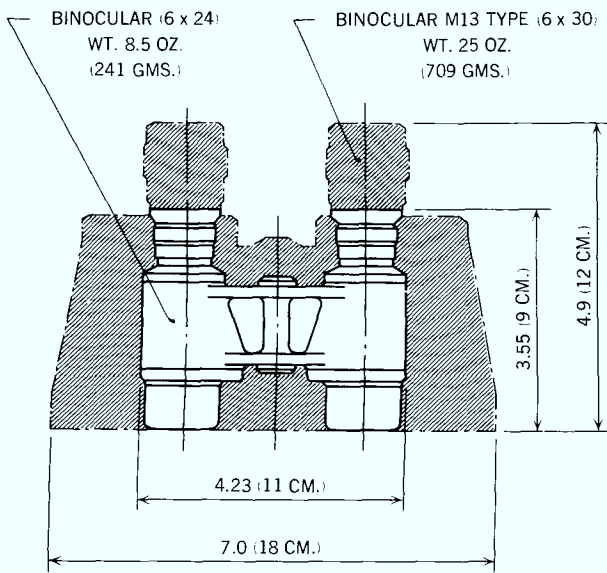


Day-Night Sight



Sightunit C2  
and Ancillaries





## OPTICAL-MECHANICAL FIRE CONTROL (cont'd)

developed and produced a sight which offers many distinct advantages over other known models. The basic design accommodates the FN Rifle or rifles of that type but the scope can be used with any rifle by changing the mount facilities. The Telescope has a length of 8" (203 mm) and a tube diameter of 1" (25.4 mm) and weighs only 10 oz. (.28 kg) including the mount. It has a magnification of 4 and a field of view of 90 mils. The Telescope Mount is fixed to the rear cover of the rifle and employs a unique shock mount device which provides instantaneous mounting or dismounting of the telescope, as the rifle changes roles, yet still maintains its zero. In range the reticle is elevated or depressed by rotating the eyepiece mount and adjustments are in ½ mil clicks from 100 yards to 1000 yards (91.4 to 914 m) with an additional reticle movement of 6 mils to allow for zeroing. In deflection the reticle is moved laterally by rotating the objective mount which again is adjustable in ½ mil clicks with 6 mils provided for zeroing. The deflection slipping scale is graduated in mils and provides 5 mils left and 5 mils right of center.

The sight optical members are cemented to the ends of a triangular prism which eliminates internal air glass surfaces. This optical system is enclosed in a metal case which incorporates elevation and azimuth adjustments and this case is in turn mounted on the rear cover of the FN rifle. Other adapter mounts can be provided if desired.

During day use the reticle is dark against the bright background but at night it is light against the dark background.

### Binoculars

Anyone who has been concerned with repair and maintenance of binoculars for Services would doubtlessly agree that due to an inherent long life there tends to be a multitude of types and makes with an ensuing logistic problem for spares and repair techniques. This company has designed a family of light-weight binoculars which is of considerable interest. In the small sizes, 5 x 20 and 6 x 24, a new prismatic erecting system is used which provides equal inter-objective and inter-pupillar distances. This allows the two halves of the main body to be designed to accept identical erecting systems thus permitting modern maintenance methods as well as economical manufacture. Both glasses have the same eyepiece and differ only in the objective lenses therefore special requirements by the user could be very easily satisfied.

A special binocular, 5 x 35, for observation, from moving vehicles such as aircraft, landing craft, tanks, etc. has been provided with a relatively large exit pupil (7 mm) and low magnification which provides considerable improvement over all present types now available for this purpose.

The 7 x 50 has been re-designed into the light-weight class. Design studies have shown that the larger glasses, including the special 5 x 35, can be produced by using one standard main body changing only the eyepieces and objectives which, of course, would bring about great savings in cost and maintenance. All of this family will meet the standard military requirements of MIL-E-5272A and optical requirements are covered by JAN-G-174 and MIL-O-13830.



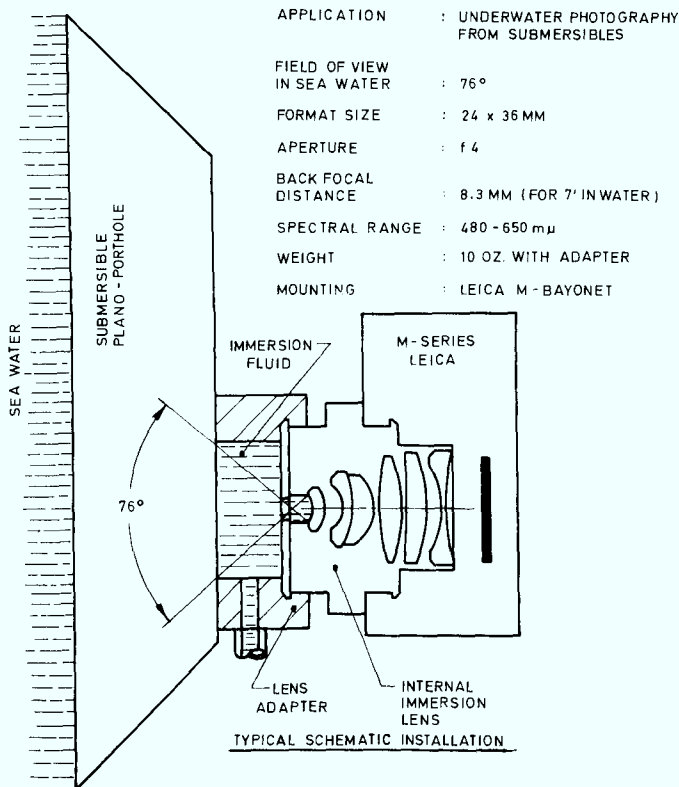
Sniper  
Sight

## INTERNAL IMMERSION LENSES FOR SUBMERSIBLES

Leitz Canada has developed a family of fully water corrected lenses for various film formats from 16mm to 70mm using a front dome which is in direct contact with sea water. This patented system allows the correction of these lenses to the same degree of performance in water as is now obtainable in aerial lenses.

When deep-sea photography is required, cameras are usually mounted on rigs or on the outside of submersibles, which limits the photographic mission by the film capacity of the camera system. It was, therefore, deemed desirable to develop a new water corrected lens system which would permit the use of cameras inside a submersible. The lens shown on this data sheet describes this immersion system.

As wide-angle coverage should not interfere with visual observation, a lens system with an external entrance pupil was selected, therefore keeping the lens diameter small and maintaining the maximum field of view of the operator. To achieve the necessary correction and angular coverage, the lens has been designed as an immersion lens, that is to say, the space between the inner surface of the plano viewing port and the front surface of the lens is filled with a liquid medium of optical properties identical with, or similar to, the outside water environment. Various methods of attaching the lens to the port-hole, either permanently or temporarily, are possible and the user may select his own preference. One method would be to cement a small mounting cylinder against the port-hole and attach the lens by means of a bayonet ring, another would be to use a simple rubber suction cup against the window.







"Typical 35 mm Underwater Camera with special water contact Lens installed. The lenses on the left are for 2 1/4" x 2 1/4" format; the three lenses on the right for 16 mm Motion Picture Cameras. The domes in the center would be in contact with the water are part of the lens system."

## LENSES FOR AIR RECONNAISSANCE CAMERAS

The picture on the facing page illustrates a group of lenses that have been developed and manufactured recently by Ernst Leitz Canada Limited for the RCAF, the United States Military Services, as well as a number of NATO countries.

Using the knowledge gained from the development of high precision photographic lenses for 35 mm cameras, the company approximately 5 years ago started research work on lenses covering larger formats. The VICOM system for the 70 mm format which is installed in the CF-104 aircraft of the RCAF was the first reconnaissance system to utilize these new lenses. The present range of lenses covers the following focal lengths and apertures:

1½"	f/2.8
3"	f/2
3"	f/2 Infra-red.
6"	f/2.8
6"	f/2.4
12"	f/4
24"	f/4

This group gives an angular coverage from 7.5° (24") to 90° (1¾"). The 24" lens is an apochromate and the designer made use of the latest developments of new optical glass. As the lenses are used with filters they are designed for optimum performance in the spectral range of 486.1 m/μ to 656.3 m/μ. The 24", however, is also achromatized for 768.2 m/μ.

Besides lenses for the 70 mm format a group was also designed and made for cameras having the 4½" x 4½" format. These lenses have the following technical specification:

6"	f/2.8
12"	f/4
18"	f/4
24"	f/4

In addition to designing and manufacturing lenses for air reconnaissance cameras the company is also engaged in the development and manufacture of optical fire control instruments, infra-red optics and special lenses for plotting tables, CRT photography, micro recording and projection equipment as well as data processing equipment.

This same firm has produced the Sightunit C2; Telescope, Sniper C1; a family of Aerial Reconnaissance Lenses as well as a Gas Laser and these items are reviewed in this section of the book.





## PHOTO RECONNAISSANCE SYSTEMS

Designed and produced by Computing Devices of Canada for the reconnaissance version of the CF-5 aircraft, this equipment is the result of many years experience in photo recce design and established knowledge in data handling and control systems. The equipment makes extensive use of modern technology to provide flexibility and long operating life.

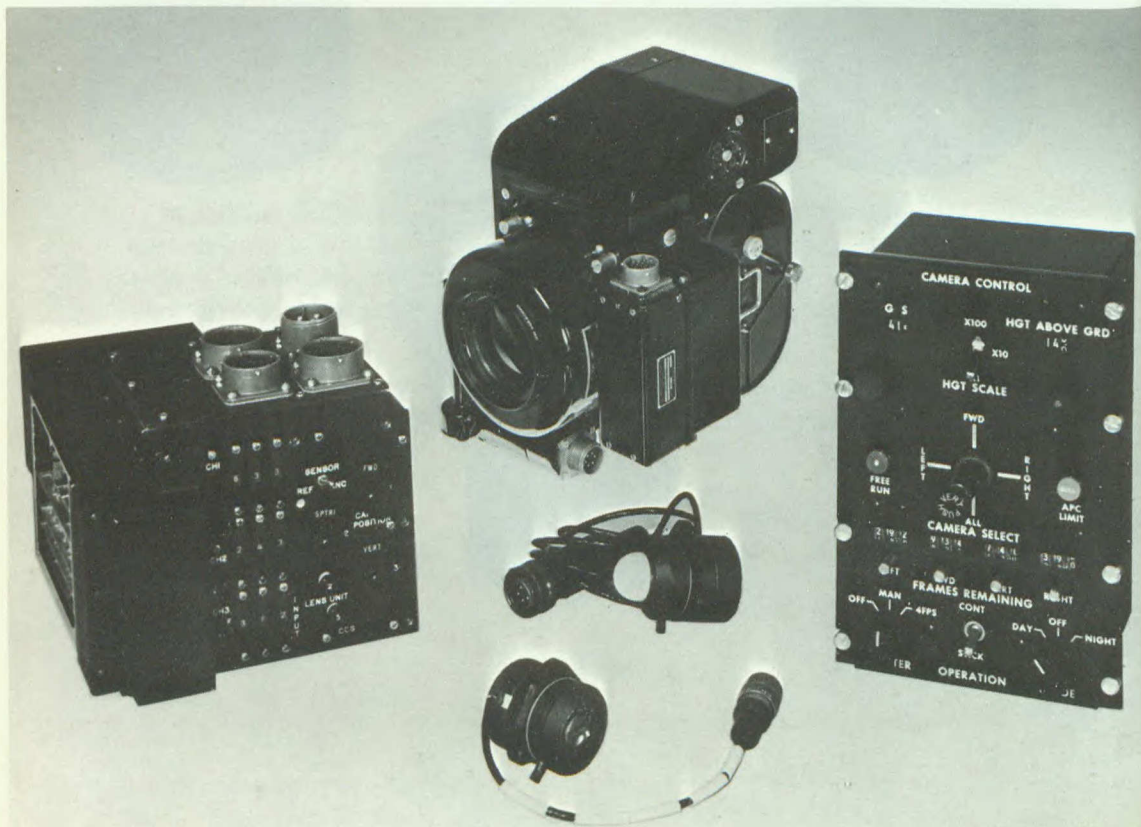
### Features:

- System: solid-state design with extensive use of microcircuits means high MTBF and great flexibility.
- Camera: the Vinten 20 mm camera has a world-wide reputation for dependability and ruggedness of design. Three are used in the system.
- Data Recording: provision is made for alpha-numeric data to be read directly from the 70 mm negative.
- Light Intensity Control: two light monitors automatically compensate for lighting conditions.

Located in the detachable nose-cone of the recce CF-5 are the computer, one light monitor and three cameras looking left, right and forward. In the pilots' cockpit are the camera control and the second light monitor. The pilots' control box contains all the operating controls for the system and includes a miniature joystick for selection of any or all of the cameras.

Computing Devices of Canada have many years of experience in the field of camera systems and have pioneered techniques for low-level high-speed photography. Early systems varied in complexity from single-camera, simple controls to multi-camera complex designs. The photo-recce pod designed for the CF-104 aircraft has been flown for many thousands of hours and has demonstrated excellent reliability and fine film quality.

Complete customer service provided by the company includes training courses for technicians, ground support equipment, manuals and engineering orders and a world-wide field representative organization.



## SMOKE GENERATOR, AIRCRAFT, ORANGE

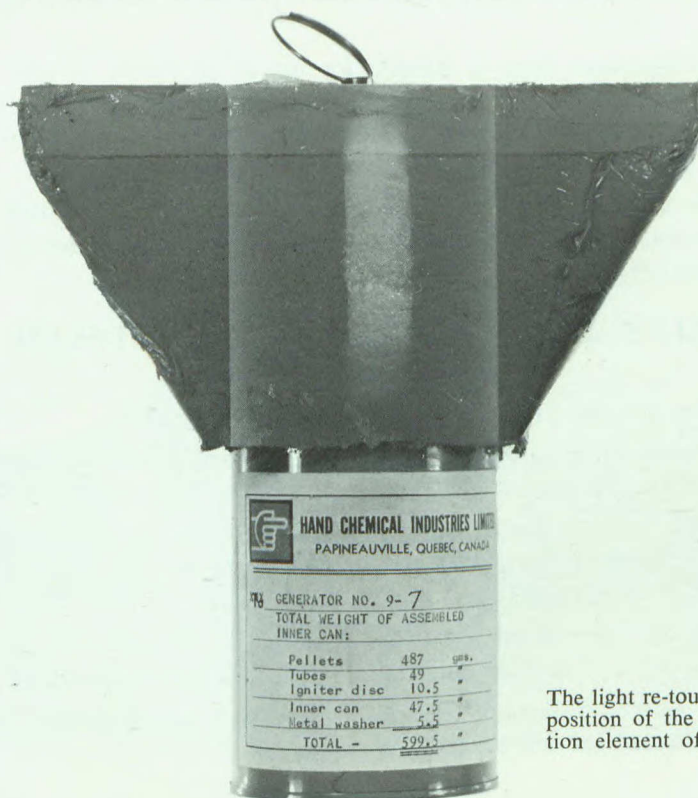
Helicopter pilots operating in remote areas frequently require reliable ground wind information prior to landing at unprepared sites. A coloured smoke generator has been designed specifically to meet this requirement.

The smoke generator functions on land or water, does not bury itself in soft ground or marsh, and creates no fire hazard even in dry grass, or similarly inflammable ground cover. The store is designed to obviate the probability of accidental initiation in the aircraft.

The smoke generator contains an extremely low-temperature burning composition producing an orange smoke, visible from a 2000 foot altitude at a slant range of one mile, against either summer or winter backgrounds. Smoke duration is two minutes. (Altitude 610 m and slant range 1.6 km)

The generator is a 3" diameter metal cylinder 8" H. (7.6 x 20 cm). This cylinder is surrounded over its upper half by an expanded poly-foam body, 8" sq. (51.6 cm<sup>2</sup>) in cross section but tapered in its lower half. This body acts as a flotation chamber in water, ensures that the generator will land in an upright position on the ground, and retards the device in air-drop to reduce landing shock and earth penetration. The total (unpacked) weight of the item is 2¼ pounds. The generator, including the firing mechanism is completely sealed.

The generator is armed by a pull-type mechanism (three pound pull). A fifteen second delay allows ample time for ejection from the aircraft. Burning will go to completion regardless of immersion in either salt or fresh water.



