See cover story on page 78

electronics and communications

an age publication
SEPTEMBER 1960

Electronics and Communications
CANADIAN EXPORT ISSUE

DESIGN WITH ARNOLD 6T CORES...

SAME-DAY SHIPMENT OF STANDARD DELTAMAX CORE SIZES

Arnold 6T tape cores (aluminum-cased and hermetically-sealed) offer you three very important design advantages. *One:* Maximum compactness, comparable to or exceeding that previously offered only by plastic-cased cores. *Two:* Maximum built-in protection against environmental hazards. *Three:* Require no supplementary insulation prior to winding and can be vacuum impregnated after winding.

Now we've added a fourth vital advantage: Maximum availability. An initial stock of approximately 20,000 Deltamax 1, 2 and 4-mil tape cores in the proposed EIA standard sizes (See AIEE Publication No. 430) is ready on warehouse shelves for your convenience. From this revolving stock, you can get immediate shipment (*the same day order is received*) on cores in quantities from prototype lots to regular production requirements.

Use Arnold 6T cores in your designs for improved performance and reduced cost. They're guaranteed against 1000-volt breakdown . . . guaranteed to meet military test specifications for resistance to vibration and shock . . . guaranteed also to meet military specifications for operating temperatures. The 6T hermetic casing method is extra rigid to protect against strains.

Let us supply *your* requirements. Full data (Bulletin TC-101A and Supplements) on request. • Write *The Arnold Engineering Company, Main Office and Plant, Marengo, Ill.*

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CANADIAN Representatives: Bayly Engineering Ltd., First St., Ajax, Ont. Telephone (Toronto Exchange) EMpire 2-3741

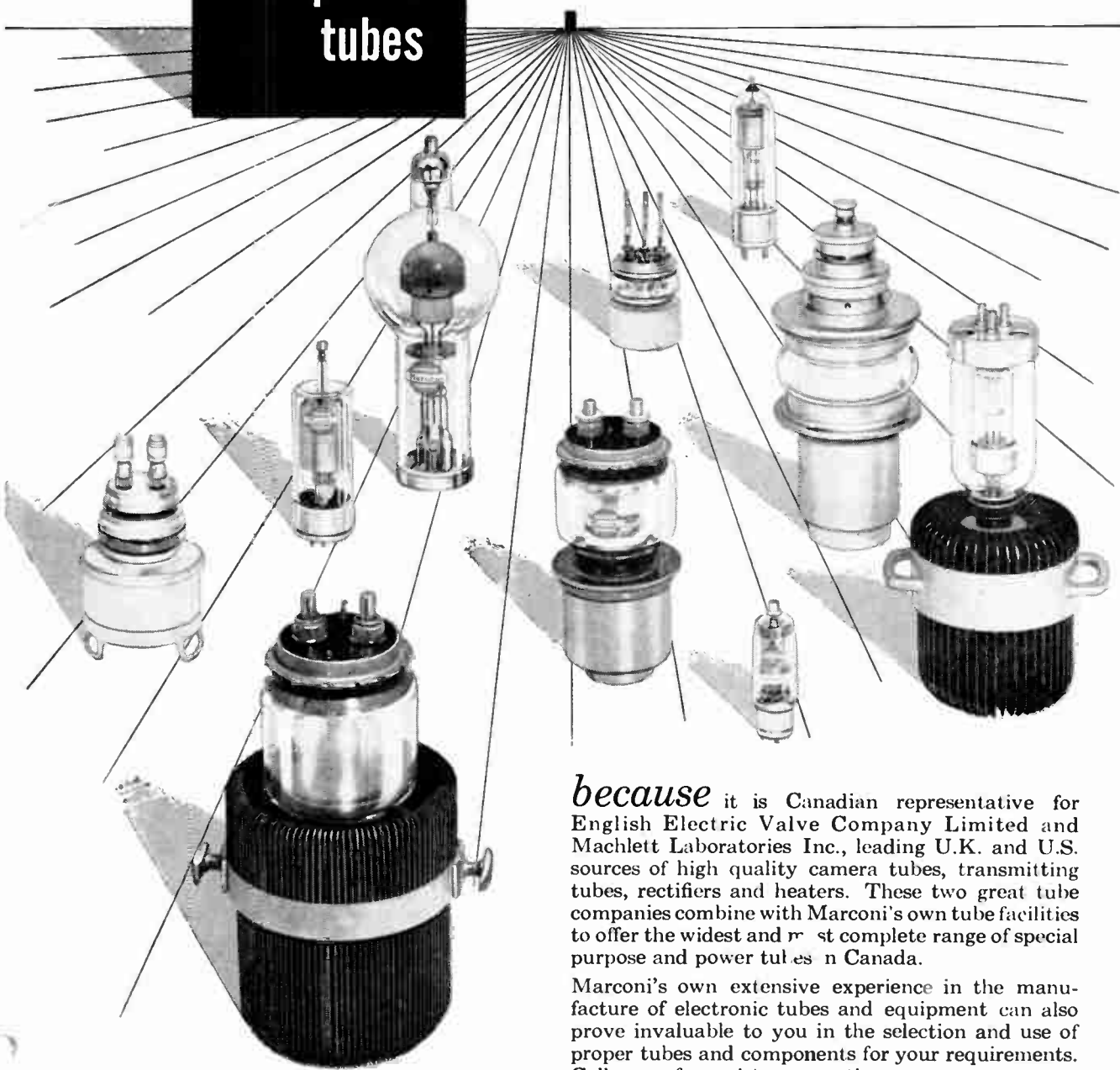
1539

READY TO ROLL! RIGHT FROM STOCK

For complete details check No. 4 on handy card, page 73

special purpose and power tubes

Why has Canadian Marconi the widest range?



because it is Canadian representative for English Electric Valve Company Limited and Machlett Laboratories Inc., leading U.K. and U.S. sources of high quality camera tubes, transmitting tubes, rectifiers and heaters. These two great tube companies combine with Marconi's own tube facilities to offer the widest and most complete range of special purpose and power tubes in Canada.

Marconi's own extensive experience in the manufacture of electronic tubes and equipment can also prove invaluable to you in the selection and use of proper tubes and components for your requirements. Call on us for assistance anytime.

ELECTRONIC TUBE AND COMPONENTS DIVISION

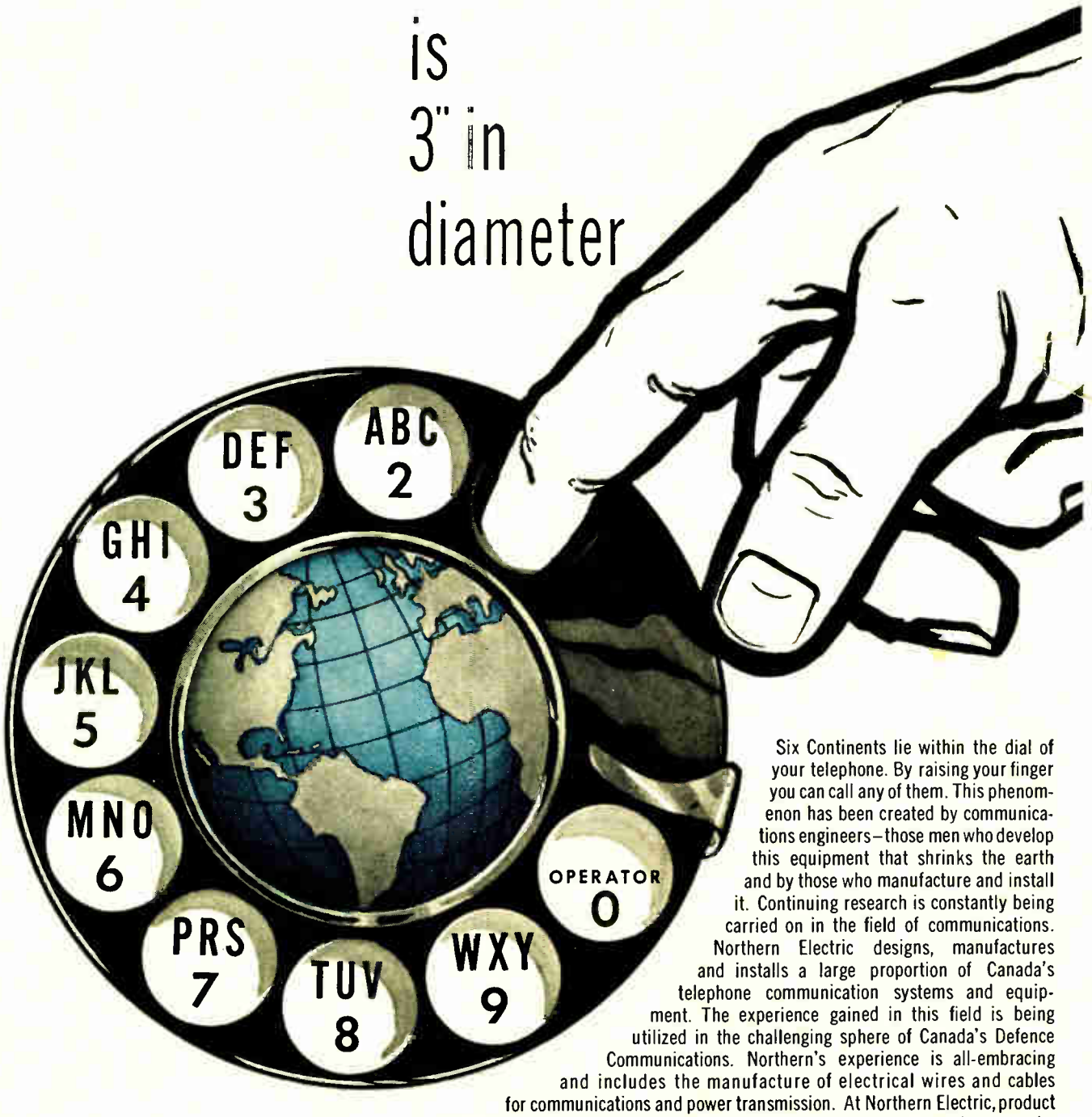
CANADIAN Marconi COMPANY

830 BAYVIEW AVENUE, TORONTO, ONTARIO

Branches: Vancouver • Winnipeg • Montreal • Halifax

For complete details check No. 15 on handy card, page 73

the world is 3" in diameter



Six Continents lie within the dial of your telephone. By raising your finger you can call any of them. This phenomenon has been created by communications engineers—those men who develop this equipment that shrinks the earth and by those who manufacture and install it. Continuing research is constantly being carried on in the field of communications. Northern Electric designs, manufactures and installs a large proportion of Canada's telephone communication systems and equipment. The experience gained in this field is being utilized in the challenging sphere of Canada's Defence Communications. Northern's experience is all-embracing and includes the manufacture of electrical wires and cables for communications and power transmission. At Northern Electric, product research and development never stops and advances are continually being made.

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For complete details check No. 40 on handy card, page 73

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electronics and communications

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CCAB

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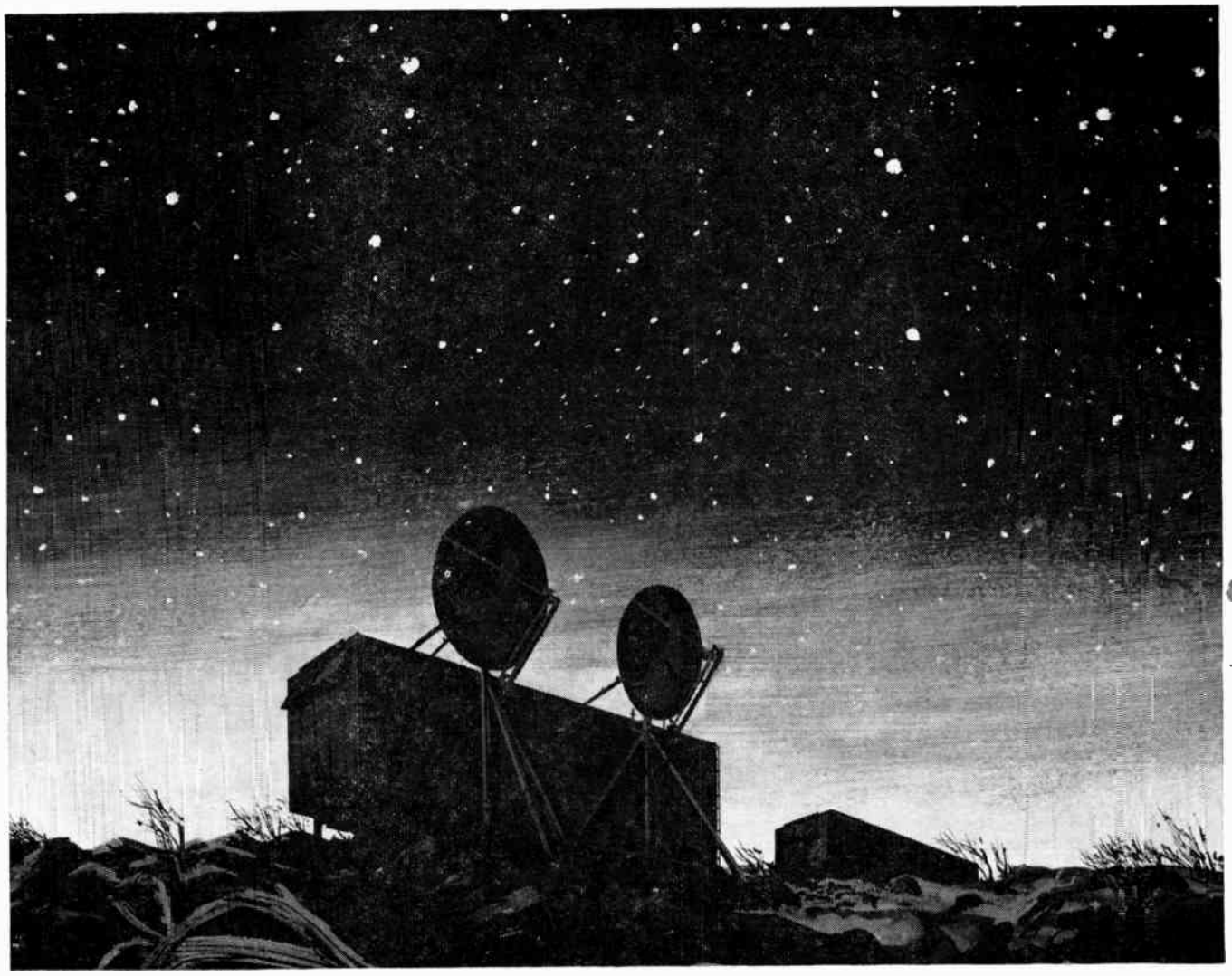
contents

SEPTEMBER 1960 Vol. 8, No. 9

departments



. . . and 200 miles away a telephone rings!

Eight hours ago, an expanse of barren mountainous country made communication impossible. Tonight, 60 telephone channels and teletype span the wilderness.

Transportable MICROSCATTER is a super high frequency radio system for long-range communication. Developed by Canadian Westinghouse, MICROSCATTER beams signals high above the earth sending two-way voice and teletype messages up to 200 miles over land and water . . . *without* costly relay stations.

The compact MICROSCATTER radio system fits in a standard 30 ft. truck trailer. Now, whenever men and equipment move, MICROSCATTER moves right along with them. It is particularly suited to military and government projects in remote locations. Units designed for self-contained field operations are set down by helicopter.

A Westinghouse communications specialist will be pleased to explain fully the MICROSCATTER operation and relate it to your problem. Contact your nearest Westinghouse office, or write to Canadian Westinghouse Company Limited, Electronics Division, Hamilton, Canada. YOU CAN BE *SURE* . . . IF IT'S WESTINGHOUSE.

MICROSCATTER APPLICATIONS

COMMERCIAL	MILITARY
Fixed Station —120 telephone channels	Wide Band —radar
—television and sound	—data
	—120 telephone channels
Transportable—60 telephone channels	Tactical and Transportable—60 voice channels
—teletype	—teletype
	—data

FEATURES

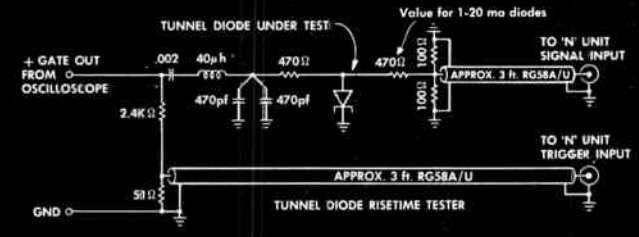
- Frequency—4400-5000 mc
- Antennas —10 to 28 ft. diameter
- Power—2 KW
- Range—100 to 200 miles

CANADIAN
Westinghouse Microscatter

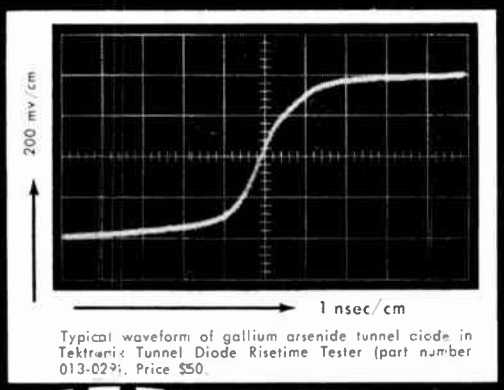
60-A-745

For complete details check No. 18 on handy card, page 73

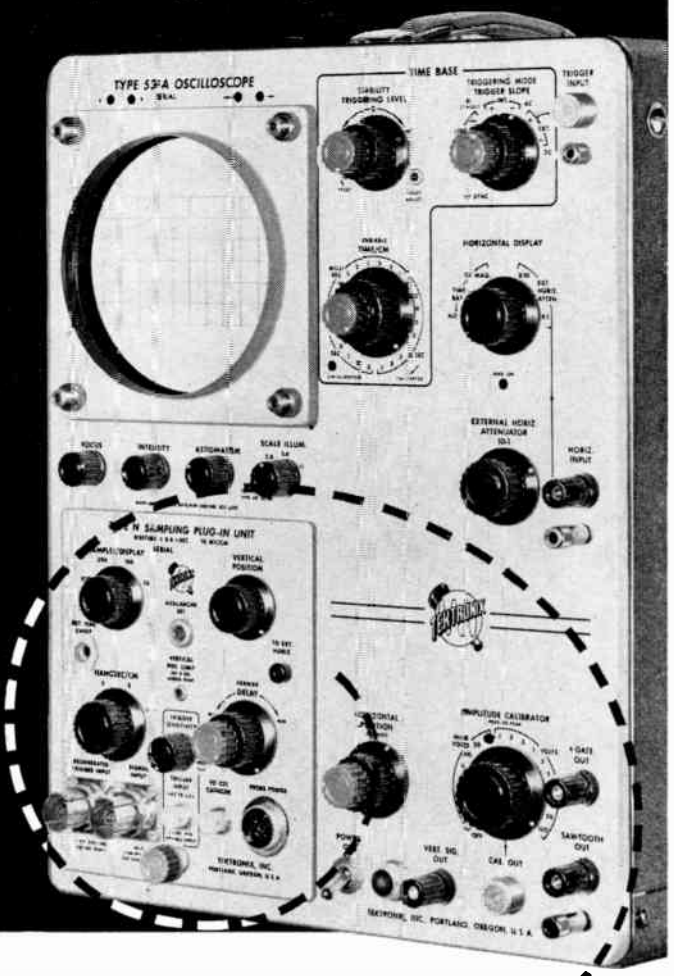
Tunnel Diode Switching Time Measurement
with Tektronix Type N Sampling Plug-In Unit



A convenient low-cost method of testing tunnel (Esaki) diodes with nanosecond switching speeds is shown above. A Tektronix Plug-In Oscilloscope provides both the current ramp source for the tunnel diode and the pretrigger for the Type N Unit. The N Unit is set up in the usual way — however, the oscilloscope main sweep generator is allowed to free run at 1 μsec/cm. The + GATE OUT not only triggers the N Unit but also provides a delayed current ramp with a low rate of change—which allows the tunnel diode to switch at essentially its own rate.



Typical waveform of gallium arsenide tunnel diode in Tektronix Tunnel Diode Risetime Tester (part number 013-029), Price $50.



NEW PULSE-SAMPLING UNIT
for all Tektronix Plug-In Oscilloscopes

The new Type N Unit converts your Tektronix Plug-In Oscilloscope to a Pulse-Sampling Oscilloscope with a rise-time of 0.6 nanoseconds. Applications in which the signal source can furnish a "pretrigger", such as that shown above, require no additional equipment.

For a completely versatile Pulse-Sampling System, Tektronix also manufactures a Pulse Generator and Trigger Takeoff, a 60-nsec Delay Line, a Pretrigger Pulse Generator, and several useful accessories. Please call your Tektronix Field Engineer for complete details and, if desired, a demonstration of the Type N Unit or the complete System.

Characteristics

- 0.6 nsec risetime (approximately 600 mc).
- 10 mv/cm sensitivity. (2 mv or less amplitude noise.)
- 1, 2, 5, and 10 nsec/cm equivalent sweep times (20 to 50 psec time noise).
- 50-ohm input impedance.
- 50, 100, 200, and 500 samples per display.
- Sampling rate — 50 c to 100 kc.
- ±120 mv minimum linear range (safe overload 4 v).
- Trigger input requirement: +0.5 v, 1 nsec duration, 40 nsec in advance of signal. Recovery time is 10 μsec. Counts down from 50 mc.

PRICE **$600**
f.o.b. factory

CANADIAN FIELD OFFICE: **Willowdale, Ontario**
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Tektronix, Inc.

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TEKTRONIX ENGINEERING REPRESENTATIVES: Hawthorne Electronics, Portland, Oregon • Seattle, Washington. Tektronix is represented in twenty overseas countries by qualified engineering organizations.

In Europe please write Tektronix Inc., Victoria Ave., St. Sampsons, Guernsey C.I., for the address of the Tektronix Representative in your country.

For complete details check No. 63 on handy card, page 73

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LOW ONLY IN PRICE

MODEL 999
Dynamic Plate—Conductance Tube Tester. Versatile, Portable. Tests All Modern Tubes. Tests Shorts, Leakage and Quality. Special Self Cleaning Lever Switches.
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MODEL OSK-1
5" Oscilloscope Kit. 5" C.R.T., Push-Pull Horizontal and Vertical Amplifiers.
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Wired $99.50

MODEL MK-3
Multi Range Multimeter. 20,000 Ohms Volt. Molded Case. Unbreakable Meter Front.
Wired $29.95

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Vacuum Tube Voltmeter. 6" Full View Meter. Input Impedance 10.5 Megacycles. Proven Printed Circuit.
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Wired $59.70

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Marker Generator
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MODEL SWG-58
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MODEL 1001
Multi-Range VOM
Kit $39.50
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For complete details check No. 57 on handy card, page 73

CRTPB newsletter

Prepared by Canadian Radio Technical Planning Board

Committees Hold Inaugural Meetings

The newly constituted Land Fixed and Mobile Committee held its inaugural meeting in Toronto recently under Chairman W. Ornstein. The objectives of this particular meeting were set out as being: agreement on terms of reference; agreement of methods of procedure; and the compilation of a priority list of specifications for the Committee's consideration. A good deal of progress was reported in meeting these objectives.

The meeting was attended by W. Ornstein (Chairman), Electronic Industries Association of Canada; N. Redsell, Association of Municipal Electrical Utilities of Ontario; G. H. Long, Canadian Association of Chiefs of Police; J. L. Marshall, Canadian Broadcasting Corporation; E. V. Collier, Canadian Electrical Manufacturers Association; R. C. Poulter, Canadian Radio Technical Planning Board (Executive Committee); W. B. Smith, Department of Transport; M. G. Macumber, Hydro-Electric Power Commission of Ontario; J. W. Ormiston, Railway Association of Canada; J. C. Gornall, Royal Canadian Mounted Police; D. W. Hinton, Telephone Association of Canada.

The agenda for future meetings will include examination of specifications for split-channelling in the 148-174 megacycle band and for motorcycle radio and portable equipment in the same band. Single Sideband Draft Specification No. 122 will also be examined.

Ship Station Specification 134

The new Maritime Committee met for the first time on August 18th, in Toronto, to formulate an agenda and to prepare the submission to the Executive Committee on DOT draft specification RSS No. 134.

This specification is entitled, "Ship Station AM Radiotelephone Transmitters and Receivers Operating in the 1605-5000 Kc Band with R. F. Power Outputs under 15 Watts". The General Co-ordinator has pointed out the urgency attached inasmuch as the DOT is under pressure for licenses from boat owners in connection with the radio phase of the Department's water safety program. Some objections have been raised on the effective date of November 1, 1960 since this does not give Canadian manufacturers sufficient time to make necessary equipment available, and this favors imported equipment at a time when Canadian manufacturers are in trouble due to foreign imports.

Executive Committee Activity

The Executive Committee met in Toronto on August 5th to discuss, among other things, the action required on the long-delayed Sideband Draft Specification RSS 122. Comments have been finalized by the joint EIA-CRTPB General H.F. Communications Committee and these comments will now be sent to the Chairman of the EIA Mobile Committee for any recommendations he might wish to make, and also to the Chairmen of the CRTPB Maritime Committee and Land Fixed and Mobile Committee, allowing 60 days for return of comments. Following this the recommendations will be sent to CRTPB sponsors for comments, allowing 30 days for handling. The recommendations will then be sent to Department of Transport.

Land Mobile Assigned Frequencies

The Executive Committee reports receipts from Department of Transport of an Index of Land Mobile Assigned Frequencies. The documents, which are quite extensive, will not be placed in the hands of any one person or committee, but will be retained in CRTPB office library for reference only. Vice-President Bridgland will review these documents and report on their content at the next Executive Committee meeting.

Radio Technical Commission For Aeronautics

Also held as reference material in the CRTPB office are the recently received copies of specifications issued by the Radio Technical Commission for Aeronautics in the United States.. Accompanying the document from President Pounsett is an index of the RTCA papers dated September 25, 1959.

the industry's business

Studying the semiconductor products to be marketed throughout Canada by Canadian Motorola Electronics Limited is John E. Raftis (seated), manager of the firm's new Semiconductor Products Division. Erling R. Johnson (left), will be responsible for order handling, and Harold M. Pipher, for sales contacts.

Canadian Motorola division for semiconductor products

Semiconductor products, covering a wide range of transistors, rectifiers and diodes, are to be marketed throughout Canada by a new division of Canadian Motorola Electronics Limited, Toronto. These products, manufactured by Motorola Inc., at their Semiconductor Products Division in Phoenix, Arizona, have not been readily obtainable in Canada.

The products cover Mesa, power and alloy/switching transistors, silicon rectifiers and zena diodes and this move by Canadian Motorola will make them available to Canadian industry generally.

Canadian industry will also have the benefit of semiconductor products that have been extensively tested in the United States as part of the defense program.

Announcing formation of the new division to market semiconductor products, R. M. Brophy, president and general manager of Canadian Motorola, said a stock has already been built up in Toronto for supply to original equipment manufacturers in Canada.

Harold M. Pipher, who has recently joined the company, will be responsible for sales contacts and Erling R. Johnson for order handling.

The division will be under the overall direction of John E. Raftis who is also manager of the firm's Microwave Division.

New firm offers industrial research services

John C. Robertson, B. Comm., formerly president of Nation Wide Interviewing Corp. Ltd., has formed a new market research company — Associated Marketing Services Ltd. This company will carry out a wide range of custom research studies.

The new company, with offices in Toronto and Montreal, will assist in the marketing of industrial products through company and product acceptance studies among industry buyers.

Mr. Robertson, associated with market research for six years, has conducted industrial research projects for major manufacturers in the electrical equipment and electronics field.

Toronto offices are located at 3425 Dundas St. W., phone No. RO. 2-7539.

In Montreal, Mrs. Mary Gratrix, a vice-president in charge of the national interviewing staff, will manage the office at 3486 Park Ave.

Appointed representative for Gen-Tec Limited

Mr. A. G. Shack of Electromechanical Products, Markham Road, Toronto, has announced the appointment of Electromechanical Products as Canadian representative for Gen-Tec Limited of Quebec, P.Q. Gen-Tec Limited are manufacturers of Gen-Tec peak load stabilizers.

MEL Sales Ltd. to rep. for Owen Laboratories

Owen Laboratories Inc. of Pasadena, California take pleasure in announcing the appointment of MEL Sales Limited of Toronto and Montreal as their exclusive sales representatives in Canada.

Owen Laboratories manufactures laboratory semi-conductor test sets and precision programmed reference voltage supplies and power supplies in addition to its basic line of transducer support equipment.

Sod turned for construction of Marconi's CFCF channel 12

Montreal recently witnessed the birth of CFCF-TV, licensed as the second English-language television station in the city.

Montreal Mayor, Sarto Fournier, watched by prominent civic and business officials, turned the first sod marking the opening of construction work on the $1,500,000 structure.

New building, which will house CFCF-TV's initial three studios and offices, will encompass some 104,000 square feet on Ogilvy Avenue, at the top of Hutchison Street in Montreal's northend. Expected to be eight months in construction, enough of the building will be available for CFCF-TV's first transmission on Channel 12 in January 1961.

"Construction of these studios marks a further definite step forward by Canadian Marconi to live up to the undertakings entrusted to us by the Board of Broadcast Governors," Stuart M. Finlayson, president, Canadian Marconi Company, said at the opening ceremony and reception.

"It is our anticipation that when this building is completed early next year the facilities provided will allow us to fully live up to our obligations to provide the finest television service possible to the people of Montreal and the surrounding area," added Mr. Finlayson.

$1 million contract awarded to MEL

A contract valued at approximately one million dollars was awarded to Measurement Engineering in July to design and manufacture new and modern Control Tower Consoles for equipping of RCAF Airports.

Work on the new contract commences immediately. No expansion in plant is anticipated at MEL but additional staff will be added to handle the work — a large percentage of which will be subcontracted to other Canadian firms.

Measurement Engineering built consoles to equip all RCAF airports seven years ago — but with advancing technology in Aircraft and Communications, these are gradually becoming obsolete. At that time 42 consoles were built for installation in airports across Canada and NATO airports in Europe.

The Airport Control Tower Console is a large desk-like affair, at which air force personnel operate complex electronic and meteorological equipment. In effect it is the nerve center of the airport for all aircraft and vehicular traffic is controlled from this point.

Lancaster N.B. to get new CGE warehouse

Sod was recently turned for the new office and warehouse building of Canadian General Electric Company Limited on Fairville Blvd. in the City of Lancaster, N.B., on the west bank of the Saint John River opposite the City of Saint John. The building will be ready for occupancy by January of next year.

The new building will house the office and warehouse operation of the Saint John Branch of the company's Wholesale Department, which has been located since 1919 on Germain St. in downtown Saint John. The local sales office of the company's Apparatus Department will also be located in the new building.

The new building will contain 19,600 square feet of floor space, 5,000 square feet of office space and 14,600 square feet for warehouse and services. Customer conveniences include a counter and display area, ample parking space, and stock for the requirements of electrical contractors and appliance dealers.

Prime Electronic Components Ontario and Quebec reps.

EFCON, Incorporated (formerly Electronic Fabricators, Inc.) have appointed Prime Electronic Components Ltd. as Sales Representatives for Ontario and Quebec.

Products consist of solid tantalum, miniature mylar, high temperature teflon, and miniature polystyrene capacitors.

From time to time EFCON will issue new engineering bulletins, test data reports, application notes and technical brochures to names on list being prepared now.

Edo (Canada) Limited gets manufacturing rights

Burnell & Co., Inc., of Pelham Manor, N.Y., a major producer of electronic filter networks and delay lines, has granted an exclusive franchise for the manufacture and distribution of its products in Canada, Great Britain and other Commonwealth areas to Edo (Canada) Limited, of Cornwall, Ont. The Canadian firm is an affiliate of Edo Corporation, of College Point, New York.

Norman Burnell, president of Burnell, said the Edo agreement is "the first step in a program to internationalize the market for our products."

"The decision to grant a manufacturing franchise in Canada," Mr. Burnell added, "was prompted by the fact that this market is currently unavailable to American firms because of a 'Buy Canada' policy. It is our belief that the Canadian electronics industry is about to enter its greatest period of growth."

Moisture instruments now available in Canada

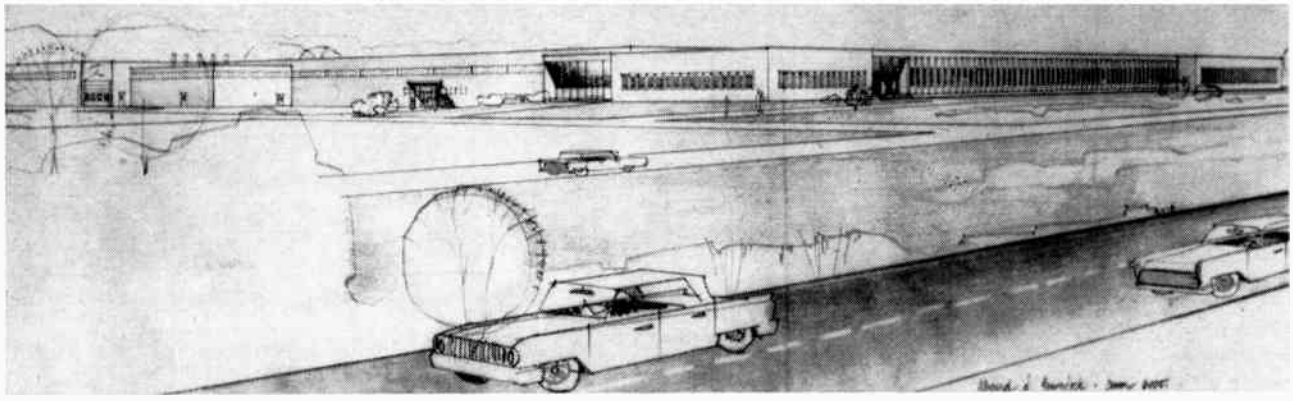
The firm of R. Acker, of Heidelberg, West Germany, have just appointed as their Canadian representatives, Canadian Research Institute, 46 St. George Street, Toronto 5, Canada. Acker is known around the world for their Moisture Meters, which are available with calibrations for textile, wood, leather and paper industries. These instruments are small portable hand-held battery operated devices which are pushed against the material to be tested, whereupon a needle indicates percentage of water directly. The moisture meters will be stocked and serviced in Canada.

George Kelk Limited move to new quarters

In order to better serve their many customers, George Kelk Limited announce that they are moving to new and larger quarters at 5 Lesmill Road, Don Mills, Ontario. The new location will provide at least twice the floor space that was previously available.

George Kelk Limited are custom engineers, manufacturers, and designers of electronic measuring and industrial control equipment. In addition to these, and other types of specialized electronic equipment, they are also manufacturers of an AC line regulator — the Stedivolt. They also represent the B & H Instrument Co. of Fort Worth, Texas, manufacturers of self balancing digital indicating equipment for measuring temperature, speed, frequency, pressure and other mechanical functions.

Engineer at Honeywell's Electronic Data Processing Division makes final adjustments on new high-speed printer that will be standard equipment with the newly introduced Honeywell 400 electronic data processing system. The Honeywell 400, the most powerful system available in its price class, is expected to make high-speed electronic data processing practical for as many as six out of 10 of the largest companies in Canada.