The light re-touched area indicates the position of the can within the flotation element of the generator.



## **MINE ANTI-PERSONNEL NON-METALLIC C3A1 (M25)**

These mines were developed by the Canadian Army and have been accepted as standard by ABC countries. The C3A1 version contains an aluminum shell 6 gr detonator, while the M25 contains a gilding metal shell M 46 detonator. The two versions are otherwise identical.

Each is a low cost plastic groundburst mine supplied in 2 principle assemblies, consisting of the body assembly; 2" diameter by 3" long (5 x 7.5 cm) with a weight of 2 oz. (57 gm); and the charge assembly, 1.5" long by 2.2" diameter (3.8 x 5.6 cm) with a weight of 1 oz. (28 gm). The total weight of the explosive is 9.45 gm.

The body assembly has a transit plug, which is removed after the body assembly has been emplaced and replaced by the charge assembly, fitted with a safety clip. Removal of the safety clip prepares the mine for function, under a load of 16 to 26 lbs. (7.25 — 11.8 kg). As long as the safety clip remains in place, loads of extreme magnitude will not cause actuation.

The mines are coloured olive drab and are designed with integral camouflage material.

Emplaced mines, after removal of the safety clip, are operationally undetectable with conventional electro-magnetic detection equipment. A detector ring can be fitted if this should be required, which makes the mine detectable by standard methods.

This Anti-Personnel Mine is suitable for use in all classes of mine fields in primary or secondary roles. Examples of operational use would be to protect positions to prevent the lifting of Anti-Tank Mines and to deny terrain to attacking forces.

The mine has been loaded by Canadian Arsenals Limited, Filling Division, with components supplied from various sources. The item is in volume production for the United Kingdom.

## **MINE ANTI-PERSONNEL NON-METALLIC PRACTICE C4A1**

The mine is a practice version of the C3A1 (M25) H.E. mine.

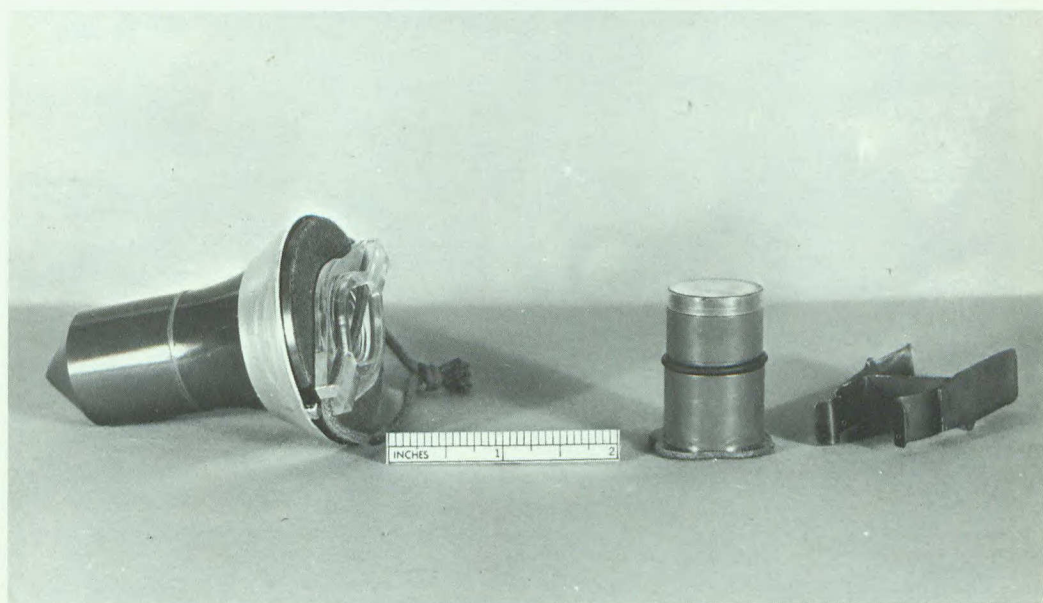
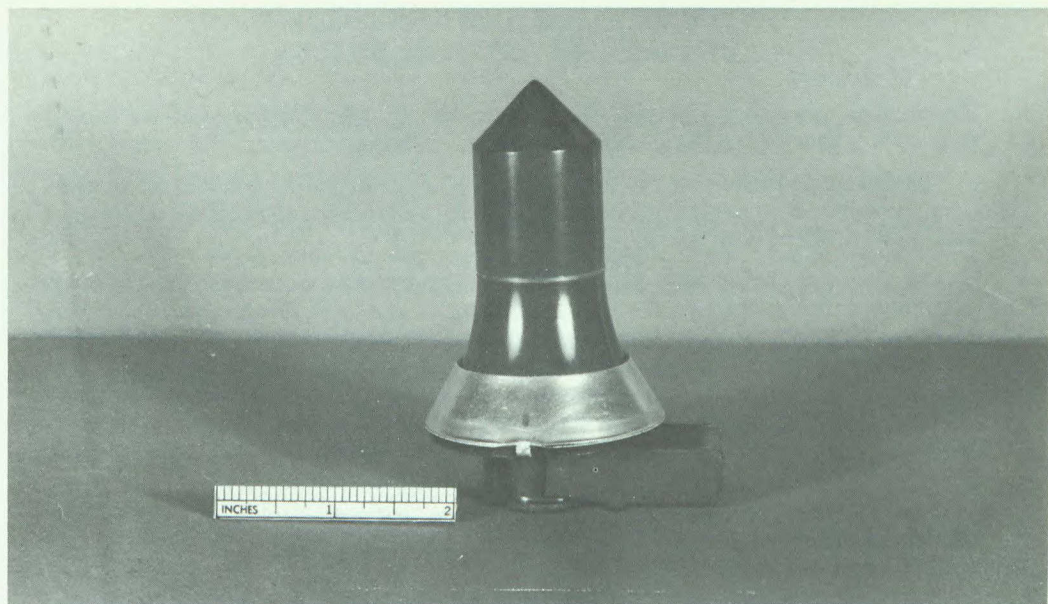
The emplacement assembly and function of the practice mine is the same as for the H.E. version. On actuation, the mine produces a blue coloured smoke signal.

Identification of the components is made through the use of standard NATO colours. It is constructed of plastic materials and is reusable at least five times by replacement of the spotting charge and the re-cocking of the body assembly.

This item has been in volume production for the Canadian Forces and the United Kingdom by Canadian Industries Limited and other contractors.

Imitation inert and dummy versions of the C3A1 Anti-Personnel Mine have been manufactured and are available as required.





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## FUSE ASSEMBLIES AND PRECISION METAL PARTS

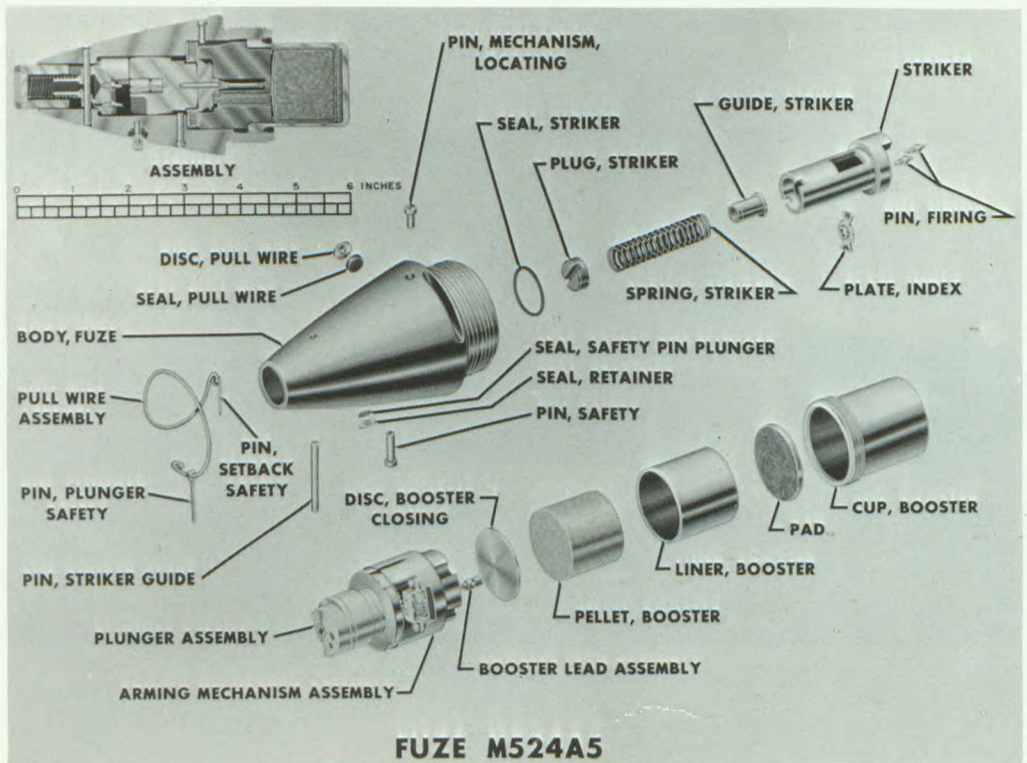
Marsland Engineering Limited has an established high quality in-house facility to produce fuses of the M524 type at a high production rate.

This integrated capability is built around equipment easily adapted to the production of precision parts for commercial needs while giving the facility more scope than a single purpose ordnance plant.

The Company has a long history as a quality supplier of mechanical parts and assemblies from stampings through machining of complex shapes and the cutting of gears, pinions and cams, on modern automatic equipment. All of these facilities are utilized in the kit for the M524 fuse which is supplied to loading plants as required. Wherever there is a demonstrated need for special production machining equipment the Company designs and builds linear as well as rotary transfer machines of high accuracy so that unskilled operators can be used to quickly achieve maximum output.

Other products include teleprinter equipment, military display systems for ship and aircraft installations, electronic components such as loudspeakers, transformers, resistors and television tuners.

A very complete electro-mechanical design and production engineering department is fully staffed at all times and is supported by development and environmental test laboratories. Under these circumstances the Company successfully handles research and development contracts for many international customers in both the commercial and military fields.



## **CANADIAN ARSENALS LIMITED**

### **(Small Arms Division)**

The Small Arms Division of CAL has provided the Canadian Armed Services with equipments and designs consistent with the exacting demands of ordnance work where consistency and long life to rigorous specifications is taken for granted.

High speed deep-hole drilling, high quantity and accuracy broaching as well as internal chroming facilities are but three of the techniques available at Small Arms which ensure a production in accordance with specifications and to inspection standards.

The very special qualities of any Arsenal and more particularly CAL, as it is a self-reliant and completely self-contained operation, makes it a valuable back-up source to other segments of the defence industry or to industry at large where the peculiar and specialized techniques of any established arsenal are understood. Very often ordnance experience in material and standards provide the positive assurance required in other than what might be normally considered straight ordnance products.

Recent production at CAL has included .50 Brownings, Air and Ground versions; 7.92 mm Bren LMG's to foreign account; 7.62 mm (FN) C1 & C2 Rifles; 9 mm C1 (Sterling) SMG's and millions of 20 mm Ammunition Links.

The design services available at SAD have made vast improvements on such standard and internationally recognized weapons as the FN Rifle and the Sterling SMG as well produced the 9 mm Browning pistol (Canadian Pattern HP) which is used as a standard side arm in a variety of countries.

The facilities at the Small Arms Division are of more than ordinary interest, as would be expected, and brief summaries of the more salient features are noted.

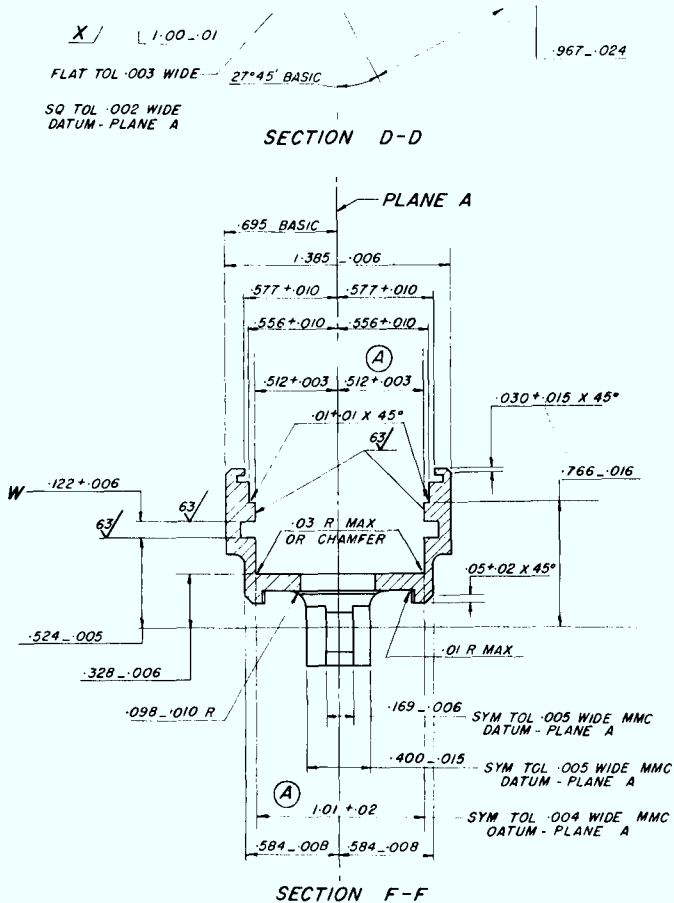
#### **METROLOGY AND GAUGE LABORATORY:**

The Division metrology and gauge laboratory is a self contained temperature and humidity controlled relatively vibration free unit established for the control and maintenance of measuring standards used in the processing of a wide range of products both defence and commercial that can be manufactured in the Small Arms plant. The measuring equipment with some exceptions is of a universal type permitting the measuring of several features with one machine and includes a three co-ordinate measuring machine, toolmakers microscope, machines for measuring up to 80 inches (203 cm), lead and pitch measuring both internal and external, internal diameter measuring to an accuracy of .00002 inches and an opposed head comparator graduated to .0000001 inches. The metrology laboratory has received R.C.A.F. approval and is listed in appendix "B" of 12 Technical Services Unit Order and Instructions T22 as a source for the complete calibration of gauge blocks as well as plain and threaded ring and plug gauges. The metrology laboratory, in addition to providing for our own internal requirements, calibrates gauge blocks and measuring standards for commercial companies.



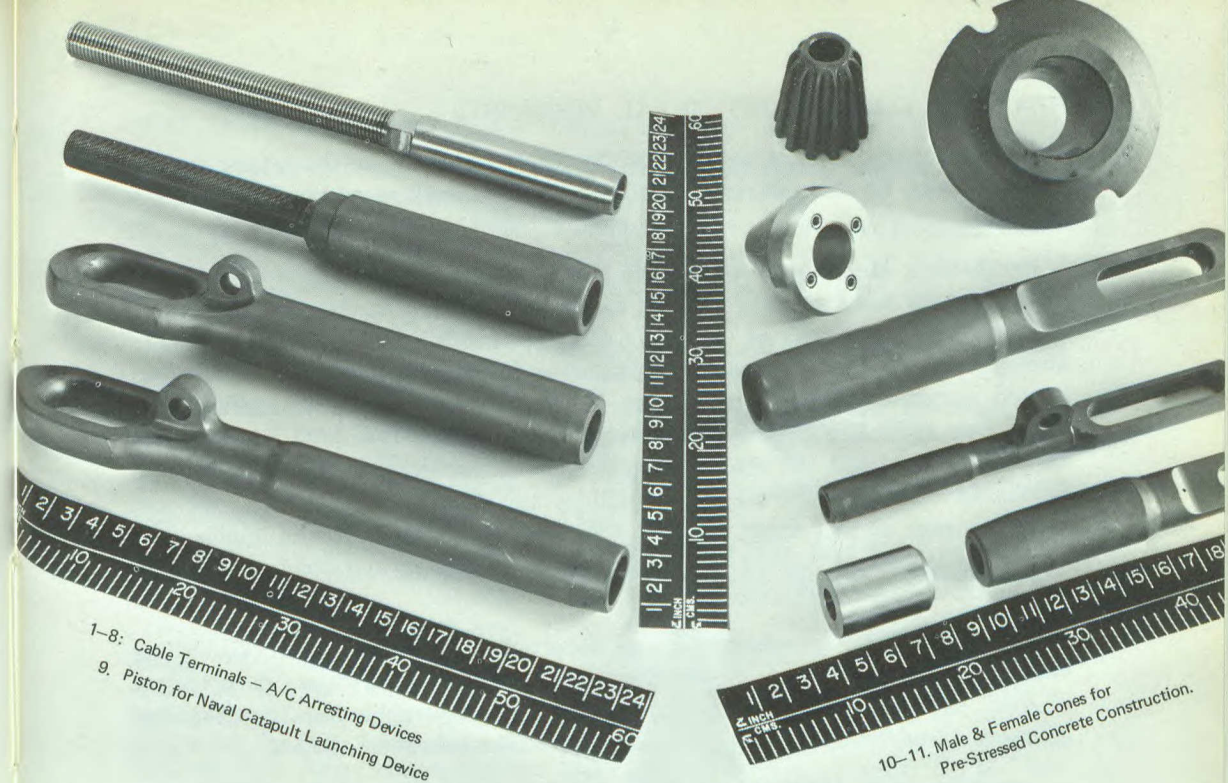
## BROACHING:

The Broach Department has 13 surface broaching machines which are pit installed to ensure ease of handling material from floor level and are serviced by an overhead crane system to facilitate the handling of heavy broach tooling. The machines range in size from 10 tons (10 metric) with a 66" (1.7 m) stroke to 25 tons (25 metric) with a 90" (2.3 m) stroke and are of the double ram type with both oscillating and shuttle table arrangements thus permitting maximum use of operator's time during the cutting period of the machine cycle. There are also two vertical internal broaching machines with automatic broach pulling and retrieving mechanisms, each machine of the multi-head type. These machines are used for precision broaching of holes, slots and other through-type internally formed shapes. These machines are capable of broaching many shapes in a wide range of sizes restricted only by their tonnage capacities.

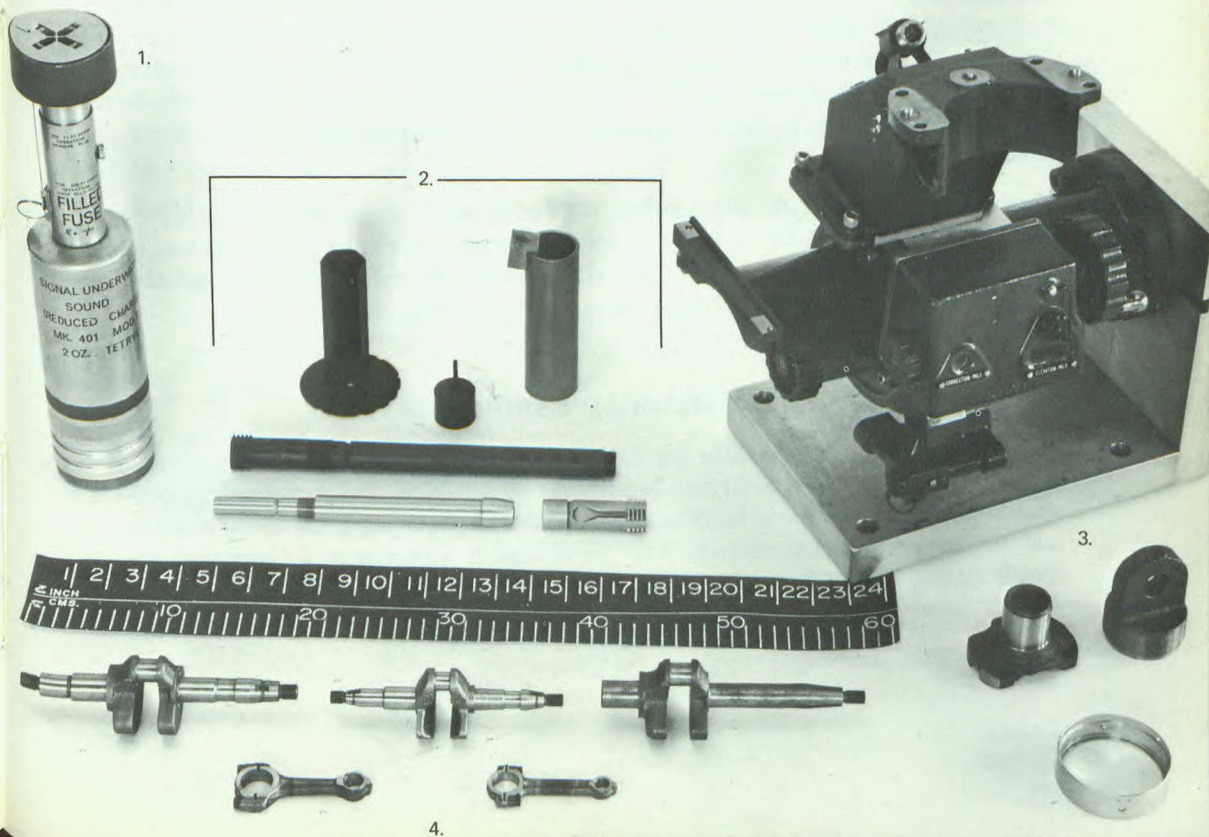


## HONING:

The Division has considerable capacity for internal honing with a honing machine equipped to hone bores from 1½" to 8" (38 - 203 mm) 2D for Internal Diameter and lengths up to 12 feet (3.7 m). Surface finishes are produced in order of 8 RMS (micro finish). Recoil and Recuperation systems on the 105 & 155 mm Howitzers are reworked on this equipment.



The diversity of the Division is shown in these items: 1. Parts for Underwater explosive devices; 2. Impact device for setting anchors in concrete for the construction trade; 3. Items for artillery Fire Control; 4. Crank shafts & connecting rods for high rpm engines.



## HEAT TREATMENT AND METAL FINISHING:

For convenience this facility will be discussed under its six specialized departments. It must be remembered that all departments work to demanding ordnance standards.

**Production Heat Treating** — The Heat Treating Department is equipped to handle ferrous metal parts in sizes up to that encountered in weapons as large as 20 mm calibre. The bulk of the heat treatment of finished parts is carried out in atmosphere controlled Lindberg carbonitriding furnaces. Barrel forgings are heat treated in non-atmosphere pit furnaces. Induction heating equipment is available in the form of 10 KW and 25 KW units (450 KC) with and without oil quenching facilities. Molten salt and lead baths are available for cyanide hardening, neutral hardening, tempering and nitriding. Facilities are available for the heat treatment of all varieties of tool steels. Support equipment includes automatic atmospheric controls, deep freeze cabinet, magnetic particle inspection and Rockwell, Brinell and Vickers Hardness Testers.

**Electroplating** — A special purpose department equipped for electropolishing and hard chromium plating of gun barrel bores and external plating on a variety of small parts. Support facilities include special bore scrubbing and lapping machines and lead-tin alloy plating for use on special conforming anodes.

**Anodizing and Alodizing** — Sulphuric acid anodizing to Mil-A-8625A type 2 and Alodine Chemical films to Mil-C-5541 are produced in this department. Tank sizes are approximately 30" square by 30" deep (76 x 76 cm) with the exception of the anodizing tank which is long enough to accept three racks at a time.

**Abrasive blasting, Tumbling, Polishing and Buffing** — The abrasive blasting facilities include a Pangborn Rotoblast, Wheelabrator, hand and tumble sand blast. Parts up to 48" (1.2 m) in length are processed. Tumbling facilities used for deburring and burnishing comprise Supersheen Tumbling Machines with compartment sizes up to 30" diameter by 24" (76 x 61 cm) width. Support facilities include storage bins, stone separators etc. The polishing equipment comprises 6 Ford Smith polishing lathes.

**Phosphating and Oxide blackening** — Phosphating is carried out to Mil-P-16232 on parts up to 36" (.9 m) in length. Oxide blackening is carried out to Mil-C-13924 on parts up to 30" (76 cm) in length. Support equipment includes acid and alkali cleaning tanks, rinse tanks, oiling benches etc.

## METALLURGICAL AND CHEMICAL LABORATORY:

This laboratory is responsible for the composite quality control of all incoming raw materials as well as in plant control over all chemical and metallurgical processes. Chemical facilities are mainly volumetric and gravimetric for metal analysis and processing solution control. The Metallurgical Laboratory is equipped for tensile testing, impact testing, hardness testing, metallograph and salt spray testing.



## DEEP HOLE DRILLING FACILITY:

The Division possesses unique deep hole drilling capabilities and has the following machines for this purpose:—

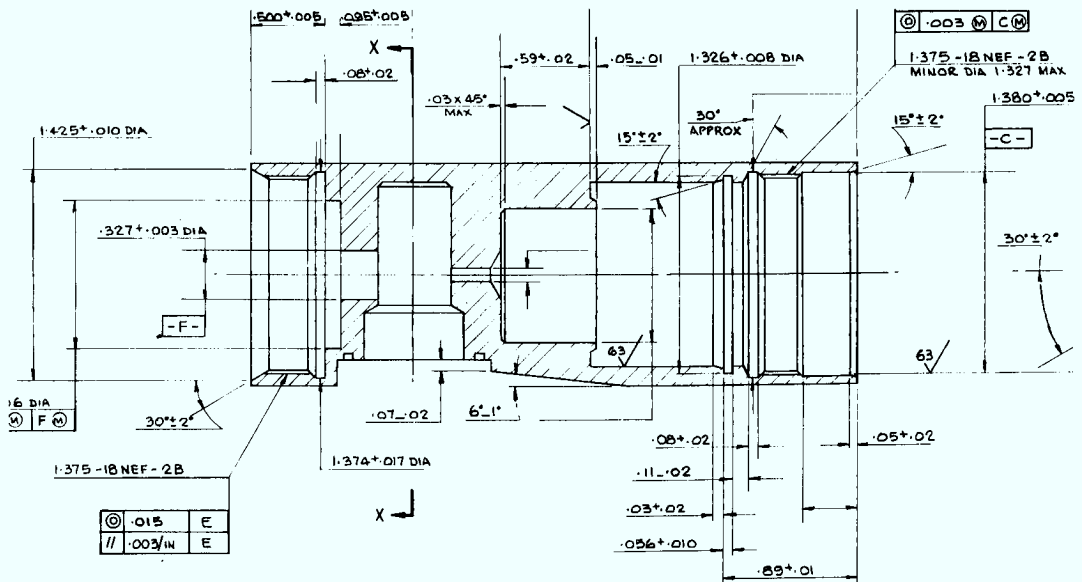
- (1) Pratt and Whitney  $\frac{1}{2}$  B drilling machines capable of drilling holes up to  $\frac{3}{4}$ " (19 mm) diameter by 50" (127 cm) long.
- (2) Barnes drilling machines, presently drilling up to  $1\frac{3}{4}$ " (44.4 mm) diameter by 96" (2.4 m) long.
- (3) Bryant drilling machines for precision drilling of small holes to fine positional tolerances in irregularly shaped components.

Other than the drilling of all types of small arms barrels these machines have applications for the drilling of a wide range of components for industry in general. The most unusual application was the drilling of 12 coolant holes  $1\frac{1}{2}$ " (38 mm) diameter with a drilled length of 86" (218 cm) through a solid copper block weighing approximately 6500 lbs (2948 kg).

Other drilling operations include such items as the wire rope holes for catapult launching terminals, roller shafts for printing machines and thermocouple welds, etc.

Canadian Arsenals (Small Arms Division) enjoy an international reputation in design and production based on such activities as; Design Agent for the Design Authority for the 7.62 FN Rifle in use in Great Britain, Australia, New Zealand, India, Canada and other countries who have adopted it; production of ordnance gauges for the U.S. Army and more lately the Division has received commendation from the U.S. Army concerning the speed and efficiency with which M137 Telescope Mounts were produced.

## TAPE CONTROL APPLICATIONS



## **CANADIAN ARSENALS LIMITED**

### **(Filling Division)**

This Division, established in the early days of World War II, was designed to load high explosives and propellants into such end products as artillery shells, mines, bombs, grenades, torpedo warheads, depth charges and mortar charges as well as rocket motors. This same facility also designs and produces components for assembly in primers, detonators, delays, as well as a wide spectrum of fuzes.

The Division's operations are also directed toward the improvement and refinement of ammunition. Its range of work covers new compositions, initiatory materials, explosive trains, pyrotechnic materials and devices employing these materials; electronic fuzes and associated power sources engineered to withstand accelerations of Kil-g magnitudes.

Applications for modern controlled-process initiatory powders are being investigated constantly to provide alternate and improved designs of igniters, detonators and primers employing electrical, stab or friction initiation. Improved safety, better manufacturing characteristics with consequent cost advantage, and more stable performance in service are the guidelines for this work. Current work includes investigations into more uniform chemical delay powders with special emphasis on the longer burning time gasless types.

The normal day-to-day work of the Division entails the handling of a wide variety of sensitive explosive compositions and ordnance components. The maintenance of an enviable quality record enjoyed by the Division over the years cannot be left to chance alone nor can it be left to an earnest desire for quality. Only through a rigid and continuing policy of staff training and regulation enforcement together with the engineering division's constant surveillance of production methods is the quality level maintained.

To consider the Division as a filling plant only would be erroneous, despite its name. This facility is staffed and equipped to cover all activities from the quality acceptance of the basic materials and components to the production of the explosive compositions, the filling operation, the assembly, and the final inspection of the end products.

### **CHEMICAL LABORATORY**

A partial listing of equipment would include semi-micro analytical balances, differential thermal analyzers and spectrophotometers. The gravimetric and physical testing bench of the Detonating Composition Room provides for safety of operations along with precision. Also included are shielded analytical balances, friction pendulum, ignition temperature tester, drying facility and ball and disc impact sensitivity apparatus.

The laboratory will also produce small batches of sensitive elements in a synthesis laboratory before scaling them up for full batch production. This same small scale operation is often used to develop the specialized techniques required to handle such new formulas. Such techniques are more important than equipment wherever exacting accuracies or the handling of sensitive or dangerous substances are involved.

The electronic calibration and environmental test of electronic components and assemblies at the Division are carried out with secondary standards which have been calibrated by a Registered Laboratory that is traceable to the primary at the National Bureau of Standards (NBS) in Washington or to the National Research Council (NRC) in Ottawa. The laboratory, which includes static and dynamic testing of electrical parameters, also tests environs of temperature and humidity cycling, vibration, spin, centrifuge and shock.

Associated with our work in electronic devices is a measurements lab containing

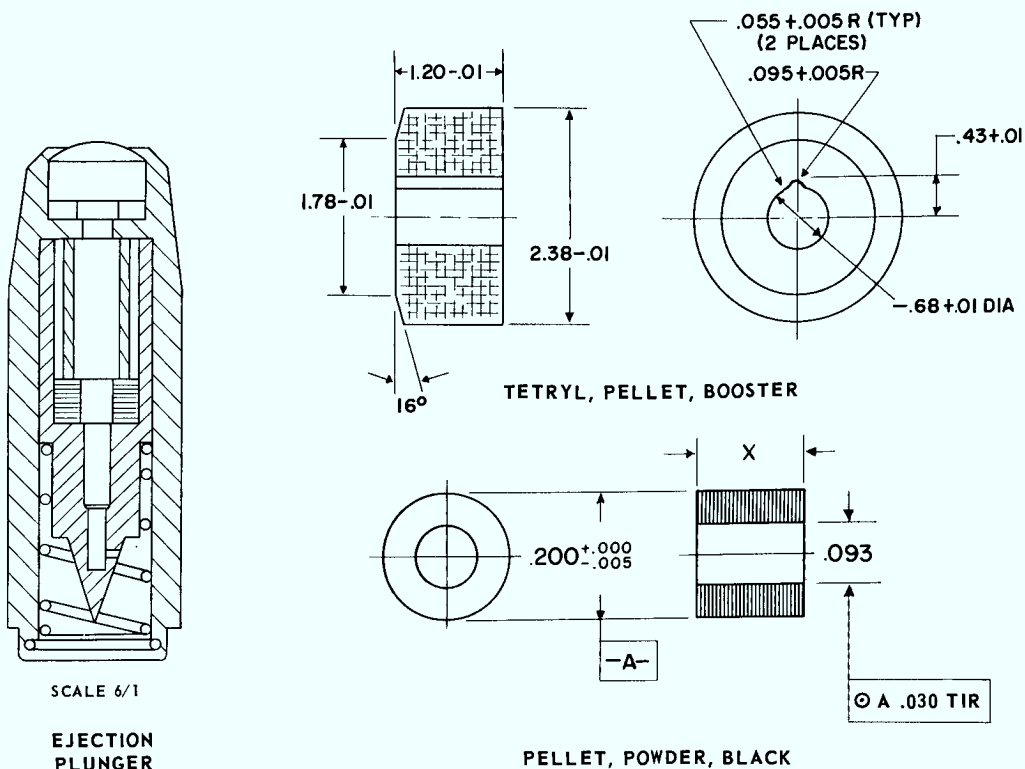
standard test equipment used for the measurements of the basic physical characteristics. Field strength antenna characteristics and power measurements can be made at ultra high frequencies.