The above picture shows an architect's conception of the Northern Electric Company Limited new building to be constructed on a 58-acre tract of land in North York on the west side of Highway 400 between Steeles and Finch Avenues. The first portion of the modern, single storey building, which will be used for the expansion of the operations of the company's telephone contract division, is expected to be completed during 1961.

DDP contracts awarded

The following is a list of unclassified electronic defense contracts for $10,000 or more awarded during the period July 16-31, 1960 to Canadian firms by the Department of Defense Production.

- Ampex of Canada Limited, Ottawa, Ont., channel record and reproduce tape system, $22,447.
- Aviation Electric Ltd., Montreal, Que., aircraft spares, $21,766.
- Burrard Dry Dock Co. Ltd., Vancouver, B.C. installation of degaussing equipment, $25,219.
- Canadian Aviation Electronics Ltd., Montreal, Que., repair and overhaul of operational flight and tactics tainers, $132,400.
- Canadian Pacific Railway Co., Ottawa, Ont., maintenance of teletype equipment, $25,000.
- Collins Radio Co. of Canada Ltd., Toronto, Ont., aircraft navigational instruments, $37,298.
- Northern Electric Co. Ltd., Ottawa, Ont., maintenance spares for telephone systems, $20,493.
- Northern Telephone Limited, New Liskeard, Ont., maintenance of telephone systems, $144,014.
- Peterson Electrical Construction Co. Ltd., Vancouver, B.C., provision and installation of telecommunications cable, $15,277.
- Sparton of Canada Ltd., London, Ont., sonobuoy transmitters, $518,248.
- University of Ottawa, Ottawa, Ont., computation services, $20,000.
- University of Toronto, Toronto, Ont., computation services, $12,000.

New laboratory for Canadian Research Institute

Construction has begun on a new plant and laboratories for Canadian Research Institute, now located at 46 St. George Street, Toronto 5, Canada. The building now being erected makes available to the firm more than triple the present space, and will include office, warehouse, laboratories and manufacturing facilities. It is the third and largest expansion in the company's 22 year history.

The new plant, situated on Curlew Drive in Don Mills, a suburb of Toronto, backs on Lawrence Avenue E., just west of Victoria Park Avenue. A feature of the premises will be a precision temperature controlled room for housing electrical standards, permitting measurements to be made to an accuracy of $\pm$ 0.001%.

Occupancy of the building will begin October 1, 1960.

Precision Welder & Flexopress expansion

To meet the rapidly growing demand for welding equipment in Canada, Precision Welder & Flexopress (Canada) Limited of Toronto, Canada, has expanded its manufacturing facilities to incorporate a complete line of resistance welding transformers.

Precision (Canada) Ltd. will manufacture, distribute, and service Kirkhof Transformers, including the revolutionary Kirkhof Epoxy Pak package type transformers, under license from the Kirkhof Manufacturing Corporation of Grand Rapids, Michigan. The combination of Precision Welders and Kirkhof Transformers gives Canadian manufacturers a ready source for a complete line of welding equipment manufactured in Canada for Canadian use.

Precision (Canada) Ltd. has experienced rapid growth over the past five years, and recently moved into an extensive new manufacturing plant at 72 Carnforth Road, Toronto. Precision's plans for manufacturing Kirkhof transformers in Canada are one more step in a joint program to serve the Canadian market better, removing problems formerly created by distance and import-export restrictions.

Eimac constructs ultra-high-voltage power supply

Eitel-McCullough, Inc., which today manufactures the world's largest klystron power-tube, is constructing an ultra-high-voltage power supply which will make possible the development and production of tubes fifteen times more powerful than existing tubes. This ultra-high-voltage power supply will be located in the super-power tube facility now under construction near Eimac's corporate headquarters at San Carlos, California. The highly-flexible power supply will be used to test electron-power tubes for many commercial applications and to meet essential electron-tube requirements for space-age radar, communication and linear accelerator systems.

Earl J. Shelton, manager of Eimac's high-power tube operations, states that the power supply will provide 282 kilovolts at 12 amperes or 3 million watts of power. High-voltage power distribution transformers will be utilized throughout the supply to assure maximum reliability. These oil-filled transformers will weigh from 5 to 15 tons each and are capable of withstanding tremendous electrical overloads.

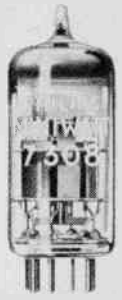
The new power supply is scheduled for completion in early 1961 and will substantially increase Eimac's development and production capabilities for super-power electron tubes.

Defense Research Board appointments

The honor of being appointed to Canada's 12-man Defense Research Board has been accorded to **Dr. J. F. McCreary,** Dean of Medicine at the University of British Columbia, and to **C. A. Peachey,** an electronics engineer in Montreal, Que.

Clip and file this reference sheet for future use

ROGERS REFERENCE BULLETIN No. 8



Philips Special Quality Pentode • Philips Special Quality Double Triode for 10,000 hours of guaranteed service

Long, dependable service with a 10,000 hour guarantee is available with two Philips ruggedized special quality tube types E188CC/7308 and E186F/7737. Both shock and vibration resistant, these two types feature very low microphony and noise.
Designed for use in mobile equipment, control equipment, transmitters and studio equipment, the Philips E188CC/7308 and E186F/7737 are recommended as improved replacements offering better microphony and noise properties than types 6922/E88CC and 6688/E180F. The Philips E188CC/7308 is an improved replacement for type 6922/E88CC *at the* same price. The Philips E186F/7737 is an improved replacement for type 6688 E180F.

E186F/7737

Broadband amplifier pentode

HEATING
Indirect by A.C. or D.C.; parallel supply.

Heater voltage	V_f	=	6.3 V
Heater current	I_f	=	320 mA

TYPICAL CHARACTERISTICS AND OPERATION[1]

			A	B
Anode supply voltage	V_{ba}	=	190	180 V
Suppressor-grid voltage	V_{g3}	=	0	0 V
Screen-grid supply voltage	V_{bg2}	=	160	150 V
Control-grid supply voltage	V_{bg1}	=	+9	0 V
Cathode resistor	R_k	=	630	100Ω
Anode current	I_a	=	13	11.5 mA
Screen-grid current	I_{g2}	=	3.3	2.9 mA
Mutual Conductance	S	=	16.5	15.9 mA/V
Amplification factor of G^2 with respect to G^1	μ_{g2g1}	=	53	
Internal resistance	R_i	=	90	kΩ

1) Operation of the tube under the conditions as given in column A is recommended because of the small spread in characteristics.

2) Life test conditions are:
V_f=6.3 V, V_{ba}=190 V, V_{g3}=0 V, V_{bg2}=160 V, V_{g1}=+9 V, R_k=630Ω, V_{kf}=70 V (cathode negative)
Life expectancy 10,000 hrs.

E188CC/7308

For use as cascode amplifier or cathode follower in RF and AF circuits

HEATER CURRENT			I	II	III
Heater voltage	V_f		6.3		V
Heater current	I_f	=	335	318-352	318-352 mA
TYPICAL CHARACTERISTICS					
Anode supply voltage	V_{ba}	=	100		V[1]
Control grid supply voltage	V_{bg}	=	+9		V[1]
Cathode bias resistor	R_k	=	680		Ω[1]
Anode current	I_a	=	15	14.2-15.8	13.5 mA
Mutual conductance	S	=	12.5	10.5-14.5	9.0 mA/V
Amplification factor	μ	=	33		
Equivalent noise resistance at 45 Mc/s	R_{eq}	=	250		Ω
Noise factor at 200 Mc/s	F	=	4.6		dB[2]
Input damping at 100 Mc/s	r_g	=	3		kΩ
Anode supply voltage	V_{ba}	=	90		V
Control grid supply voltage	V_{bg}	=	0		V
Cathode bias resistor	R_k	=	120		Ω
Anode current	I_a	=	12		mA
Mutual conductance	S	=	11.5		mA/V
Anode voltage	V_a	=	100		V
Control grid voltage	V_g	=	−5.5		V
Anode resistor	R_a	=	1		MΩ
Anode current	I_a	=		< 20	μA
Anode supply voltage	V_{ba}	=	100		V
Control grid supply voltage	V_{bg}	=	+9		V
Cathode bias resistor	R_k	=	680		Ω
Control grid resistor	R_g	=	0.1		MΩ
Control grid current	$-I_g$	=		< 0.1	1 μA

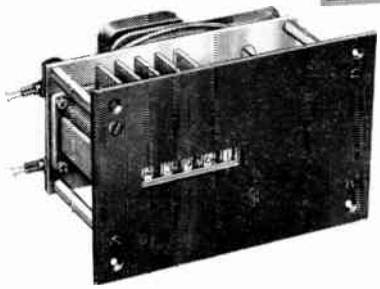
1) V_g hum is the hum voltage referred to the grid. Measured with a fully screened tubeholder and straight response curve of the filter; frequency of the heater voltage = 50 c/s +3 percent of voltage 500 c/s. Centre tapping of the heater supply transformer grounded.

ROGERS

electronic tubes & components

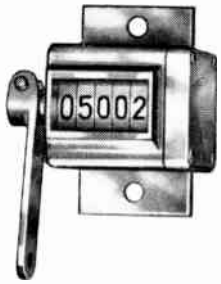
A DIVISION OF PHILIPS ELECTRONICS INDUSTRIES LTD.
116 VANDERHOOF AVE., TORONTO 17, ONTARIO

Veeder-Root COUNTER READOUT Bulletin



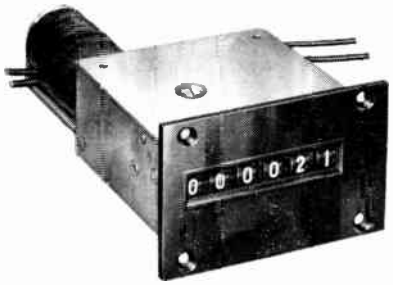
Data Readout Counters

Each wheel has ten-position switching mechanism for transmitting counter readings electrically. Actuated mechanically or electrically.



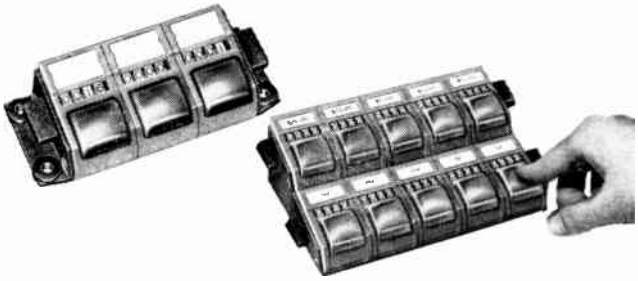
General-Purpose Counters

A complete square case line for light duty counting where small size is required. Available as direct drive, revolution, ratchet, rotary ratchet and geared counter.



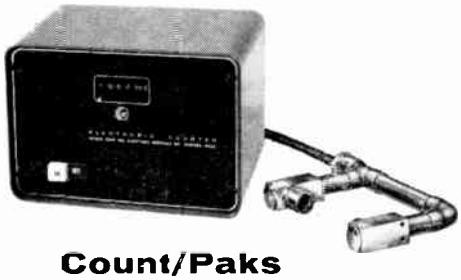
Magnetic Counters

For remote indication. Actuated electrically by variety of switches or photocells. High speed, quick reset model features 3000 cpm, small panel area.



Vary-Tally

Multiple unit reset counter for more accurate tallying. Ideal for quality control, production control, piece work, and analysis work. Available in strips and tiers.



Count/Paks

Complete packages for high speed, non-contact counting. Pulse stretching circuit for counting small objects. Photohead designed for specific applications.

Miniature Precision Counters

Complete line of specialized counters and readout devices for military, aircraft and missile instrumentation. Precision gearing and complete "systems" available.

Electronic Countrols

Predetermining Counters provide automatic control of machine operations, with single stop motion or series of sequential stop motions. Count electrical impulses, speed to 5000 counts per second.

Send for catalog information and data sheets on the complete line of Veeder-Root Counters.

Veeder-Root

OF CANADA LTD.

"The Name that Counts"

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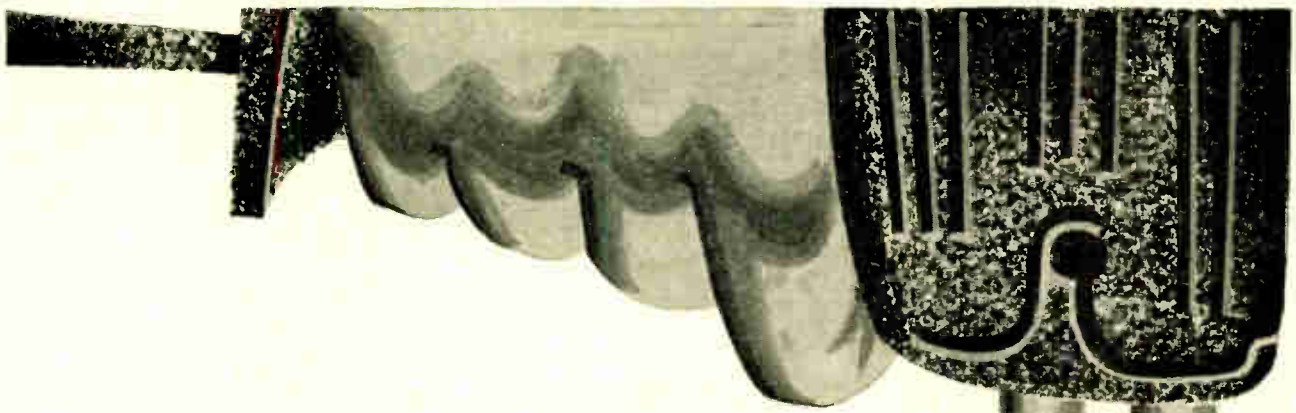
Offices & Agents in Principal Cities

VR 0-50

For complete details check No. 67 on handy card, page 73



Would you buy fixed resistors just because they're the **easiest to solder?**

Of course you wouldn't!

But when you add the highest degree of "solderability" of any resistors on the market to top-notch reliability in other physical and electrical characteristics — well, that's something else. Like a lot of other cost-conscious producers, you'll then be using Stackpole Coldite 70+ Resistors!

Stackpole Coldite 70+ "solderability" saves time and money in your production. It assures perfect connections that eliminate a lot of possibilities for costly field service later on.

Coldite 70+ performance fully matches the "solderability" of the leads. They're designed to meet or excel MIL-R-11 in every respect. And they're tops in load life, humidity and moisture tests!

CANADIAN STACKPOLE LIMITED • 550 Evans Ave., Toronto 14, Ontario

STACKPOLE
Coldite 70®+
fixed composition resistors

CERAMAG® FERRITE CORES • VARIABLE COMPOSITION RESISTORS • SLIDE & SNAP SWITCHES • CERAMAGNET® CERAMIC MAGNETS • FIXED COMPOSITION CAPACITORS BRUSHES FOR ALL ROTATING ELECTRICAL EQUIPMENT • ELECTRICAL CONTACTS GRAPHITE BEARINGS, SEAL RINGS, ANODES • HUNDREDS OF RELATED CARBON & GRAPHITE PRODUCTS.

For complete details check No. 17 on handy card, page 73

EIA report

by R. T. O'Brien

Full Program Ahead For Committees

Following the summer holiday period nearly all the engineering committees are scheduled to meet in September to attack a long list of specifications and standards that are still in the proposal stage.

The Receiver Division Engineering Committee has succeeded in finalizing a specification for a portable broadcast receiver which was requested by the Emergency Measures Organization of the Federal Government. The EMO asked for a receiver which could be included in a recommended list of items that could be contained in shelters for use in the case of national emergency.

The specification is now in the hands of receiver manufacturers for comments before being finally approved as an EIA Standard.

Safety And The CSA

One of the busiest groups in the EIA committee structure is the Sub-Committee on Safety and CSA. Under Chairman W. F. Miller of Canadian Admiral Corporation this group has been very busy reviewing, at the invitation of the Canadian Standards Association, the Specification C22.2 No. 1 which deals with the construction and test of Power Operated Radio, Television, and Electronic Devices under the Canadian Electrical Code Part II.

The Committee is attempting to revise the safety standards to bring them into line with modern manufacturing processes; the developments in miniaturized components; and the advances in materials used in components, picture tubes, enclosures and mechanical assemblies.

The work of the Committee, in dealing with fire and shock hazard parts of the specification, is hampered to some extent by the lack of precise information on the incidence of fires and shock accidents across the nation since there seems to be no reliable data collection agency collating such information. It is a generally accepted fact that Canadian manufacturers, always mindful of their responsibility to the consumer, are building not only high quality home entertainment and industrial equipment but safe equipment. Only very occasionally do we see a report of an isolated incident of fire or shock accident being caused through faulty appliances and considering the many thousands of radio and television sets that have been placed in Canadian homes the safety record appears to be outstanding.

DOT Single Sideband Draft Specification

After many months of work the General H.F. Communications Committee, a joint committee with the CRTPB, has completed its comments on the DOT Draft Specification RSS-122 for single sideband equipment. The draft will now be considered in the CRTPB committees before being sent to sponsors and finally the comments will be sent to DOT. This process should take about two months before the specification can be considered finished.

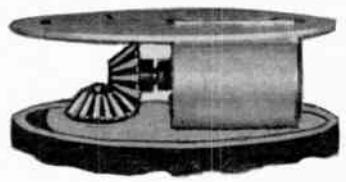
Committee Looks At Color TV

The new Broadcast Committee met for the first time on August 23rd to consider the production of a Canadian EIA television transmitter specification for monochrome and color equipment.

Under the chairmanship of Fred J. Heath of Canadian General Electric Company the new committee combines the old Television and Broadcast Committees and has representation from Northern Electric Company and RCA Victor Company among other manufacturers interested in the production of television and broadcast equipment. It is hoped that a draft standard for Canadian equipment can be produced within two months.

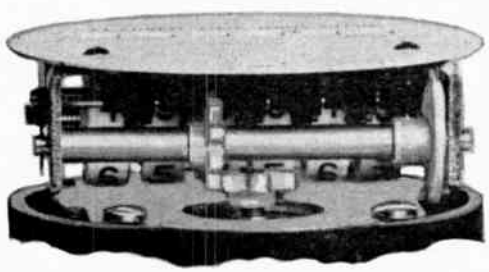
EIA-IRE Golf Tournament

Don't forget the combined EIA-IRE golf tournament and dinner being held at the Cedar Brae Golf Club, Toronto, on September 29. Arrangements are in the hands of Ernie Walton, Kester Solder Company of Canada.



The original version was a close tolerance assembly utilizing a small standard commercial counter, linked to the motor by a conventional bevel gear.

how does a GOOD product become BETTER ?



The redesigned assembly features a loose "paddle-wheel" linkage (time only runs in one direction, so backlash is no problem!), and a counter composed of large separated number wheels in a specially tooled frame. Result—better readability, less critical assembly and much improved performance under environmental extremes.

**New type available in standard Bach-Simpson styles, in 3" and 4" sizes. Ask for Model ET1F.*

Well, we haven't any magic formula. But witness the case of our Elapsed Time Indicator, an example of Bach-Simpson's continuing effort in the field of product improvement.

Our original models, using conventional gears and counters *designed for a variety of applications*, found wide acceptance. However, increasingly rigorous operating conditions and the desirability of an easier readout dictated a shift to components *especially designed for the job.*

Ingenious design — rigorous testing — tooling — and precision production all under one roof have resulted in a substantially improved product, directly interchangeable with older models, at no increase in cost.

"DESIGN AND ENGINEERING" A trained Engineering Staff brings a wide variety of experience to bear on electrical, electronic and mechanical problems.

"TESTING AND QUALITY CONTROL" Our facility includes equipment to produce conditions ranging from 90° below zero cold and 70,000 foot altitude to the impact of a naval broadside.

"TOOLING AND PRECISION ASSEMBLY" An outsize toolroom and comprehensive production facilities permit design flexibility and closely controlled in-plant production of nearly all components.

Bach-Simpson
LIMITED
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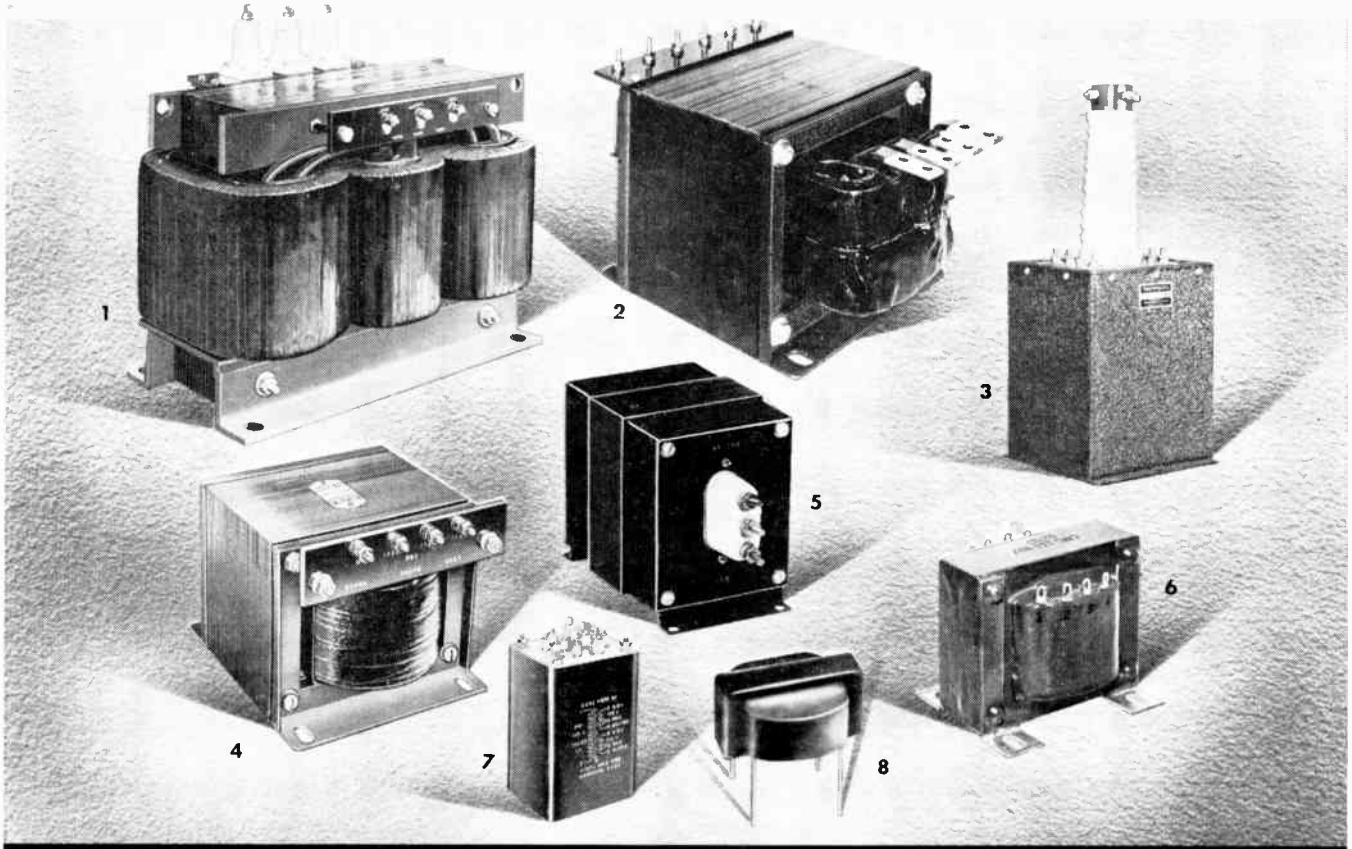
For complete details check No. 10 on handy card, page 73

HAMMOND Transformers for Electronic Equipment

Hermetically Sealed • Plate Supply • Filament • Multi-winding • Input and Filter • Silicon, Selenium Power Rectifier • Input, Interstage and Output in all types • Cathode Ray • Modulation • High "Q" Inductors • Transistor . . . and other special type Transformers.

1. 3-Phase, Plate and Rectifier Types . . . for special equipment.
2. Heavy Current Transformers . . . for oil pipe line heating.
3. High Voltage Plate Transformers . . . for test purposes.
4. Power Transformers . . . for modern electronic circuits.
5. Rectifier, Filament Transformers . . . for industrial electronic equipment.
6. Encapsulated Types . . . Plate, Filament, etc. to 1600 cycles.
7. Military Transformers . . . to all specifications oil or epoxy filled.
8. Transistor Transformers . . . with solid leads or pins, for printed circuits.



Transformers to over 54,000 specifications

Hammond makes and stocks more than 1,000 items in ratings from a few millivolts to 40 K.V.A. and offers the experience and facilities to engineer special transformers as single units or in production quantities. Hammond has built transformers to more than 54,000 *different specifications.*

HAMMOND
ELECTRONIC TRANSFORMERS

Standard Items Stocked by Leading Jobbers

H2

HAMMOND MANUFACTURING COMPANY LIMITED • GUELPH, ONTARIO, CANADA

For complete details check No. 27 on handy card, page 73

CANADA'S

MOST COMPLETE LINE OF WIRES AND CABLES FOR DOMESTIC AND EXPORT MARKETS

BUILDING WIRES and CABLES

Flameseal—Types TW & TWU
Flexible Armoured Cable—
—Types AC & ACL
Philex Cable—Types NMD-3 & NMW-10
Rubber Braided—Type RH-RW
Rubber Neoprene Cables
Service Entrance Cables

BARE CONDUCTORS—LINE WIRE

Electrolytic Copper Rod
Solid & Stranded Copper Conductors
Aluminum & ACSR
Brass & Bronze Wire
Copperweld Wire & Cable
Trolley Wire
Furnace Cables
Soaking Pit Cable
Polyethylene & Neoprene Line Wire
Weatherproof Line Wire

CONTROL CABLES

Traffic Signal Control
Railway Control
Elevator Cable
Thermostat Control
Organ Cable
PVC & Polyethylene Control
Rubber Neoprene Cable

MAGNET WIRES

Round, Square, Rectangular
Enamel, Formel
Paper, Cotton
Polyester, Nylon
Polyurethane

FLEXIBLE WIRES, CABLES and CORDS

Annunciator
Aircraft Cable
Fixture Wires
Flexible Cords
Railway Cables
Military Wire
Neon Sign Cable
Oil Burner Cable
Office Wire
Portable Cords—SV, SJ, S, SJO, SO
Portable Cables—SW, SWO, W, G, SH
Motor Lead Cables
Welding Cable

MISCELLANEOUS

TV Camera Cables
Cable Terminations
Junction Boxes
Potheads
Splicing Materials

COMMUNICATIONS WIRES and CABLES

Alpeth Cables
Stalpeth Cables
Radio & Coaxial Cables
Fire Alarm & Signal Cables
Interphone Cables
Paper Lead Telephone Cables
Philplex Switchboard Cables
Telephone Wires & Cables
Telegraphic Cables
Terminating Cables

ROCKBESTOS CABLES

Boiler Room Wires
Fixture Wire—Type AF
Power—Types A1, A2 & A7
Range & Stove Wires
Switchboard—Types A18, A19
Appliance Lead Wires
Special High Temperature Wires
Soil Heating Cable

POWER CABLES

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Protected
Rubber Neoprene Cables
Paper Lead Cables
Varnish Cambric Insulated
Marine Cables
Mining Cables
Submarine Cables
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Phillips Electrical Company LIMITED

WIRES CABLES

6029

industry personnel

Carman R. Hughes

Carman R. Hughes elected vice-president of GT&E International

Carman R. Hughes has been elected a vice-president of General Telephone & Electronics International Incorporated, international manufacturing, marketing, and engineering subsidiary of General Telephone & Electronics Corporation, it was announced recently by Gene G. Beare, president of GT&E International.

In his new post, Mr. Hughes is responsible for co-ordinating all manufacturing, sales, and engineering activities in Canada, involving subsidiaries and associated companies. In addition to serving as a vice-president of GT&E International, he will continue to serve as president of Automatic Electric (Canada) Limited, Automatic Electric Sales (Canada) Limited, and Canadian (B.C.) Telephones and Supplies Ltd. His headquarters are at 100 Strowger Boulevard, Brockville, Ontario, Canada.

A citizen of Canada, Mr. Hughes was born in Oshawa, Ontario. He was graduated from that city's Collegiate College and Vocational Institute, and subsequently attended the Radio College of Canada.

GT&E International, together with Automatic Electric International, produces a wide range of products in the communications, electronics, and electrical fields, with subsidiary manufacturing facilities in Canada, Italy, Belgium, Argentina, Brazil, and Mexico. Associated manufacturing companies are located in Great Britain, Italy, Japan, and Mexico. More than 80 international sales offices, agents, and distributors for Automatic Electric and Lenkurt products are located in 68 countries and territories throughout the world. A total of 125 Sylvania International sales offices, agents, and distributors are located in 77 countries and territories.

In addition to manufacturing, marketing, and engineering operations outside the United States, GT&E International, together with Automatic Electric International, has responsibility for the marketing abroad of products made in the U.S. by all of the GT&E domestic manufacturing subsidiaries. In addition to Automatic Electric, Sylvania, and Lenkurt, these subsidiaries include Leich Electric Company and Electronic Secretary Industries, Inc.

J. M. Brian

H. C. Blenkhorn

R. D. Wilson

NISA appoints Canadians to committee duties

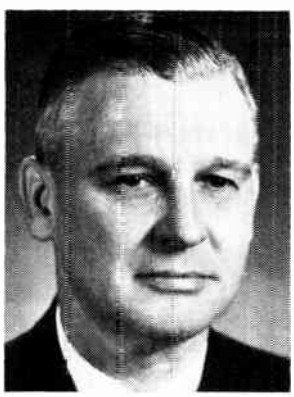
J. Arthur Turner Jr. of Tampa, Florida, president of the National Industrial Service Association, Inc., has announced the appointment of two Canadians to act as chairmen of association committees and has named a third representative from Canada to join the Engineers' Advisory Committee.

Horace C. Blenkhorn, president, Blenkhorn & Sawle, Ltd., of St. Catharines, Ontario, has been appointed chairman of the By-Laws and Resolutions Committee of the NISA. Mr. Blenkhorn served as international president in 1959-60. He is a member of the association's board of directors and executive committee.

Ross Sawle, vice-president of the St. Catharines' firm, has been named to the association's Engineers' Advisory Committee.

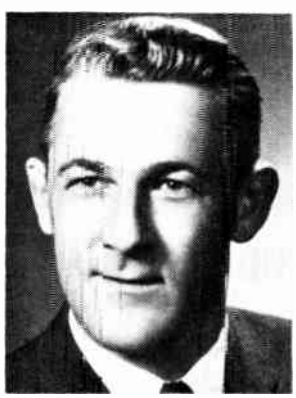
Arthur G. Bamford, general manager, Sutherland-Schultz Electric Co., Ltd., Kitchener, Ontario, has been appointed chairman of the Canadian Affairs and the Management Committees of the NISA. Mr. Bamford is serving his second year as a director of the association. He is a former president of the NISA's Ontario Chapter, one of three regional associations of the industry in Canada.

The National Industrial Service Association will officially change its name next April 1 to Electrical Apparatus Service Association, Inc. Its national headquarters are in St. Louis, Missouri.



E. L. Crossman

A. G. Ballard



R. J. French

Control Switch Division appoints Canadian rep

The Control Switch Division of Controls Company of America has announced the appointment of Brian Engineering, Ltd., as their Canadian distributor and sales representative.

Brian Engineering, who have offices in Montreal and Toronto, will handle the complete line of Control Switch Division products. This line includes switchlites, pushbutton switches, precision snap-action switches, indicator lights, toggle switches, special switches and panel components.

Prior to their appointment by Control Switch Division, Brian Engineering handled only Electrosnap products. They will now handle sales of both Electrosnap and Hetherington lines, as an OEM sales engineering representative and also as a stocking distributor.

J. M. Brian is general manager of Brian Engineering. **T. D. White** is industrial sales manager, while **B. D. Vallillee** is supervisor of Ontario Sales.

Brian Engineering offices are located at 5275 Van Horne Avenue, Montreal, Que., and at 2773 Dufferin St., Toronto, Ontario.

Stokes Co. of Canada appoints general manager

The appointment of **Roy D. Wilson,** as general manager of F. J. Stokes Company of Canada, Ltd., subsidiary of F. J. Stokes Corp., Philadelphia, has been announced by A. A. Hutchings, vice-president. The Canadian subsidiary of Stokes has its headquarters at 4198 Dundas Street West, Toronto, Ont., and offers complete sales and service facilities throughout Canada.

K. F. Kellerman named to major post by Bendix

Karl F. Kellerman, former assistant to the vice-president of engineering, has been appointed to A. P. Fontaine, executive vice-president of The Bendix Corporation.

Mr. Kellerman will assist management in the expansion of Bendix commercial and industrial activities at both the corporate and divisional levels to plan and work out product programs.

Mr. Kellerman joined the Bendix staff in 1955 as associate director of systems planning. From 1953 to 1955 he was president of Kellerman & Company, consulting engineers, Washington, D.C.

Union Carbide appoints silicones technical rep

Robert John French has been appointed a Silicones Technical Representative to the Eastern Sales District of Union Carbide Canada Limited, Bakelite Division. The announcement, made by W. S. Berry, sales manager, indicated that Mr. French will be handling the sales of "Union Carbide" Silicones.

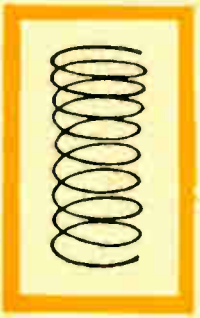
Mr. French graduated from Sir George Williams College in 1950 and since that time has gained a thorough technical background in industry in Eastern Canada. He has completed an extensive training program at the research laboratories of the Silicones Division of Union Carbide Corporation at Tonawanda, N.Y.

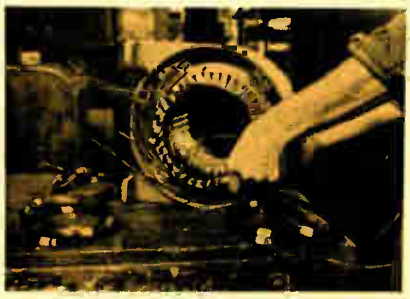
Mr. French will be located in the company's Montreal office at 1255 Laird Blvd., Town of Mount Royal, Montreal 16, Quebec.

Beckman Instruments names regional manager

The appointment of **Paul E. Paules** as western regional manager for the Scientific and Process Instruments Division of Beckman Instruments, Inc., has been announced by Roy F. Brown, marketing manager.

LOOK TO FEDERAL FIRST





MAGNET WIRE FOR THE SMALLEST COIL TO CANADA'S LARGEST TRANSFORMER

Yes, look to Federal first for magnet wire to meet every manufacturing demand. Federal research provides new product development and testing to meet the growing and changing demands of the industry. Exacting quality control during every stage of production ensures magnet wire of absolute top quality, for the smallest television coil to the largest power transformer.

Federal magnet wire—Formel, Isonel, Isomelt, Isobond, Daglas and conventional enamels are specified and used by leading engineers who know they can rely on Federal's technical perfection ... whether in square, rectangular or round shapes. Every type of insulation or covering is available from Federal. All of our enamels are made to our own or customer's specifications. Sizes range from #6 to #40.

Federal's continuing research program also develops new packaging to improve production methods and to help lower your downtime.

Federal engineering and production specialists are available to assist with your individual manufacturing problems and to specify the right Federal product to meet your requirements. Write today for further details.