Specialized equipment for the laboratory simulation of operational environments include very high speed spinners, (48,000 rpm), very high-g simulation, and the instrumentation required to record these test environments. Analog devices are used to simulate electronic and other physical mechanisms. An analog computer and a high frequency response recorder are included. Particularly, the laboratory is equipped for the measurement, analysis and assessment of proximity fuzes in developmental or investigative phases. This includes not only the electronic components, but in addition, electro chemical and mechanical devices.

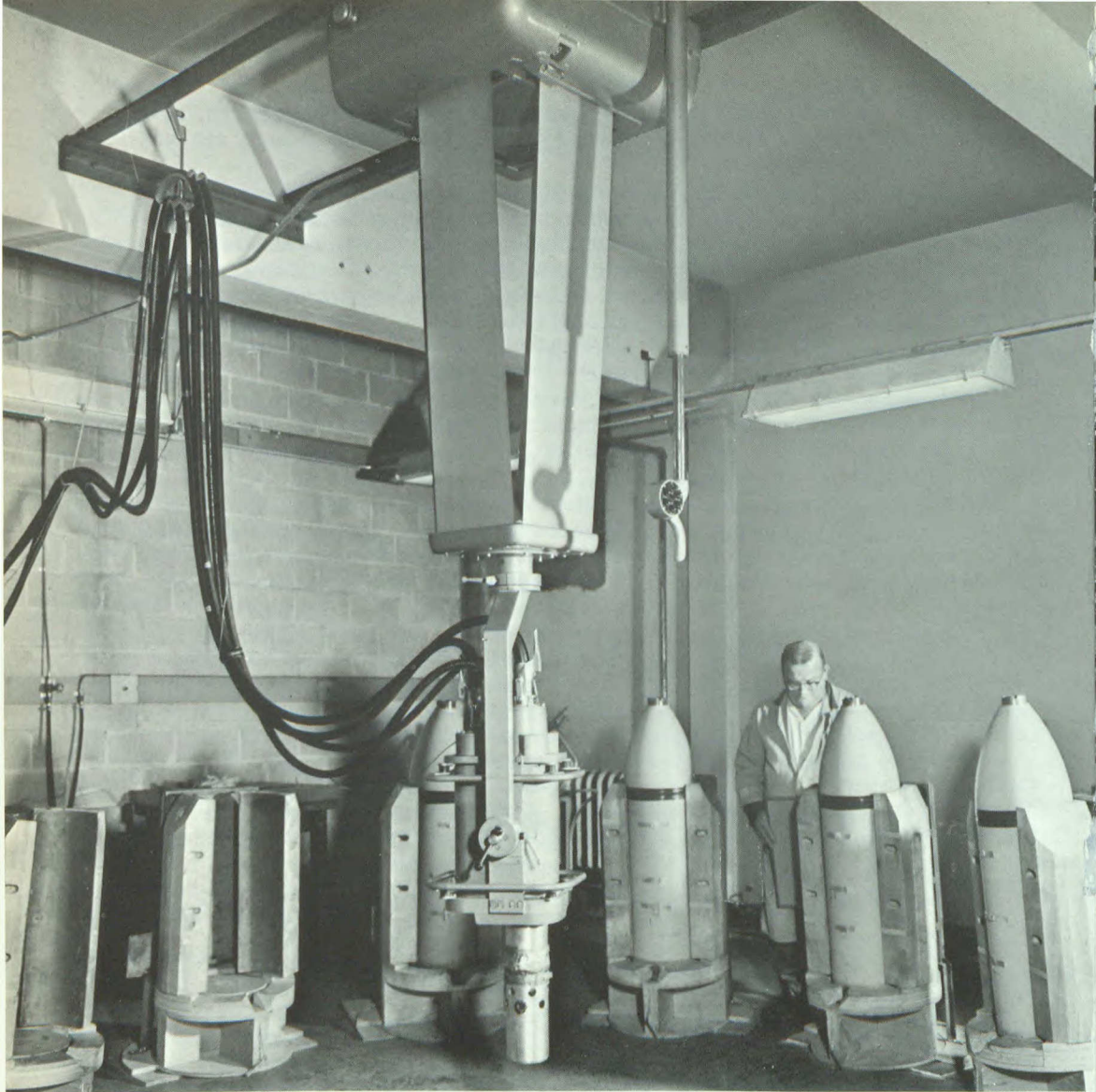
Closely associated with this work is the standard and the special equipment used for the measurement of peak amplitudes and intense light pulses from pyrotechnic sources. Selection and calibration of photo cells and filters to provide equivalent spectral response can be done.

Two complete radiographic laboratories are equipped to handle any film radiography assignment within the capabilities of the five X-Ray machines operated by the Division. The X-Ray equipment includes the 10 to 300 Kilovolt range, as well as a 220 Curie Cobalt source. A 150 KUP maximum fluoroscopic unit for line inspection, fed by a conveyor, is also available.

For small components (in the millimeter range) a 3M microfilm reader with an 8" x 10" micro-flash attachment is used for film inspection and the unit will accept lens with a magnification up to 35:1. A dry paper reproduction can also be obtained within a few seconds. Some samples of components radiographed in the Small Component Laboratory are: small electronic and mechanical components, detonators and primers of a few millimeters in diameter or larger, electronic and mechanical assemblies and filled cast explosives up to 5" dia. x 15" H. (12.7 x 38 cm). In high quantity productions where 100% X-Ray examination must be carried out a Duplex is used with 60 to 220 KUP units, fed by a conveyor system



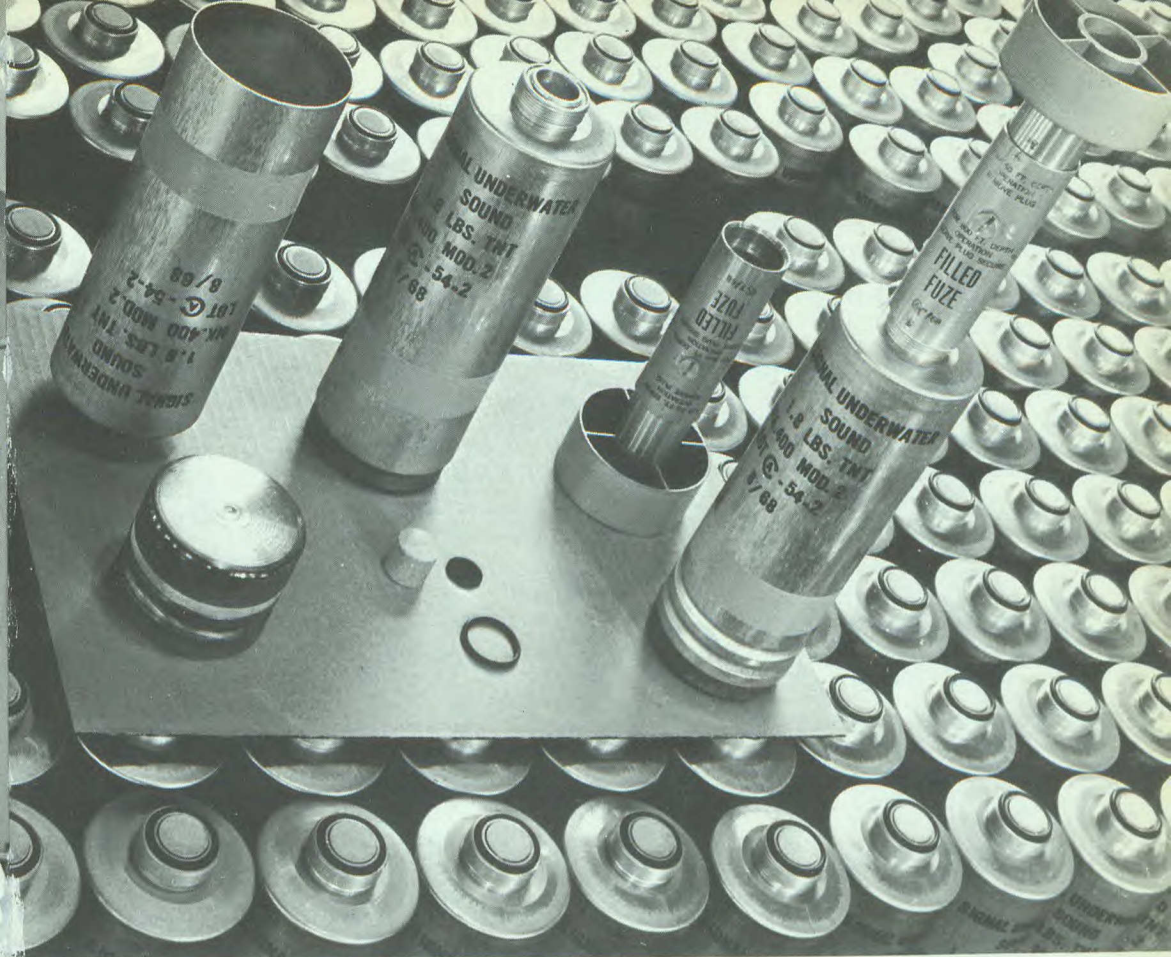




and with automatic film carriage and exposure control which provides for multiple exposures on the same film when the X-Ray ports are suitably masked.

The second radiographic laboratory is designed to accommodate medium and large type cast explosives in various kinds of metallic and non-metallic casings. The equipment features a 100 to 300 Kilovolt machine using a 360° exposure rod anode tube or a 30° exposure tube with a medium or fine focal spot. A 220 Curie Cobalt source with a 360° exposure capability is located in an adjoining shielded room. Both Laboratories are equipped with a darkroom and a viewing room, and films can be either hand-processed or by an automatic processing machine. Film illuminators include four low intensity viewers, one Sextuplex medium intensity viewer and five high-intensity viewers.





A good example of the high production capabilities of the Division is in the line producing the propelling charge M4A1 for the 155 mm. Howitzer SPM109. Each charge consists of five increments of varying weights. The operation consists of filling the charge to a predetermined weight, check weighing, and then loading into the increment bag and finally to the bag sewing station. The accuracies required in the production of these charges are worth noting and here the Base Charge, which weighs 4.270 lbs. (1.9 kg), has a tolerance of  $\pm 1.6$  drams and other increments, weighing from 1 to 3 lbs. (.45 to 1.4 kg), have a tolerance of .8 drams. This line can use approximately 42,000 lbs. (19,051 kg) of propellant per shift and, therefore, safety precautions are a must.

For the above reason, the operating shop is equipped with a high-speed deluge system capable of operating within one second after the flame has reached the heat-actuated device located directly above each supply bin on the line, and is capable of extinguishing the fire in a few seconds. All equipment is grounded to prevent any build-up of static electricity; flexible grounding cables are clipped to the propellant cans when pouring into the bins.

This high production capability is supported by vast secure magazine areas for explosives. Other storage areas are maintained for components.

Another facility available is the Proof Yard which is equipped to test primers, detonators, delays, fuzes, artillery primers, special devices, and flash and smoke munitions. Tests are carried out for sensitivity, pressure bar, sandcrushing, dent test output, delay times, jolt, jumble, drop, low and high frequency vibration.

## TRUCK 1¼ TON, 4 x 4 "RAM"

This vehicle has been selected by the Canadian Forces to replace the ¾ ton (762 kg) payload M-37 utility truck. The 1¼ ton (1270 kg) cross country payload was chosen as being optimum for the lightest load-carrying vehicle in tactical units.

This truck is unorthodox in that the frame consists of a monocoque construction aluminum hull, thus providing an inherent swimming capability and maximum protection from dirt and damage to the power train.

The RAM is lightweight, compact, and highly mobile. It meets current military speed and grade requirements. It will float and swim without prior preparation. Water propulsion and steering are provided by the wheels. This vehicle has exceptionally good ride, handling, and control characteristics on or off the road. These advantages are provided by the long stroke, independent suspension, carefully selected springs, and long parallel control arms. Fast manual steering and power-assisted disc brakes also contribute to exceptional control and driving ease.

The commercially proven 318 cubic inch (5.2 lit.) V-8 gasoline engine is located under the cab and is readily accessible for easy maintenance. The remainder of the power train in the 1¼ ton truck consists of a rugged three-speed automatic transmission, a single-speed transfer case, and front and rear driving axles.

The all aluminum integral watertight body provides the lightest weight for the strength required to handle the rugged off-road jobs. The cargo body of the 1¼ ton truck provides 58 square feet (5.3 m<sup>2</sup>) of usable space. The full-width tailgate makes it easy to load.

A variety of special purpose kits (e.g. ambulance, communications, etc.) are being developed for the vehicle.

This vehicle is now undergoing technical and user trials, which will be completed in mid-1970. The vehicle will be in quantity production in 1971.

### Weights

Curb	6,000 lbs. (2,722 kg.)
Payload (Cross-Country)	2,500 lbs. (1,134 kg.)
Payload (Highway)	4,000 lbs. (1,814 kg.)
Crew Allowance (two men)	450 lbs. (204 kg)
G.V.W. (Cross-Country)	8,950 lbs. (4,060 kg.)
G.V.W. (Highway)	10,450 lbs. (4,740 kg.)

### Dimensions

Overall Length	180.00 inches (457 cm.)
Overall Width	89.00 inches (224 cm.)
Overall Height	95.75 inches (144 cm.)
Reducible Height	70.00 inches (178 cm.)
Cargo Body Length	97.00 inches (246 cm.)
Cargo Body Width	85.00 inches (216 cm.)
Cargo Body Area	58.00 sq. ft. (5.3 m <sup>2</sup> )
Ground Clearance	
(a) Standard Tires (9.00x20)	13.62 inches (34.65 cm.)
(b) High Mobility Tires (16x20) (Opt.)	15.42 inches (39 cm.)
Approach Angle	
(a) Standard Tires	60°
(b) High Mobility Tires	65°