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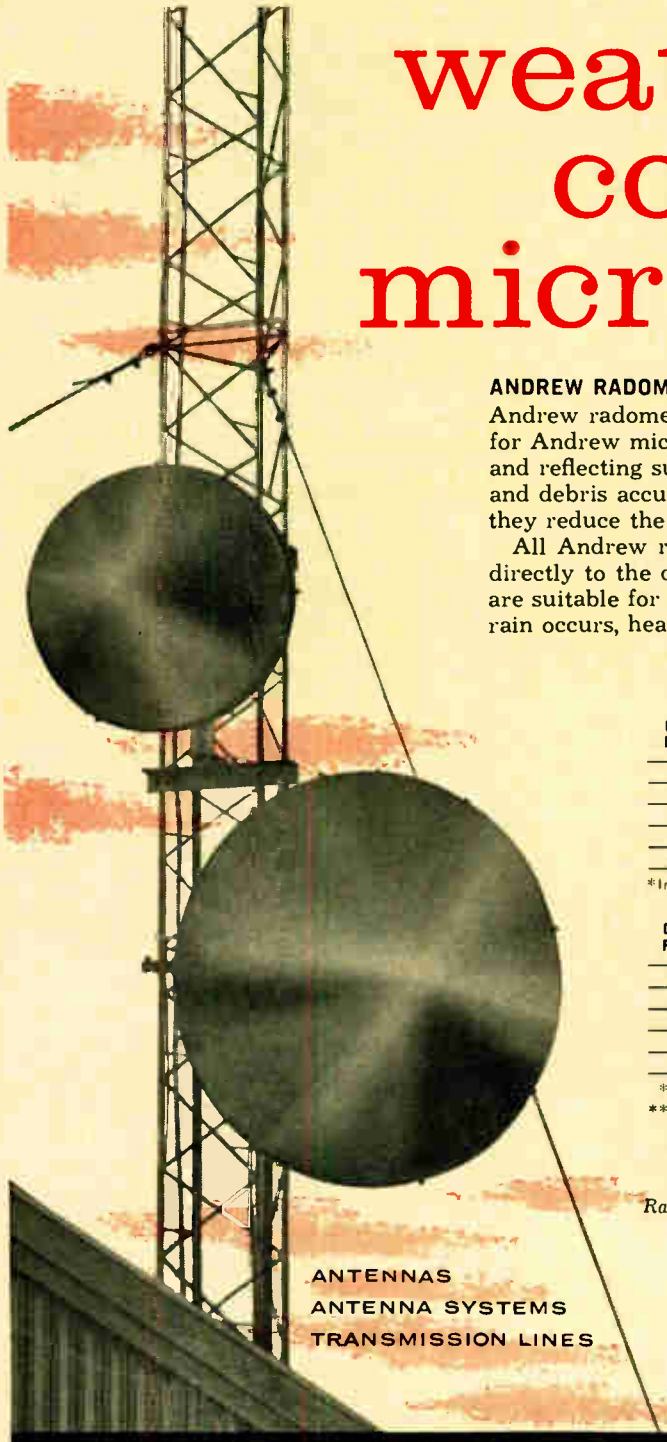
For complete details check No. 47 on handy card, page 73

weather conditioned microwave



ANDREW RADOME EQUIPPED ANTENNAS DEFY ICE...SNOW...WIND

Andrew radomes provide excellent 2-way year-round protection for Andrew microwave antenna systems. First, they protect feed and reflecting surface against the attenuating effects of snow, ice and debris accumulation. Secondly, for tower mounted antennas they reduce the effects of wind thrust by 35%.

All Andrew radomes are lightweight and easy to install—clip directly to the dish rim of existing antennas. Unheated radomes are suitable for all but exceptional cases. In areas where freezing rain occurs, heated radomes can be provided.

SPECIFICATIONS

STANDARD RADOMES

Dia. Feet	Type No.	Attenuation @ 6 kmc. db	VSWR Contribution @ 6 kmc	Thrust at* 30 psf (Flats), lbs.
10	R10	0.4	0.02	1,990
8	R8	0.4	0.02	1,270
6	R6	0.4	0.02	714
4	R4	0.4	0.02	320
2	R2	0.4	0.02	75

*Including antenna

HEATED RADOMES

Dia. Feet	Type No.	Attenuation @ 6 kmc. db	VSWR Contribution @ 6 kmc.	Thrust at* 30 psf. (Flats), lbs.	Power** Reqmts.
10	HR10	0.7	0.02	1,990	3,400 watts
8	HR8	0.7	0.02	1,270	2,400 watts
6	HR6	0.7	0.02	714	1,200 watts
4	HR4	0.7	0.02	320	550 watts
2	HR2	0.7	0.02	75	150 watts

*Including antenna

**Power requirements for HR10 and HR8 are 3 wire single phase 60 cycle 220 volts.

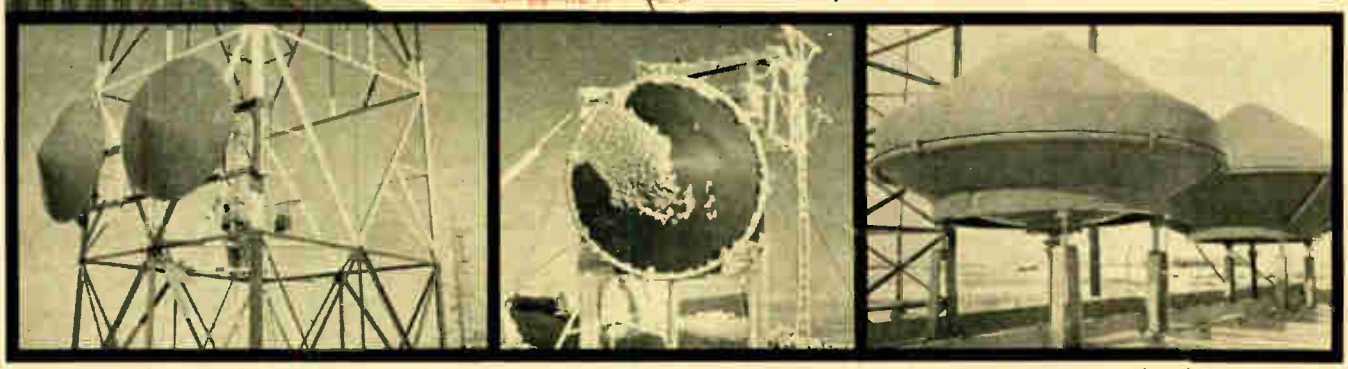
Power requirements for HR6, HR4 and HR2 are single phase 60 cycle 115 v.

For further details on ANDREW Microwave Antennas, Radomes, Wave Guides write for new Andrew Catalog CM.

ANTENNAS
ANTENNA SYSTEMS
TRANSMISSION LINES

Andrew ANTENNA CORPORATION LTD.

606 Beech Street · Whitby, Ontario
Telephone: MOhawk 8-3348



"We have paid particular attention to antennas during extremely high wind conditions of gusts up to 40-60 m.p.h. It is very obvious that these radomes quite materially reduce the wind loading on the parabolas—due to their shape factor." *(Police Broadcast)*

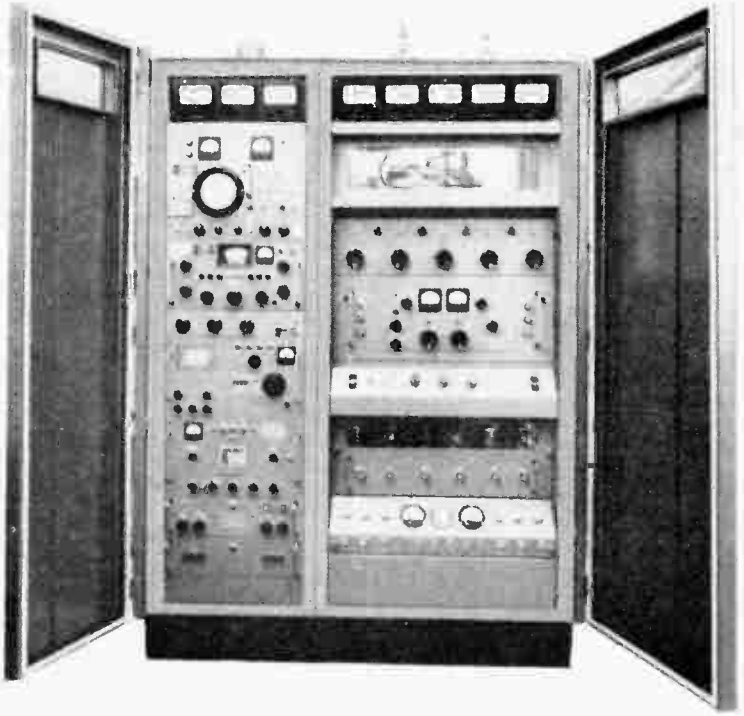
"We have had up to four inches of ice on the radome with practically no reduction of antenna effectiveness. During high winds, radome reduces pressure on the dish. *(AM-TV Station)*

"Our field forces report that the radomes produce a signal loss of less than 1 db per antenna. Several radomes were removed and antennas inspected following a heavy snowstorm and no snow or ice was found in the antennas." *(Gas Pipeline Company)*

For complete details check No. 3 on handy card, page 73

TELECOMMUNICATIONS

for industry and defence
manufacturers and designers
of a wide range of
communications equipment

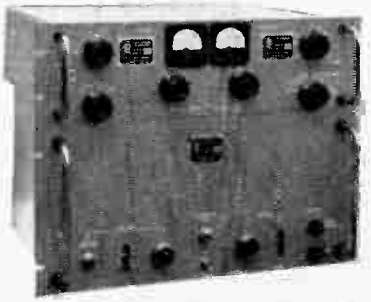


GENERAL PURPOSE HI-POWER TRANSMITTER

This unit is capable of providing 10 kw PEP output throughout the range 4 to 28 megacycles. The Model GPT - 10K includes all excitation equipment, V.F.O., spectrum analyzer, F.S. Exciter, and complete "on the air" testing circuitry. **Bulletin #207**

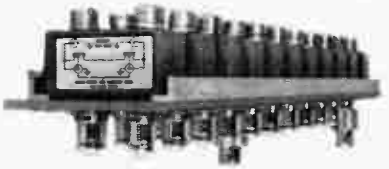
Write for applicable Sales Service Bulletins.

The TMC series of Antenna Multicouplers covers the frequency range 15 kc to 30 mc and provides an effective match with a minimum of interaction between receivers, and a minimum of intermodulation and cross modulation. #155

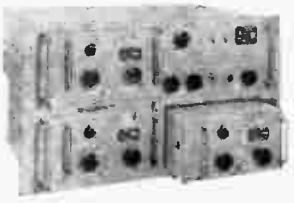


The TMC Model SBE, Transmitting Mode Selector, is a universal exciter permitting the transmission of any intelligence on Single or Double Sideband, with or without carrier. #195

The Model GPR-90 Receiver is a professional, general purpose communications receiver of the double conversion superheterodyne type covering the frequency range of .54 to 31 mcs. in 6 bands. TYPE OF RECEPTION: AM, CW, MCW, FS and SSB. #179



The TMC Series Model SPP Switching Patch Panel for use in RF Signal Distribution systems where a "normalizing" patching scheme is indicated. #210



The Model FFR is a highly versatile receiver, covering the frequency range 50 Kcs, to 32 Mcs and is used for dependable, unattended continuous reception of AM, CW, MCW, FS and SSB signals. Provision is made for Crystal, Internal and External operation of the HFO and BFO. The Receiver is also available with squelch (CODAN) and for Beacon Monitoring purposes. #200

T.M.C. *Canada* LIMITED

R.R. 5, OTTAWA, ONTARIO

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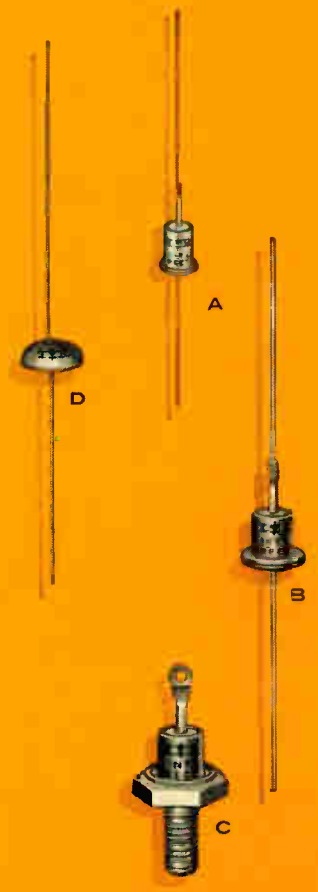
For complete details check No. 62 on handy card, page 73

A PARTIAL LISTING OF INDUSTRY'S **WIDEST LINE!**

GENERAL PURPOSE SILICON DIODES



Type Number	Peak Inverse Voltage, Volts	DC Output Current, Ma	Max. DC Reverse Current Ma
A — 300 Ma Rated (at 50°C), 50 to 500 PIV Reverse Current Characteristics at 100°C			
1N1701	50	300	0.4
1N1702	100	300	0.4
1N1703	200	300	0.3
1N1704	300	300	0.3
1N1705	400	300	0.3
1N1706	500	300	0.3
A — 500 Ma Rated (at 50°C), 50 to 500 PIV Reverse Current Characteristics at 150°C			
1N1707	50	500	0.4
1N1708	100	500	0.4
1N1709	200	500	0.3
1N1710	300	500	0.3
1N1711	400	500	0.3
1N1712	500	500	0.3
B — 550 to 750 Ma Rated (at 50°C), 100 to 500 PIV Reverse Current Characteristics at 100°C			
SD-91	100	550	1.0
SD-92	200	550	1.0
SD-93	300	550	1.0
SD-94	400	550	0.80
SD-95	500	550	0.65
SD-91A	100	750	0.5
SD-92A	200	750	0.5
SD-93A	300	750	0.5
SD-94A	400	750	0.4
SD-95A	500	750	0.3
B — 250 Ma Rated (at 150°C), 50 to 600 PIV Reverse Current Characteristics at 150°C			
1N536	50	250	0.4
1N537	100	250	0.4
1N539	300	250	0.3
1N1095	500	250	0.3
1N1096	600	250	0.3

Type Number	Peak Inverse Voltage, Volts	DC Output Current, Ma	Max. DC Reverse Current Ma
B — JAN Types — 250 Ma Rated (at 150°C) Reverse Current Characteristics at 150°C			
1N538	200	250	0.3
1N540	400	250	0.3
1N547	600	250	0.3
C — JAN Types — 400 to 1000 Ma Rated (at 135°C) Reverse Current Characteristics at 135°C			
1N253	95	1000	0.001
1N254	190	400	0.001
1N255	380	400	0.0015
C — Power Supply Types, 800 Ma Rated (at 100°C) Reverse Current Characteristics at 25°C			
1N607	50	800	0.025
1N608	100	800	0.025
1N609	150	800	0.025
1N610	200	800	0.025
1N611	300	800	0.025
1N612	400	800	0.025
1N613	500	800	0.025
1N614	600	800	0.025
C — Mag. Amp. Types, 800 Ma Rated (at 100°C) Reverse Current Characteristics at 25°C			
1N607A	50	800	0.001
1N608A	100	800	0.001
1N609A	150	800	0.001
1N610A	200	800	0.001
1N611A	300	800	0.001
1N612A	400	800	0.0015
1N613A	500	800	0.002
1N614A	600	800	0.0025
D — Commercial Types, 200 to 500 Ma (at 70°C) Reverse Current Characteristics at 100°C			
5E4 (Cap. Load)	400	350	0.5
(Res. Load)	400	500	0.5
2E4 (Cap. Load)	400	200	0.5
(Res. Load)	400	300	0.5

FOR DETAILED DATA, CIRCLE READER-SERVICE CARD NO. 0000.

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Choose from the industry's widest line of axial lead and stud mounted silicon diodes, (if you'll excuse the expression) available "off-the-shelf" from our exclusive Canadian Representative, Douglas Randall, Canada, Ltd. Providing our Canadian friends and customers with a complete coast-to-coast service, Randall Limited sales engineers offer immediate attention and prompt delivery of the entire International Rectifier Line.

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scatter matter

Scanning the international scene

Electronic devices to permit soft landings of space vehicles on the moon are being studied at Raytheon Co.'s Airborne Equipment Center at Sudbury, Mass. Soft landings are essential to space navigation. Damage to space-craft or their sensitive equipment could leave astronauts stranded or wandering aimlessly in space.

The first closed-circuit television system in the Virgin Islands will swing into operation in September with five video channels and two FM music frequencies. The system, under construction since November 1959, is being engineered and equipped for its operator, the Virgin Isle TV Cable Corp. It is being built in Charlotte Amalie, capital of St. Thomas, largest of the Virgin Islands' three principalities, at a cost of more than $150,000. When completed it will service an estimated 15,000 permanent residents plus the thousands of annual guests of that burgeoning tourist mecca.

Developmental Engineering Corporation of Leesburg, Va., and Washington, D.C. has been chosen by Cornell University as one of a four-firm team which will jointly produce the final design of the world's largest radio telescope. The ionospheric radar probe, powerful enough to detect an object about three feet square at a distance of 22,000 miles, will improve astronomical measurement accuracy by at least ten times. The reflector portion of the radio telescope will have a diameter of 1000 feet. The largest fully steerable radar currently in operation (Jodrell Bank, England) has a 250-foot reflector.

The world's largest meteorological radar system, designed for detecting typhoons, has been completed at the Komukai plant of Tokyo Shibaura Electric Company. It went into operation at the end of August.

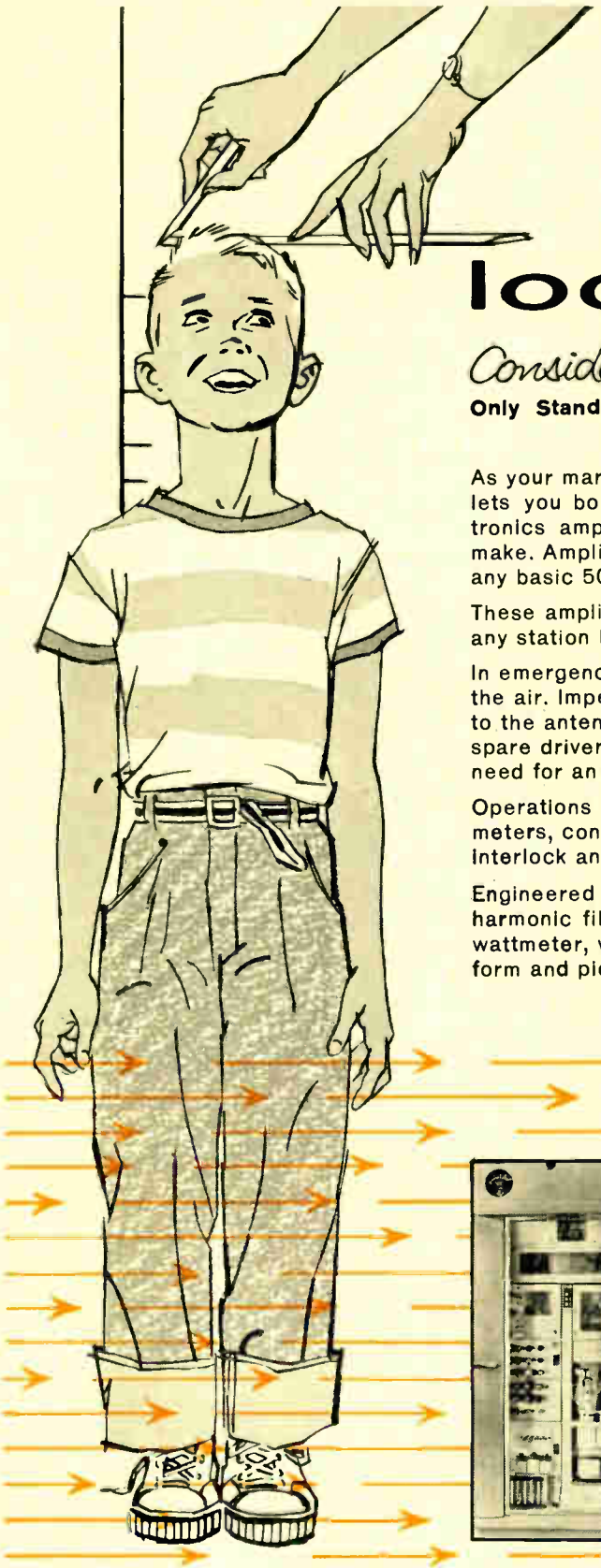
The unit, which was ordered at the end of 1959 by the Meteorological Agency, operates at 3,000 megacycles, has a maximum output of 600 kilowatts and an observable distance of 312 miles. The latter two factors make it double the capacity of similar radar units already installed at Fukuoka, Osaka, Naso and Okinawa stations as well as another set up in Tokyo.

It is particularly designed for observing typhonic "eyes" or storm centers, and for determining the direction of oncoming typhoons, rather than merely for observing cloud and rainfall.

A spaceship put together in outer space could take man to the moon after 1965 using systems already developed, a scientist at North American Aviation's Missile Division predicts. The outer space assembly idea was called the "in-transit rendezvous" method by its originator, Charles E. Kaempen, a research specialist at Missile Division. He disclosed his method in a paper prepared for the 11th International Astronautical Congress in Stockholm, Sweden, August 15-19. Kaempen's method would use Saturn boosters and the Mercury manned capsule. Both are developed now and are expected to be operational by 1965.

Deep-penetration radar beams may soon help to unlock trapped oil reserves jellied in rock thousands of feet beneath the earth's surface. Raytheon Company revealed recently that it has under development an electronic oil well heater which may aid in the recovery of some of the vast oil reserves which cannot be brought to the surface by present methods. It is estimated that these inaccessible resources comprise seven times the amount of oil as that which has been considered economically recoverable up to this time.

Admiral International Corporation has announced the completion of arrangements for the manufacture of Admiral television receivers in New Zealand. The TV receivers will be produced under license by Collier and Beals Limited of Wellington.



look ahead

Consider "Growth Potential"

Only Standard Electronics TV transmitting equipment can grow from 500 to over 50,000 watts.

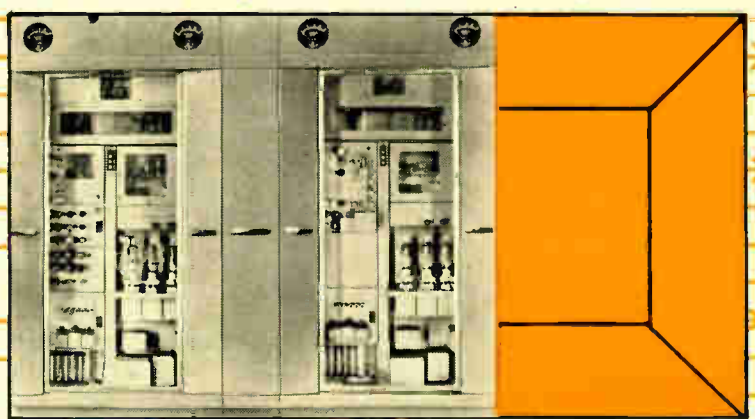
As your market grows, so can your station. "Growth Potential" lets you boost power economically by **adding** Standard Electronics amplifiers to your present equipment, regardless of make. Amplifiers of 10 - 25 and 50 KW output may be used with any basic 500 watt driver.

These amplifiers are self-contained units; easily adaptable to any station layout.

In emergencies, the built-in Patchover protection keeps you on the air. Impedance matched units permit connecting the driver to the antenna in seconds, in the event of amplifier trouble. A spare driver can provide full power in reserve, eliminating the need for an entire transmitter line-up for standby.

Operations and maintenance are planned-for. Large-faced meters, controls mounted in front, full length glass doors, and interlock and overload systems make daily work easier.

Engineered auxiliary equipment includes: antenna diplexer, harmonic filter, linearity correction amplifier, RF dummy load wattmeter, vestigal side-band filter, visual demodulator, waveform and picture monitoring console.



Standard Electronics TV transmitting equipment is distributed in Canada by

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COMPANY LIMITED

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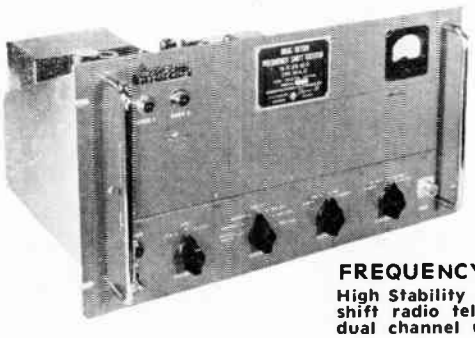
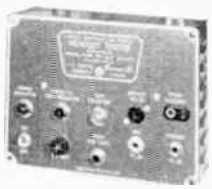
YOUR PROBLEMS Our Answers

Shown below is equipment which has been developed and produced by this All Canadian company in quantity to meet new operational or specific customer requirements.



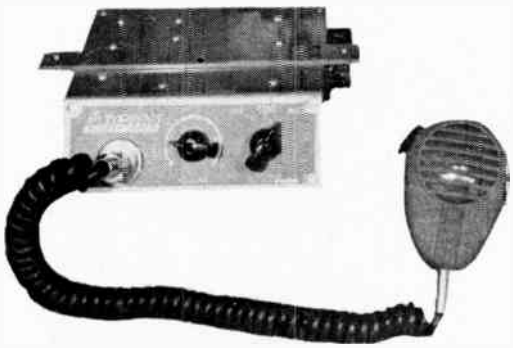
FREQUENCY SHIFT EXCITER
High Stability LF Keyer — Exciters for narrow shift radio teletype circuits. Both single and dual channel units available.

RF EXCITER
± 0.001% stability for use with ground transmitters. An economical method of increasing transmitter stability. Wide-Band, frequencies to 8 Mc/s.

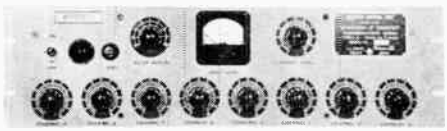


HEADSET TESTER
Installed in air force Crew Rooms, providing a rapid indication of performance of various types of headsets, headphones and microphones.

TRANSISTORIZED RECEIVER
Meets rigorous communications performance requirements, exceptional cross-modulation and desensitization specifications. Produced in quantity for Canada Department of Transport.



MOBILE AUDIO AMPLIFIER
Panel mounted in vehicle, forwards radio messages to external crew through roof-mounted loudspeaker. Also employed as loud hailer. 8 watts, 6 or 12 volt DC systems.



MULTI-CHANNEL AUDIO AMPLIFIER
An example of custom production. Used with airport traffic control circuits.

CONTROL PANEL
For convenient control of multiple radio transmitter and receiver circuits, also incorporates control tower inter-communication system. Back lighted panel for use in radar operations.

Contact us in the early stages of your requirements.

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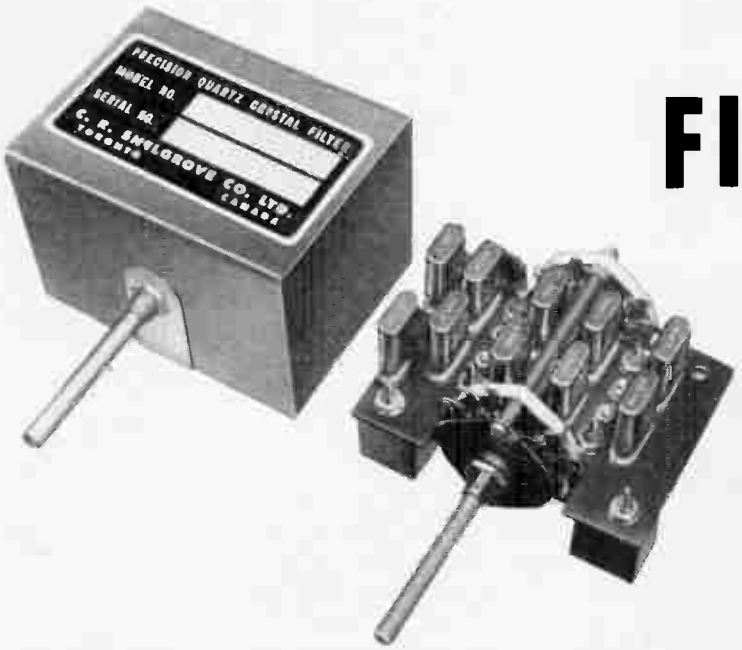
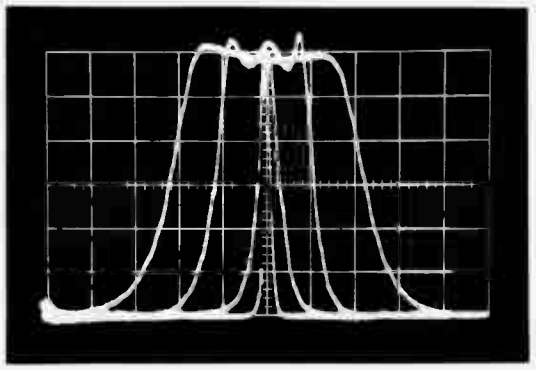
For complete details check No. 64 on handy card, page 73

FOUR BAND PASSES AT YOUR FINGER TIPS!



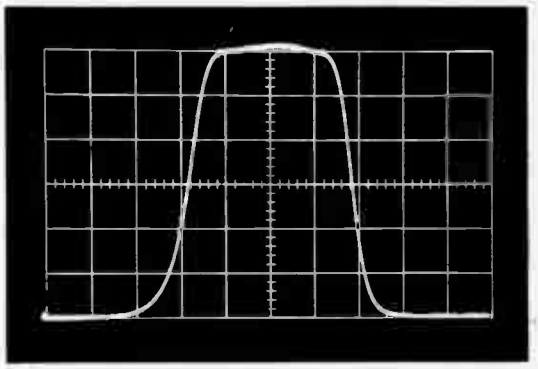
Actual photograph of selectivity curves.



You can have this and much more too, if you utilize the many advantages of a

CRYSTAL FILTER BY SNELGROVE

Perhaps you don't need four band passes; maybe your application requires only one band pass, but the selectivity curve is hard if not impossible to obtain with conventional L/C networks.



If selectivity combined with stability is a design problem, we would be pleased to discuss the application of a Snelgrove Crystal Filter.

For quartz crystals and crystal ovens of proven superior quality at reasonable prices it pays to patronize a "Quality House". We have been a preferred source of crystals by the elite of the electronics industry for over ten years. There must be a reason!

C. R. SNELGROVE CO. LIMITED

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For complete details check No. 54 on handy card, page 73

briefing the industry

■ According to W. E. Curry, electronic consumer division manager of Dominion Electrohome Industries Limited the heavy import of Japanese electronic tubes into Canada has not yet affected his company. However Mr. Curry states that: "no matter how much we 'Buy Canadian' to help Canadian economy we will soon be forced to buy the cheaper Japanese tubes. We can't indefinitely shrug off a two-thirds saving if our competitors take advantage of the lower price." Electrohome uses about 1,500,000 tubes a year.

■ The Defense Expenditures Committee of the House of Commons was recently told that the Canadian electronics industry may receive $200 million equipment orders from The Netherlands, West Germany and Belgium. D. B. Mundy, chief of the Electronics Branch of the Department of Defense Production said that the anticipated orders were for jet plane flight simulators.

■ Officials of the Canadian Marconi Company have recently made known that the company is selling Japanese electronic tubes in Canada. Canadian Marconi Company is the first Canadian firm in the field to import Japanese tubes and sell them under their name. According to Mr. Slinger, manager, Electronic Tube and Component Division, the Canadian electronic tube business is disintegrating under the present import set-up and his firm has made the move to protect its interests in the field. Imported tubes being sold by Marconi have the words "Marconi" and "Made in Japan" imprinted on the glass envelopes of the tubes.

■ Transport Minister George Hees has stated in the House of Commons that the German firm of Felton and Guilleaume of Cologne have been awarded an $8,296,455 contract for the construction of a Newfoundland-Iceland submarine cable. The bid was the lowest of three submitted according to Mr. Hees, the other two being Cables de Lyon, France $8,428,051 and Submarine Cables and Standard Telephones and Cables, London, $8,533,466. Mr. Hees disclosed details of the bids as the result of pressing from Lionel Chevrier (Liberal member for Montreal) who complained that the French company had planned on building an electronics plant in Quebec to execute the order. The French concern, according to Mr. Chevrier had purchased a $2.5 million site for its proposed plant at Trois Rivieres.

■ The 10th Annual Report of the Canadian Overseas Telecommunications Corporation shows a net profit of approximately $1,000,000. The Report shows that all six services operated by the Corporation, telephone, telegraph, international telex, leased circuits, program transmissions and overseas photo pictures all enjoyed increased revenues. After the Corporation had paid out $938,407 for income tax and $528,790 interest charges on government loans, the net profit for the year amounted to $947,638.

■ What is expected to be the largest data processing system in Western Canada is expected to be completed by 1961 for the Provincial Auditors Branch of the Alberta Government. C. K. Huckvale, provincial auditor is arranging for the installation of the equipment with a New York firm. According to Mr. Huckvale the switch-over to electronic accounting will take several years and initially the equipment will probably be retained on a rental basis.

■ Defense estimates tabled in the House of Commons recently by Defense Minister Pearkes indicated that the acquisition of submarines for the Royal Canadian Navy is more than a probability. *Electronics and Communications* has stated on several previous occasions that the use of this type of vessel was under active study by defense authorities in Ottawa. We believe that it will not be too long before a definite statement will be made with respect to the actual acquisition of these vessels and that the electronic equipment for them will provide a much needed shot in the arm for the Canadian electronics industry.

has something new

IN MOBILE RADIO

The Systcoms I S L 148-174 Mc/s Mobile Radio telephone — the smallest . . . anywhere . . .

The unexcelled engineering skills of I S L electronic engineers and technicians have perfected this rugged line of transceivers to pass the rigid requirements of the Department of Transport of Canada, and the F. C. C. in the United States.

FEATURES:

- **Transistorized power supply**
- **One to six channels**
- **For mounting under the dash or in the cab of all vehicles**
- **Narrow or Wide-band (30 Kc/s or 60 Kc/s channel spacing)**
- **Size 4" high by 11" wide by 12" deep (10 x 28 x 30.5 cms)**
- **Weight 15 lbs. (6.8 Kgms)**
- **Utmost in reliability, performance, low maintenance costs. Proved by year-long field tests under severe climatic and road conditions.**

Write for complete specifications and description OF OTHER equipment. Fixed base and repeater stations and trunk-mount sets also available.

Inquiries invited from reliable agents; some territories still open.

Territoires encore non-couverts; agents responsables envitès à faire application.

Solicitamos informes de firmas accreditadas; tenemos zonas disponibles.