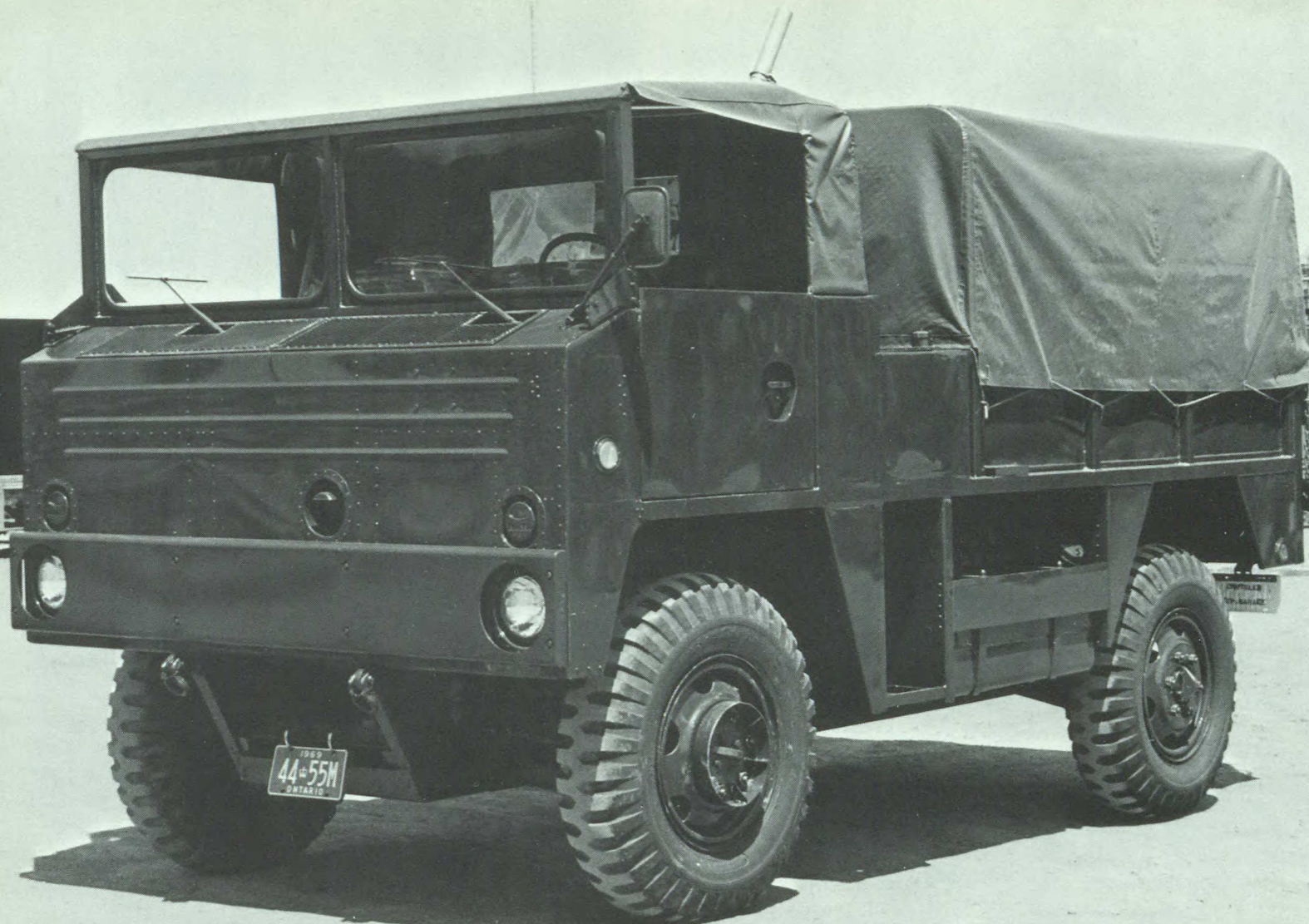
### Performance

Maximum Speed	60 mph (97.6 kilo/h.)
Gradeability (Forward Slope)	60%
(Side Slope)	30%
Range (Highway)	340 miles (547 km)

### Departure Angle

(a) Standard Tires	48°
(b) High Mobility Tires	52°
Turning Radius	
(a) Standard Tires	29 feet (8.8 m)
(b) High Mobility Tires	30 feet (9 m)





## **“DYNATRAC”—(XM-571)**

Canadair Limited has designed and developed an extremely versatile tracked vehicle – the Dynatrac. The U.S. Army, who have an interest in this vehicle designate it as the XM-571.

The Dynatrac is a fully tracked, articulated, high mobility, utility carrier with a payload capacity of 2,000 pounds (907 kg) plus driver and co-driver. The vehicle is designed to be used as a cargo or personnel carrier, as a litter evacuation unit, as a platform for a series of light weapons systems and for a variety of other uses such as common post, liaison, scouting and wire laying.

The Dynatrac's swimming ability permits it to cross inland water bodies without special preparation. It will operate at high altitudes and under conditions of driving rain, snow or dust and in temperatures ranging from  $-65^{\circ}\text{F}$  to  $+115^{\circ}\text{F}$  ( $-54^{\circ}\text{C}$  to  $+46^{\circ}\text{C}$ ).

The Dynatrac's exceptional off-road performance is largely the result of a combination of the following unique features: **LOW GROUND PRESSURE**—The fully loaded vehicle has a mean ground pressure, at no sinkage, of about 2 pounds per square inch reducing to about 1.5 pounds per square inch at 4" sinkage. This has been achieved by the maximum use of low density, high strength materials. **HIGH TRACTIVE EFFORT**—A high tractive effort to gross weight ratio of greater than 1:1 is obtained by the use of a high performance engine, suitable gear ratios, and low structural weight. The vehicle can negotiate steep slopes or pull heavy loads with equal ease. **ALL TRACKS POWERED**—Each track of each unit is powered by the engine in the front unit. Over ridges, in ditches, in mud or deep snow, regardless of carrier attitude, optimum tractive effort is produced. Linked hulls prevent “nose high” trim when the Dynatrac is underway, thereby maintaining full traction. **ARTICULATED STEERING**—By using hydraulic actuators to deflect one unit in relation to the other, steering forces are kept within the structure and are not transmitted to the ground. This reduces “bog-down” hazard, a major disadvantage of conventional tracked vehicles when operating in swampy areas.

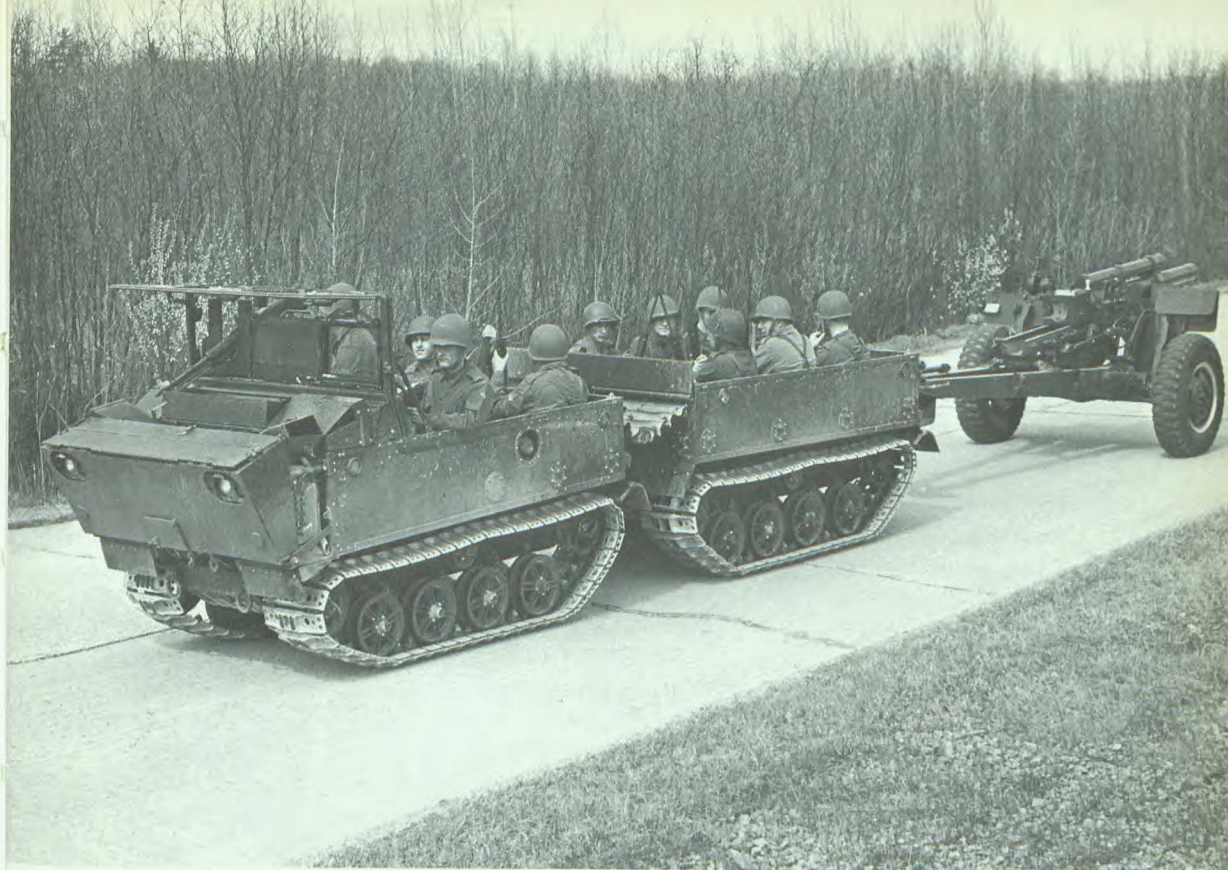
Whenever required, the front unit may be operated alone. In this case, steering of the unit is accomplished by a conventional clutch-brake system. Front and rear units can be separated or connected in less than two minutes without special tools.

The Dynatrac, with full payload, is transportable by medium helicopter. In addition, the front and the rear units with their respective payloads are individually transportable by light helicopter.

The Dynatrac's design permits the addition of a third articulated unit which is powered in the same way as the second unit. The third unit will carry a 1500 pound (680 kg) payload, increasing the vehicle's carrying capacity to a total of 3,500 pounds (1590 kg) plus driver and co-driver. With three units connected, the Dynatrac retains its high off-road mobility and its performance is virtually unaffected under normal cross-country conditions.

Economy of operation, ease of maintenance and reliability have been designed into the Canadair Dynatrac making it one of the most versatile and highly mobile vehicles in its class today.







## AIRFIELD FOAM CRASH TRUCK—MARK 9B

This Foam Crash Truck designed by Pyrene Manufacturing to carry a fire fighting crew of five with their equipment, with utmost speed over rough or improved terrain. In the event of a fire, foam can be discharged immediately, through the turret, on arrival at the scene. The crash truck comprises a 6 x 6 L.H.D. chassis powered by a V.8 gasoline engine developing 330 B.H.P., a water tank, foam tank, and high expansion foam making equipment, allowing full foam production when the vehicle is moving at any speed.

The foam-making equipment consists of variable flow generator/inductor assembly, coupled to an air blower and centrifugal fire pump. These are driven by a V.8, 534 cubic inch gasoline engine. The engine, the blower and the pump are transversely mounted at the rear of the vehicle. The engine compartment is enclosed by a removable light alloy-cover. The 833 Imperial gallon (379 lit.) capacity water tank is connected to the fire pump and the foam tank to the variable 'round-the-pump' inductor.

The generator discharges foam at a nominal expansion ratio of 12:1 through the turret and through two handlines simultaneously or independently as required. The handlines are located in lockers, immediately aft of the crew compartment and consist of 60 ft. (18.3 m) lengths of 4 inch (10.2 cm) foam hose to which are coupled foam nozzles with spray/jet equipment. All the controls for the production and discharge of foam are located within reach of the driver. The turret is designed to discharge at two outputs; when set to the "HIGH" range it is capable of discharging 5000 gallons (2273 lit) per minute. Operating with the turret set in the "LOW" output range, discharge from the turret is reduced to approximately 2500 gallons (1136 lit) per minute, but either one or two 60 ft. handlines can be used simultaneously.

Ground sweep nozzles are installed at the front of the vehicle to provide a foam coverage immediately in front of, and the full width of, the vehicle. Additional foam nozzles are fitted in the wheel arches to provide protection for the tires. Twenty-six of these Mark 9B Airfield Crash Trucks were manufactured for the Royal Canadian Air Force, and are presently in service at bases throughout Canada.





## AIRFIELD FOAM CRASH TRUCK—MARK II

The Mark 11 Airfield Crash Truck was designed to combat fires at the smaller domestic airfields in the Dominion of Canada. Emphasis was placed on "One Man Operation" throughout and a simplified air aspirated foam system incorporating the basic characteristics of foam produced by the larger trucks has been employed.

Total foam output is 2500 Imperial gallons (11,365 lit.) per minute through the cab mounted turret and 1440 Imperial gallons (6550 lit.) per minute through the 2½" handline. A Mark 6F fire pump is coupled to the 400 Imperial gallon (1800 lit.) aluminum water tank. A 60 Imperial gallon (272 lit.) foam concentrate tank is fitted together with a round the pump inductor system.

Provision is made to allow the truck to be used as a standard fire engine taking water from the tank or external pressure sources to deal with class "A" (domestic) fires. Seventeen of these Mark 11 vehicles have been supplied to date to the Canadian Department of Transport for use at airfields in the more remote regions of Canada.





## AIRPORT AMPHIBIOUS CRASH AND RESCUE VEHICLE

Canadian developed off-road vehicles have been successfully adapted to a wide variety of roles and environments. Typical of such adaptation is the Amphibious Airport Crash and Rescue Vehicle developed from the Bombardier Musket Tractor. Known as the "Red Angel" this vehicle was designed for operation on and around airfields located near marshes, shallow water areas and tidal flats.

With a ground speed of 25 MPH (40 km) and a water speed of 10 MPH (16 km) the vehicle can reach downed aircraft regardless of the position of crash. The floatation chambers, dimensional stability and snorkel type engine air inlets allow operation in waves and breakers up to four feet in height. The vehicle's high permissible payload of 5 tons enhances its rescue capability and permits the carriage of a variety of fire-fighting and salvage equipment.

Engine (Land)	— 190 HP
Engine (Water)	— 20 HP Vicars Hydraulic
Ground Speed	— 25 MPH (40 km)
Water Speed	— 10 MPH (16 km)
Payload	— 5 Tons



## AIRFIELD SWEEPERS

With the advent of jet engines the presence of foreign objects on airfield surfaces has become an even greater problem and cause for concern than before. Damage to aircraft and airfield fixtures continues to mount where adequate protection is not provided to meet these new conditions.

The Sicard SW-112 Airport Sweeper was developed in co-operation with military and civilian airport equipment engineers and is used by numerous international airports throughout the world. The brush-blower combination cleans up to 1,000,000 square feet (92,899 sq. m.) of runway per hour at a speed up to 25 mph (40 Km/hr). The brush will clear the finest sand or 15 pound (6 kgs) rock with equal ease. The unit operates twelve months a year, in snow, slush, water and all weather conditions. It is equipped with a dependable 230 H.P. V-8 gasoline engine.

The brush and blower are fully adjustable to eliminate dead runs and match local conditions. The heavy-duty steel brush revolves at 400 R.P.M. The blower develops approximately 6,000 cu. ft/m. The air velocity at the nozzle is about 225 mph (365 Km/hr.). A solenoid remote control box allows the driver of the towing vehicle to operate the sweeper from his cab. All hydraulic controls are duplicated manually on the sweeper for emergency use.

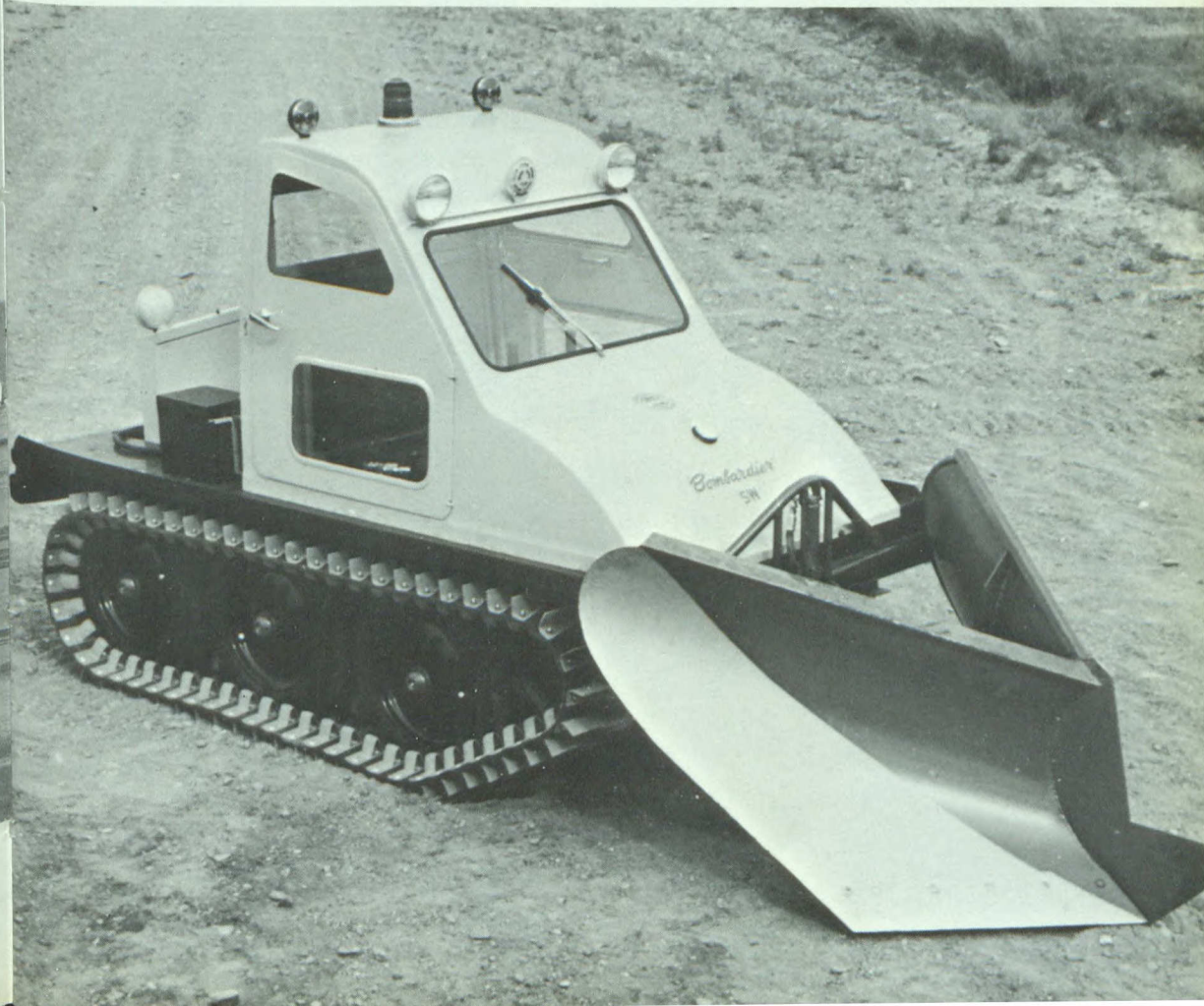




## SNOWPLOWS

The compact Bombardier SW is only 48 inches (1.2 m) wide but is capable of snow clearance with V-plow, one-way plow or pusher blade. It is easy to operate, has excellent all-round visibility and is equipped with a warm, comfortable cab. Originally designed as a side-walk plow, it has been used extensively in camp sites and other limited access area.

It has a top speed of 25 mph (40 Km/hr). Tracks are 5" (12.7 cm) rubber belts with heavy duty steel cross-links. The suspension and track system is the standard Bombardier principle which has been proven through more than 75 years service.





## SNOWBLOWERS

The Snowmaster, manufactured by Sicard Inc., is the result of 25 years of development under the severe weather conditions that plague Canadian cities and airports. It is designed to operate efficiently under any snow condition, using augers to pulverize hardened snow or ice before feeding them to the impeller. Using its powerful turbine, the Snowmaster casts 200 feet (61m) and more — spreads snow away from runway shoulders — reduces risk of backdrift — prevents accumulation that can endanger underslung engines and wingtips.

Snowmaster's high-powered diesel and gasoline engines — turbo-charged or naturally aspirated — are built to operate at full load under most severe conditions. The Snowmaster is available in various sizes and capacities from 5 to 60 tons (4.5 to 54.4 metric tons) of snow per minute.

Small detachable type units can be installed on suitable commercial or industrial tractors whereas all high-powered units are normally installed on heavy duty all-wheel drive Sicard trucks.

Sicard provides an operational training program whereby Sicard's field men visit areas throughout the world to train personnel on operation and servicing of their equipment.

This company also manufactures: Refuse collectors; Street sweepers; Highway tractors and mine and quarry trucks.



## TRACKED CARRIERS—BOMBARDIER

Bombardier offer a variety of models of the type illustrated, using the same basic vehicle, and each incorporating special features required by the particular application.

With double width tracks and greater flotation, the vehicle can carry payloads of 6,000 lbs. over rough terrain, soft soil and through swamps. The 125 HP engine gives plenty of reserve power for high gear operation over tough terrain.

The standard but unique Bombardier flexible suspension is incorporated in the vehicle and speeds of up to 25 MPH are attainable. Unloaded ground pressure is around 1.0 p.s.i., the total weight of vehicle varying from 4000 to 6000 lbs. (1814 to 2721 kg) dependent upon the role for which it is designed.

Some of these roles are:—

*Safari* — Light personnel carrier, capable of carrying driver and six passengers and having a loaded ground pressure of less than 1.5 p.s.i. (0.1 km/cm<sup>2</sup>).

*Muskeg Carrier* — an all purpose carrier, fitted with cab and used for transportation of men, materials and equipment over snow, ice and the softest soil.

*Muskeg Tractor* — Shown in the illustration. Can be adapted for fire-fighting, logging, ski-slopes, as a dozer, grader, back hoe and many other applications. As an option, a 190 HP — V8 engine is supplied, and an 11 ft. tracked tractor is also available.

*J5 Tractor* — This is a smaller version (only 3 roadwheels instead of 4) and is illustrated on the opposite page. Versatility is the keynote of this model, which is ideal for logging, ranching, recreation, fire-fighting, conservation, construction, snow removal, transmission, pipe line work, etc. A small tracked trailer is available.

*RAM Skidder* — This is similar to the J5 but is also equipped with 10,000 lbs. (4536 kg) winch and hydraulic dumping platform.

All these vehicles are stock production items and are in current use in 32 different countries.

*Terrain Master* — The heaviest of the Bombardier line. This is an articulated four-track vehicle having an 8-ton payload. Both gasoline and diesel powered versions are available.





## TRACKED CARRIERS—FOREMOST

FOREMOST TRACKED VEHICLES LTD. over the past four years has developed a complete line of off-road tracked carriers ranging in rated load capacity from two (2) tons to thirty (30) tons. The vehicles have gained acceptance in many areas due to their tremendous versatility.

All FOREMOST units are four track units with a general configuration similar to a truck, that is engines and transmissions are located at the front on the main frame with a standard truck type cab, either in the tilt cab arrangement or in the standard cab arrangement as shown on the illustrations. All units incorporate full power hydraulic steering which enables the machines to steer under any conditions with minimal driver effort. The main frame behind the cab is of standard automotive truck dimensions so that any loads or items which can be mounted on trucks can similarly be mounted on these vehicles.

All FOREMOST units are capable of climbing 65% forward slopes and handling 50% side slopes. Ground pressure is kept at a minimum through the use of extra wide rubber and steel tracks and mobility through swamps is increased through the use of front idlers.

Many options are available in all sized units. These include: gasoline and diesel engines in several horsepower ratings; synchromesh, powershift and automatic transmissions; 3 Man Cabs, 6 Man Cabs and full personnel bodies; flat decks with or without live rolls; cab heaters and block heaters; heavy duty tracks for rock or stump usage; front and rear winches; long wheel base for extra long loads; grill guards; escape hatch; snow and ice cleats; and cold weather operational aids. Many additional options are available at the users request.

Listed below are basic specifications of seven FOREMOST models:

Model No.	Payload	G. V. W.	(at 6" penetration) Ground Pressure Loaded	Top Speed
Spider	1,200 lbs. (544 kg.)	3,050 lbs. (1,384 kg.)	0.68 psi	16 mph. (25.7 km/hr.)
S-100	4,000 lbs. (1,814 kg.)	16,800 lbs. (7,620 kg.)	1.9 psi	16 mph. (25.7 km/hr.)
S-200	6,000 lbs. (2,721 kg.)	20,300 lbs. (9,208 kg.)	1.8 psi	16 mph. (25.7 km/hr.)
6 T	12,000 lbs. (5,443 kg.)	32,000 lbs. (14,515 kg.)	2.5 psi	14 mph. (22.5 km/hr.)
8 T	16,000 lbs. (7,257 kg.)	40,000 lbs. (18,144 kg.)	2.3 psi	14 mph. (22.5 km/hr.)
10 T	20,000 lbs. (9,072 kg.)	48,500 lbs. (22,000 kg.)	2.2 psi	12 mph. (19.3 km/hr.)
12 T	24,000 lbs. (10,886 kg.)	58,000 lbs. (26,309 kg.)	2.1 psi	12 mph. (19.3 km/hr.)
30 T	60,000 lbs. (27,216 kg.)	144,500 lbs. (65,545 kg.)	4.1 psi	14 mph. (22.5 km/hr.)







## TRACKED CARRIERS—FLEXTRACK-NODWELL

Flextrack-Nodwell produce a product line of low ground pressure tracked carriers with payloads ranging from less than one ton up to thirty tons. With full loads each carrier can negotiate slopes in excess of 60% and are safe on side hills of 30% or greater. Flextrack-Nodwell have design facilities to manufacture tracked carriers to meet most all off-highway needs.

The basic carriers are built either with two tracks and controlled differential steering or with four tracks and hydraulic wagon type steering. Either coil torsion spring suspensions or walking beam suspension is available in the various models, each designed to meet particular ground conditions.

Diesel power is standard in the larger 20 and 30 ton payload models and gasoline is standard with diesel as an option in the smaller models.

With spring steel grouser bars and flexible track belt or rayon/nylon or nylon from 4 to 7 plys, track life has been experienced in excess of 3000 hours. To complement this, special options of mud and snow cleats, ice picks, side hill cleats and reinforcing bars, are available as options to meet the varying conditions to improve performance.

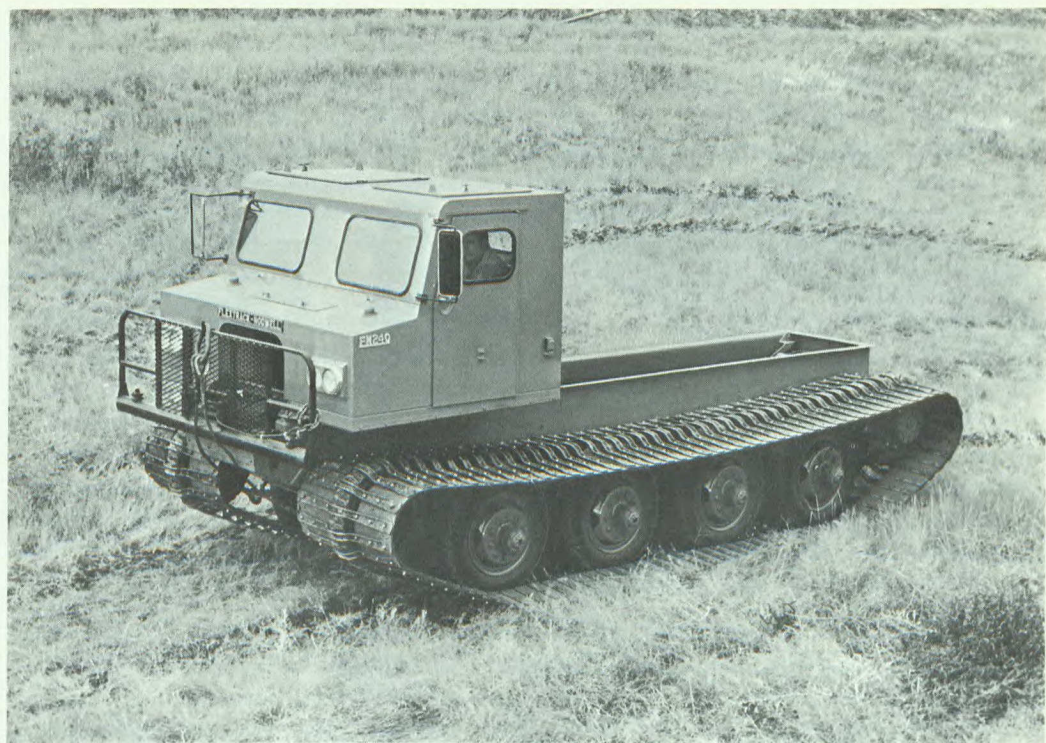
Body designs are available with only engine cowl, etc., open one and two man cabs, closed two man cabs, crew cabs or fully closed bodies for personnel, or supplies. Standard type decks designed for the rated payloads are optional, and if required rear winches and/or gin poles and dead or live rolls are available.

The company produces three basic lines which are as follows:

- (i) The Lightweights which have proven to be ideal for utility companies in service and general survey roles;
- (ii) The Mediumweights, which are in general workhorses of the line and may be equipped as personnel and logistics carriers, recovery vehicles, tankers, crash rescue vehicles, fire-fighting units and amphibious carriers which will find a wide variety of uses particularly with respect to military employment.
- (iii) The Heavyweights, which are the large diesel powered four-track vehicles with a long and successful history in the north, have particular application in the transportation of heavy bridging units and construction equipment; despite such heavy loads these vehicles maintain a ground pressure of less than 4 p.s.i.

Flextrack-Nodwell can equip a tracked carrier to meet the majority of custom demands where an off-highway vehicle is the requirement. These requirements may range from light survey units to artillery tractors and engineering equipment prime movements.

Today, Flextrack-Nodwell vehicles are active in Holland, Gabon, Pakistan, South America, Australia, in most states of the U.S.A., including hundreds in Alaska, and Canada, with ground pressures as low as ½ pound per square inch for deep mountain snow, and up to 3 pounds per square inch carrying rated payloads, this equipment negotiates snow, mud, sand, and muskeg with ease.



## TRACKED CARRIERS—GO-TRACT

The Go-Tract series of General Purpose Tracked Vehicles are designed to provide mobility over a wider range of terrain conditions than was hitherto available from vehicles using conventional pin and belt tracks. To meet this requirement it was necessary to develop a new track and suspension system. This system is now developed, has been in service for several years, provides a high degree of reliability, requires minimal maintenance and can be repaired in the field with simple tools.

The Go-Tract track eliminates the pin, and the belt. Each pitch is made up of three elements, a flexible unit, a guide plate and a grouser. The track components are bolted together and interlock to form a continuous track unit. The heaviest track component weighs only 10 lbs (4.5 kg), but the track has a tensile strength of 105,000 lbs. (47,628 kg). This simple construction enables a new track element to be fitted in the field using a cold chisel and hammer to remove the nuts, and a wrench to assemble. The most elementary tooling will suffice to draw the ends of the track together, as the compensating idler system allows the track to become slack when the engine is stopped.

To reduce suspension system maintenance and failure, steel springs and torsion bars have also been eliminated. They have been replaced by a system utilising a hollow rubber spring system. The system performs satisfactorily at  $-60^{\circ}\text{F}$  ( $-51^{\circ}\text{C}$ .) and provides an excellent ride particularly in the fully laden state, but minimizes loss of the 18" (45.7 cm) ground clearance when the vehicle is loaded.

Today Go-Tract vehicles are fulfilling a wide variety of uses. Apart from freight carriers they are equipped with many types of manipulative equipment — cranes, back-hoes, earth borers, oil drills, compressors, pole erectors, gin poles (up to 72 ft. (21.9 m) with appropriate winches), grapples etc.

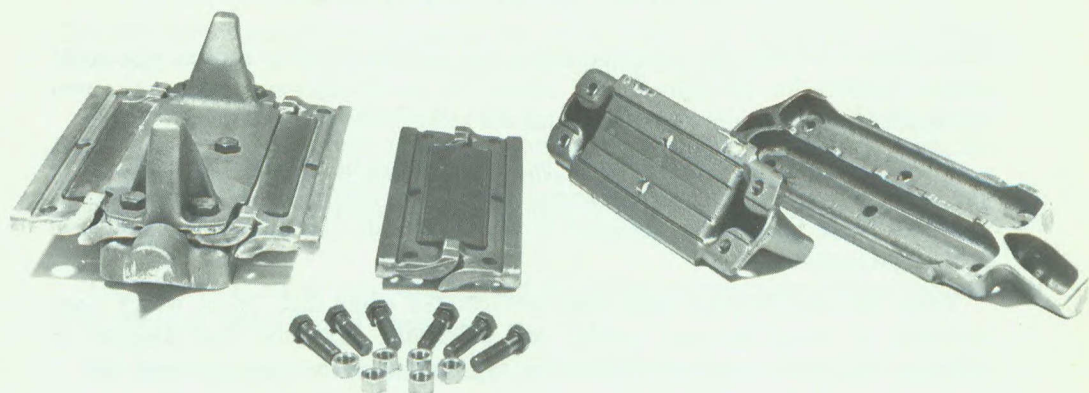
The GT120 and 220 chassis are also offered with maximum speed capabilities of 28, 34 and 40 mph (45, 54.7 & 64.4 km/hr) for airport fire-fighting. Several vehicles are now fulfilling this role.