INTERNATIONAL SYSTCOMS LIMITED

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For complete details check No. 32 on handy card, page 73

Electronics and Communications

CANADIAN EXPORT ISSUE

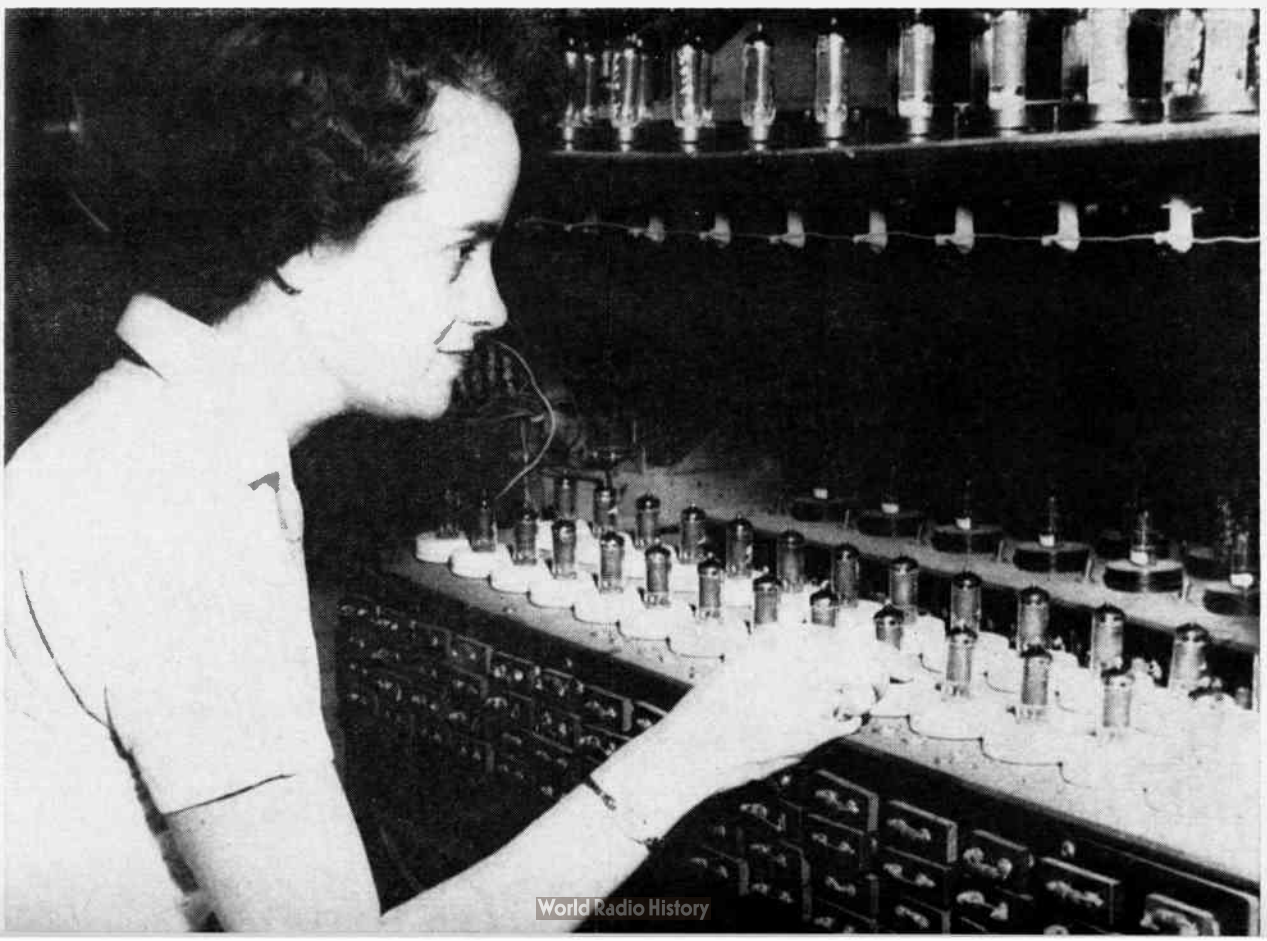
Canada's electronics industry its origin–growth and achievements

From a humble World War I beginning, it flourished through the lush 20's — grew unimpeded through the lean 30's and stood ready at the outbreak of World War II to offer its invaluable assistance to the cause of Allied victory. Today it is second to none in creative and productive ability and offers to all comers from markets around the world equipment of unexcelled quality.

The earliest application of the electronic art and science occurred in Canada during World War I when wireless equipment was used by the Armed Services for communication purposes. In 1919 irregular broadcasting for amateur radio enthusiasts began, and the first regular broadcasting station started operations on November 4, 1920, to cater to the public demand for programs.

In 1923 four large manufacturers of electrical power line equipment were producing radio receivers in Canada, although some receivers were imported from the United States. As the art developed at an increasingly rapid rate, the principles were applied to the fields of power equipment, public communication equipment, and radio transmission and reception, and other companies were formed to commence production in the expanding new field. Thus was established the first of what was to be an ever increasing series of new secondary industries founded in Canada as a result of the Electronic Revolution.

In 1929 there was a sufficient number of interested companies to establish the Radio Manufacturers Association, the original name for the Electronic Industries Association of Canada, and the production of radio receivers, for the consumer market, and of broadcasting and studio equipment, all of which provided the incen-



At right, Paul P. Webb of the RCA Victor Research Laboratories, Montreal, with sample of the newly-announced alpha-particle detector against a background of the nucleonic equipment used in the RCA Victor tests.

tive for the opening of plants to make electronic components. In 1932, there were enough companies manufacturing parts to create a new Division within the RMA (Radio Manufacturers Association), a Parts and Accessory Division. There were, at that time, sixteen members in the new Division; today there are sixty eight, and these sixty eight member-companies now produce, in Canada, practically every type of component necessary for electronic communication equipment and consumer products such as radio or television receivers and, to an ever increasing extent, for industrial, commercial and military electronic equipment.

Importation into Canada

Notwithstanding the formation of new companies to manufacture radio receivers in Canada, in the late 1920's quantities of radio sets were imported into Canada, mainly from the United States. However, as more plants were opened in Canada and more workers trained, importation was quickly reduced until, by the early 1930's, imports had been lowered to a very small proportion of the total output of the Canadian industry. This trend to manufacture in Canada was further encouraged by the "working" provisions of the Canadian Patent Act, which are patterned after those of the corresponding British act.

The accompanying table shows how rapidly importation declined as this new Canadian industry developed its production facilities.

Year	Radio Sets Imported	Total Sales In Canada
1927	45,000	74,000
1928	60,000	122,000
1929	64,000	180,000
1930	80,000	225,000
1931	30,000	274,000
1932	450	114,000

From 1932 to the present time the number of radio (and later television) receivers imported into Canada has been almost negligible compared to the vast production output of the Canadian Electronics Industry.

Location of electronic manufacturers

In accordance with natural development, the majority of the new manufacturers opened plants in the more densely populated and industrialized areas of the country, in Ontario and Quebec. Here were located other industries such as the woodworking industry, used for supplying cabinets for the earlier types of radio receivers, the wire industry, and other production resources which the new electronic industry stimulated. Also, transportation, power supplies, labor force, and other facilities were readily available. The early factories were established mainly in the Toronto-Hamilton area in Ontario and in the Montreal area in Quebec.

Illustration on opposite page shows life testing of tubes at Canadian General Electric plant in Toronto. Samples from every production lot of tubes are taken out for life testing for 500 to 1,000 hours at higher-than-normal voltages. Should any faults develop, the entire production run is taken out to eliminate any possibility of faulty tubes reaching the market.

Below, technician at Pylon Electronic Development Company, Ltd., LaSalle, Quebec, is shown working on pre-wired sub-assemblies of power units, part of a growing line of proven solid-state devices manufactured by the company.

Checking Bourns' TRIMPOT® potentiometers at Douglas Randall (Canada) Ltd., Toronto. Each TRIMPOT® is individually inspected 100 per cent for all electrical and mechanical specifications in order to maintain high quality performance standards for military and commercial applications.

The bridging of an RSC Remote Control Unit, which is part of the AN/FRA-501 and AN/FRR-502 Remote Control Receiving System, is being carried out in the test and inspection department of T.M.C. (Canada) Ltd., Ottawa, manufacturers of communications equipment.

Technological development

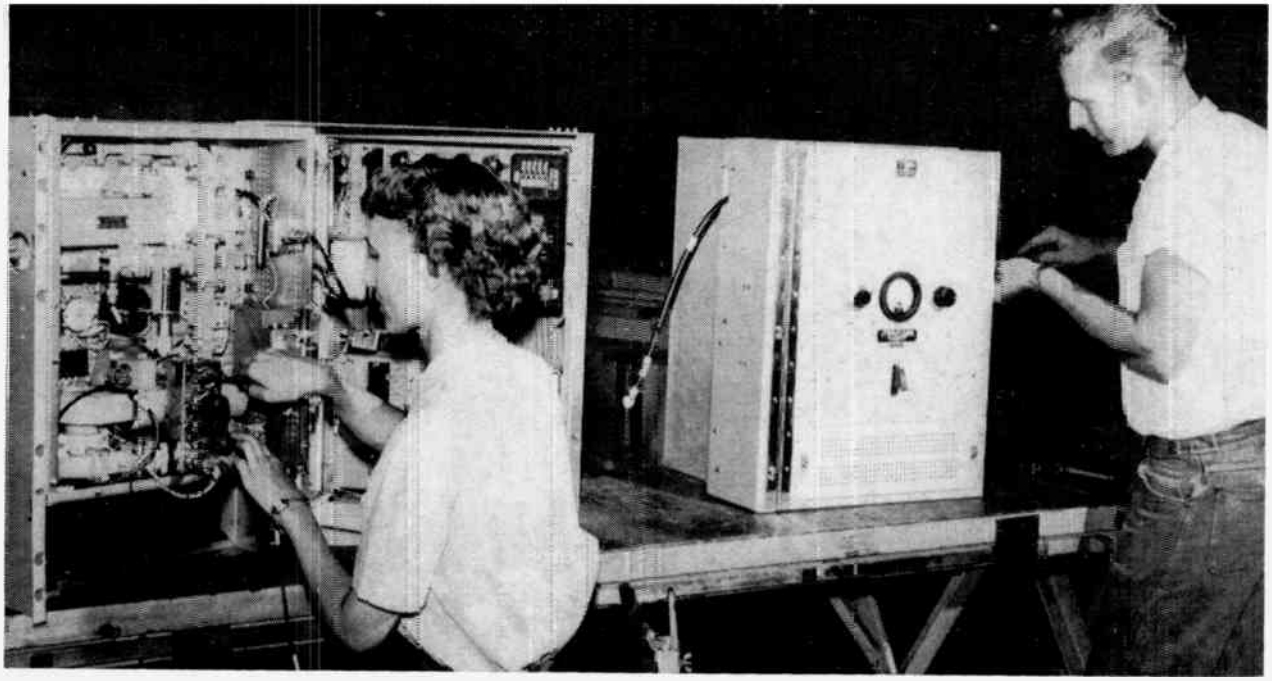
The technology of the art and science of electronics developed at a rapid rate in the early years of the industry, a process which has increasingly accelerated over the years. The hundreds of inventions and innovations made available by applying the production embodiments of fundamental research to give sensitivity, better selection, and more efficient general operation gave the Canadian public exceptional value in consumer products such as radio receivers and combination phonographs. Techniques of mass production were adopted in factories producing this merchandise, resulting in improved receivers being marketed at steadily reducing prices.

From the early crystal sets, the radio receiver as known today was gradually evolved. The invention and use of the vacuum tube had a tremendous impact on the art as it made possible detection and amplification qualities hitherto unknown. Further developments followed rapidly — the grid leak, regeneration or feedback, and the use of a variable tuning condenser were all incorporated in radio receivers in the middle 1920's. These technical innovations were followed by the adoption of neutralization, a circuit minimizing radio interference by eliminating unwanted signals from the receiver.

The commercial use of the tuned radio frequency circuit followed rapidly and, in 1928-1929 one of the most important technological advances was incorporated into production radio receivers — the power supply circuit.

Until 1928 all radio receivers were battery-operated with the exception of one special purpose type of radio receiver produced by one manufacturer of the period. With the advent of the power supply circuit it was made possible to plug a lead from a radio receiver

A portion of the control cubicle assembly line at Mechron Engineering Products, Ottawa, Ontario. These cubicles form part of No-Break power plants providing uninterrupted power and supplied by Mechron to the Department of National Defense.



Line operators completing the final assembly on parametric amplifiers at Northern Electric Company Limited, Belleville, Ontario. These units are currently being used as low noise RF amplifiers in Tropospheric Scatter Systems. Frequency range: 755-985 mcs. The overall gain is in excess of 40 db from the UHF input to the IF output. Noise figure: 2 db. The IF output is at 70 mcs. Input VSWR is better than 1.3:1 across 15 mcs. bandwidth.

into the power supply of a house, making batteries redundant.

In the 1930's many more improvements were made. Screen grid tubes were used and the principles of superheterodyning and super-regeneration were adopted as standard engineering features.

During this period, 1920-1939, the Canadian Electronics Industry produced radio receivers for the home market, transmitting equipment for broadcasting studios, communication equipment for overland and marine use, and other electronic equipment, and some experimental work was undertaken by a few of the larger manufacturers who had research laboratories and similar facilities.

In the same period of development the components section of the industry had built up a great capacity in Canada and was developing and manufacturing an ever-increasing amount of the thousands of different components for use in the electronic equipment being manufactured. This had resulted, by 1937, in the achievement of an average of over 80 per cent Canadian-made content in every radio receiver produced. Immediately prior to World War II the industry was producing electronic goods with a factory shipment value of just under $20 million.

The electronics industry in World War II

When World War II broke out in September 1939 the Canadian Electronics Industry was fully engaged in fulfilling the domestic demands for its products. The build-up of the industry from the early 1920's had resulted in the possession, by Canada, of a home industry working at a peak of efficiency and having a vast potential production capacity. That this was of invaluable aid in winning the war is indisputable, particularly when electronic eyes and ears played such a vital part in military communication and in detection and destruction of enemy targets on land, at sea, and in the air.

Immediately after the outbreak of war, the production of electronic products such as radio receivers, and transmitting equipment for broadcasting stations, was rapidly tapered off and the industry was turned over to the manufacture of electronic equipment for war use. Under the stimulus of government contracts rapid expansion took place, and many existing plants were considerably extended and new plants built and equipped.

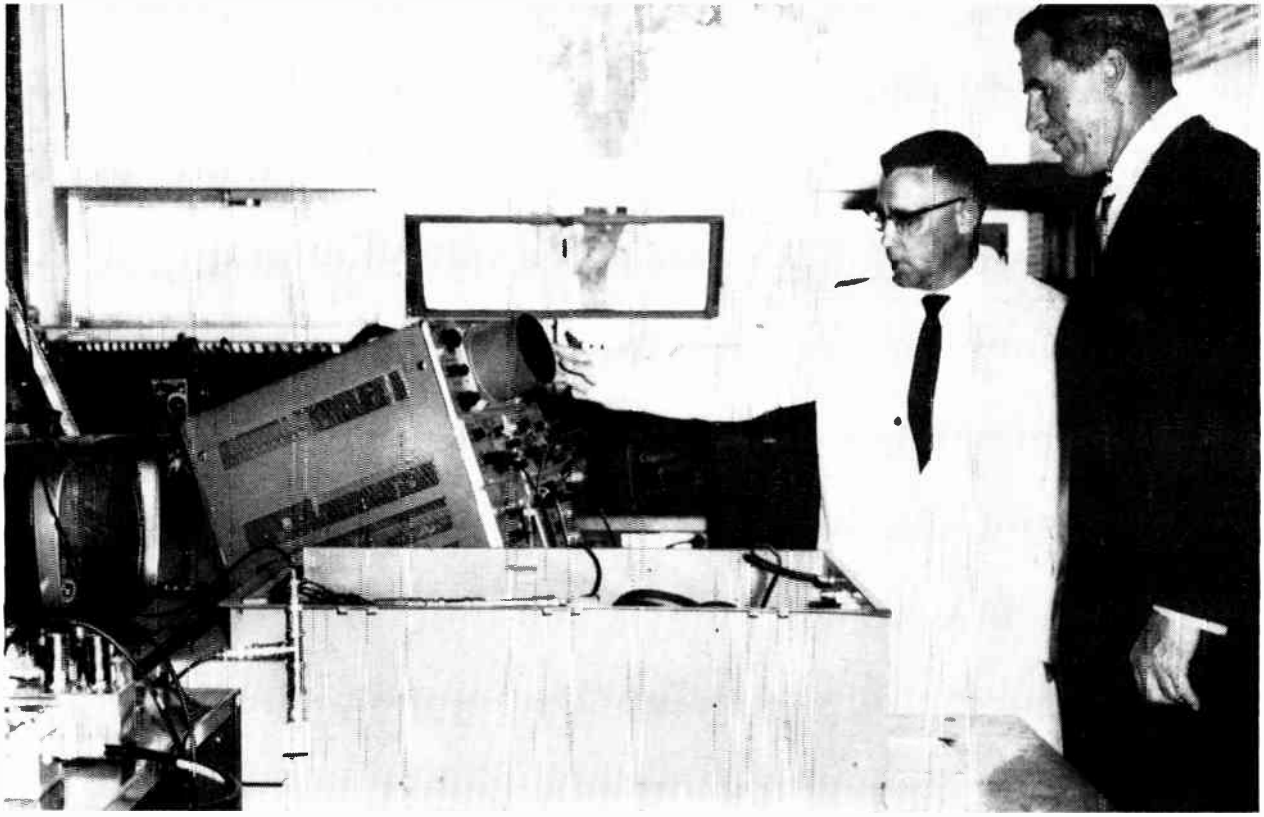
During the six years of war the Canadian Electronics Industry produced equipment for all three Armed Services of Canada and for the Armed Services of Allied countries. Some of this equipment included radar, for airborne and shipborne use and for identification of aircraft by land bases, radio and radio-telephone communication equipment, electronic anti-aircraft control apparatus for the automatic sighting and fire control of gun batteries, remote radio control of pilotless aircraft, electronic navigation aids which were vitally necessary for ships in convoy and in the approaches to foggy or dark estuaries, and the production of sonar, the underwater counterpart of radar for the detection of submarines, navigational aids for blind approach and landing of aircraft in bad weather and at night were also manufactured as well as air position indicators in the form of radio beacons.

The use of Loran navigational equipment by the Royal Canadian Navy not only required the building of this equipment but necessitated the construction and installation of numerous electronically-equipped shore stations along the country's seaboards.

The delicate electronic mechanism used in the proximity fuse of anti-aircraft shells was made in Canada during the war and these shells were instrumental in increasing the effectiveness of air defense in Europe and elsewhere.

Special devices

Some of the more specialized electronic devices and components developed and produced in Canada during wartime were the Telcothene cable and connectors, the VT-90 or micropup tube, the NR-99 tube, various magnetrons and associated devices, the famous VT-98 high power pulse transmitter tube operating at 200 m/c., the acorn tube family, cathode ray tubes with long-persistence screens, the latter being mass produced in various sizes from 5 inch to 12 inch, the fuze tube, the klystron and TR tubes, 10 centimeter crystals, power Selsyns, carbon type and silverstat voltage regulators, specialized meters, high voltage capacitors, specialized resist-



Hon. George Hees, Minister of Transport, right, is shown equipment used for testing a community antenna television amplifier by radio engineer Walter Macklon, during the minister's visit to the new DOT standards testing laboratory in Ottawa. The new laboratory is rendering valuable service to the fields of business, industry and communications.

ors, wave change switches, VHF panoramic receivers, pulse transformers, 800 cycle alternators and specialized types of antennas.

During the last full year of the war, 1944, the dollar volume of the output of the industry, exclusive of Crown companies, was over $120 million, and development and productivity were gaining momentum at such a rapid rate that the total output for 1945 would have doubled this if the war had continued. If the output of the Crown company, Research Enterprises Limited, and the work sub-contracted by this organization, was added to the previous output, it is estimated that the total volume during the peak year of wartime production would have amounted to about $250 million.

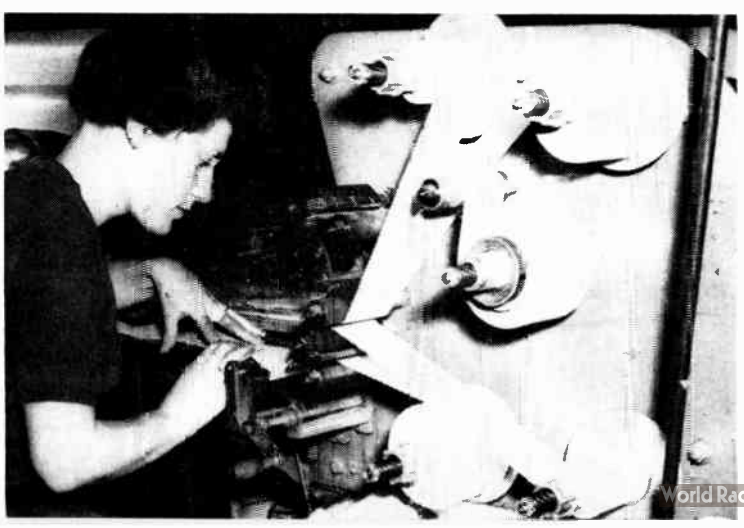
The industry since 1945

This vast industrial expansion and the experience gained by wartime production had an impact on the industry which, when peace returned, accelerated the adoption of wartime electronic products for commercial and industrial use. Like most industries which had rapidly expanded during the war years, retrenchment took place but it did not by any means diminish the Electronics Industry to its prewar size. Many of the plants that had been built and equipped solely for the war effort turned to the production of peacetime electronic components, while many firms which had expanded within themselves during the war years never returned to their pre-war sizes.

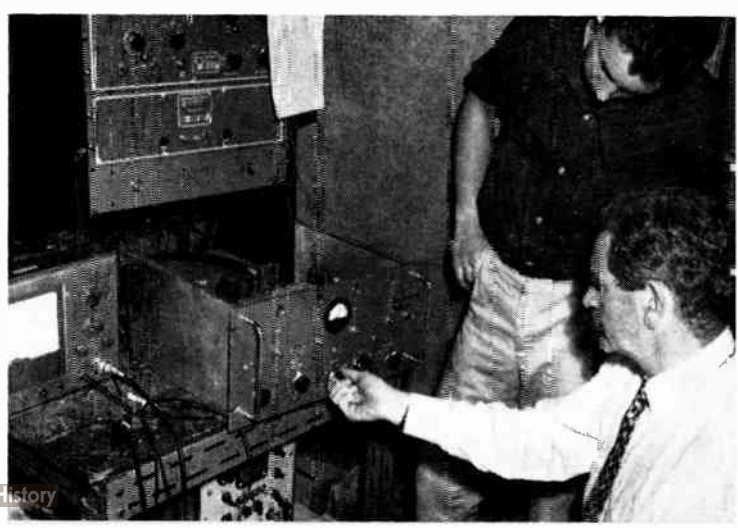
This enlarged and modern, well-equipped industry soon converted to the production of commodities for peaceful use — improved radio receivers and ultimately, television receivers for a domestic market which, due

Continued on page 68

Mrs. Maureen McCormick, an employee of the Telegraph Condenser Company of Toronto, is shown winding electrolytic capacitors, a highly skilled operation.



Colonel J. MacMillan and laboratory technician of Northern Radio Mfg. Co. Ltd., Ottawa, Ontario, are shown checking out communications equipment prior to delivery. Northern Radio Mfg. Co. Ltd. are designers and builders of a wide range of industrial and military type communications apparatus.



James Key

The capabilities of Canada's electronics industry

A message from James Key, President
Electronic Industries Association of Canada

H.R.H. The Duke of Edinburgh has said, "There is hardly any field of science, engineering, or technology in which Canada cannot show some outstanding example". The statement is particularly true in our electronics industries, whose impressive list of products contribute so importantly to the development of Canada as an industrial nation.

Canada utilizes over seven million square feet of manufacturing floor space and employs nearly twenty thousand production workers, engineers, scientists, and administrators in the development and production of the equipment which unites the nation by radio and television; equipment which provides entertainment, education and news; and so many products vital for the nation's defense.

Achievements of Canada's electronics industries in research, design, and development are recognized as being amongst the finest in the world. In the entertainment field alone over four million Canadian-made television receivers have been placed in Canadian homes. As a result over 85 per cent of the population now enjoy television broadcasting and research and development have enabled the electronics industry to be ready for production of color telecasting equipment and receivers immediately official licensing of color transmission is approved.

Canada's prestige in the industrial world has been achieved through the development and production of equipment such as doppler navigation systems, flight simulators, microwave and multiplexing systems, sonar equipment for air and sea defense, fire control and communication equipment, data handling and processing equipment, many types of electron tubes and semiconductors including highly specialized klystrons and magnetrons, and a host of component items which make all these products possible. The list is impressive. In addition, Canada's electronics industries provide installation, maintenance, and environmental test facilities and service facilities which are recognized as being second to none.

Many electronic products on the market today were in the research stage ten years ago. To ensure that the unknown electronic requirements for the exciting future are available Canada's electronics industry is planning, researching, and developing now for its finest years.

Electronics and Communications
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Reference guide to Canadian manufacturers of electronic equipment

On the following pages there are listed Canadian electronics equipment manufacturers and the type of products they manufacture. The list has been compiled from ELECTRONICS and COMMUNICATIONS Annual Electronic Engineers Buyers' Guide and Directory and it will be seen from the list that the Canadian industry is capable of providing a wide range of electronic apparatus — apparatus second to none in quality and which is available to overseas customers. If you should be in need of any of the equipments listed, it will pay to investigate Canada's ability to provide it expeditiously, courteously and with complete satisfaction.

Equipment

Acme Electric Corp. Ltd.,
50 Northline Road, Toronto 16, Ont.
(power supplies)

Addison Industries Ltd.,
9 Hanna Ave., Toronto, Ont.
(portable communications, measuring equipment)

Aircraft Appliances & Equipment Ltd.,
585 Dixon Road, Box 177, Weston, Ont.
(test equipment, power supplies, mag-amp regulators)

Allen-Bradley Canada Ltd.,
135 Dundas Street, Galt, Ont.
(motor controls and switchgear)

Allied Circuit Techniques Ltd.,
1 Robinson St., Oakville, Ont.
(packaged circuits)

Andrew Antenna Corp. Ltd.,
606 Beech St., Whitby, Ont.
(waveguides, transmission lines, antenna systems, antennas)

Automatic Electric (Canada) Ltd.,
100 Strowger Blvd., Brockville, Ont.
(telecommunications)

Aviation Electric Ltd.
200 Laurentian Blvd., Montreal 9, Que.
(flight control equipment)

Bayly Engineering Ltd.,
Hunt St., Ajax, Ont.
(dummy loads, rf monitors)

Beaconing Optical & Precision Materials Co. Ltd.,
455 Craig St., Montreal, Que.
(microwave links, optical equipment)

Bogue Electric of Canada Ltd.,
P.O. Box 900, Ottawa, Ont.
(naval switchgear, rotary power supplies)

The Brunswick-Balke-Collender Co. of Canada Ltd.,
38 Hanna Ave., Toornto, Ont.
(plastic aircraft parts, radomes)

Canadian Admiral Corp. Ltd.,
501 Lakeshore Road, Port Credit, Ont.
(multimeters, amplifiers)

Canadian Applied Research Ltd.,
750 Lawrence Ave. W., Toronto 19, Ont.
(optical and photographic, navigation and survey, airborne radar)

Canadian Arsenals Ltd.,
Warden Ave., Toronto, Ont.
(radar, optical equipment)

Canadian Aviation Electronics Ltd.,
6214 Cote De Liesse Rd., Montreal, Que.
(radiation instruments, flight simulators)

Canadian General Electric Co. Ltd.,
830 Lansdowne Ave., Toronto, Ont.
Electronic Equipment & Tube Dept.
(mobile and fixed radio, transmission systems, servo amplifiers, radar)

Canadian Line Materials Ltd.,
3595 St. Clair Ave. E., Toronto 13, Ont.
(power supplies, carrier current)

Canadian Marconi Co.,
Electronic Tube & Components Div.,
830 Bayview Ave., Toronto 17, Ont.
(mobile radio telephone and telegraph comm., microwave, multichannel, industrial equipment, autopilot, broadcast, navigation, radar)

Canadian Westinghouse Co. Ltd.,
Electronic Division,
P.O. Box 510, Hamilton, Ont.
(microwave & troposcatter communications, countermeasures, data handling, industrial control, radar)

Collins Radio of Canada Ltd.,
11 Bermondsey Rd., Toronto 16, Ont.
(troposcatter, ground and airborne communications, direction finders)

Computing Devices of Canada Ltd.,
P.O. Box 508, Ottawa 4, Ont.
(pulse height analyzer, navigation, radar, data handling, computers)

J. H. Darcy Ltd.,
51 Abbott St. N., Smith Falls, Ont.
(test equipment)

Daystrom Ltd.,
840 Caledonia Rd., Toronto, Ont.
(transmitters, communications receivers, flight computers, instruments, servos, amplifiers, analyzers, recorders, controllers)

Decca Radar (Canada) Ltd.,
23 Six Points Rd., Toronto 18, Ont.
(meteorological equipment, facsimile, teletype, radar)

E.M.I.-Cossor Electronics Ltd.,
2005 MacKay St., Montreal, Que.
(vhf communications, microwave, sonar, video, audio, hydrophones, test equipment, instruments)

Edo (Canada) Ltd.,
P.O. Box 97, Highway No. 2, East Front,
Cornwall, Ont.
(echo and depth sounders)

Edwards High Vacuum (Canada) Ltd.,
P.O. Box 515, Cumberland Ave., Burlington, Ont.
(instruments and high vacuum equipment)

Electronic Communications Ltd.,
P.O. Box 88, Station "O", Montreal, Que.
(telephone equipment, remote control)

Electronic Materials, International Ltd.,
342 Gladstone Ave., Ottawa, Ont.
(airborne and ground communications)

Electronic Research & Development Co. Ltd.,
210-Ninth Ave. S.E., Calgary, Alta.
(carrier, fixed station and land mobile, uhf, vhf)

W. R. Elliott, Engineered Sound Systems Ltd.,
169 Kipling Ave. S., Toronto 18, Ont.
(sound systems)

Ferranti-Packard Electric Ltd.,
Industry St., Toronto 15, Ont.
(scatter communications systems, fire control, flight systems, components and computer systems)

Fleet Manufacturing Ltd.,
Gilmore Rd., Box 300, Fort Erie, Ont.
(antennas, radomes)

The Garrett Manufacturing Corp. of Canada Ltd.,
4 Racine Road, Rexdale, Ont.
(controls, aircraft instruments)

General Instrument — F. W. Sickles of Canada Ltd.,
151 Weber St. S., P.O. Box 408, Waterloo, Ont.
(telemetering equipment, radiosondes)

Honeywell Controls Ltd.,
Vanderhoof Ave., Toronto, Ont.
(instrumentation systems, domestic, industrial)

International Business Machines Co. Ltd.,
Don Mills Rd., Toronto 6, Ont.
(business machines, computing equipment)

Johnson Matthey & Mallory Ltd.,
110 Industry St., Toronto 15, Ont.
(radar tuners)

George Kelk Ltd.,
130 Willowdale Ave., Willowdale, Ont.
(instrumentation, industrial equipment, aircraft test)

Kitchener Electronic Industries Ltd.,
139 Dundas St., Kitchener, Ont.
(intercom, audio)

Lenkurt Electric Co. of Canada Ltd.,
7018 Lougheed Highway, North Burnaby, P.O., B.C.
(telegraph, microwave, carrier telephone for wire, radio and cable)

Long Sault Woodcraft Ltd.,
St. Andrews East, Quebec.
(plastic radomes)

Lucas-Rotax Ltd.,
2200 Eglinton Ave. E., Toronto, Ont.
(controls and generating equipment)

Marsland Engineering Ltd.,
154 Victoria St. S., Kitchener, Ont.
(instrumentation, plotting equipment, servo systems)

Measurement Engineering Ltd.,
232 John St., Arnprior, Ont.
(audio and rf communications, industrial and nuclear controls, radar displays, instruments)

Mechron Engineering Products Ltd.,
2437 Kaladar Ave., Ottawa 1, Ont.
(diesel-generators, power control panels)

C. C. Meredith & Co. Ltd.,
80 Thomas St., Streetsville, Ont.
(control panels, generating sets, magnetic amplifiers, telemetering equipment, power supplies, lighting controls)

Muirhead Instruments Ltd.,
677 Erie St., Stratford, Ont.
(bridges, resistance boxes, synchros, servo)

R. H. Nichols Ltd.,
4544 Dufferin St., Box 500, Downsview, Ont.
(dielectric heating, data transmitters, supervisory controls)

Northern Electric Co. Ltd.,
1600 Dorchester St. W., Montreal, Que.
(cable and wire, radar, wire and radio communications equipment)

Northern Radio Manufacturing Co. Ltd.,
1950 Bank St., Ottawa, Ont.
(telecommunications)

Peffer Sounds Systems Ltd.,
40 Maurice St., Kitchener, Ont.
(intercom systems)

Philco Corp. of Canada Ltd.,
Don Mills Rd., Don Mills, Ont.
(communications, radar)

Philips Electronics Ind. Ltd.,
116 Vanderhoof Ave., Toronto 17, Ont.
(radar, telecontrol, telemetry, communications)

Powertronic Equipment Ltd.,
50 Bermondsey Rd., Toronto 16, Ont.
(dielectric generators, controls & power generators)

Pye Canada Ltd.,
84 Northline Rd., Toronto 16, Ont.
(industrial TV, two-way radio)

RCA Victor Co. Ltd.
1001 Lenoir St., Montreal, Que.
(industrial equipment, radar, communications)

Radio Engineering Products Ltd.,
1080 University St., Montreal 3, Que.
(communications)

Raytheon (Canada) Ltd.,
61 Laurel St. E., Waterloo, Ont.
(navigation, radar)

Servomechanisms (Canada) Ltd.,
123 Rexdale Blvd., Rexdale, Ont.
(test equipment, industrial controls, servo systems)

Sharpe Instruments Ltd.,
6080 Yonge St., Willowdale, Ont.
(geophysical instruments)

Sinclair Radio Labs.,
21 Toro Rd., Box 179, Downsview, Ont.
(rf oscillators)

Sparton of Canada Ltd.,
Elm St., London, Ont.
(instruments, radar, sonobuoys)

Sperry Gyroscope Co. of Canada Ltd.,
P.O. Box 710, Montreal, Que.
(aeronautical and marine instruments and systems)

Spilsbury and Tindall Ltd.,
120 East Cordova St., Vancouver 4, B.C.
(radiotelephones)

Standard Telephones & Cables Mfg. Co. (Canada) Ltd.
9600 St. Lawrence Blvd., Montreal, Que.
(telecommunications, radio navigation)

Stark Electronic Instruments,
Ajax, Ontario.
(instruments)

Syntron (Canada) Ltd.,
928 Queenston Rd., Stoney Creek, Ont.
(automation equipment)

T.M.C. (Canada) Ltd.,
River and Limebank Rds., R.R. No. 5, Ottawa, Ont.
(remote control, antenna accessories, communications equipment)

Taylor Instruments Companies of Canada Ltd.,
75 Tycos Dr., Toronto 19, Ont.
(instruments)

Tinsley Instruments Ltd. (Canada),
P.O. Box 99, Smiths Falls, Ont.
(instruments, measuring standards)

F. V. Topping Electronics Ltd.,
94 Laird Dr., Toronto 17, Ont.
(audio equipment and communications)

TranSonic Ltd.,
McMaster Ave., Ajax, Ont.
(ultrasonic transducers)

Vector Labs Inc.,
736 Notre Dame St. W., Montreal 1, Que.
(controls, special instruments)

COMPONENTS

Acme Electric Corp. Ltd.,
50 Northline Rd., Toronto 16, Ont.
(transformers)

Aerovox Canada Ltd.,
1551 Barton St. E., Hamilton, Ont.
(fixed capacitors)

Airtron Canada Ltd.,
349 Carlaw Ave., Toronto 8, Ont.
(waveguide components)

Allied Circuit Techniques Ltd.,
1 Robinson St., Oakville, Ont.
(printed circuits)

Amphenol Canada Ltd.,
349 Carlaw Ave., Toronto 8, Ont.
(cables, connectors)

Arrow-Hart & Hegeman (Canada) Ltd.,
Industry St., Mount Dennis, Toronto 15, Ont.
(switches and motor controls, wiring devices)

Audio Transformer Co. Ltd.,
202 Regina St. N., Waterloo, Ont.
(transformers)

Automatic Electric (Canada) Ltd.,
100 Strowger Blvd., Brockville, Ont.
(electro-mechanical components for telecommunications)

Aviation Electric Ltd.,
200 Laurentian Blvd., Montreal 9, Que.
(aircraft instruments)

Bayly Engineering Ltd.,
Hunt St., Ajax, Ont.
(delay lines, transformers, coils, filter networks)

Beaconing Optical & Precision Materials Co. Ltd..
455 Craig St. W., Montreal, Que.
(gear trains and gears)

Campbell Mfg. Co. Ltd.,
45 Sheppard Ave. E., Willowdale, Ont.
(cable harness, speakers, microphones, headsets)

Canada Wire & Cable Co. Ltd.,
Postal Station "R", Toronto 17 (Leaside), Ont.
(cables and wires)

Canadian Admiral Corp. Ltd.,
501 Lakeshore Rd., Port Credit, Ont.
(meter shunts)

Canadian Applied Research Ltd.,
750 Lawrence Ave. W., Toronto 19, Ont.
(de-icing controls)

Canadian Electric Resistors Ltd.,
18 Curity Ave., Toronto 16, Ont.
(power resistors)

Canadian General Electric Co. Ltd.,
Electronic Equipment and Tube Dept.,
830 Lansdowne Ave., Toronto, Ont.
(semiconductors and tubes)

Canadian Line Materials Ltd.,
3595 St. Clair Ave. E., Toronto 13, Ont.
(relays, rectifiers)

Canadian Marconi Co.,
Electronic Tube and Components Div.,
830 Bayview Ave., Toronto 17, Ont.
(tubes)

Canadian Stackpole Ltd.,
550 Evans Ave., Toronto 14, Ont.
(fixed resistors)

Canadian Westinghouse Co. Ltd.,
Electronics Div.,
P.O. Box 510, Hamilton, Ont.
(tubes)

Cannon Electric Canada Ltd.,
160 Bartley Dr., Toronto 16, Ont.
(relays, connectors)

Capacitors of Canada Ltd.,
36 Upton Rd., Scarborough, Ont.
(capacitors)

Carriere and MacFeeters Ltd.,
936 Warden Ave., Scarborough, Ont.
(solenoids, relays, electro-mechanical components)

Centralab Canada Ltd.,
669 Bayview Ave., Toronto, Ont.
(switches, capacitors)

C. P. Clare Canada Ltd.,
P.O. Box 134,
2700 Jane St., Toronto, Downsview, Ont.
(relays)

The Constanta Co. of Canada Ltd.,
280 Regina Ave., Montreal 19, Que.
(resistors)

Croven Limited,
Beech St., Whitby, Ont.
(crystals, ovens)

Daly Capacitors Ltd.,
140 Kendal Ave., Toronto 4, Ont.
(capacitors)

Continued on page 70

Electronics and Communications
CANADIAN EXPORT ISSUE

Canada's Foreign Trade Service represented in many lands

The Foreign Trade Service of the Canadian Department of Trade and Commerce maintains Trade Commissioners in all the principal countries of the world. Located strategically in the main industrial centers, Canada's Trade Commissioners are available for discussion on matters pertaining to the exchange of business between Canada and the countries to which they are assigned. Informed on government import and export regulations and well qualified to advise on matters relating to the Canadian manufacturing industry. it is suggested that in order to expedite any business negotiations with Canada a visit to the closest Canadian Trade Commissioner would be well advised. For the information of those who may be interested in doing business with Canada we list in the following pages the names and addresses of Canada's Trade Commissioners abroad.