Go-Tract vehicles are supplied in three basic designs:

Model	Vehicle Weight	G.V.W.	Gradeability	Side Slope Performance	Speed
GT120	16,500 (7484 kg)	32,000 (14,515 kg)	60%	40%	15 (24 km/hr)
GT220	18,500 (8191 kg)	32,500 (14,739 kg)	60%	40%	15 (24 km/hr)
GT620*	23,500 (10,659 kg)	39,500 (17,917 kg)	60%	40%	14 (22.5 km/hr) (either direction)

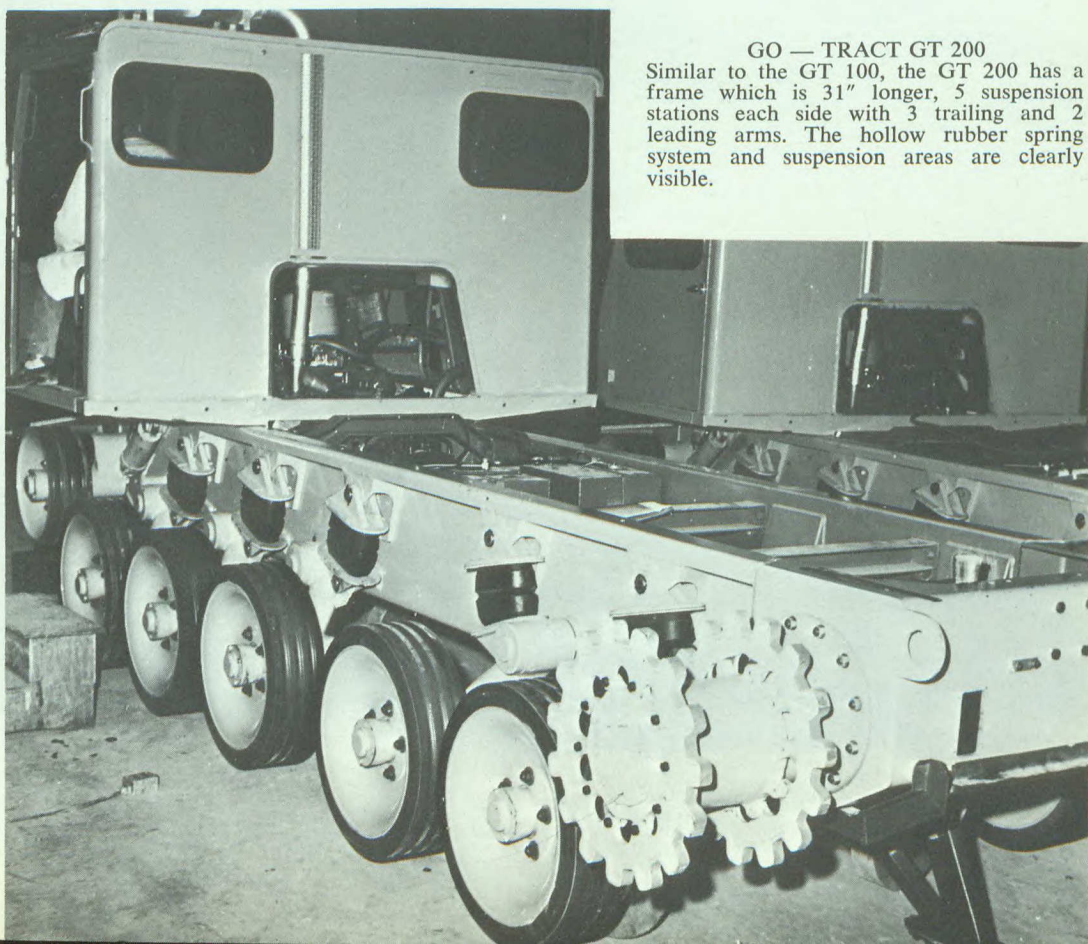
The basic GT620 is 128" (3.3 m) wide, and is designed to carry low density products such as bulk supplies, prefabricated structures and bridging components and also to provide a wider base and greater stability for cranes and other manipulative equipment.





#### GO — TRACT GT 200

Similar to the GT 100, the GT 200 has a frame which is 31" longer, 5 suspension stations each side with 3 trailing and 2 leading arms. The hollow rubber spring system and suspension areas are clearly visible.

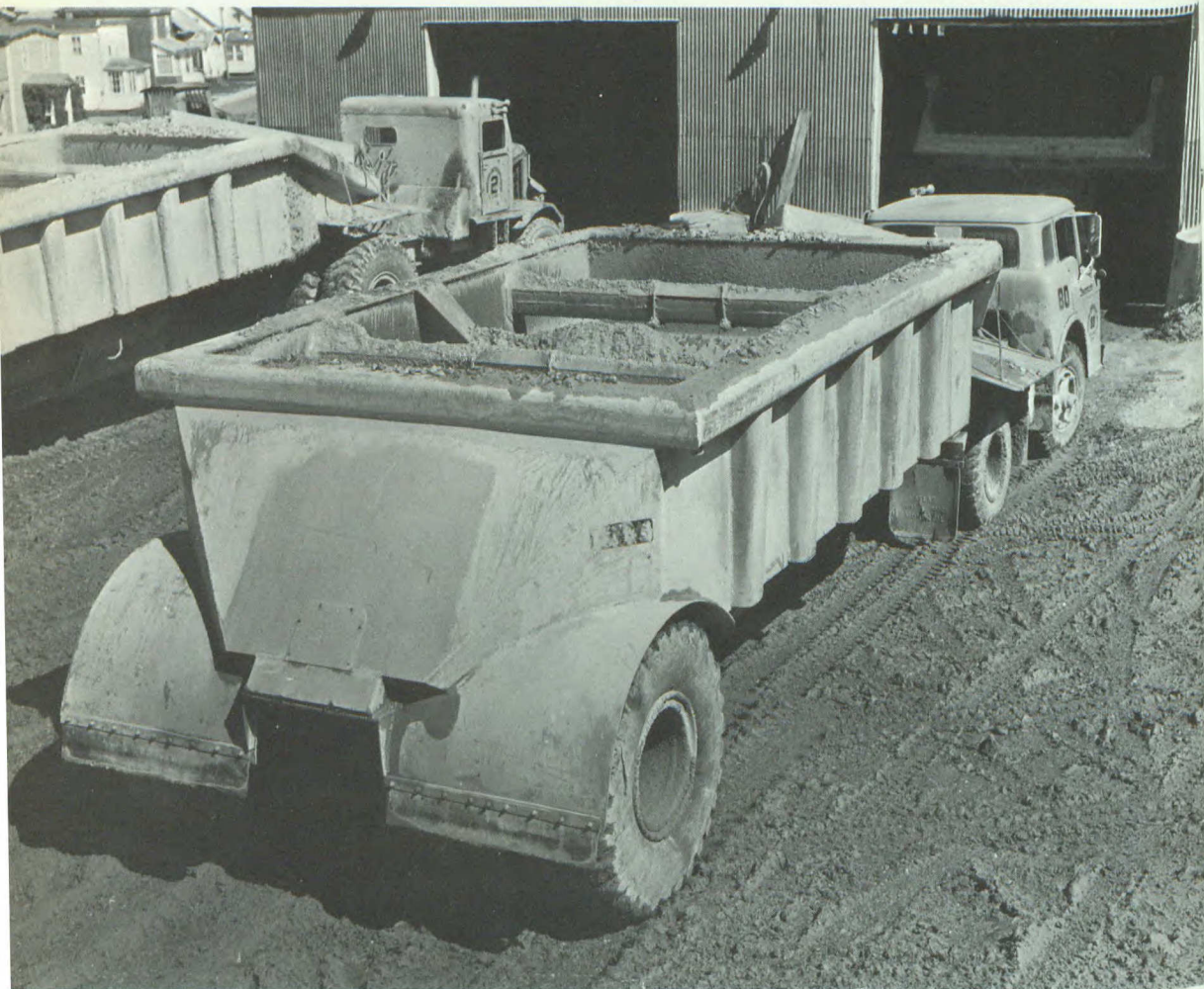


## HEAVY-DUTY CONSTRUCTION VEHICLES BOTTOM DUMP TRAILERS

Atlas Hoist and Body Inc. manufactures a line of bottom dump trailers with some models suitable for off-highway and others for on-off-highway. Depending upon the application, these units are fabricated for either steel or aluminum.

They are designed to be hauled by any make of on or off-highway tractor, and are manufactured in payload capacities up to 120 tons. Where highway use is involved, these trailers are designed to operate within the required dimensional and weight limitations.

There are twin hopper units with air-operated clam shell doors which open smoothly to dump the load quickly and efficiently. With the load dropped in winrows, the grader can quickly level the aggregate to form a smooth road bed.





## HEAVY-DUTY CONSTRUCTION VEHICLES REAR DUMP TRAILER

The rear dump trailers manufactured by Atlas Hoist and Body Inc. have been developed for use in heavy construction and mining operations.

Payload capacities vary from 30 tons to 65 tons (20 cu. yds. to 40 cu. yds.), each trailer being designed to suit a specific application. Depending upon the application, they are fabricated of either ultra-high strength, heat-treated steel or of aluminum. They can be coupled to all makes of rubber-tired tractors and operate as integrated units.

The wide body offers easy loading, and the robust construction permits the unit to be operated under rugged conditions.

The single axle on the trailer makes it possible to turn on a road bed of less than 36 feet (10.9 m) but the vehicle is also capable of relatively high road speeds.





## REFUSE SYSTEMS

With the increasing emphasis on the curbing of pollution in all its forms the efficient handling of refuse at military bases may present a variety of problems if a systems concept is not envisaged. With logistic and financial considerations as the guiding parameters Atlas Hoist & Body have designed and produced such a system.

In large refuse producing areas such as military stations normal collection methods may meet to-day's standards but they will certainly not equal to-morrow's demands.

One system to meet such demands is considered below.

Stationary compactors in sizes of  $\frac{3}{4}$  cubic yards,  $1\frac{1}{4}$  cubic yards or 2 cubic yards for stationary installation at military bases and industrial plants. The material is dropped into a hopper and the compacting operation is automatic. Electric push button cycles the unit to compress, return and stop automatically and allows the unit to operate continuously while refuse is being compacted. The compactor forces refuse into containers to ensure that the container handles the maximum amount of refuse. The container can then be detached and loaded by means of a roll-off hoist.

Closed containers, from 1 cubic yard to 42 cubic yards, can be loaded by either the rear loader packer or the roll-off hoist manufactured by Atlas. These allow sanitary collection of refuse at the location as well as ease of handling and loading onto the hauling equipment.

The Roll-Off Hoist is designed to load and unload containers and operate by means of two (2) double acting hydraulic cylinders which tilt the frame rails, after which a cable is attached to the container and the hydraulically operated winch pulls the container onto the sills, which are then lowered to allow normal vehicle operations. Dumping a trailer is very simple, since the same hydraulic cylinders tilt the sill and body so that the material is unloaded at either an incinerator, or, a sanitary land fill.

Another major problem which has reared its head is that of dumping sites. Land fills are becoming rarer in major metropolitan areas and refuse must be hauled longer distances. The solution to this problem is the establishment of a terminal equipped with larger, 6 cubic yards to 10 cubic yards, stationary compactors which can load and compact the material into semi-trailers which would be hauled by means of standard highway tractors to the long distance land-fill sites.

Atlas has designed a 75 cubic yard, compactor/ejector trailer with both top loading and rear-loading available. Material is either loaded through the top by means of front end loaders, or, dumped directly from vehicles, or, can be loaded by means of the 6 to 10 cubic yards stationary compactors in the terminal. This allows a maximum amount of refuse to be hauled at legal payloads for the longer distances.

Atlas Hoist & Body also produce a line of standard and custom bulk movers for the construction trade in both on and off highway applications. For further information please see pages 322 and 323.



The Roll-Off hoist which makes the scheduled and pre-packaged collection of refuse not only economical but well within contamination limits.

## FLOATER HOSE

Floater Hose was developed by Uniroyal to help solve the problem of fuel supply to and from areas without port facilities where tankers and barges have to load and unload fuel while at anchor.

With Floater Hose, drum deliveries can be converted to bulk handling in areas where the small volume of petroleum products consumed justify expensive undersea lines, submarine hose, mooring facilities and attendant cathodic protection. Heavy coupled lengths of suction and discharge hose, which require empty drums for flotation can be eliminated by using this type of hose.

With long lengths of hose to eliminate metal connections and a specific gravity less than water to eliminate metal drums, Floater Hose can be handled readily. The hose is collapsible for coiling and retrieving on mechanical steel reels. It is light yet strong enough to withstand the pull and drag of wave movements, as well as internal pressures, and floats when filled with petroleum products having specific gravities less than 0.92.

The hose can be used in temperatures as low as -40F (-40C) while handling oil products, petroleum fuels, jet fuels, as well as high octane mixtures. Special features can be built in for the handling of L.P.G.

It is constructed of NBR inner tube for resistance to all commercial fuels: two or four layers of spirally applied synthetic cord plies for strength, lightness and extreme flexibility; a neoprene outer cover for good wearing and weathering qualities; and an anti-static wire to assure proper dissipation of static electricity. Various other tube compounds can be furnished to handle other materials. Every length of Uniroyal Floater Hose is hydro-statically tested before leaving the factory. It is manufactured in continuous unspliced lengths up to 650 feet (198 M) thus allowing storage on reels either near the storage tanks or on the fueling vessels.

The company will supply various couplings as required.

SIZE	PLIES	APPROX. O.D.	APPROX. WT. PER FT.	WORKING PRESSURE
2"	2	2½"	1.0	200
2"	4	2¾"	1.4	400
2½"	2	3"	1.4	200
3"	2	3½"	1.5	150
3"	4	3¾"	2.0	275
4"	2	4½"	1.9	125
4"	4	4¾"	2.6	200
5"	2	5½"	2.3	100
6"	2	6½"	2.8	75
6"	4	6¾"	3.7	150





## REFRIGERATION AND HEATING UNIT

Developed by Galt Equipment Limited this unit is for the movement of perishable cargo in containers. The unit was proven in service, operating on railroad and on deck of ocean-going vessels in the North Atlantic.

The Galt Thermotrol Model 200A is a completely packaged self-contained unit powered by a diesel engine. It features direct compressor drive via magnetic clutch and a hydraulic fan drive for condensor and evaporator fans. Both cooling and heating are automatically applied as required to maintain set temperature against variable ambient temperatures.

Defrosting of cooling coil is automatic, initiated by static pressure differential switch sensing air resistance of the cooling coil and temperature terminated by a remote bulb actuator sensing the coil temperature. Manual overrides are provided for manual operation of defrost system.

The complete unit is readily detachable and may be exchanged with same of other model units in minutes for purpose of repair, preventative maintenance or application of other purpose equipment. When detached the unit does not expose the interior of the container other than the two openings for supply and return air. Those openings may be suitably protected by screens or bars to prevent unwanted access to cargo. Construction of the unit is substantially in aluminum and weight is kept to a minimum.

Single cylinder four cycle diesel engine of 10 H.P. at 2,700 RPM continuous output ("A to DIN 6270). Deutz FIL 410. Engine is fitted with fuel lift-pump, electric starting gear of heavy duty capacity for cold weather starting. Heavy duty generator and voltage regulator, extended oil sump and remote lub-oil make-up tank, automatic lub-oil make-up pump maintaining proper oil level in crankcase. Engine can operate safely for 15 days, without adding lub-oil.

### Specifications

AIR Standard rating 516-60, Group  
IVR-22, 8.52 T.R.

Two cylinders  
Bore: 2½" Stroke: 2"

Displacement: 880 C.F.H. at 1,350 R.P.M.  
Forced feed lubrication

Maximum speed: 1,750 RPM  
Oil Charge: 5 pints.

Net heating capacity for continuous heating: 6,000 BTU/hr.  
-10F box & 90 ambient (14,000 BTU/hr)  
-20F box & 90 ambient (31,000 BTU/hr) max.

All controls are mounted in water proof enclosure with system ON-OFF Switch on the face of the control box. A Partlow recorder-controller maintains temperature at set point and controls heating or cooling as required automatically. Static pressure initiated temperature terminated Defrost Control.

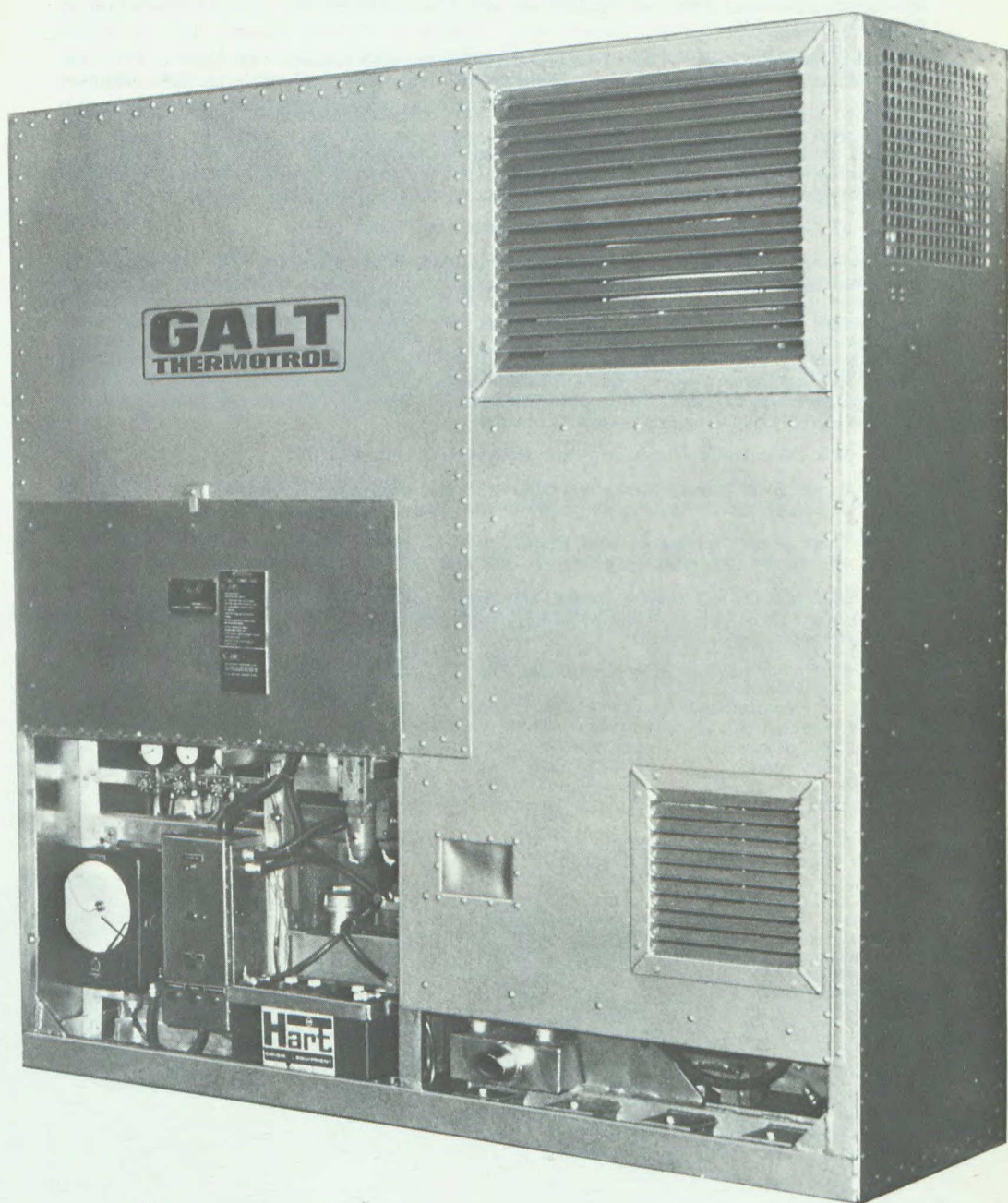
Manual defrost and over-ride switches are located tamper proof, inside control cabinet.

Recording of temperature on 7 or 14 day chart, inkless system, -20 to plus 80F range.

Width: 6 ft. 3½"  
Height: 6 ft. 9"

Depth: 1 ft. 11¾"  
Weight: 1960 lbs. includes totally equipped  
unit except fuel tank.







# RAIN REPELLANTS FOR WINDSHIELDS

A semi-permanent rain repellant for aircraft and automobile windshields has been developed by Canada's National Research Council and has been perfected and put into production by Frank W. Horner Ltd.

The equipment consists of two kits; SPR67 Glass Kit with Glaze — for glass surfaces and SPR67 Glaze — for plastic surfaces, perspex, acrylic, etc. Both kits are in aerosol containers.

**SPR 67 GLAZE** is a combination of waxes and plastics dispersed in a hydrocarbon solvent and is used on any plastic surface and it is simply sprayed on a clean surface and then polished with a clean cloth to form a dependable and durable film. It may also be used as a final protective coating over the repellent film on glass since it prolongs the life of the film considerably.

## **SPR 67 GLASS KIT WITH GLAZE** for glass windshields only:

a) **Pre-cleaner** consisting of water and finely powdered abrasives to wash the windshield. (b) **"Antifreeze" Cleaner** — an aerosol unit containing a mixture of abrasives and disilane compound dispersed in a hydrocarbon solvent. This formulation acts as a repellent surface conditioner. It is used to remove any wax glaze which may be present if this has been used, and prevents any build-up of deteriorated film on reapplication. (c) **Repellent** — an aerosol unit containing the same abrasive agents and disilane compound found in the antifreeze cleaner but in different proportions. (d) **Glaze** — same as the glaze used on plastic windshields. An application of this formulation over the repellent film will increase the durability of the film considerably by acting as a protective coating.

- SPR 67 is entirely invisible when well applied and polished.
- It will form a semi-permanent bond with the windshield surface without altering or damaging the characteristics of Perspex or glass windshields.
- There is no decrease in light transmission, no change in refractive index, and is not affected by temperature cycling of  $-65^{\circ}\text{F}$  to  $300^{\circ}\text{F}$  or speeds up to 700 m.p.h.
- SPR 67 does not require the use of wipers at speeds in excess of 40 m.p.h.  
"Ideal for low-level flight, including takeoff and landing." Also suitable for expressway driving.
- SPR 67 is unaffected by normal de-icing with heat, alcohol or glycol.

Some of the comments by various test agencies are noted below. "The pilot reported that the rain repellent effectively improved visibility. On the windshield with the repellent applied, the rain beaded up into droplets and the areas between the droplets were clear and provided satisfactory visibility. . . . It appears, when regularly applied per the instructions, that SPR 67 is an effective rain repellent and a definite aid to good visibility." North American Rockwell Corporation, Sabreliner Division, Los Angeles, California. (T-39A)

"Inflight performance of the SPR 67 Glaze is excellent. The repellent was tested in very light to heavy rain and afforded excellent visibility. Treated areas appeared as clear sections of an otherwise obscured windshield. The repellent becomes effective immediately after brake release during take-off and is effective down to turn-off speed on landing. Repellent becomes effective at around 40 KIAS." Department of U.S. Air Force, Wright-Patterson Air Force Base, Headquarters Aeronautical Systems Division. (T-38 Test)

"In moderate to heavy rain the aircraft was lost by the GCA Radar due to the precipitation when the aircraft was 5 miles out on the final approach leg. At this point the pilot was instructed to take over visually. Vision was completely obscured thru untreated glass while the runway was clearly visible thru the repellent sections. Visibility was so good that the pilot felt no need to actuate the pneumatic rain removal system. The pilot afterward stated, "If I hadn't had the repellent I would have had to go around." Flight Test Plan/Report ASTDN FTR 68-36.

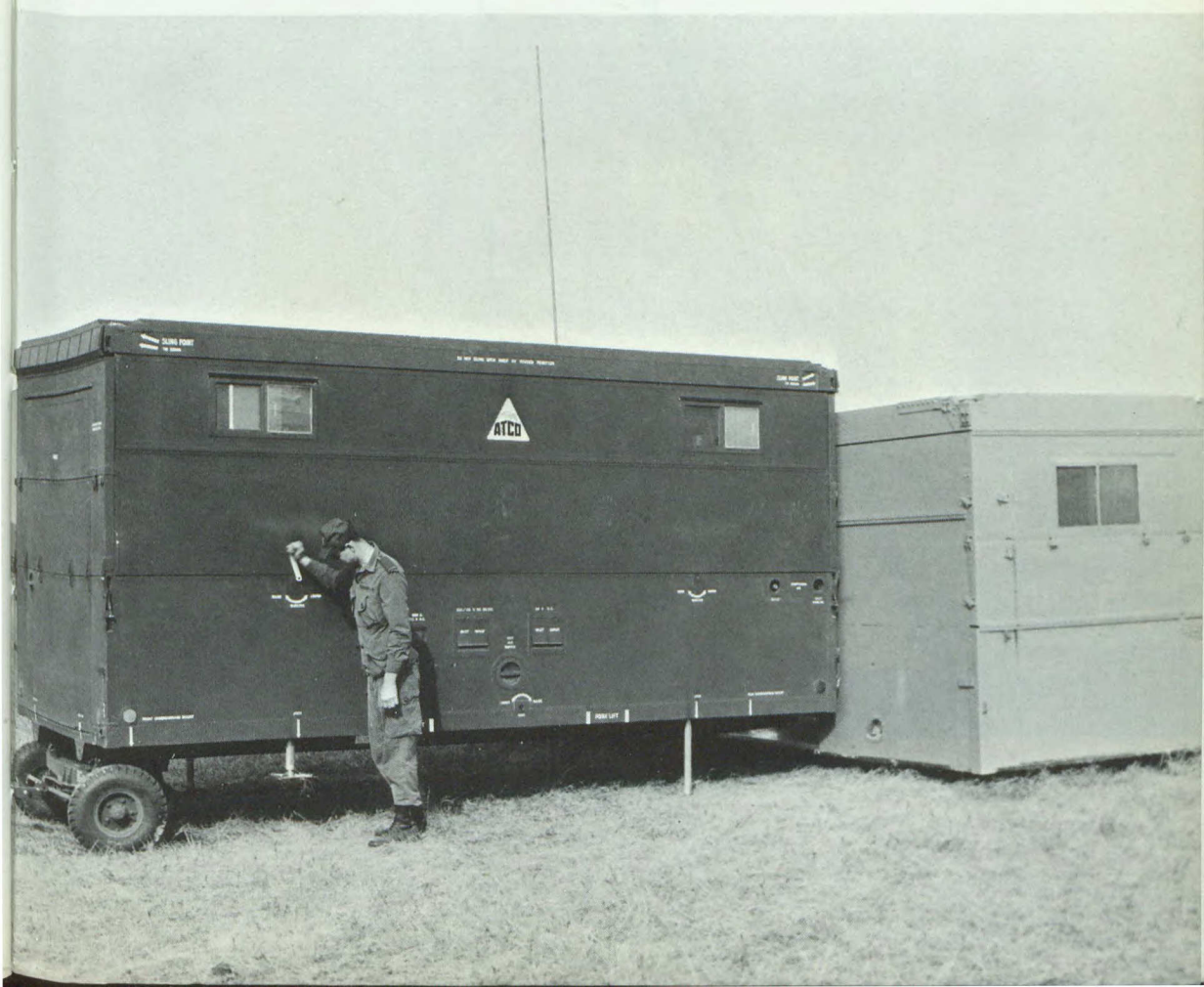
## MILITARY AIR-LIFT BUILDINGS

ATCO Research and Development Center has designed a family of military air-lift buildings. One system, known as A.M.S. (Air-Mobile Shelter) expands vertically by a ratio of 2:1 through a simple cranking procedure. Structure is ultra-lightweight and provides a controlled, dust-free environment under field conditions for such things as repair work on turbine helicopter motors.

A.M.S. is designed primarily for lift as sling load under Bell 204-B or 205 helicopters, as internal load in Hercules aircraft. Removeable mobilizers permit transport as trailer, and built-in skids provide for limited ground movement without mobilizers.

Three-man crew can have unit ready for use in less than 22 minutes, including removal of mobilizers and complete deployment from folded condition.

ATCO's other type of military shelter expands laterally, via unfolding lightweight hinged panels, to increase useful floor area by ratio of 3.1. ATCO shelters can be fitted as bunks, latrines, workshops, or variety of other applications. Shelters can serve individually, or can be coupled as complexes to provide large floor areas.



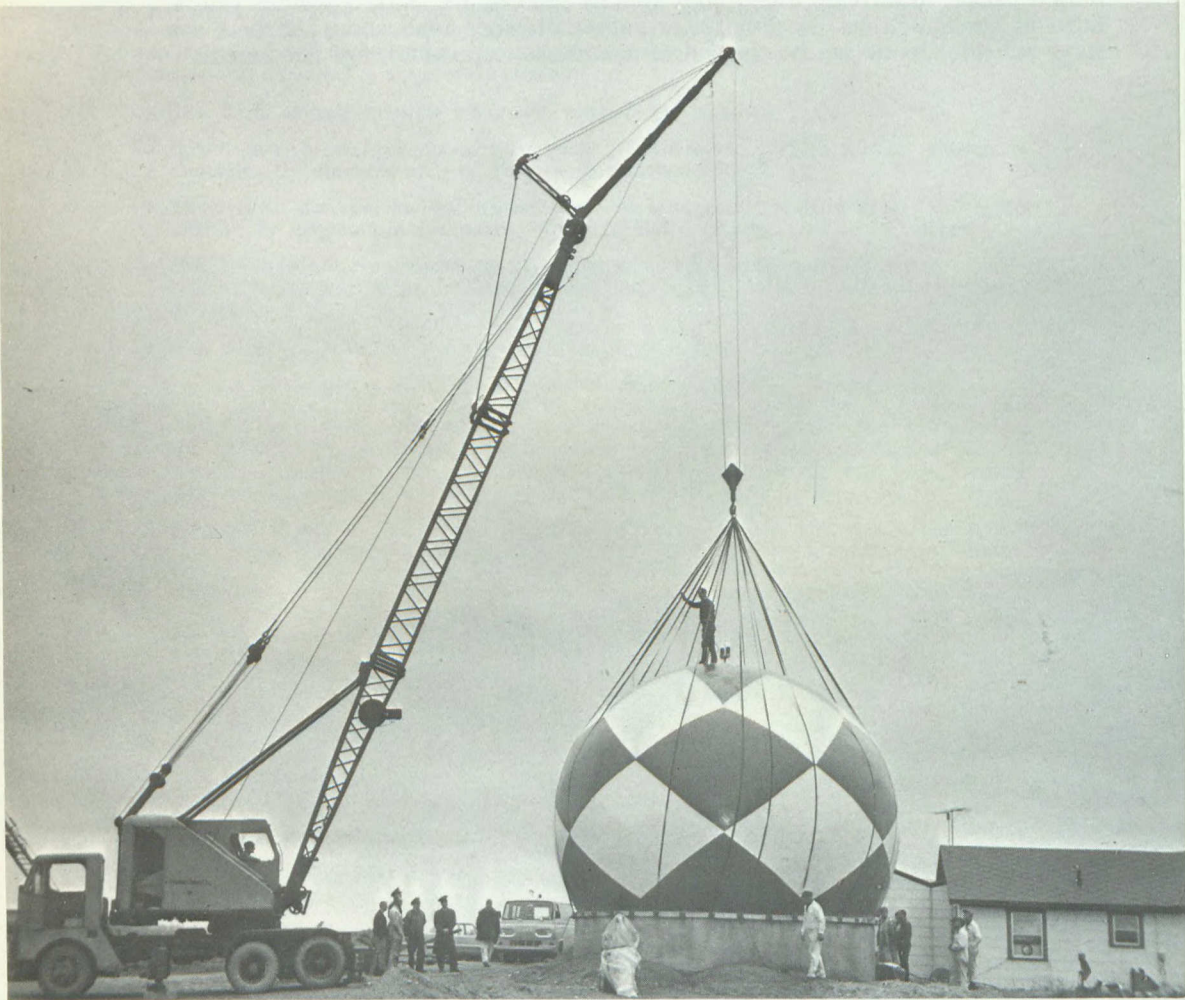


## APPLIED CHEMICAL FOAMS

Polyurethane radomes incorporating the *Foamlock* assembly technique have been in use in Canada for many years, and have withstood the rigours of extreme cold and very hot weather conditions.

Being constructed of polyurethane only — with no metal parts — and uniform foam density throughout — there are no variations in boresight accuracy and transmission losses are in the order of only 1%.

A standard 27 ft. (8 m) diameter radome is manufactured by Applied Chemical Foams Ltd., a wholly owned subsidiary of Spar Aerospace Products Ltd., and are assembled on site, anywhere in the world.





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