Canadian Trade Commissioners Abroad

Territory	Officer	City Address	Mail and Cables, Office Telephone
Argentina	C. S. Bissett Commercial Counsellor G. E. Blackstock Assistant Commercial Secretary	Canadian Embassy Bartolome Mitre 478 Buenos Aires	Mail: (City Address) Cable: Canadian Tel.: 33-8237
Australia (Capital Territory New South Wales, Queensland, Northern Territory) Dependencies	S. V. Allen Commercial Counsellor for Canada L. D. Burke Assistant Commercial Secretary	7th Floor, Berger House 82 Elizabeth Street Sydney	Mail: P.O. Box 3952 G.P.O. Cable: Canadian Tel.: BW 5696
Australia (Victoria, South Australia, Western Australia, Tasmania)	T. G. Major Commercial Counsellor for Canada	83 William Street Melbourne	Mail: (City Address) Cable: Canadian Tel.: MU 4716
Australia	R. B. Nickson Commercial Secretary	Office of the High Commissioner for Canada State Circle Canberra	Mail: (City Address) Cable: Domcan Tel.: U-1304
Austria Bulgaria, Czechoslovakia, Hungary, Romania, Yugoslavia	R. K. Thomson Commercial Counsellor P. A. Freyseng Assistant Commercial Secretary	Opernringhof Opernring 1 Vienna 1	Mail: (City Address) Cable: Canadian Tel.: 57-25-97
Belgium Luxembourg, European Economic Community, European Atomic Energy Community, European Coal and Steel Community	L. H. Ausman Commercial Counsellor P. T. Eastham Assistant Commercial Secretary	Canadian Embassy 35 rue de la Science Brussels 4	Mail: (City Address) Cable: Canadian Tel.: 13.38.50

Territory	Officer	City Address	Mail and Cables, Office Telephone
Brazil	Wm. Jones Commercial Counsellor	Canadian Embassy Edificio Metropole Av. Presidente Wilson 165 Rio de Janeiro	Mail: Caixa Postal 2164 Cable: Canadian Tel.: 42-4140
Brazil	D. M. Holton Consul and Trade Commissioner R. C. Anderson Vice Consul and Assistant Trade Commissioner	Canadian Consulate Edificio Alois Rua 7 de Abril 252 Sao Paulo	Mail: Caixa Postal 6034 Cable: Canadian Tel.: 36-6301
Ceylon	I. V. Macdonald Commercial Secretary	Office of the High Commissioner for Canada 6 Gregory's Road Cinnamon Gardens Colombo	Mail: P.O. Box 1006 Cable: Canadian Tel.: 91341
Chile	H. M. Maddick Commercial Secretary	Canadian Embassy 6th Floor Av. General Bulnes, 129 Santiago	Mail: Casilla 771 Cable: Canadian Tel.: 64189
Colombia Ecuador	J. H. Bailey Commercial Secretary and Consul	Canadian Embassy Edificio Banco de Los Andes Carrera 10, No. 16-92 Bogota	Airmail: Apartado Aereo 3562 Surface Mail: Apartado 1618 Cable: Canadian Tel.: 43-00-65
Congo Angola, Central African Republic, Chad, Congo (French Community), Gabon	R. A. Bull Acting Trade Commissioner	C.C.C.I. Building Boulevard Albert 1er Leopoldville 1	Mail: Boite Postale 8341 Cable: Canadian Tel.: 2706
Cuba	R. R. Parlour Commercial Counsellor	Canadian Embassy Edificio Ingenieros Civiles Calle 17 y o Vedado Havana	Mail: Apartado 1945 Cable: Canadian Tel.: 32-3526
Denmark Greenland, Poland	Commercial Counsellor (absent)	Canadian Embassy Prinsesse Maries Allé 2 Copenhagen V	Mail: (City Address) Cable: Canadian Tel.: Hilda 3306
Dominican Republic Puerto Rico	W. B. McCullough Commercial Counsellor J. M. Knowles Assistant Commercial Secretary and Vice Consul	Canadian Embassy Edificio Copello 408 Calle El Conde Ciudad Trujillo	Mail: Apartado 1393 Cable: Canadian Tel.: 2-8138
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A simple design technique for high performance transistor AC amplifiers

A design technique for AC amplifiers which is deemed to have considerable merit

by D. G. W. Mace & R. N. Blunt *

This article presents a method of designing transistor amplifiers using DC coupling between stages and overall negative feed back. The method gives rise to an economical design which is stable with temperature. It is also gain stable with the variation in transistor parameters to be expected between units of a given type.

In order that this technique may stand in a better light, it is proposed to review the more common methods, pointing out their salient features. These methods fall broadly into two groups:

1. Transformer coupled
2. Capacitor coupled

The first of these two methods depicted in Figure 1, has the following advantages:

1. The maximum possible forward gain can be realized.

2. It is relatively easy to stabilize the transistor against I_{co} (leakage current) drift, due to the presence of a low impedance DC path in the base circuit via the transformer winding.

3. The use of transformers enables the input and output impedances of the amplifier to be matched to the source and load impedances.

4. They also provide DC isolation from associated equipment.

The method has the following disadvantages:

The bandwidth of the amplifier is restricted by the particular transformers used. The low frequency response will particularly be sacrificed if miniature transformers are used, due to the relatively low standing current permissible in units of this type. On the other hand, if larger transformers are used, the advantage of compactness through the use of transistors is lost, although this is perhaps not a major consideration. The greatest disadvantage occurs when we consider the problem of gain stability. Due to the disparity in characteristics between transistors of a given type, it is not to be expected that two similar amplifiers will necessarily give the same results. In fact the forward current gain may vary by a factor of 2:1 for each stage. The obvious method to stabilize the gain is to introduce overall feed back around the amplifier. For three or more stages overall feed back is difficult to control in the presence of the associated transformers and frequency dependent transistors.

Second method

The second most common method is depicted in Figure 2. This is probably the most widely used method for building amplifiers and has much to commend it.

Its main advantages are:

1. The design is easy.
2. The operating points can be well defined.
3. Problems of I_{co} drift can be minimized.
4. Uses readily available components.

In a multi stage amplifier the difficulty of gain stability is again present and the multiplicity of reactive components again renders feed back difficult.

It might be pertinent here to mention why we are concerned with gain stability. In domestic equipment, where a human operator is included in the system the gain may be adjusted to suit the individual.

However, we are concerned with high performance precision equipment which is designed to operate unattended in servo systems.

In the unlikely event that any one piece of equipment has to be replaced it is expected that a direct exchange can be made without a need for further adjustment. It is our object herein to explain a third technique which resolves most of the limitations arising in the foregoing configuration.

Since AC couplings are troublesome in feed back

Continued on page 52

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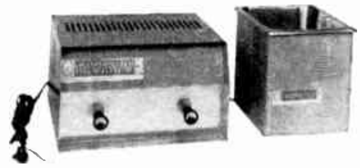

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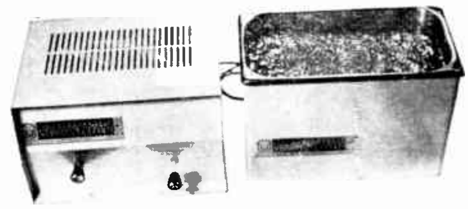

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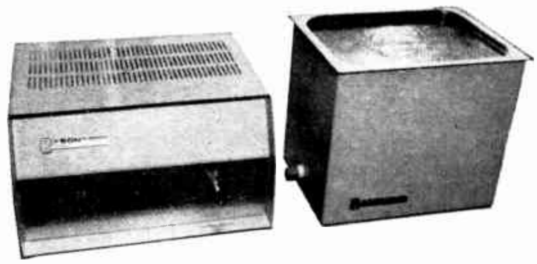

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High performance transistors

Continued from page 50

amplifiers it would seem attractive to use DC coupling and this, in fact, is what is done.

Figure 3 depicts a simplified circuit using the DC coupling technique. In this particular circuit, point X (the first emitter) is a stabilized reference point to which the output level of the circuit is referred. The DC level at which the output sits is well defined by the ratio of the feed back resistor (R_f) and the input impedance of the first transistor stage.

The only change that is likely to occur in the output level will be caused by I_{co} (leakage current) in the 1st transistor. For a given type of transistor, this can be established at a maximum value at the highest ambient temperature to be anticipated and the known dissipation at the collector junction. To maintain DC stability then this leakage current must be offset by an equal and opposite amount of current flowing through the feed back resistor R_f. This will result in a net change of voltage at the output. Typical values for this would be:

I_{co} 50μamps at 60°C ambient
R_f 20,000 ohms
Change in output $= I_{co} \times R_f = 1$ volt
This is considered quite acceptable.

The exhibits a technique of fixing the DC feed back circuit. Subsequent transistor stages will also contribute to drift but, generally speaking, their effect will be negligible.

Referring to the rest of the circuit, in order that the loop gain to DC may be made high, the various emitter potentials are most easily established by means of avalanche diodes.

It would of course be possible to use low resistance high current networks for this purpose or alternatively by passed emitter resistance. In this latter case, care has been taken in shaping the low frequency portion of the open loop response of the amplifier. This, then establishes the conditions for DC stability.

There remain two items to consider. The first is that the leakage current should have impedance into which to flow, in order that the 1st stage transistor will continue to operate. To this end R_b in Figure 3 should be not too high a value. The second point to consider is the forward AC gain required and gain stability and hence the correct AC loop gain which will establish the desired conditions.

The DC feed back path in the amplifier is proportioned to give a low closed loop gain between input and output terminals of the amplifier. In order to provide a satisfactory response at frequencies other than DC this feed back must be reduced. The slope of this reduction as a function of frequency, will be directly reflected in an increase in closed loop gain. This reflection will cease when the loop gain of the amplifier approaches unity. That is to say within the limits predetermined by the amplifier forward characteristic it is possible to shape the closed loop gain of the amplifier by the appropriate inverse shaping of the feed back circuit.

It is well to notice that in determining the feed back system the whole feed back loop must be maintained stable.

Continued on page 57

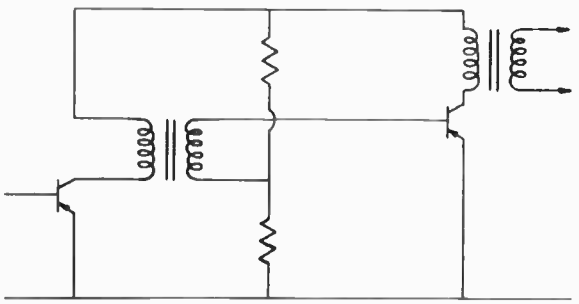


Figure 1

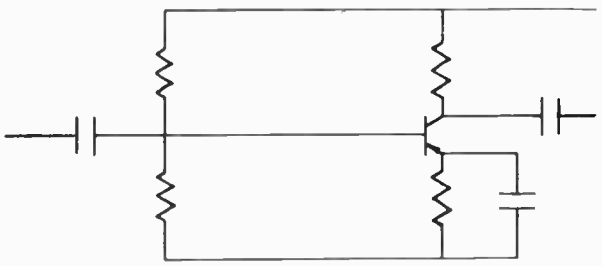


Figure 2

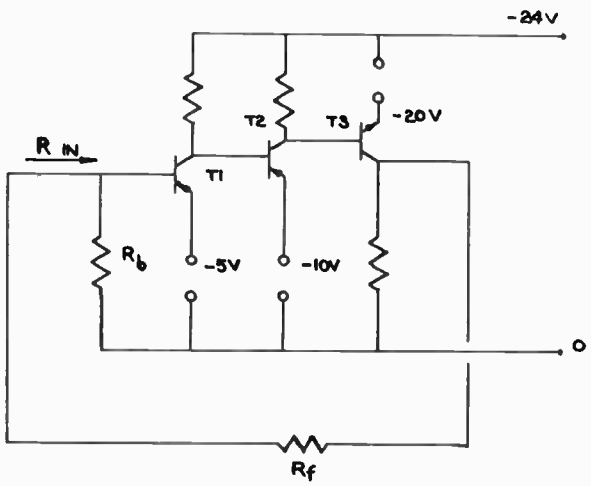


Figure 3

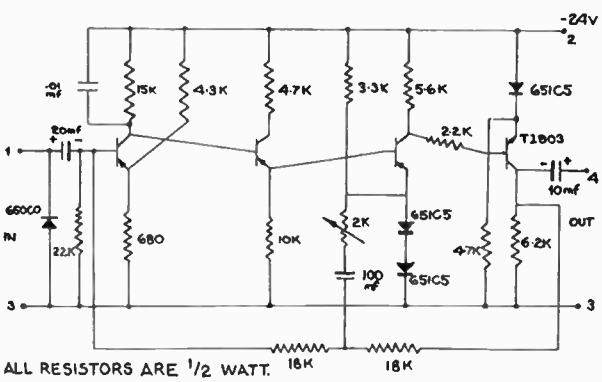
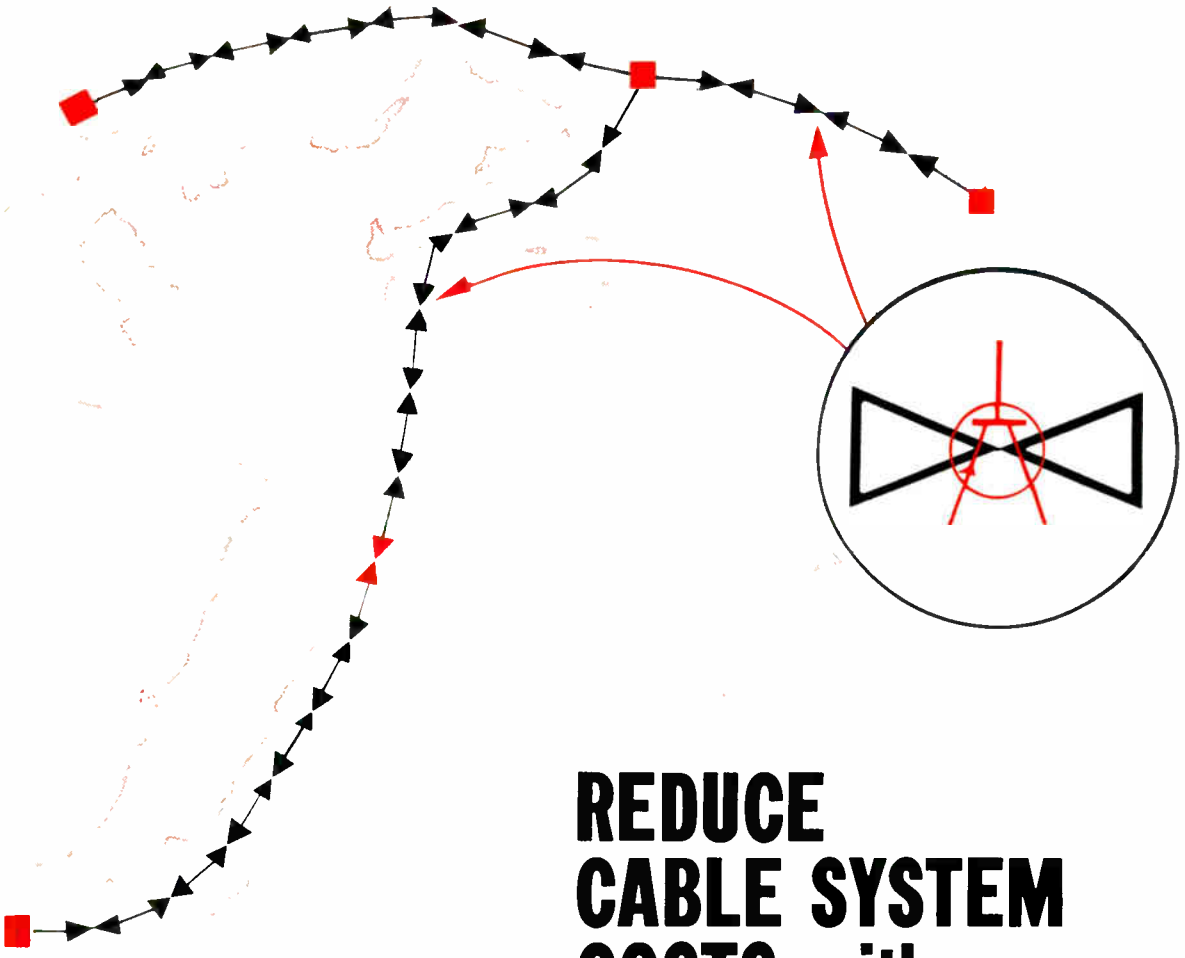


Figure 4



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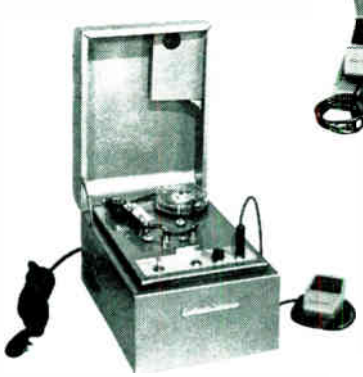

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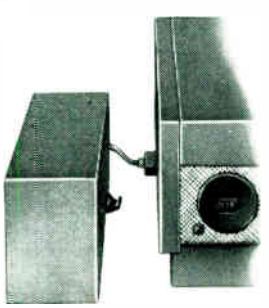

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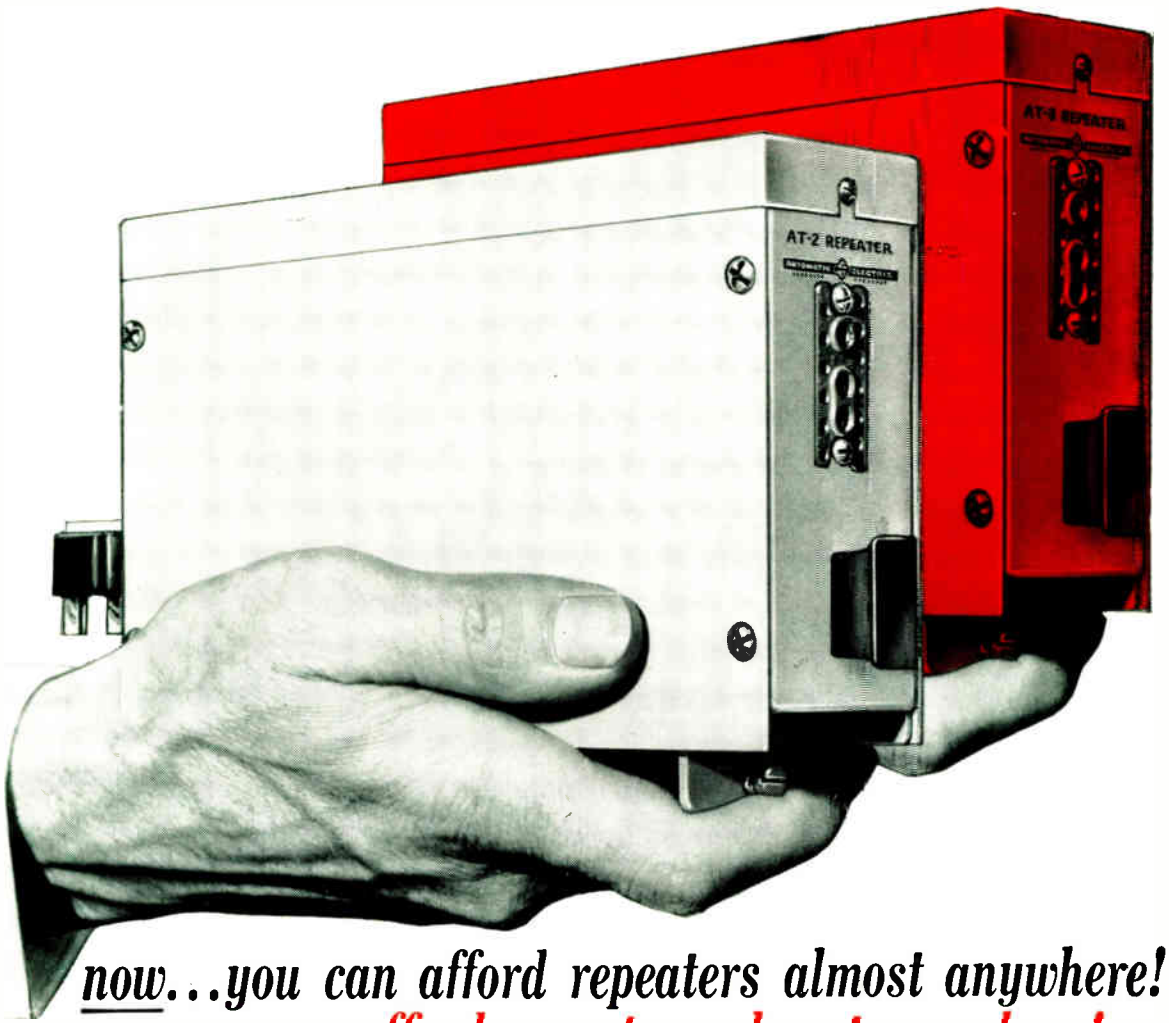


now...you can afford repeaters almost anywhere!

now...you can afford repeaters almost anywhere!

Automatic Electric's new Type AT-2 and AT-3 Voice Frequency Repeaters can improve transmission on many trunks or long lines where the cost of conventional repeaters and other methods are prohibitive. AT Repeaters end the need for costly cable loading—or the use of heavier gauge cable to raise transmission level. Outside plant costs can be reduced on new installations by using smaller gauge cable with these repeaters.

AT-2 and AT-3 Repeaters provide, for the first time, all the benefits of the negative-impedance principle (economic voice frequency amplification on marginal trunks, special service circuits and foreign exchange lines), plus all the space saving, long life advantages of transistorized circuits. Initial cost is low; only 1/10th as much current used as conventional repeaters, and use of transistors instead of tubes practically eliminates maintenance.

Type AT-2 and AT-3 repeaters are in satisfactory service with many telephone companies across Canada. Write for further information. *Automatic Electric Sales (Canada) Limited, 185 Bartley Drive, Toronto 16, Ontario. Branches in Montreal, Ottawa, Brockville, Hamilton, Winnipeg, Regina, Edmonton, Vancouver.*

5615-2R

AUTOMATIC ELECTRIC GENERAL SYSTEM

Subsidiary of

GENERAL TELEPHONE & ELECTRONICS

For complete details check No. 9 on handy card, page 73

High performance transistors

Continued from page 52

Complete circuit

A complete circuit of a suggested amplifier is shown in Figure 4. It can be seen that the fixed voltage references are obtained from zener diodes with the exception of stage 1. This was deliberately made a resistance divider in order to maintain the input impedance to the 1st stage to a minimum of 10,000 ohms.

However, the voltage at T_1 emitter is held constant by virtue of the fairly low impedance of the divider chain and the limited amount of current handled by the transistor.

It will be appreciated that the presence of C_2 in the feed back network will not affect the DC stability of the circuit but will reduce the loop gain to AC.

Measurements of open loop gain, on amplifiers of this type is rather difficult, although not impossible.

However, with a working knowledge of Ohms Law and knowing the maximum and minimum current gains to be expected from each transistor it is a comparatively simple matter to calculate the loop gain. A requisite amount of AC feed back may then be chosen to determine the thru gain with certainty within the limits selected.

The AC loop gain may be adjusted by making C_2 a suitable size and/or placing resistance in series with it.

The small condenser C_1 shown connected across the collector load of stage 1 is to control the high frequency response of the open loop.

There is another problem encountered in amplifiers designed for servo systems. This is the response to an overload signal. The particular amplifier described here will give full output with an input of 3 millivolts. In certain systems it may be presented with 60 volts or more.

AC coupled amplifiers, under these conditions very often 'block' or give output signals of incorrect phase, resulting in poor servo performance.

This is usually caused by capacitors becoming charged by the rectifying action of the transistors or grid current in tube amplifiers. This cannot occur in the present suggested design, as all working voltages are definitely established, and there is a minimum of capacitive components used.

In fact, an overload gives rise to a cleanly clipped square wave of correct phase relationship to the input.

Readers may wonder why C_2 is not returned to the common ground line. There is a very good reason for this.

When the amplifier is first switched on, C_2 has to charge to approximately 3 of 4 volts, via feed back resistor RF. This takes approximately 1 second. During this time the amplifier is held off. If C_2 were returned to common positive, the amplifier would be held 'Full on' during the 1 second period and the transistors would undoubtedly suffer from over load.

As a further protection from accidents of this kind a current limit resistor is included in series with the base of T4.

In designing high performance transistors amplifiers, it is necessary to consider more parameters than would be the case in a tube amplifier of similar performance. This article attempts to draw attention to the particular parameters which need to be considered. It also attempts to present a satisfactory technique for the complete design of an amplifier to meet particular specifications of electrical performance and environmental conditions.

The production testing of transistors

The DfI Automatic Transistor Test Set automatically sorts transistors into three classifications: 1. Accepted, 2. Retest, 3. Reject.

The transistors are pre-loaded onto small flat test fixtures and manually transported to the test equipment. Once in the machine, the transistors feed automatically from a magazine until empty. Eight magazines feed into the input of the machine at the same time. Empty magazines are replaced with full ones by the operation.

Retest and reject sorting is accomplished at the end of the first portion of the machine. Retest sorting is done at the end of the second section. It is possible to insert additional transistors into the machine between the two portions to make up for the number of units which will have been removed at the end of the first portion. This can be desirable, depending on test requirements, as means of reducing retest time for transistors which have previously been classed as retests.

In addition, removal and alteration of tests at any time is made practical as a result of the modular construction methods employed. These changes may be made without affecting the rate of testing.

The test fixture consists of a molded blank of insulating material with three spring loaded contacts at one end. A simultaneously made contact on the top and the bottom insures a positive contact with one-half the contact resistance.

A centrally located Master Programmer, consisting of a reader for IBM-type punched cards, will remotely select any combination of pre-set test bias conditions and readout limits at the various test stations. Where required for maximum flexibility, several independent sub-program devices might apply to one test by applying a separate sub-programmer for each.

An outstanding feature of the remote control scheme used is the ultimate simplicity in remote electrical connection. A single conductor between the master and sub-programmer can carry all the necessary positioning information. This contributes to a reliable, trouble free system.

Built-in program versatility makes efficient use of the test system. One master program card is easily removed and replaced by another one coded to a different set of specifications. The equipment is then ready to perform the same tests under different bias conditions and against different test limits.

CONWAY ELECTRONIC ENTERPRISES

the leader in measuring instruments for Research Development and University use

Precision Instruments of great accuracy and Low Price!

Laboratory Voltmeters & Ammeters. Precision moving — iron instrument which are made as voltmeters up to 650 V and ammeters up to 100 A for DC and AC 15 to 1000 c/s. The accuracy is 0.5%.

Shielded Precision Wattmeter. For power measurements of DC and AC (mains frequency). Instrument is of the iron-free, electrodynamic type shielded from external influences. Accuracy 0.2%.

Lightweight Portable AC DC Wattmeter, built to comply with lab and test room requirements. Accuracy 0.5%. Voltages switchable: 60-120-240 V. Supplied in single and double current ranges 0.5 to 10 A.

Insulation Resistance Meter. Designed to measure the resistance of electric installations etc., applying a test voltage of 2500 V which is supplied by a DC crank generator operated by hand.

Large Precision Potentiometer. Used in labs and calibrating departments for the most accurate measurements of potential from 0 to 1.5 V by the balancing method. Maximum permissable error at 20°C is 0.02%.

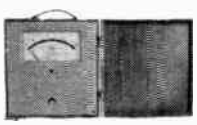
Vibrating Reed Frequency Meter. Designed for measuring the power frequency in AC systems and for frequency checking and measurement in labs and test rooms and calibrating departments. Voltage ranges from 50 to 250 V. Frequency range 20 to 100 c/s per second. Accuracy 0.5%.

Avomet. A universal Volt ampmeter for AC and DC use. Ranges from 0.06 to 600 V and from 1.2 milliamps to 6 amps F.S.D. Sensitivity 1000 Ohms/Volts. Accuracy on DC 1% on AC 1.5%.

R.L.C. Bridge. Designed for speedy resistance inductance and capacitance measurements. The Galvanometer indicates balance for resistance measurements using inbuilt DC source. For L and C measurements inbuilt generator is employed. The Wheatstone bridge circuit is used for resistance measurements. Maxwell bridge for inductance and De Sauty for capacitance measurements. Accuracy 2%.

Direct Reading Fluxmeter, for measuring flux density of magnetic fields. The instrument is based on the galvano-magnetic Hall effect. Accuracy 2.5%. Three ranges: 2000, 5000 and 20,000 Gauss.

Vibrating Reed Frequency Meter. A low weight small dimension portable instrument to satisfy all lab and test room requirements. Accuracy 0.5%. Voltage ranges 110, 220, 380 or 500 V. Frequency range 55 to 65 c/s.



Electrostatic Voltmeter, for direct measurement of High AC and DC voltages of up to 25 kV. Accuracy 1.5%. Internal capacitance 8pF.

Portable Electrostatic Voltmeter. Used for currentless operational measurements of DC and AC voltages. Range 300, 600 or 1,200 V. Accuracy 1.5%.

The above represents a small cross-section of our Precision Instruments available. Please inform us as to your own requirements. Brochures available on request.

Special Prices applicable to establishments under duty-free circumstances

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For complete details check No. 20 on handy card, page 73

product panorama

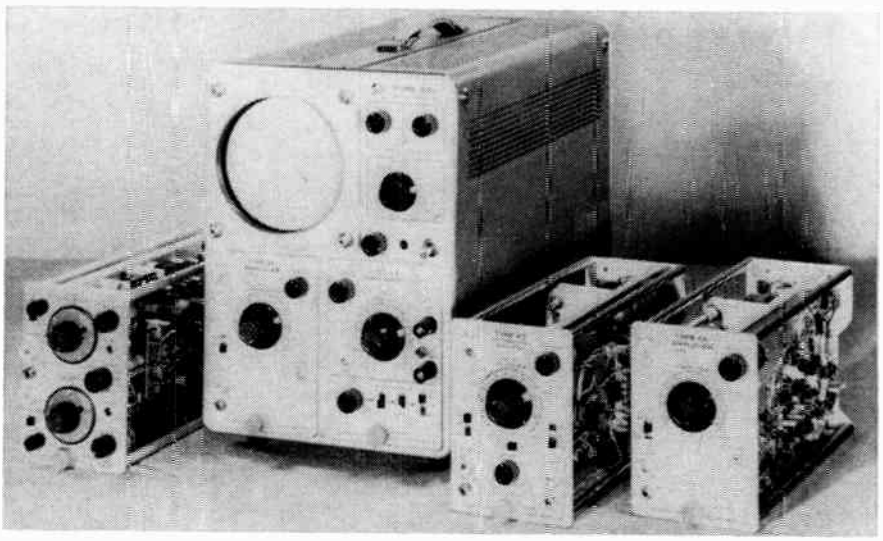
For further information on New Products use Readers' Service Cards on pages 73 and 74.

Type 561 oscilloscope

Item 579

Operating with low-cost signal-amplifier and time-base plug-in modules, the Type 561 offers the type and degree of performance demanded for a particular application. Basically an indicator unit, the Type 561 contains a 5-inch crt with 3.5 kv accelerating potential, an 8 x 10 cm viewing area, an amplitude and sweep-time calibrator, and a husky power supply capable of handling additional contemplated plug-in modules. The indicator unit powers any two of the five presently available modules — which drive the crt deflection plates directly. Dimensions are about 13½" high by 9¾" wide by 19" deep. Weight is less than 27 pounds.

If further information is desired, please contact **Tektronix Inc., Willowdale, Ontario.**



Item 579

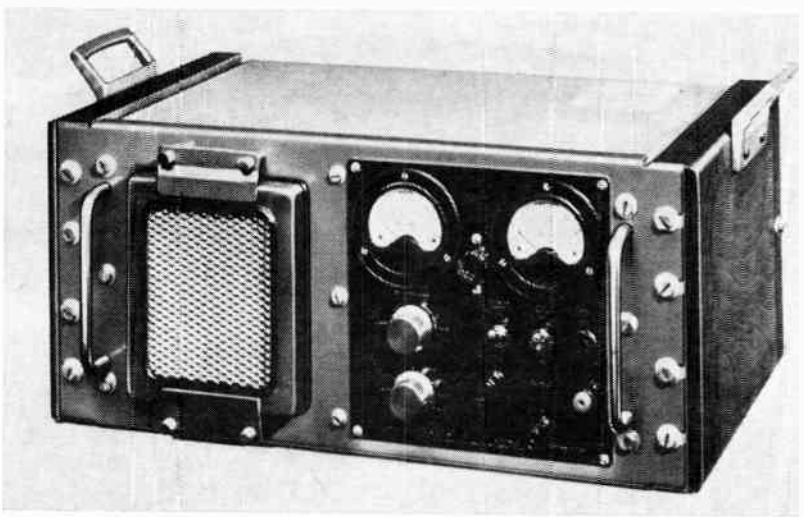
Transistorized DC power supply

Item 580

Type DC 84 is a voltage stabilized DC power supply with a substantial output current and a stability over most of its range of roughly 1 part in 1000. The voltage control range is 0-72 volts and load capacity over the entire range is 0-1.5 amps. Its immediate application is in research and development organizations dealing with transistor circuitry especially those concerned with the latest silicon semi-conductor applications.

Special circuits have been incorporated in the design which fully protect the instrument against overload and short circuit conditions. These are entirely electronic and involve no electro-magnetic devices with moving contacts.

Available from **The Glendon Instrument Company, 46 Crockford Blvd., Scarborough, Ont.**



Item 580

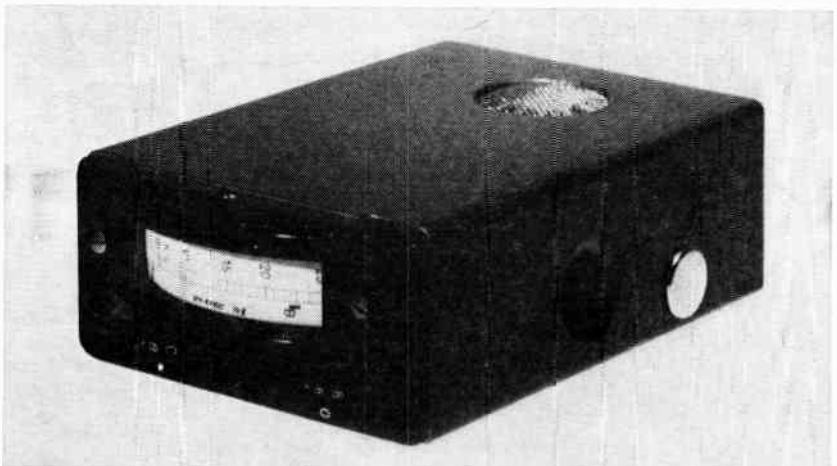
Portable sound level meter

Item 581

Completely transistorized and battery-operated, the new MINOPHON sound level meters weigh only 15 ounces and are pocket-sized (5" x 3½" x 1½"). Applications include: measuring noise levels in factories, offices and outdoor locations, survey of noisy areas for hearing damage studies, analysis of acoustic materials, establishing satisfactory sound levels for public-address systems.

Stocked in Canada, two models are available.

For further information contact **R-O-R Associates Ltd., Don Mills, Ont.**



Item 581

Item 582

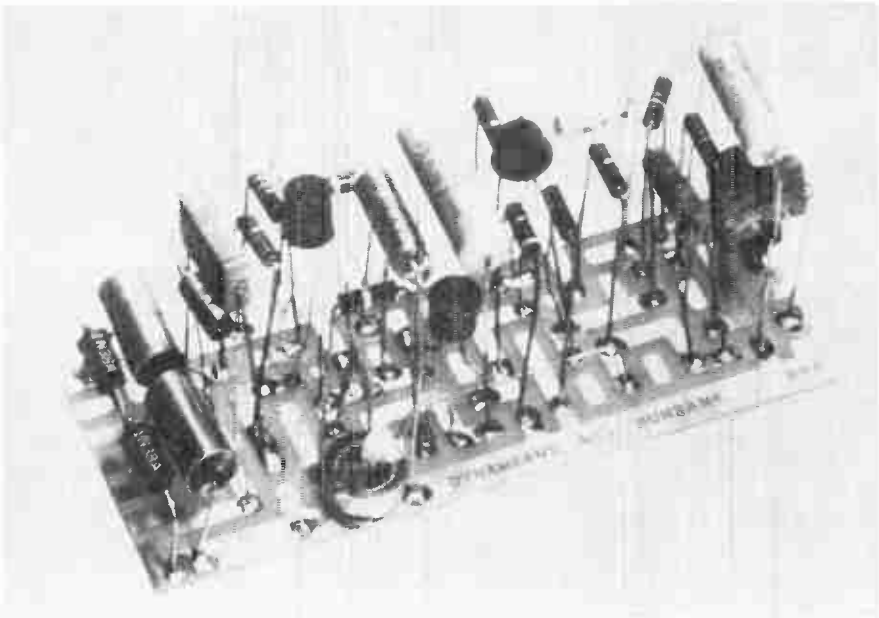
Mobile radiophone

Item 582

Newly available in Canada is the low-power, very low-cost Kaar IMP (Industrial Mobile Phone) to halt the losses of materials-handling deadheading and backtracking within factories, warehouses and yards — or in any application needing effective voice communications over relatively short distances.

IMP comes complete with key locking, shock mount, microphone, whip antenna, cables and all crystals; it is completely tuned and ready to operate. No out-of-pocket installation cost is necessary, since plant personnel can easily install IMP. Dimensions on the shock base, but excluding antenna: 13½" long, 9½" wide, 6½" high. Weight is 24 lbs.

Further information is to be had from **Tele-Radio Systems Limited, 3633 Dundas St. West, Toronto 9, Ont.**



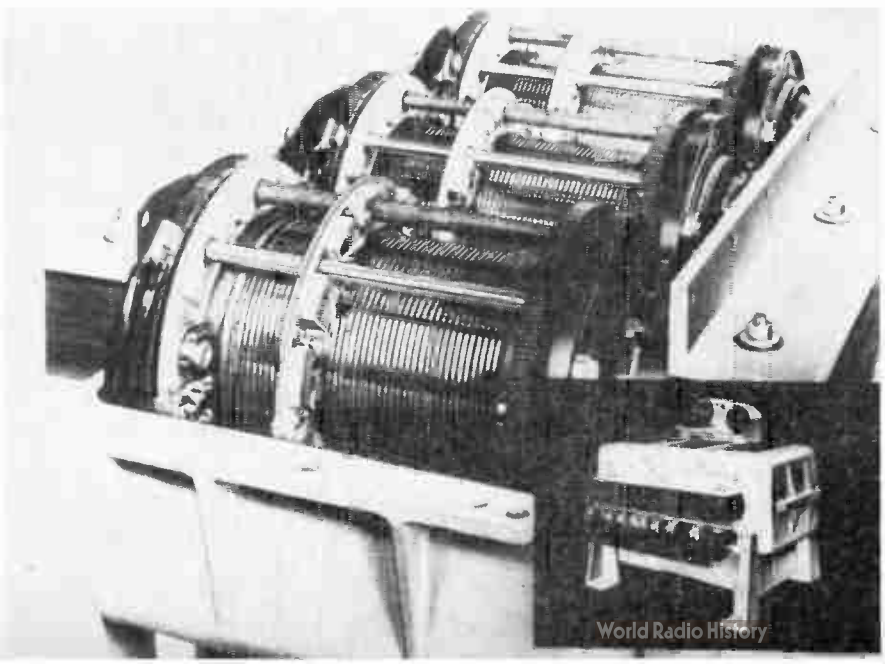
Item 583

Circuit development board

Item 583

Dynameans Circuit Development Board is a high quality printed circuit board bearing a pattern which is capable of accepting almost any circuit arrangement with equal ease. It was evolved by the Dynameans Co. during electronic circuit development and has proved to be a real timesaver. It can be repeatedly soldered to allow for circuit changes and for re-use with numerous circuit lash ups.

Available from **L. J. Bardwell Co., Box 142, Sta. "D", Toronto, Ontario.**



Variable transformers

Item 584

Introducing an entirely new design concept, Powerstat variable transformers of the H-C series feature high current ratings and performance characteristics never possible with conventional toroidal wound types. Patented re-entry rings and helical coils permit continuously-adjustable control of 1600 increments over the range of zero to maximum output voltage. Settings can be made with exceedingly fine adjustment because resolution is better than 1/10 of 1 per cent of the input voltage. The motor-driven brushes are always in contact with only one turn of the helically wound coil. Because of this, low resistance brushes are used resulting in very low voltage drop. Efficiency is reported to be highest of any variable transformer. Two types are available. Both are remotely operated from a control unit mounted either on the Powerstat frame or at any other convenient location.

For more information write for H-C Series Powerstat Bulletin P459HC from: **The American Superior Electric Co., Ltd., 174 Evans Ave., Toronto 18, Ont., Canada.**

Item 584

Mill shapes of polycarbonate resin

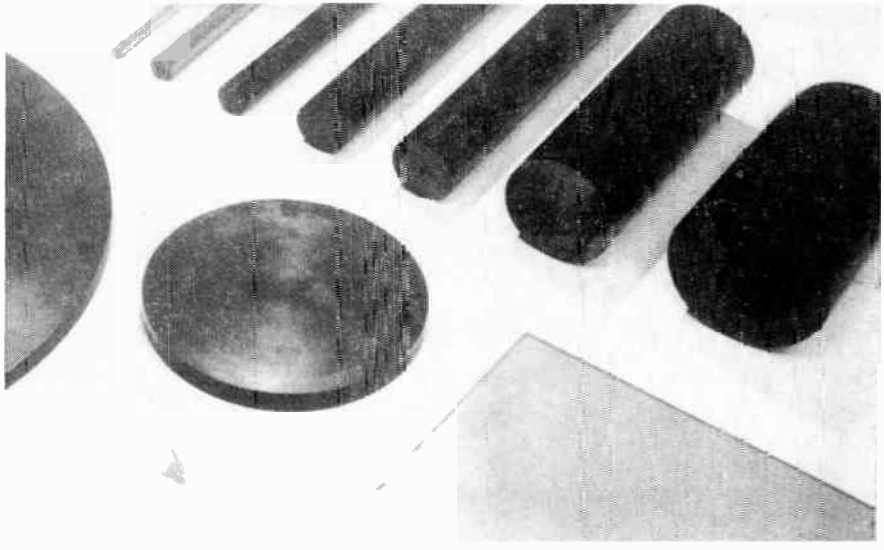
Item 585

Mill shapes of a new polycarbonate resin, trademarked POLYPENCO, include rod, tubing, plate and discs which are readily fabricated into close tolerance finished parts for industry.

The new thermoplastic is characterized by unusually high impact strength, superior heat resistance, outstanding dimensional stability and good electrical properties. It has zero water absorption.

Present availabilities include rod from ½" diameter through 4", discs 6" through 18" diameter with thicknesses of ¼" to 2", and plate ¼" to 1½" thick. Flexible mechanical tubing is also in use.

Canadian representatives: **Peckover's Ltd., 115 McCormack Street, Toronto, Ontario.**



Item 585

New General Radio Strobotac

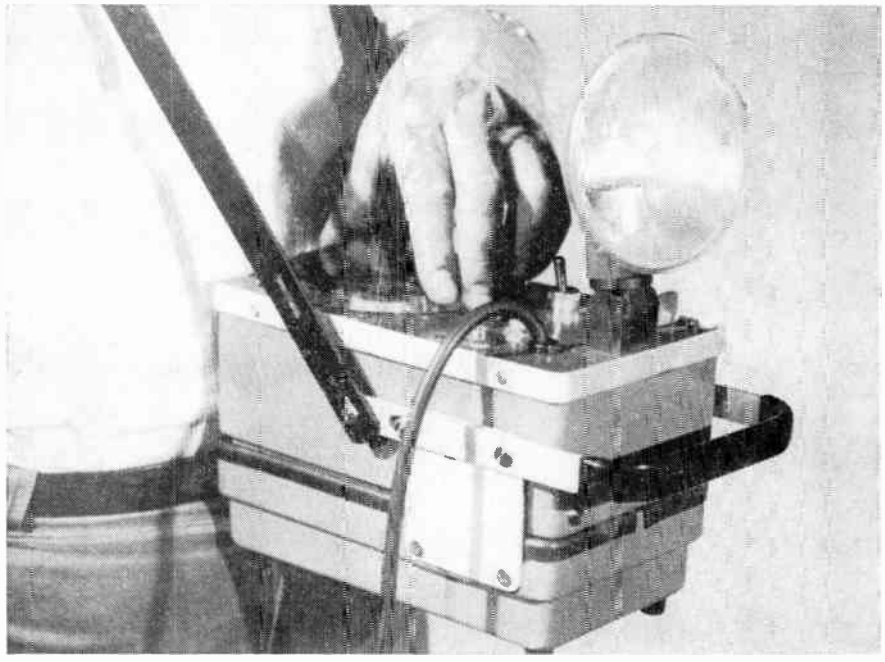
Item 586

A completely new design of the stroboscopic tachometer, sold for many years under the trade name, Strobotac®, and widely used in the mechanical and electrical industries for the measurement of rotating machine-part speeds and observation of their operation in slow motion, has been announced by the General Radio Company.

Small and portable, the new model (Type 1531-A) features a fundamental speed (flashing-rate) range of 110 to 25,000 rpm and brilliant white-light flashes with extremely short duration — 1 to 6 microseconds — permitting fast action to be 'stopped'.

The light is housed in a parabolic reflector assembly, the reflector swiveling around the lamp so that the light can be directed toward practically any point.

For further information write to **General Radio Company, 99 Floral Parkway, Toronto 15, Ontario.**



Item 586

Micro-Miniature connectors

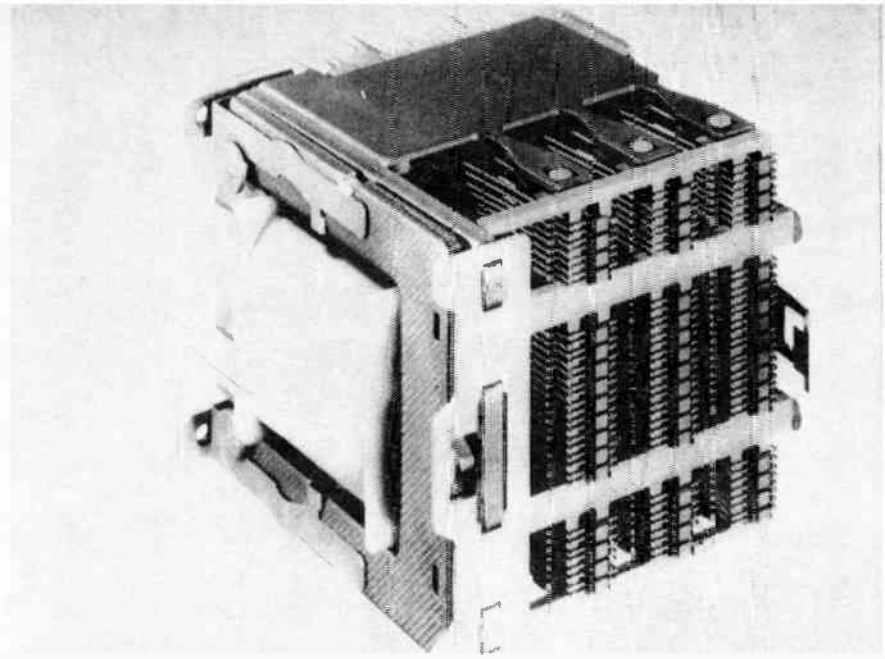
Item 587

Two new series of Micro-Miniature connectors have been developed and introduced by Amphenol.

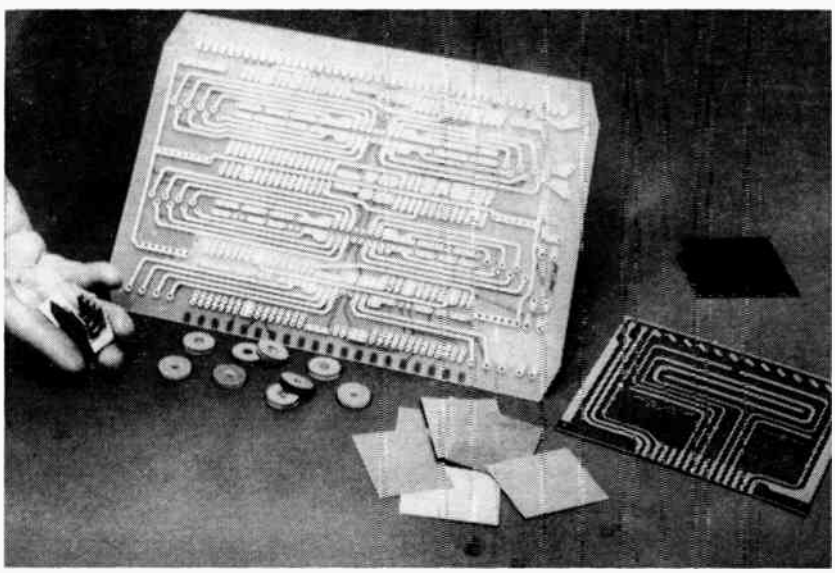
The "Micro-Min" — 74 Series, is available in 19 contacts, single side and 38 contacts double side, and is intended for use in flat form packaging. The 19 contact connector pair consist of a receptacle and a mating board, which may be used for component mounting, or as an adaptor to flexible flat cable or to a printed wiring board. For double sided wiring boards, 2 flexible cables or printed circuits, the 38 contact "Micro Min" can be used. In both the 19 and 38 contact versions, contacts are on .050" centers, and connector length is 1-5/6".

For further information contact **Amphenol Canada Limited, 349 Carlaw Avenue, Toronto 8, Ontario.**

Item 587



Item 590



Item 591

DC digital voltmeter *Item 588*

A new low cost DC digital voltmeter for general laboratory and industrial applications has been introduced by Electro-Logic Corporation. This unit, known as the Model V-1 converts an unknown voltage into decimal numbers with an accuracy of 0.5 per cent of full scale. The V-1 has high speed response, 1/24 of a second for full scale. Quick response saves operator's time and eliminates annoying delays normally occurring with even expensive digital voltmeters.

Small in size, extremely rugged and dependable, the Model V-1 has the acknowledged advantages of reliable digital presentation.

Only a quiet hum is audible during operation of the V-1. Clatter and thump characteristic of other instruments is absent.

For further information contact **Computing Devices of Canada Ltd., P.O. Box 508, Ottawa, Ontario.**

Fast curing varnish

Item 589

Dow Corning 980 Varnish, the newest addition to our range of silicone electrical impregnating varnishes, slashes oven curing time to a mere 6 hours at a low temperature of only 150°C. Besides reducing oven time, 980 Varnish speeds production while exhibiting a heat stability and a tank stability superior to previous silicone varnishes.

There are other remarkable qualities of 980 Varnish, for example: run-off is reduced, leaving cleaner ovens and racks: it is compatible with most organic electrical components which are not damaged by this new low curing temperature; 980 Varnish will not attack other silicone components; it has sufficient heat stability to withstand 220°C service with a thermal life exceeding other silicone varnishes.

If you should require more information write **Dow Corning Silicones Limited, Tippet Road, Downsview, Ont.**

New "wire-spring" relay by Automatic Electric

Item 590

A new "wire-spring" relay, designed to transfer up to 51 circuits quickly for 100 million or more operations without readjustment, has been developed by Automatic Electric.

Called the Series WQA (wire-spring, quick-acting), it is the first industrial control component of its kind that has been engineered to make or break so large a number of circuits at the same time.

The WQA is available in one, two, or three levels of contact assemblies, with up to 17 Form C combinations, each. Other forms, such as A or B, may also be obtained by special order. Operating voltages range from 6 to 220 DC. Rectified AC is also accommodated. The largest contact pile-up (51) requires less than 4 watts operating power.

To insure positive contacting, the relay is made with twin, independent contacts of Code 0 (palladium-silver). The self-equalizing contacts are coined after welding to dome configuration for proper mating, and will carry 3 amps, 150 watts, non-inductive load. Contacts are protected from dust by a transparent plastic cover.

Individual adjustment of spring contacts is not necessary on the WQA. The entire level of stationary springs may be controlled by simple adjustment of their supporting arm. Solderless-wrap terminals eliminate soldering defects and provide gas-tight, corrosion-resistant connections. The insulation resistance of the relay is a minimum of 1500 megohms at 80°F, 88 per cent relative humidity.

Special features of the new relay include impregnated coil, and fungicidal treatment.

Dimensions of the WQA are: one level, 4.06" x 3.14" x 2.19"; two levels, 4.06" x 3.14" x 2.97;" three levels, 4.06" x 3.14" x 3.78". Its net weight is 2.25 lbs. (approx.). Shipping weight about 3 lbs.

For further details write to **Automatic Electric Sales (Canada) Ltd., 185 Bartley Drive, Toronto 16, Ont.**

National announces availability of combination materials

Item 591

National Fibre Co. of Canada, Ltd. announces the availability of combination materials for applications requiring the versatility of Phenolite laminated plastic or vulcanized fibre, bonded to other materials. Many different combinations can be furnished to meet special requirements.

Information about these or other special combination materials is available from **National Fibre Co. of Canada, Ltd., 107 Atlantic Ave., Toronto, Ontario.**

High speed tester

Item 592

A magnetic tape tester just announced by Potter Instrument Company of Plainview, N.Y. detects tape defects as small as one bit length at speeds up to 150 ips and packing densities as high as 1500 bits per inch. Faults are indicated by a pilot lamp on each channel and the tape transport stops on the fault, which is easily accessible for inspection and repair.

Two combinations of tape speed and packing density can be selected by manual switching and, for each combination, one of two threshold levels can be chosen by a second selector switch. Threshold levels are continuously and individually adjustable for each playback amplifier by means of multi-turn potentiometers. Each playback amplifier card is provided with test points at which the linear signal can be observed and the output signal monitored by means of an oscilloscope.

For further information, write to **Instronics Limited, Box 100, Stittsville, Ontario.**

Item 592

Audix model TA/5S

Item 593

This is a completely portable, fully transistorized amplifier self-powered by internal, dry, re-chargeable cells. The equipment is light in weight and is instantaneous in operation and is intended to be strap-carried over the shoulder. No rotary transformers, vibrators, etc. are required or used. The amplifier has an almost indefinite life and the internal storage batteries are designed for continuous and long operation and are easily removed for re-charging. A power line charging unit is available.

For further information contact: **Conway Electronic Enterprises Ltd., 1514 Eglinton Ave. West, Toronto 10, Ontario.**

Radio telephone terminal

Item 594

DQ78, the most economical and flexible Radio Telephone Terminal and Transmission System, is now available from the Canadian Marconi Company.

This unit has built-on multiplex equipment — up to 12 channels on each rack of radio equipment, thereby requiring less space. It also features low power consumption. Can operate from AC or DC supplies, thus reducing to a minimum standby generating sets and fuel bills.

Other features include:

More channel-miles/dollar with equipment designed with the low capacity user in mind.

One 7 ft. high standard rack contains a single radio terminal and 12 duplex telephone channels or a complete two-way radio repeater.

Provides greater economy. Battery operated version available using static inverters.

Full channel drop and insert facilities provided at all stations. Optional: 100 mW or 1W output. Frequency stability of 0.005 per cent.

Initial low-capacity equipment may be modified to high capacity simply by changing plug in units as system requirements increase.

Toll quality telephone channels up to distances of 1000 miles.

Hot standby, twin path and diversity versions are available.

Canadian Marconi Company, Telecommunications Dept., 970 McEachran Ave., Montreal 8, Que.

Quartz crystal filters

Item 595

Quartz crystal filters offering band pass characteristics, not easily obtainable, if not impossible, using conventional L/C Networks, are now made in Canada. Center frequencies from 10 Kc. to 15 Mc. with band passes from a few cycles to more than 50 Kc. can be provided in either symmetrical or asymmetrical filters.

Some advantages of crystal filters are:

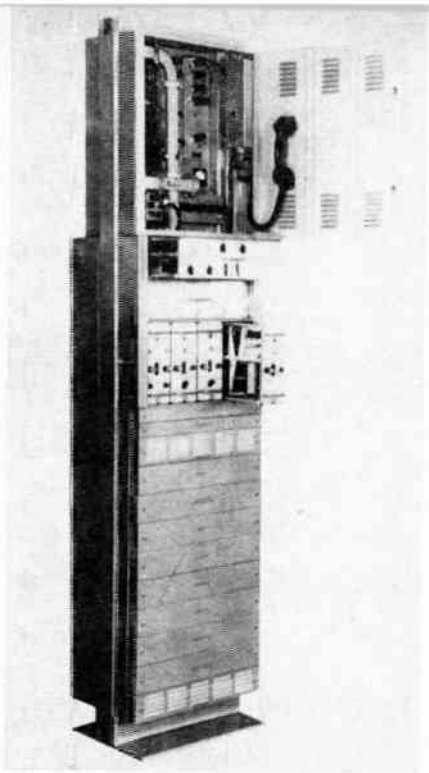
High selectivity with shape factors better than 2.1 (6 to 60 db). High stability over a wide temperature range. No alignment required. Low insertion loss. Wide impedance range.

Very close frequency calibration (Band pass center and width may be held to .001 per cent if required.).

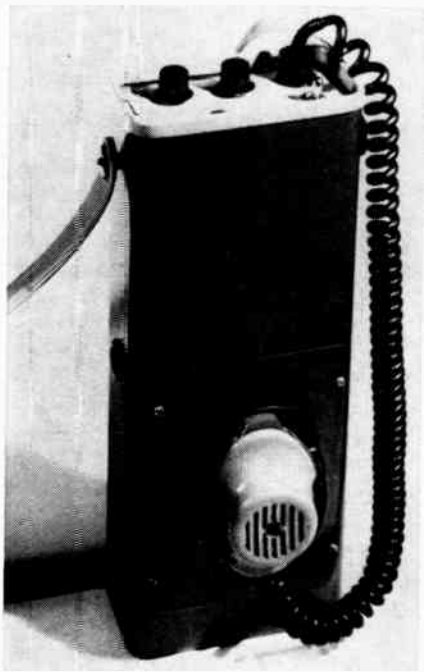
Very compact (saving much space in miniaturized design.).

More than one band pass may be designed into one unit. The type illustrated has four band passes which may be switched from the front panel of a receiver or other device.

C. R. Snelgrove Company Ltd., 141 Bond Ave., Don Mills, Ontario.



Item 594



Item 593

Item 595

Continued on page 72

The choice of a universal logic element

The performance requirements of a Static Switching System designed to fulfill the needs of Canadian industry are presented in the following article

by N. L. Carlson *

Using a specification based on these requirements, the technology of electrical switching is reviewed and the reasons for selecting a transistor as the basic switching element are outlined. Possible mechanizations are discussed and the more significant design details of two resistor-transistor combinations are presented. The attributes of a common-emitter inverter operating in the digital mode which led to its choice as a universal logic element for Static Switching are offered for consideration.

Static switching hardware is designed to supplant electro-mechanical relays in order to improve the performance and extend the capabilities of electrical control equipment. Like the relay mechanization, a static system employs bistable switching elements to implement conditional relationships between specified inputs and outputs. These relationships can be expressed by logic equations using the so called primitive functions AND, OR and NOT. The multiple input devices used to mechanize these three functions are called logic elements and they operate as follows:

AND — output changes state only when all defined input signals are applied.

OR — output changes state when any one or several input signals are applied.

NOT — output changes state when input changes; output is the complement of the input.

Logic elements are the fundamental building blocks of a static switching system but other elements are necessary to complete the mechanization. For example conditional relationships quite frequently specify a sequence in which an intentional time delay of repeatable duration is included. Thus a time delay unit is a necessary addition to the hardware. Devices which have a conditional memory can be described as permanent, off-return (seal-in type), and flip-flop (reset type) are also required. Power amplifiers are needed if the power level at which the logic mechanization operates is below that of the connected load. Occasionally it is necessary to galvanically isolate a signal from the source in which case devices having this property are required. All these and other special functions supplement the logic mechanization and have been named ancillaries.

This paper deals with the search for and selection of primitive logic elements best suited to meet the diverse demands of increased productivity imposed on industrial control equipments which must maintain a competitive position in the marketplace.

Performance requirements

There are several properties of bistable switching hardware which characterize its performance and by which the capabilities of a particular mechanization can be measured. The choice of a transistorized multiple input inverter designed to operate in the switching mode as a universal logic element for industrial control equipment was made by evaluating it and other contenders against an estimate of performance requirements. The major concepts which were considered during the evaluation are outlined below.

Reliability Regardless of the means by which reliability is defined and measured, the objective of minimizing the probability of error at a cost that can be justified remains constant[1]. The overall reliability of a static switching system implementing a given amount of logic is a complex function involving the stability of each component, the total number of components, and the number and types of electrical connections[2].

**The foregoing article was written by Mr. Carlson while employed in the System Application Engineering Unit of Canadian General Electric, Peterborough. Mr. Carlson has subsequently been transferred to the Computer Department of General Electric in Phoenix, Arizona.*

Consequently the variation and deviation of component characteristics with stress (electrical, thermal, mechanical, etc.), cycling, and time must be known if the circuit design is to accommodate the worst combinations of initial tolerances, characteristic deviation, operating conditions, and loading specified. Widely used, highly developed components, manufactured under close quality control in volume quantities are to be favored for reasons of uniformity, economy, and available data. To avoid exceeding the capabilities of components during normal operation, and thereby reduce the probability of failure, their ratings must be representative and correctly interpreted. Minimum factors of safety must be applied to component ratings likely to be affected by abnormal conditions such as operational mishandling. Straightforward, simple circuitry using the fewest number of components and therefore having the fewest number of connections are to be favored. The modular technique enhances reliability by making detailed design and comprehensive testing of subassemblies possible. The circuits must be analyzed to determine the maximum stress imposed on the components such as may be caused by the frequency of switching cycles, and the failure of one component should not cause the others to be overstressed. Note that failure of bistable switching circuits must include partial turn on.

Versatility Studies of present day industrial controls have shown that the logic relationships involved seldom require more than five conditional inputs to AND and OR functions. They also revealed that the number of loads (inputs to other logic elements) is usually below five. Consequently, to make the hardware adaptable to the majority of logic situations encountered, it should provide elements capable of driving five other loads and of recognizing five independent inputs. Outputs and inputs of logic elements must couple without external impedance matching and without special regard as to the number of loads other than the maximum. Output and input impedance of logic elements should be compatible with advanced industrial hardware such as card readers and data logging equipment. Logic element switching time should be as short as practical in order to extend the capabilities of industrial control equipment to include new techniques such as numerical control. All static switching hardware must operate satisfactorily over an ambient temperature range from —5 to 60 degrees Centigrade and in the presence of strong electric and magnetic fields.

Simplicity Industrial control equipments implementing complex logic relationships require a substantial amount of design engineering. In addition, each equipment, which fulfills its own particular requirements, must be debugged during installation and trouble shot when in service. Consequently logic elements whose operation can be easily understood and which can be readily applied with the aid of a few rigid ground rules are desirable because they simplify the design and maintenance problems. Trouble shooting problems are facilitated by logic elements which can be quickly tested by such standard maintenance equipment as a battery and a DC voltmeter.

Possible mechanizations

Switching devices which process discrete information that can be expressed by 0 and 1 are called bistable. Every switch has a transfer characteristic which relates its output state to the input signal or signals applied. Figure 1 shows the transfer characteristics of two ideal switches which exhibit a step change of output state

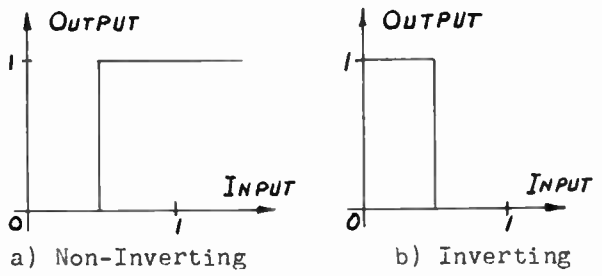


Figure 1 Transfer characteristics of ideal switches.

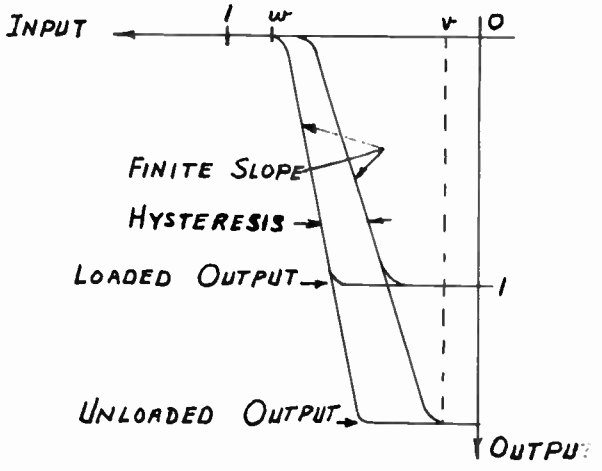
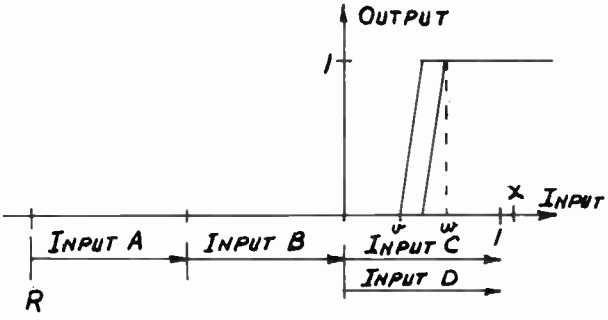


Figure 2 Transfer characteristic of practical inverter.



Figue 3 Non-inverting Kirchoff Adder.

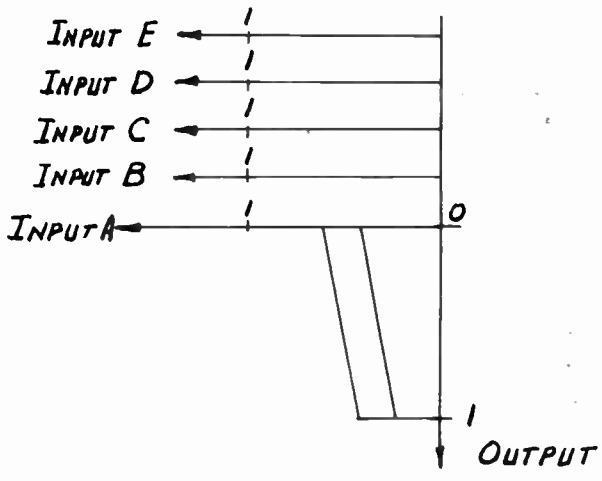


Figure 4 Multiple input inverter.

LIST OF SYMBOLS

Ebb min	=	minimum allowable bias supply voltage, + x volts
Ebb max	=	maximum allowable bias supply voltage.
Vbe min	=	minimum allowable emitter junction reverse bias, typically +0.2 volts.
Vbe max	=	maximum attainable emitter junction forward bias, typically −0.5 volts.
Rb max	=	maximum tolerance bias resistance.
Rb min	=	minimum tolerance bias resistance.
K	=	number of inputs.
P	=	pyramid factor — number of output loads.
V sat max	=	maximum allowable saturated collector emitter voltage, typically −0.25 volts.
V sat min	=	minimum attainable saturated collector emitter voltage, typically −0.1 volts.
R min	=	minimum tolerance input resistance.
R max	=	maximum tolerance input resistance.
Ico max	=	cut off collector current at maximum operating temperature.
Ico min	=	cut off collector current at minimum operating temperature.
Ecc max	=	maximum allowable collector supply voltage, −Y volts.
Ecc min	=	minimum allowable collector supply voltage.
Rc max	=	maximum tolerance collector resistor.
Rc min	=	minimum tolerance collector resistor.
h_{FE} min	=	minimum tolerance forward current gain at lowest operating temperature.
Vo min	=	minimum acceptable cut off output voltage, −Z volts.
A	=	$\frac{\text{R max}}{\text{R min}}$
B	=	$\frac{\text{Rb max}}{\text{Rb min}}$

upon increasing the magnitude of the signal applied to the input. At the step, the output can assume any value between 0 and 1 and therefore cannot be defined in terms of the input signal amplitude. The inverting switch transfer characteristic shown in Figure 2 indicates the departures from idealized performance to be expected from a practical mechanization. The output regulation, finite slope, and hysteresis combine to increase the range of input signal over which switching is effected. This range is bounded by v and w which permit the two significant input signals to be defined. If "a" is the input signal amplitude then:

i) input signals where a<v can be represented by 0 and

ii) input signals where a>w can be represented by 1. It will be noted that v and w are displaced from the input 0 and 1 respectively, shown in Figure 2. This displacement in each case is the factor of safety against noise which could cause partial turn on.

Kirchoff adder. There are at least two ways in which several independent inputs can be used to effect a switching action. The first is known as a Kirchoff adder and its operation is indicated in Figure 3. Upper and lower bounds 0 and x are imposed on all input signals so that inputs represented by 1 become w>a>x, and those by 0 become 0<a<w. A bias reference R is provided and the inputs are "summed" against the bias. This approach offers considerable scope as a multifunction logic element. In the case shown, for example, the output will change state if A and B and (C or D) are present. It requires that the number of units of bias be appropriately adjusted for each function and is most practical with switches having a low output regulation (i.e. low output impedance or an output clamp). It can be seen that satisfactory operation hinges on the input signal and reference tolerances that can be maintained[3].

Inverter The second way several inputs can be used to cause switching is to make each input operate separately on the transfer characteristic. Such an arrangement is shown in Figure 4 for a multiple input inverter with negative going signals. In this case no special restrictions are placed on the input signal values so that 0 represents inputs signals a<v and 1 represents input signals a>w. Output switching occurs if a signal of 1 is applied to any input and conversely output switching does not occur if 0 is applied to all inputs. This method of using an inverter coincides with the original requirements for the three primitive logic functions AND, OR and NOT if input signals for the AND function are defined to be 0 and those for the OR function to be 1. The NOT function requires only that the output relay be the complement of the input which is an inherent property of a single input inverter. No bias adjustment is necessary to generate different functions and high output impedance circuits can be used because there is no restriction (other than physical) on the upper bound of a 1 signal.

A multiple input inverter is an embodiment of the Scheffer organ whose attributes have long been recognized[4]. Until recently, it has not been popular for two reasons; a practical mechanization did not exist and mainly because of this, the accepted logic concepts do not lend themselves to its application. The advent of transistors, with their small saturation voltage, has eliminated the first objection and the second has been met by providing the necessary extension to the definitions and symbols. [5, 6, 7] In a logic array comprised of building blocks the output of one element is connected to the inputs of several other elements. In this way, the magnitude of the output signals 0 and 1 may

be equated to the input signal definitions for 0 and 1.

Amplifiers With the possible exception of the low temperature, super conductivity cryotron, each known switch is subject to internal losses. To overcome signal attenuation either each switch must provide signal amplification or an amplifier must be inserted in the logic network each time the signal level falls below a specified minimum value. Mechanizations of the latter category are generally cheaper than the former but require more engineering to apply.

Each amplifier requires a power supply and it is possible to classify the various logic mechanizations according to the type of amplifier and the nature of its power supply. Only those amplifiers employing magnetic elements or transistors were considered as major contenders. Magnetic elements saturate and consequently alternating or unidirectional pulsed power supplies must be used to permit flux reset. The response time of any amplifier using magnetic elements cannot be less than one half cycle because of the resetting necessary. To improve the response time and to reduce the size of the magnetic elements but maintain useable voltage level, the power supply frequency can be increased. Magnetic switching amplifiers using high frequency power supplies were considered to be unsuitable for industrial applications because of the problems introduced by unwanted phase shift and attenuation. The response time of transistor amplifiers operating in the switching mode and supplied with DC power is limited only by capabilities of the transistor and the circuit design.

Looking at the mechanical side of the picture, transistors are packaged in a strong case and come with three leads ready to be connected into the circuit. Magnetic cores must be wound with at least two coils, probably more, each end of which must be connected into the circuit. Additional components such as diodes, capacitors, resistors are usually required to complete the amplifier circuit. Both tape wound and stacked cores exhibit changes of their B-H characteristic when subjected to small mechanical deformation. If used, special precautions such as cone encasement in non-magnetic material or the use of special potting compounds must be observed if B-H uniformity is a prerequisite. Uniformity is usually necessary and is a good reason for using tape wound toroids. However, their price is practically constant up to about 10 VA and is comparatively higher than transistors.

Universal logic element

A transistor becomes a highly efficient switch with built-in amplification when operated with the emitter junction reverse biased for cutoff and both junctions forward biased for saturation[8]. It is a highly developed component with well defined characteristics and ratings which can be used in several different circuit configurations. Many different types and classes are commercially available from several manufacturers who produce them in large quantities under carefully controlled conditions. Competition in the marketplace is forcing a general price down trend and the demand for special features has been catered to by vendors.

For example, a family of medium power alloy junction transistors capable of switching rates up to 100 KC whose characteristics have been stabilized by 100 hours aging at 100 degrees C and whose welded, hermetically sealed cases have been subjected to a high pressure detergent test are available for industrial applications. Their rugged construction, small size and ability to be

Continued on page 81

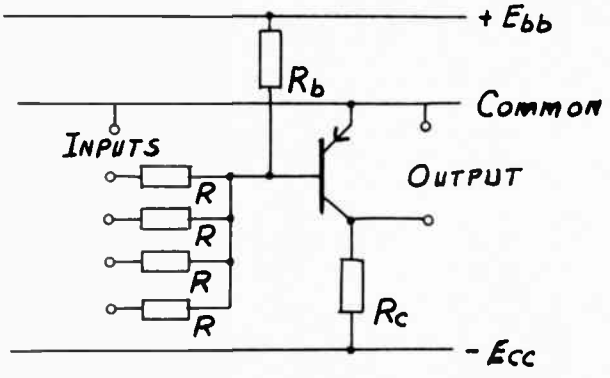


Figure 5 PNP transistor inverter.

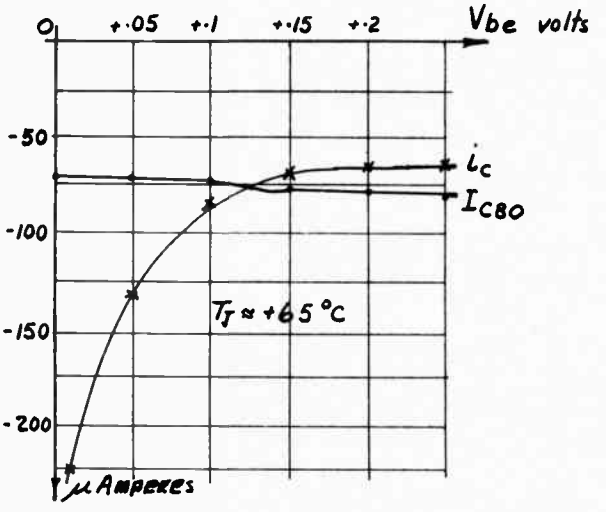
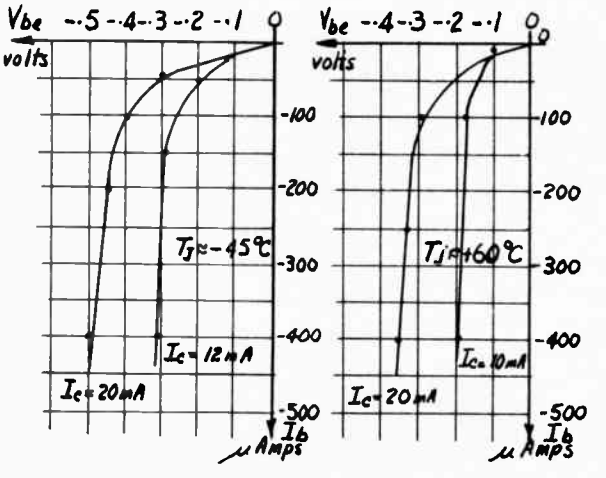


Figure 6 Base reverse characteristic for typical germanium alloy junction transistor.



a) Low temperature *b) High temperature*

Figure 7 Base forward characteristic for typical germanium alloy junction transistor.

Canada's electronics industry

its origin — growth and achievements

Continued from page 38

to wartime restrictions, was short of these products, electronic equipment for industry — for controlling mass production assembly lines in factories, for visual control of iron and steel smelting processes, for automatic inspection apparatus for the production of small mechanisms, radar developments for defense purposes on land, at sea and in the air, fixed and mobile radio communication equipment for all purposes, and the application of electronics for use with nuclear energy. Other electronic applications dealt with equipment for radio broadcast and television telecast stations and studios, communication equipment for the high frequencies (HF), very high frequencies (VHF), ultra high frequencies (UHF), and super high frequencies (SHF), of the radio spectrum, power line carrier current equipment, telephone carrier current apparatus, voice frequency telegraph equipment, computer and data processing equipment systems, electronic equipment providing the "guide" for guided missiles, and the application of electronic control devices and television to industrial processes and methods of production in the Electronics Industry and in other separate and remote industries.

Industry expansion

During the decade 1945-55 the Canadian Electronics Industry grew at an extremely fast rate, in terms of total volume of goods produced, in factory floor area, in employment of workers, in development of new products and in the size of its contribution to the defense program. Because of the auto-generative nature of the art and science of electronics, there is undoubtedly no visible end to its practical application for the production of new and useful products. In 1948 no television receivers were being produced in Canada but in seven years' time, by the end of 1955, over 2,000,000 television receivers had been manufactured in this country, and other examples of this type of expansion can be found in other sectors of the industry. According to recent estimates, 80 per cent of the electronic products being manufactured in Canada were not known in other than laboratory form ten years ago.

The manufacture of electronic components in Canada is as old as the radio receiver segment of the industry. Through the years the number and type of components have changed in accordance with developments in the art and science of electronics and in some phases component production has become a very highly skilled and scientific mass-production technique which is undergoing continuous development and improvement. As a result, highly specialized components have been made available at low cost to other segments of the industry.

Industries established prior to the manufacture of electronic components in Canada have been stimulated and expanded by the requirements of the Electronics Industry. Industries producing sheet steel, batteries, copper wire, machine screws, fasteners, brass, copper and aluminum sheet and strip, dials, nameplates, bakelite and fiber sheets, rods and tubes, paint, lacquer, plating, rivets, nuts and bolts, printed paper and instruction manuals, cartons, furniture and cabinets, solder, tool-making, moulding powders and other products have benefited considerably in volume of output as a result of the requirements of the electronics industry.

The Canadian electronics industry today is second to none in its ability to produce quality products of advanced engineering and technological design and stands ready to offer delivery and service that is unexcelled.

It can be said without qualification that overseas buyers of electronic equipment would do well to investigate the advantages of competitive prices, the willingness to accept small run orders and the many other extensions of courtesy and co-operation which the Canadian electronics industry is prepared to offer to overseas buyers.

Canadian Admiral executive appointment

Stuart D. Brownlee, president of Canadian Admiral Corporation, Ltd., recently announced the appointment of **John R. Bonner** as vice-president and general manager of Ensign Acceptance Corporation. Ensign is a wholly owned subsidiary of Canadian Admiral Corporation.

Mr. Bonner has been with Canadian Admiral for the past five years, serving as assistant credit manager at the Toronto sales branch, and credit manager at the Winnipeg, Calgary and Vancouver branch offices.

Canada's official observer at European conference

A prominent Canadian professional engineer and mining authority, **Dr. George B. Langford, P.Eng.,** of Toronto, has been selected as Canada's official observer to the forthcoming Conference of Engineering Societies of Western Europe and the U.S.A. (EUSEC) to be held in Brussels, August 29 to September 3.

Dr. Langford, who is head of the department of geological sciences at the University of Toronto, and a member of Council of the 19,800-member Association of Professional Engineers of Ontario, will be the only Canadian attending the multi-nation conference. Delegates will discuss engineering education and exchange ideas on curricula, teaching methods and enrolment.

Dr. Langford is a former president of the APEO, and also serves as co-chairman of Ontario's certification program for engineering technicians and technologists.

Since Canada is not a member of the EUSEC organization, she is entitled only to an observer-representative. This will mark the first time that a Canadian, representing the Canadian Council of Professional Engineers, will be attending the conference.

Reference guide to Canadian manufacturers

Continued from page 42

J. H. Darcy Ltd.,
51 Abbott St. N., Smiths Falls, Ont.
(relays)

Daystrom Ltd.,
840 Caledonia Rd., Toronto, Ont.
(potentiometers, meters)

E.M.I.-Cossor Electronics Ltd.,
2005 MacKay St., Montreal, Que.
(deflection coils)

Edo (Canada) Ltd.,
P.O. Box 97, Highway No. 2, Cornwall, Ont.
(acoustic transducers)

El-Met Parts Ltd.,
Head St., Dundas, Ont.
(magnetic shielding, cores, metal laminations)

Erie Resistor of Canada Ltd.,
7 Fraser Ave., Trenton, Ont.
(capacitors)

Fleck Mfg. Ltd.,
80 Harvey St., Tillsonburg, Ont.
(wire harness, cords)

General Instrument, F. W. Sickles of Canada Ltd.,
151 Weber St. S., P.O. Box 408, Waterloo, Ont.
(transformers, coils, TV tuners, rectifiers)

Hammond Manufacturing Co. Ltd.,
Guelph, Ontario.
(chassis, racks, chokes, reactors, transformers)

Helipot Div. of Beckman Instruments Inc.,
3 Six Points Rd., Toronto, Ont.
(potentiometers, coils)

Honeywell Controls Ltd.,
Vanderhoof Ave., Toronto, Ont.
(instruments)

International Rectifier of Canada Ltd.,
1581 Bank St., Ottawa, 1, Ont.
(photoelectric cells, rectifiers, diodes)

International Resistance Co.,
349 Carlaw Ave., Toronto 8, Ont.
(resistors)

Johnson Matthey & Mallory Ltd.,
110 Industry St., Toronto 15, Ont.
(seals, capacitors, contacts, resistance wire)

Lucas-Rotax Ltd.,
2200 Eglinton Ave. E., Toronto, Ont.
(transformers, alternators, motors)

Mallory Battery Co. of Canada Ltd.,
228 St. Helen's Ave., Toronto 4, Ont.
(batteries)

Marsland Enigneering Ltd.,
154 Victoria St. S., Kitchener, Ont.
(magnetic clutches, gear trains, tuners)

C. C. Meredith Co. Ltd.,
80 Thomas St., Streetsville, Ont.
(resistors)

National Semiconductors Ltd.,
146 Bates Rd., Montreal 26, Que.
(photo cells)

Neosid (Canada) Ltd.,
10 Vansco Rd., Toronto 18, Ont.
(microwave materials and powered iron core components)

Osborne Electric Co. Ltd.,
95 Wesley St., Toronto 18, Ont.
(relays, transformers)

Philco Corp. of Canada Ltd.,
Don Mills Rd., Don Mills, Ont.
(transformers)

Phillips Electrical Co. Ltd.,
Brockville, Ont.
(cables and wires)

Potter and Brumfield Canada Ltd.,
135 Oxford St., Guelph, Ont.
(relays)

Precision Electronic Comp. (1956) Ltd.,
50 Wingold Ave., Toronto 19, Ont.
(resistors)

Quality Hermetics Ltd.,
45 Hollinger Rd., Toronto 16, Ont.
(glass-to-metal seals)

RCA Victor Co. Ltd.,
1001 Lenoir St., Montreal, Que.
(components for guided missiles, semiconductors, tubes)

Radio Components Ltd.,
50 Wingold Ave., Toronto 19, Ont.
(aerials, coils, switches)

Radio Condenser Co. Ltd.,
6 Bermondsey Rd., Toronto 16, Ont.
(capacitors)

Raytheon (Canada) Ltd.,
61 Laurel St. E., Waterloo, Ont.
(tubes)

Rogers Electronic Tubes & Components,
116 Vanderhoof Ave., Toronto 17, Ont.
(filters, crystals, semiconductors, and tubes)

Sharpe Instruments Ltd.,
6080 Yonge St., Willowdale, Ont.
(headphones)

Sinclair Radio Labs Ltd.,
21 Toro Rd., Box 179, Downsview, Ont.
(waveguide components, multicouplers, filters, antennas)

S. G. Smallwood Ltd.,
391-397 King St. E., Kitchener, Ont.
(coils)

C. R. Snelgrove Co. Ltd.,
141 Bond Ave., Don Mills, Ont.
(crystals, ovens)

Standard Television Products Ltd.,
108 Sydney St., Kitchener, Ont.
(transformers)

Stanwyck Coil Products Ltd.,
17 Laurier St., Box 1059, Hawkesbury, Ont.
(transformers, coils)

Stegg Electric Ltd.,
P.O. Box 211, Belleville, Ont.
(contactors, relays)

Syntron (Canada) Ltd.,
928 Queenston Rd., Stoney Creek, Ont.
(rectifiers)

Taylor-Leslie Mining & Eng. Corp. Ltd.,
P.O. Box 312, Terminal "A", Toronto, Ont.
(rectifiers)

Telegraph Condenser Co. (Canada) Ltd.,
50 Bertal Rd., Toronto 15, Ont.
(capacitors)

Thermo Electric (Canada) Ltd.
P.O. Box 10, Brampton, Ont.
(measuring components)

Tinsley Instruments (Canada) Ltd.,
P.O. Box 99, Smiths Falls, Ont.
(potentiometers)

Continued on page 78

Product Panorama

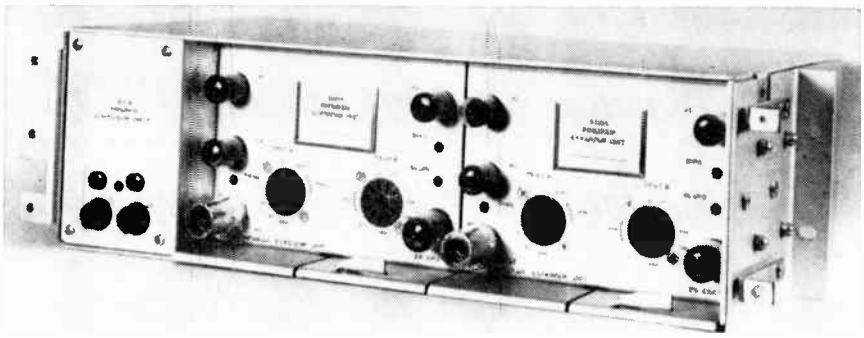
Continued from page 63

Lenkurt Electric Company develops a new program compandor

Item 596

Although program material may be transmitted at carrier frequencies over open wire line, cable or radio, the majority of program transmission in Canada, is at audio frequency over physical circuits. The frequency range of the program transmission is from 100 to 5,000 cps with some high quality circuits utilizing a range from 50 to 10,000 cps whereas the normal voice circuit range is 300 to 3,400 cps. When dealing with program transmission it has been found that many circuits are unsuitable for program material due to a high level of noise. A suitable circuit must exhibit a signal to interference performance approximately 20 db better than that required for voice transmission. In most cases it is not possible to raise the average signal level as this could cause overloading on peak signals or interference in adjacent circuits. This type of problem, in most instances, may be minimized through the use of a compandor.

A compandor comprises a compressor at the transmitting terminal and an expandor at the receiver terminal. The action of these units is complementary. At the transmitting terminal the compressor reduces the wide dynamic range of the program signals while at the receiving terminal the expandor restores the signal to their original intensity range. Thus the interference, caused by noise, cross talk, etc. in the transmission path is effectively reduced. This reduction is often sufficient to allow transmission routes or systems which otherwise could not provide the necessary signal to interference performance, to be used for program transmission.



Item 596

For further information contact: **Lenkurt Electric Company of Canada Limited, 7018 Lougheed Hwy., North Burnaby P.O., Vancouver, B.C.**

Hermetically sealed varactor diodes

Item 597

Type MA-4297 silicon mesa varactor diodes with 120 kMc cutoff frequency have been introduced by Microwave Associates, Inc., of Burlington, Mass. The new diodes are housed in hermetically sealed reversible-polarity cartridges with outline dimensions similar to MA-450 series varactor diodes.

Shunt capacitance is on the order of 0.4 μμfds and approximate series lead inductance is 2×10^{-9} henries.

Noise figures of 0.5 db are reported in radio astronomy equipments operating in the 1420 megacycle region, using the MA-4297 varactors.

Price and delivery data is available from **E. G. Lomas, 227 Laurier Ave. W., Ottawa 4, Ontario.**

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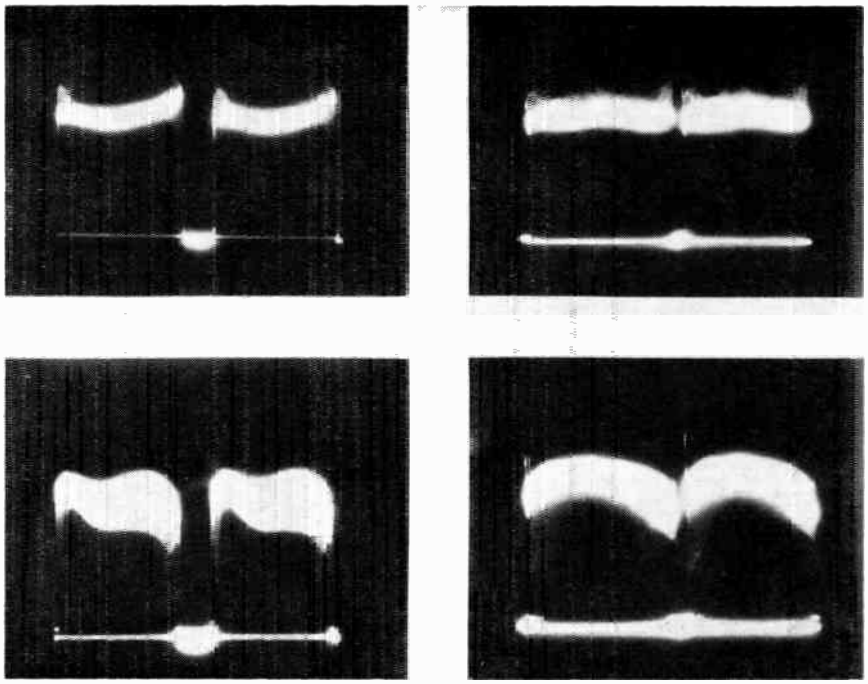
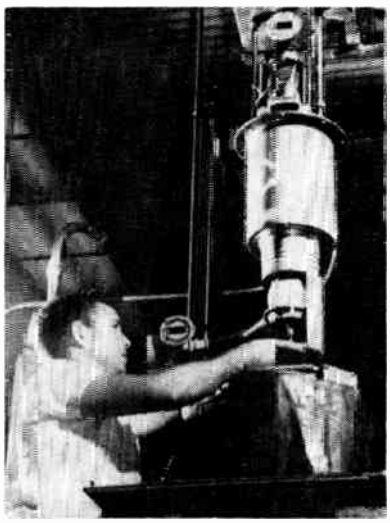
Page number is on the right. Key number for use with READER SERVICE CARD is on the left.

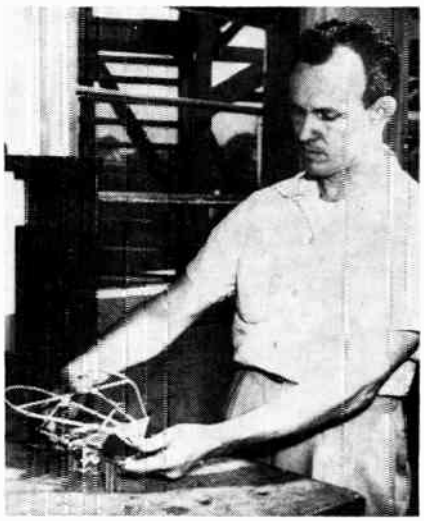
The BOMARC missile shown above is programmed for use in the United States and Canadian defense systems. The Canadian government announced recently that a SAGE-BOMARC combination was its choice for the defense of major population areas and industrial complexes.



Marked improvement in quality of television picture produced by General Electric's new GL-7293 field mesh image orthicon is seen in comparison of its video wave form patterns (at top) with those of the standard 5820 broadcast tube (bottom). Photographs taken from video wave form monitor show landing patterns in response to the same uniform white scene. Wave forms of the new tube are relatively flat, while wave forms of the 5820 are distorted.



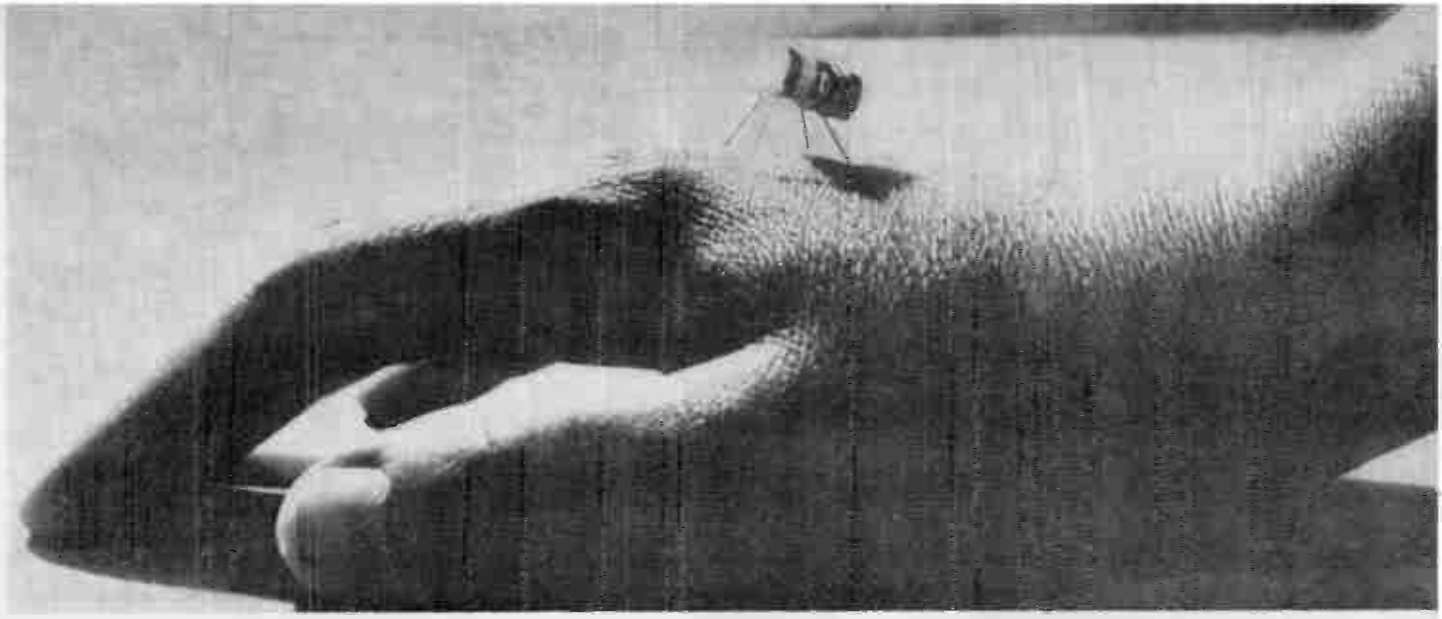
First photo of Sperry C-band klystron shows technician completing factory tests on an electron tube that supplies 3,000,000 watts of precise radar power for detection and automatic tracking of small, fast-moving targets at longer ranges than formerly possible. It is the first klystron to generate such intense radar energy for radars operating in frequency bands above four billion cycles per second.



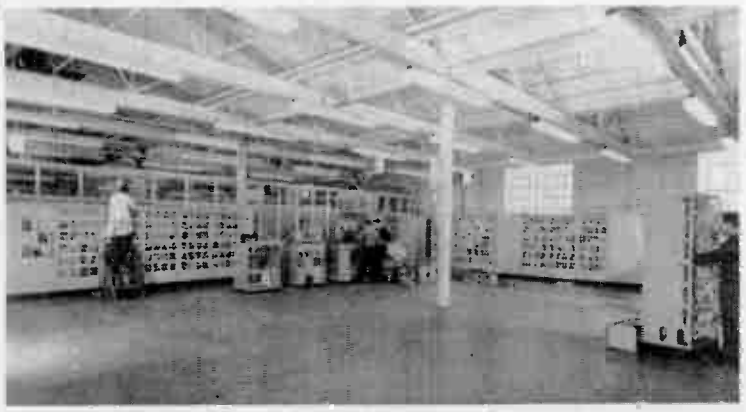
Collins Radio Company engineer demonstrates how the ultra high frequency descent-recovery antenna for Project Mercury will work. The antenna will be collapsed (shown in the photo) under the antenna fairing, and when the fairing is blown off on descent of the capsule, the antenna is erected.

close-up

looking lenswise at your industry in action



Don't swat — this "insect" won't bite. It is actually a precision air capacitor, made by Johanson Manufacturing Corp., Boonton, N.J. Even though extremely small — less than ½ inch long — the device is fully adjustable over a 10:1 range. Its primary uses include missiles, computers, and many other electronic devices in need of fine tuning.



A general view of the EMIDEC 2400 Computer under construction at the Hayes factory of E.M.I. Electronics Ltd. The computer is one of the most advanced in the world and when completed will be capable of "absorbing" all the information in the Encyclopaedia Britannica in less than four minutes.

Shown above is the rotor balancing department of M. Ten Bosch Inc. The equipment measures rotor displacements less than a millionth of an inch at any speed from 1,000 to 200,000 rpm. Rotors as small as 0.5 grams and up to 100 pounds are handled in the standard vibration mounts.

Among the hundreds of operations involved in the manufacturing of semiconductors at the Radio Valve Company Ltd. of Canadian General Electric in Toronto is the imprinting of the maker's name. Shown in the above photograph, an employee holds semiconductor at the printing machine which imprints the type and maker's name.

Reference guide to Canadian manufacturers

Continued from page 71

Titania Electric Corp. of Canada Ltd.,
Herbert and Brock Sts., P.O. Box 672,
Gananoque, Ont.
(capacitors, thermistors, transducers)

United-Carr Fastener Co. of Canada Ltd.,
231 Gage Ave. N., Hamilton, Ont.
(hardware, printed circuit boards)

Universal Wire and Cable Co. Ltd.,
2155 Moreau St., Montreal, Que.
(wire)

Varian Associates of Canada Ltd.,
45 River Dr., Georgetown, Ont.
(microwave tubes)

Ward Leonard of Canada Ltd.,
1070 Birchmount Rd., Box 70,
O'Connor Postal Station, Toronto 16, Ont.
(motor controls, relays, resistors)

Welwyn Canada Ltd.,
1255 Brydges St., London, Ont.
(resistors)

COVER STORY

The front cover illustration of this issue of *Electronics and Communications* shows Type RA and L variable resistors undergoing a rotational life test at Precision Electronic Components (1956) Ltd., Toronto, Ontario. In the rotational life test pictured, twelve controls under full load are tested at 15,000-25,000-50,000 and 125,000 cycles for rotational noise, torque and resistance changes.

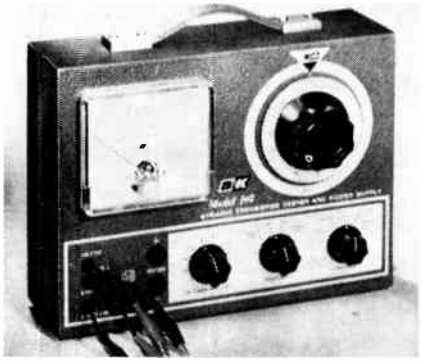
Product Panorama

Continued from page 72

Transistor tester

Item 598

New Model 160 professional quality low-cost transistor tester for servicing, lab, and industrial use is now produced by B&K Manufacturing Co., Chicago.



This new instrument saves time and guesswork in servicing transistor sets and equipment. Simplifies incoming factory inspection and speeds on-the-line testing. Facilitates laboratory testing and transistor quality control.

Uses a true small AC signal measurement for transistor current gain (beta). Reads directly in beta — gives quick accurate direct reading of current gain of the transistor, not a relative indication. No interpolation, no calculation necessary. Beta measurement is accurate within ±3 per cent — there's no guesswork.

Test conditions are stable. All transistors are automatically biased to standard 1 ma. collector current.

For complete information, write **Atlas Radio Corporation Ltd., 50 Wingold Avenue, Toronto 19, Ont.**

Mercury relays

Item 599

The Electronic Equipment Group of Philips Electronics Industries Ltd. announce the availability of an improved version of the Ebert Plunger Type Mercury Relay for power and control circuitry applications.

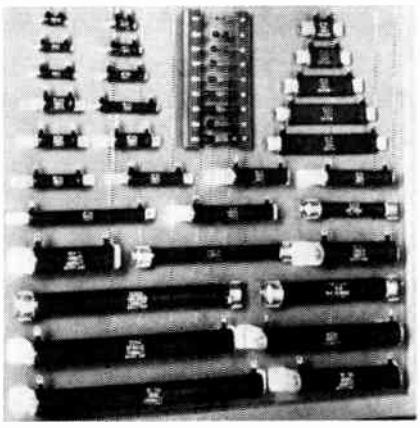
CSA approved for use in Canada the Ebert Relay contacts are hermetically sealed in a glass tube to make them impervious to dust and contamination. This relay offers quiet operation for use in equipment working in low noise level areas; long life because there are no rubbing contacts to wear; small size — it is a 60 amp., 3 pole unit measuring 3⅜" deep by 6⅝" high by 6" wide.

Complete information is available from the **Electronic Equipment Group, Philips Electronics Industries Ltd., 116 Vanderhoof Avenue, Toronto 17, Ont.**

Resistors

Item 600

A comprehensive line of Canadian designed Vitreous Enamelled Resistors is now manufactured and marketed by Marsland Engineering Limited.



Axial Terminal Types RW 55 to RW 59 and Tab Terminal types RW 29 to RW 47 (inclusive) have CAMESA and ASESA approval under MIL-R-26C specifications.

Featuring special alloy metals in both terminals and windings these resistors have a multi-layer enamel coating fired at temperatures above 1200°F and are completely sealed against moisture and corrosive fumes.

For detailed information write **Marsland Engineering Limited, 154 Victoria St. South, Kitchener, Ont.**

Continued on page 87

Choice of a universal logic element

Continued from page 67

connected without special sockets are attractive packaging features.

There are several more classes and types of transistors using germanium than silicon. Although silicon transistors can be operated at higher junction temperatures and exhibit a smaller leakage current than germanium they have a lower forward current gain and larger saturation resistance. As the amplifying switch of a multiple input inverter circuit, where the bias provides both thermal protection and 0 signal margin, the alloy junction germanium transistor offers superior characteristics at less cost.

A transistor connected in the common emitter configuration and having several inputs is shown in Figure 5. Depending on the relative values of R and R_B, it can be made to operate as a Kirchoff adder or as a Scheffer organ. The relatively high output impedance of this circuit limits its usefulness as a Kirchoff adder unless a diode clamp (shown dotted) is supplied to limit the output regulation. In addition to reducing the input signal tolerance a diode clamp improves the frequency response reducing the base overdrive. For operation as a universal logic element R and R_B are selected to reverse bias the emitter junction under all conditions of cutoff and to forward bias the collector junction from one input under all conditions of saturation.

Figure 6 shows the cutoff characteristics of a typical alloy junction germanium transistor having a h_{FE} of 78 at 25 degrees C. Note that the collector current falls below I_{CBO} when the emitter junction is reverse biased beyond 200 millivolts.

The characteristic shown in Figure 7 shows the change of emitter junction saturation with collector current and junction temperature.

Using these characteristics and others, circuit operation under the worst combination of tolerances and ambient temperatures can be analyzed by writing the loop and node equations. A set of equations for an inverter designed as a universal logic element is given in the appendix.

Conclusion

The transistorized inverter was selected as the device best suited for service as the logic element of static switching hardware for industrial control equipments. It is a straightforward circuit using few standard components which can be designed for reliable operation as a universal logic element. In this role, it can be applied to logic situations employing advanced control techniques where high switching speed is necessary. Its operation can be easily understood and remembered by means of a few simple ground rules and it can be readily tested after assembly and in the field. Output and inputs can be shorted to ground and partial turn on can exist indefinitely without damaging any components. No special coupling devices are required nor is any adjustment needed to implement any one of the three primitive logic functions. Its components can be assembled automatically by standard techniques and packaged with good volume efficiency. Finally, it is one of the most economical mechanizations of a static switching logic element.

Continued on page 86

engineers' book-case

Mathematics for Engineers (Vols. 1 and 2) by W. N. Rose.

These two volumes, each of which is devoted to certain areas of engineering mathematics, strike a remarkable compromise between the purely theoretical and the practical approach to engineering mathematics. Volume 1 (9th Edition) treats fully the fundamental rules and processes of algebra, plane trigonometry, mensuration and graphs, the work being carefully graded from an elementary to an advanced stage. Volume 2 (5th Edition) is devoted to the calculus and its applications. Graphic proofs or constructions are used to amplify or explain the subject throughout the book. Of particular importance are complete chapters devoted to the applications of differentiation and applications of the calculus.

John F. Rider Publisher, Inc., 116 West 14th St., New York 11, N.Y., hard cover bound, price — Volume 1, $6.60; Volume 2 — $6.60.

Electromagnetic Energy Transmission And Radiation by Richard B. Adler, Lan Chen Chu and Robert M. Fano.

This book treats electromagnetic waves and oscillations in one, two, and three space dimensions, using time-domain, complex-frequency-domain, and energy points of view.

To insure a proper balance of emphasis between physical considerations and analytical technique, the authors avoid the more formal procedures of boundary-value problem solution by employing a method of field synthesis. This approach involves study of elementary solutions in empty space, in enough detail to make clear in advance the kinds of boundary conditions simple combinations of them will require.

The significance of the various solutions is further illustrated by the simplest analytical models suggestive of practical devices.

John Wiley and Sons Inc., 440 Fourth Ave., New York 16, N.Y., 621 pages, hard cover bound, price $14.50.

Fundamentals of Electrical Engineering, 2nd Edition, by Fred H. Pumphrey.

Based on the thorough research which characterized its highly praised predecessor, this book affords the reader new insight into the field of modern electrical engineering.

Completely new data includes full chapters covering *Transistors . . . Magnetic Amplifiers . . .* new material on *DC Machine Amplifiers . . .* and a new presentation of *Sensing Units.*

The wide scope of the text makes it useful for readers working in fields other than electrical engineering, as well as specialists. This scope is achieved through the emphasis placed on principles and applications the reader will encounter no matter what field of engineering he enters. Here is a book geared to a "motivation slant" pertinent to mechanical, civil, chemical, and industrial engineering — through practicable illustrations and easily understood applications.

Founded on a study of DC and AC circuits the book provides a clearly constructed framework of these circuits. A concise treatment of electrical machinery theory is given as a background for a later analysis of the amplifier characteristics of these machines, and the use of transfer function terminology in control analysis. Those particularly interested in industrial production will find the highly effective — yet brief — chapter on the selection and use of electric motors, provides much helpful information.

Prentice-Hall Inc., 70 Fifth Ave., New York 11, N.Y., hard cover bound, 534 pages, price $8.50.

Design of Transistorized Circuits for Digital Computers by Abraham I. Pressman.

The author, an authority of the area of digital computer circuit design, has written a text of great value to the engineer who is concerned with the miniaturization of digital computers by transistorizing the circuits. To be of greatest general utility, the author employs "worst-case" design techniques. Among many computer circuit design considerations, the author presents in detail and analyzes every major scheme for performing transistorized computer logic. Of special benefit in computer design is his treatment of the calculations of transistor switching times — turn-on time, turn-off time, and storage time. The eleven chapters in the book admirably treat the gamut of subjects suggested by the title.

John F. Rider Publisher, Inc., 116 West 14th St., New York 11, N.Y., contains 316 pages, hard cover bound, price $9.95.

Letters to the editor

The CRTPB

The Editor:

On behalf of the Canadian Radio Technical Planning Board I wish to congratulate you and thank you for the publication of the article by R. C. Poulter entitled "Let's take a look at the CRTPB", which appeared in the July issue of your Journal.

Notwithstanding the continued publication of the CRTPB news letter in your Journal each month, and the direct efforts of Mr. Poulter in his capacity as Director of Publicity of the Board, it has been evident that the work of the Board and its readiness to be of service is all too little known within our industry and allied fields. The distribution of Mr. Poulter's excellent article to the recipients of your worthy Journal will certainly go a long way to bridge this gap.

With best regards and wishes for the continued success of *Electronics and Communications*.

F. H. R. Pounsett,
President,
Canadian Radio Technical Planning Board.

Electronic imports problem

The Editor:

I was very pleased to receive the August issue of *Electronics and Communications*. I know that you realize the seriousness of the importation problem to Canada's manufacturing industry and I feel that you personally, and your publication, are making a very worthwhile contribution in placing the facts before your readers.

Thank you for your help.

R. M. Robinson,
Vice-President,
Electronic Equipment & Tube Dept.
Canadian General Electric Co. Ltd.

For better understanding

The Editor:

May I congratulate you on your issue of August 1960!

In presenting the story of the problems facing the electronics industry as fully as you have, you have performed a valuable service which, I trust, will lead to better understanding on the part of government officials of the seriousness of our position.

W. E. Curry,
Vice-President,
Dominion Electrohome Industries Ltd.

The editors of *Electronics and Communications* receive many letters for publication each month. Unfortunately, due to space restrictions, it is not possible to publish all of them and it is suggested that, if publication is desired, letters to the editor be kept as brief as possible.

Japanese imports

The Editor:

The material in your magazine concerning Japanese competition with Canadian tube manufacturers has interested me greatly. However, may I present an aspect of the situation which has been untouched.

Japan has undertaken an experiment in democracy the outcome of which can bring hope or disillusionment to hundreds of millions of people. As well Japan is Canada's bastion against the might of Communism in the Pacific. What are the chances that this bastion may fall?

An examination of the facts which lay behind the mob violence of the Kishi government is very revealing. Dave Carey in the *Vancouver Sun* of August 10 says:

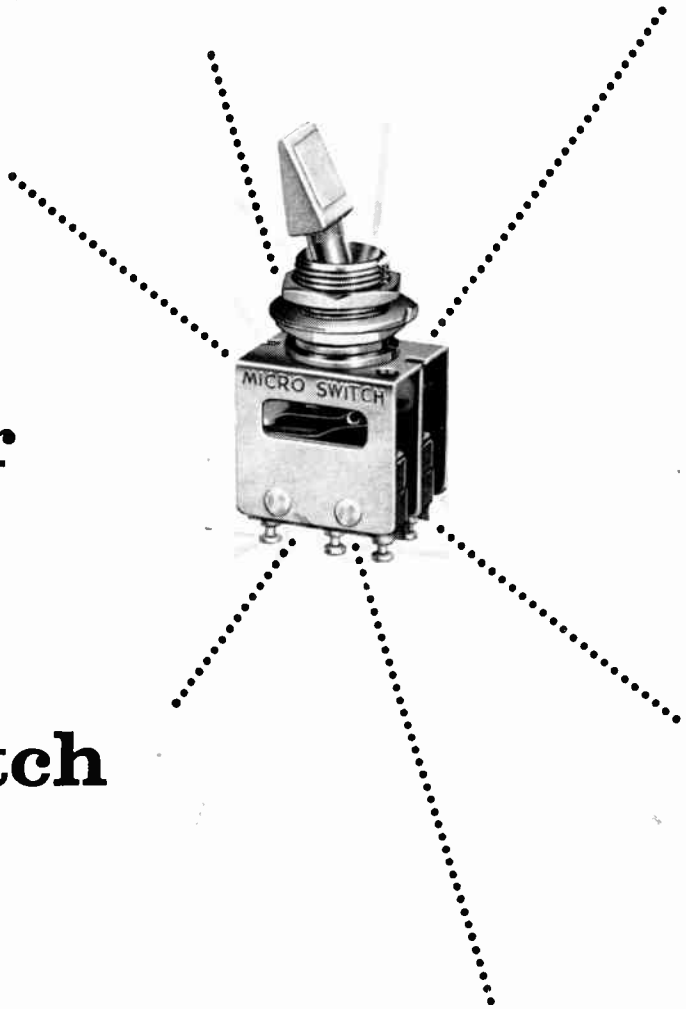
"The Communist inspired rioters in Japan were paid from Communist coffers 1,000 yen a day to do their work.

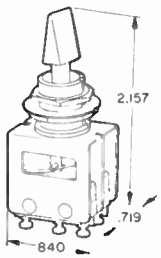
"That money came from two sources. First from the remunerative ticket sales of such cultural exchange programs as the Peking Opera, the Bolshoi Ballet, and the Leningrad Symphony. Secondly, it came from a big trade deal made by Japanese business men for Chinese lacquer."

Japan must export to survive. If she cannot trade with us, she must turn elsewhere. The encouragement of Japan in the desperate fight which she is waging is of paramount importance and must become the decisive factor in every consideration of Japanese-Canadian trade.

E. H. Tull,
University of Western Ontario.

New Tab-Indicator Toggle Switch





"400" SERIES TOGGLE SWITCHES
Five models available, including 2-position and 3-position types. All are rated at 5 amperes, 250 vac.

The new "400" Series Toggle Switch from MICRO SWITCH has a paddle-shaped tab which can be numbered or color-coded as an indicator. The standard model has a natural metallic finish which will maintain a fresh appearance through long and constant use. The anodized aluminum tab is also available in black or in colors.

The basic switches used are precision snap-action, long-life units, requiring a minimum of space. They conform to specifications for MIL-S-6743, with two isolated single-pole double-throw circuits. Turret terminals make wiring easy, and contact enclosures are dust-tight.

Five models are presently available in the "400" Series, including both momentary and maintained contact types. Write for Data Sheet No. 174 describing these new tab-indicator toggle switches.

For complete details check No. 29 on handy card, page 73

Choice of a universal logic element

Continued from page 81

APPENDIX

Multiple input inverter as Universal logic element

Worst condition at elevated temperature. Emitter junction must be reverse biased to ensure cutoff operation of transistor when all inputs are connected to saturated drivers. Summing currents at the base node

$$\frac{(\text{Ebb min} - \text{Vbe min})}{\text{Rb max}} = \frac{\text{k (Vbe min} - \text{Vsat max)}}{\text{R min}} + \text{Ico max} \tag{1}$$

Worst condition for low temperature operation. Collector junction must be forward biased to ensure saturated operation of transistor when all inputs but one are connected to saturated drivers. The one input is supplied by a fully loaded cutoff driver. Summing the currents at the base node

$$\frac{(\text{Ebb max}-\text{Vbe max})}{\text{Rb min}} + \frac{(\text{k-1})\ (\text{V sat min}-\text{Vbe max})}{\text{R min}} - \frac{\text{Ecc max}}{\text{Rc min } h_{FE}\text{ min.}} + \frac{\text{k(Vsat min}-\text{Vbe max)}}{h_{FE}\text{ min R min}} - \text{Ico min} = \frac{(\text{Vbe max}-\text{Vo min})}{\text{R max}} \tag{2}$$

The cutoff driver referred to above must support P loads identical to those described by eq. 2. Summing the currents at the collector node

$$\text{P}\ \frac{(\text{Vbe max} - \text{Vo min})}{\text{R min}} = \frac{(\text{Vo min} - \text{Ecc min})}{\text{Rc max}} + \text{Ico min} \tag{3}$$

Letting R max = AR min and restricting Vo min, combine equations (2) and (3). Letting Rb max = BRb min solve equation (1) for Rb min, substitute in equation (2)

$$\frac{\text{B}\left\{(\text{Ebb max} - \text{Vbe max}) + (\text{Vbe min} - \text{Vsat max})\ \text{k} + \text{Ico max R min}\right\}}{\text{R min}\ (\text{Ebb min} - \text{Vbe min})} + \frac{(\text{k-1})\ (\text{Vsat min} - \text{Vbe max})}{\text{R min}} = \frac{(\text{Vomin} - \text{Ecc min})}{\text{A P Rc max}} + \frac{\text{Ico min}}{\text{A P}} + \frac{\text{Ecc max}}{\text{Rc min } h_{FE}\text{ min}} - \frac{\text{k(Vsat min} - \text{Vbe max)}}{\text{R min}} + \text{Ico min} \tag{4}$$

Solve equation (4) for R min

$$\text{R min} = \frac{\left\{\frac{\text{Ebb max}-\text{Vbe max}}{\text{Ebb min} - \text{Vbe min}}\right\}(\text{Vbe min} - \text{V sat max})\ \text{kB} + (\text{k-1})\ (\text{V sat min} - \text{Vbe max})}{\left\{\frac{\text{Vo min} - \text{Ecc min}}{\text{A P Rc max}} + \frac{\text{Ecc max}}{\text{Rc min } h_{FE}\text{min}}\right\} + \text{Ico min}\ (1+\overline{1}\ ) - \left\{\frac{\text{Ebb max} - \text{Vbe max}}{\text{Ebb min} - \text{Vbe min}}\right\}\text{BIco max}} \tag{5}$$

The above are the equations for satisfactory operation over the temperature range specified and under the worst combination of tolerances and loading. The circuit must of course also be analyzed for component stress under normal and abnormal operation to ensure reliable operation.

References

[1] *Proceedings of Second RETMA Symposium on Applied Reliability, June 1957.*

[2] *Proceedings of Second RETMA Conference on Reliable Electrical Connections, September 1956.*

[3] *Arithmetic Operations in Digital Computers (book) R. K. Richards, D. Van Nostrand Co. Inc. Princeton, N.J. 1955, Chapter 3, page 96.*

[4] *Ibid, Capt. 2, page 35.*

[5] *A Transcribing Card Punch, C. T. Cole, Jr., K. L. Chien and C. H. Profster, Jr. Proceedings of Eastern Joint Computer Conference, Dec. 10-12, 1956, pp. 80-83.*

[6] *Transistor NOR Circuit Design, W. D. Rowe and G. H. Roger, A.I.E.E. Transactions paper 57-196, Winter General Meeting, 1957.*

[7] *Organization of Logic for the Universal Logic Element, E. Boote, IRE Canadian Convention, Oct. 8-10, 1958.*

[8] *Large-Signal Behavior of Junction Transistors, J. J. Ebers and J. L. Moll, Proceedings of IRE vol. 42, pages 1761-1772, December 1954.*

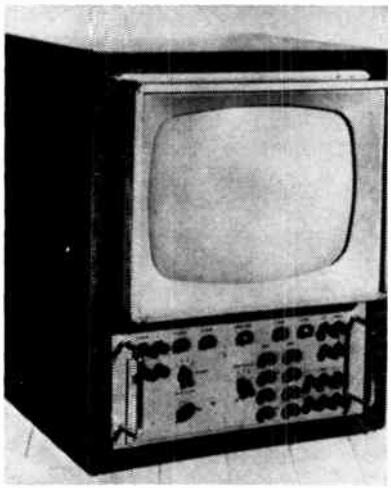
Product Panorama

Continued from page 80

Display oscilloscope type 279

Item 601

The display oscilloscope type 279 has been designed primarily for demonstration and instructional use in schools, technical colleges, and universities, but will be found of value in any application requiring an exceptionally large viewing screen.



It employs a 17-inch cathode ray tube with a rectangular screen having a brilliant orange long persistence trace. A 4-beam electronic switch is incorporated to enable related waveforms from up to four sources to be viewed simultaneously for comparison purposes. Each of the four traces may be adjusted in amplitude and vertical position by means of independent controls.

The Y amplifiers operate from DC to 10 kc/s with a maximum sensitivity of 18 cms per volt. An X amplifier of similar characteristics can be used either with the built-in time base or with an external signal for showing Lissajous figures. The hard valve time base provides sweep periods from 1 sweep per second to 1000 sweeps per second and is fitted with an internal synchronization circuit which locks automatically on the channel 1 signal.

For further information: **Conway Electronic Enterprises Limited, 1514 Eglinton Ave. West, Toronto 10, Ont.**

Push button switch assemblies

Item 602

Three new actuator designs have been added to the line of "One-Shot" pushbutton switch assemblies, manufactured by Micro Switch, Toronto, Ont., a division of Honeywell Controls Limited. These devices have a special circuit to produce a single, square wave pulse, regardless of the speed of switch operations.

These new "One-Shot" assemblies can be furnished with any of six pre-engineered potted circuit packages that furnish pulse widths of 0.1 to 10.0 microseconds, and can produce output voltages up to 180 volts and drive loads as low as five ohms. There is no constant power drain.

Pulses can be positive or negative. Application areas include computer and radar consoles, data link, checking ring counters, setting and resetting flip-flops, keyboards, and reflected pulse systems.

Please direct inquiries to **Merchandising Department, Honeywell Controls Limited, Vanderhoof Avenue, Toronto 17, Ont.**

High-speed oscillograph

Item 603

The Hathaway Model RS-9 Thirty Oscillograph records up to 32 independent channels of analog information. Within the recorder's case, up to four initiating relays may be housed, to automatically start the recorder on such faults as low line voltage, overcurrent, neutral current flow, overvoltage.

Accessories which may be purchased with the basic oscillograph include a chart advance mechanism to prevent record fogging during periods of non-operation, digital time and date recorder, static reference traces, and externally-mounted initiating relays.

Further information is available from the Canadian representative, **B. H. McGregor, P.O. Box 156, Station "H", Toronto 13, Ontario.**

techdata for engineers

Synchro and resolver manual

Item 604

This 27-page illustrated technical discussion of the electrical characteristics of synchros and resolvers is being offered without charge. The manual describes in detail the application and significance of such parameters as electrical error, electrical zero, fundamental null, total null, transformation ratio, and phase shift. When synchros and resolvers are used in systems each of the "data-sheet properties" undergoes drastic change whose nature is thoroughly explained. Methods of measurement and the basic specifications for test equipment are also included.

Distributed by **Theta Instrument Corp., 520 Victor St., Saddle Brook, N.J.**

Glossary of terms

Item 605

To fulfill a long felt need, Standard Wire and Cable Company of Los Angeles has announced the publication of a pocket sized "GLOSSARY OF WIRE AND CABLE TERMS".

The booklet, a 4 x 6 pocket sized publication, lists alphabetically common terms, expressions, and units used in the electrical wire and cable industry. It is indispensable as a reference to engineers, designers, technicians and purchasing personnel.

Available at no cost on letterhead requests to **Standard Wire and Cable Company, 3440 Overland Avenue, Los Angeles, California.**

Handbook of pilot lights

Item 606

The new "Dialco Handbook of Pilot Lights" fills a special and longfelt need in industry. The selection of the lamp is a prerequisite to the choice of a Pilot Light, since each Series of Pilot Lights is designed to be used with a single type of lamp. Accordingly, the text of the handbook opens with an eight-page Lamps Section which discusses 15 types of Incandescent Lamps and six types of Neon Glow Lamps. The sections which follow are in categories by particular lamp type; the text covers in detail the specific assemblies designed to receive the lamps, including life-size illustrations of all Pilot Lights as well as technical data such as dimensions, lens styles, finishes, optional features, mounting clearance hole, etc.

Interested individuals are invited to write for a "Handbook Application Form". The limited publication of this invaluable manual necessitates a review of prospective recipients. All qualified personnel will assuredly be favored with a copy. For the application form, please write to the **Dialight Corporation, 60 Stewart Ave., Brooklyn 37, N.Y., attention: "Handbook Dept.,"**

Bomac product catalog

Item 607

Bomac Laboratories, Inc., Salem Road, Beverly, Mass., has released a new product catalog. It contains specifications on over 600 microwave tubes and components including: TR, ATR, pre-TR tubes; shutters; reference cavities; crystal protectors; silicon diodes; magnetrons; klystrons; duplexers; pressurizing windows; noise source tubes; high frequency triode oscillators; and surge protectors. It also contains full information on how to order as well as a complete listing of Bomac's representatives. **Bomac Laboratories Inc., Salem Road, Beverly, Mass.**

Digital Data Handling

Item 608

"Electronic Digital Data Handling for Communications" describes equipment now available as well as techniques and devices presently in test for accurate and speedy flow of information between the computer and remote stations.

Included is a description of two types of hardware designed to enable communications to bridge the data processing gap. The D300 series is equipment which immediately converts information between punched paper and magnetic tape in either direction. Modular construction enables the user to specify "image" conversion or, as optional features, format control, reordering and translation.

The D500 series provides for transmission as well as conversion of data. The same options are offered as well as the choice of one or more of several checking features.

Speeds, costs and equipment for all types of transmission media are compared, including teletype grade facilities, telephone grade facilities, audio and video.

Savings for the computer user by use of "off-line" conversion equipment are detailed in a number of case histories. Line drawings compare the problems and terminology of the communication and computer people. **Digitronics Corporation, Albertson Ave., Albertson, L.I.**

John L. Plant rejoins Collins Radio

The appointment of **John L. Plant** as vice-president and general manager of Collins Radio Company of Canada Ltd. was recently announced by A. A. Collins, president and chairman of the board of directors of the company.

Mr. Plant, who retired from the RCAF with the rank of Air Vice Marshal in August 1956, entered industry with Collins Radio Company of Canada Ltd., and later joined Avro Aircraft Limited. The recent appointment again associates Mr. Plant with Collins Radio.

J. P. Giacoletto, who has held the position of vice-president and general manager since December 1957, will continue as vice-president until his return to the parent company in the U.S.A. at a later date.

Key appointments for Montreal's CFCF-TV

Key appointments to the staff of CFCF-TV, recently licensed by the Department of Transport as Montreal's second English-language television station, have been announced by R. E. Misener, manager of the broadcast division, Canadian Marconi Company, and general manager of CFCF-TV.

Vincent Dittmer, of Toronto, backed by broadcasting experience throughout Canada, the United States, and Latin America, is appointed business manager, CFCF-TV.

S. B. Hayward, of Montreal, formerly radio and television director of a Toronto advertising agency, becomes program manager of the new station.

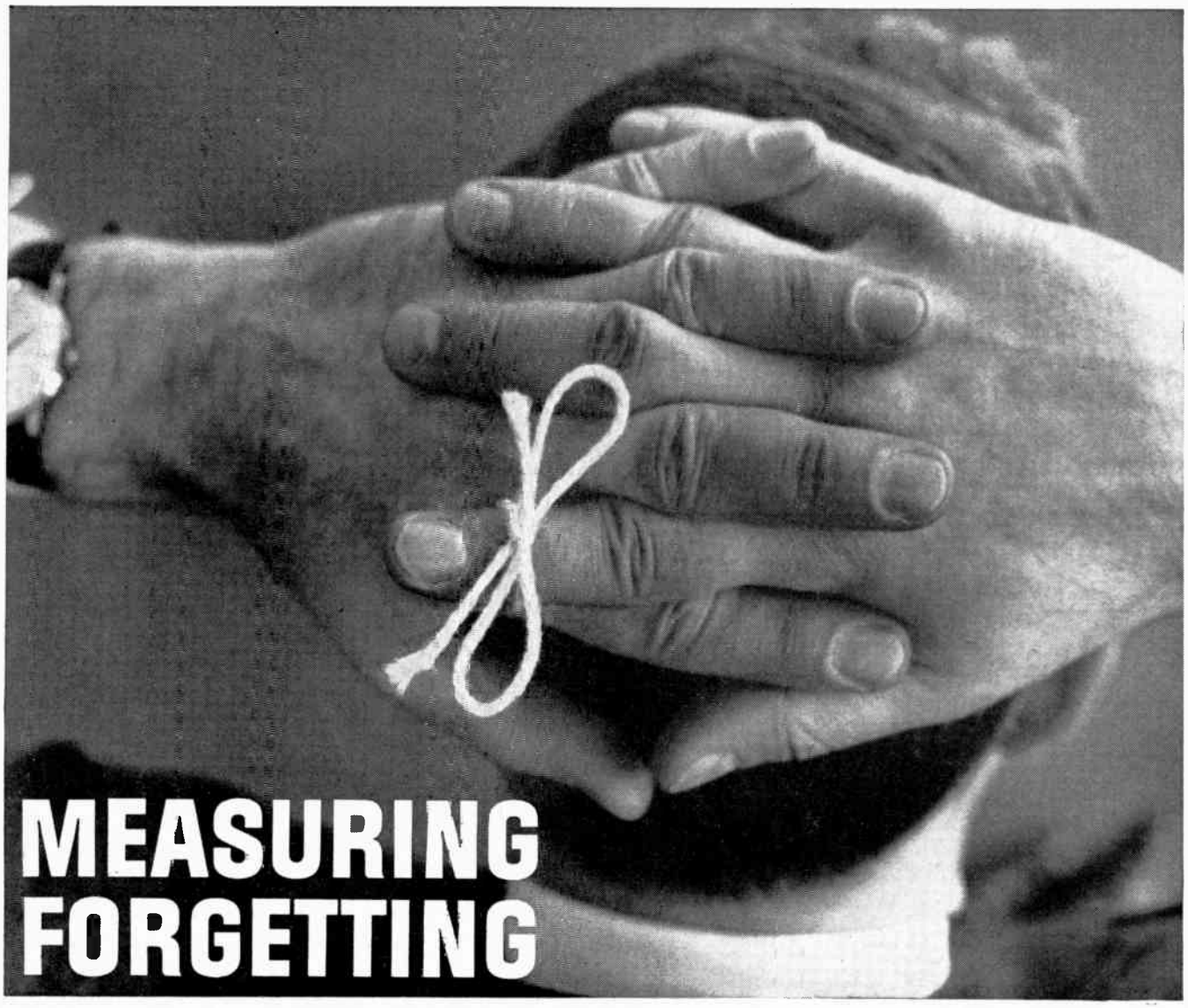
Controller, CFCF-TV, will be **John Logan,** of Toronto, a former management consultant.

R. J. Johnston, a native of Windsor, Ont., and formerly with CKLW-TV in that city, has been appointed sales manager.

Position of chief engineer will be filled by **J. C. Douglas,** of Sutton, Que., who has been closely associated with television since its introduction to post-war Canada. Mr. Douglas, with Canadian Marconi since 1948, supervised the installation of equipment, training of staff, and organized network TV programs for the United Nations at Flushing Meadows, N.Y.

J. A. Boyd, of Timmins, Ont., becomes operations manager. Mr. Boyd was formerly station manager of CKSO-TV, Sudbury, Canada's first privately-owned TV station.

Promotion manager is **P. A. Tweedie,** of Hamilton, Ont., whose broadcasting career began with CHSJ and CFBC radio stations in Saint John, N.B.



Many years ago, a German psychologist, a Professor Ebbinghaus, measured how quickly and easily people forget things. The same general findings have been substantiated by scientists since.

. . . by the end of the day you forget over a third.
. . . by the end of the week you forget over a half.
. . . by the end of the month you've forgotten two-thirds.

This points up a major benefit of business paper advertising. It not only gets your message straight to the people who specify and buy but it also makes it economically possible to do so *often* because it costs just a very few cents per contact.

Even when your salesmen are out of sight, your company and its products are not out of mind when you advertise consistently in business newspapers.

One or more of the over 140 B.N.A. publications specializes in the particular market you want to reach . . . gets your message straight to the men who specify and buy. Business Newspapers Association of Canada, 100 University Ave., Toronto 1.

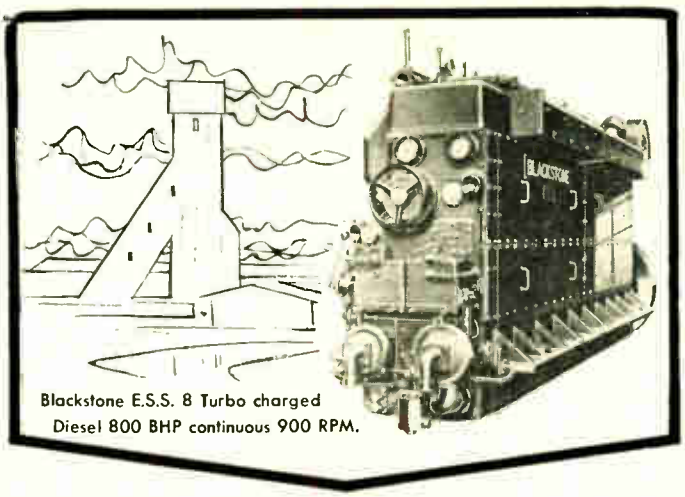
6-4

THE *BEST* CANADIAN BUSINESS PUBLICATIONS BEAR THIS EMBLEM

BNA

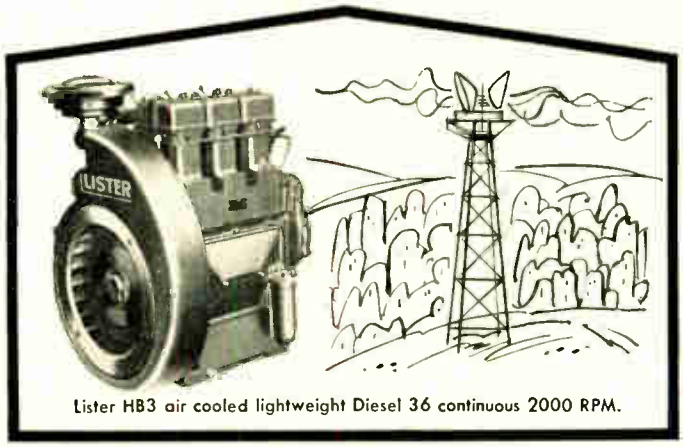
BUSINESS NEWSPAPERS

GET YOUR MESSAGE THROUGH CLOSED DOORS TO PEOPLE WHO SPECIFY AND BUY



Blackstone E.S.S. 8 Turbo charged Diesel 800 BHP continuous 900 RPM.

ALL KINDS OF POWER



Lister HB3 air cooled lightweight Diesel 36 continuous 2000 RPM.

LISTER-BLACKSTONE DIESEL ENGINES

Wherever you use Diesel power, there is a Lister-Blackstone engine to handle the job efficiently, economically. The full line includes units from 3½ to 1400 BHP.

Built in a tradition of reliability, all models incorporate the very latest improvements in Diesel design. Easy maintenance and dependable operation are assured when you specify Lister-Blackstone. Service and spare parts are available from coast to coast.

Write us for details indicating application.

CANADIAN LISTER-BLACKSTONE LIMITED

1921 Eglinton Ave. E. Scarborough Toronto 13 Ontario
VANCOUVER MONTREAL
In the U.S.: Lister-Blackstone, Inc., 42-32 21st Street, Long Island City 1, N.Y.

For complete details check No. 14 on handy card, page 73

get the shortest etching time with HUNT ETCHANTS

Wherever Hunt Etchants are used production rates jump.
HUNT R. C. E. *(Rapid Circuit Etch)* is a fast acting, specially balanced etchant for printed circuit board production.
HUNT S. C. E. *(Solder Circuit Etch)* is the only prepared product formulated to etch solder-plated boards at room temperature without attacking the solder.
Send for: **R. C. E. TECHNICAL BULLETIN 1 & 1A**
S. C. E. TECHNICAL BULLETIN 3

FOR SUPERIOR RESULTS AROUND THE CLOCK USE HUNT GRAPHIC ARTS CHEMICALS

PHILIP A. HUNT COMPANY (CANADA) LTD.

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TORONTO 1, ONTARIO
TELEPHONE EMPIRE 3-5456
MONTREAL SALES OFFICE
TELEPHONE WE 2-3607

MANUFACTURING CHEMISTS ESTABLISHED HUNT

For complete details check No. 30 on handy card, page 73

B. H. McGregor appointment

Dynisco, Inc., of Cambridge, Massachusetts, recently announced the appointment of **B. H. McGregor, P.Eng.**, P.O. Box 156, Station "H", Toronto 13, Ontario, as their exclusive agent for Canada.

Dynisco is the new name for Dynamic Instrument Co., who are well-known as manufacturers of strain gauge pressure transducers, differential pressure transducers, and force transducers.

Finkler appointed Gen-Pro representative

General Products Corporation, Union Springs, New York, has appointed **Len Finkler Ltd.** as its sales representative for the Dominion of Canada, effective immediately.

The upstate New York firm manufactures a full line of electrical terminal boards for commercial and military applications; custom thermosetting parts; specialized electro-mechanical assemblies and wire harnesses.

In its new capacity, the Finkler organization will service the entire Dominion of Canada and serve as a supplier for the complete Gen-Pro line.

Borden Chemical Co. names district manager

Francis W. Linehan has been named district manager for the Western Operations Department of The Borden Chemical Company, a division of The Borden Company, according to an announcement by R. T. Hanson, general manager.

In his new capacity, Mr. Linehan will be responsible for sales and manufacturing of the company's products in the western part of Canada as well as in the State of Washington. He will operate from the company's western headquarters in Seattle, Washington.

at the touch of a ● BUTTON ~ your phone becomes an INTERCOM

It's versatility, not magic, that Northern Electric has built into this intercom telephone. Through advanced research and technology, this one phone does what 3 or 4 standard phones could never do. It lets you:

- talk to others in your office by just dialing or pushing a button
- confer with as many as 6 persons at once
- add another person to an outside call
- handle outside calls on the same phone

Intercom telephones are another step forward in the science of communications by Northern Electric, who design and manufacture most of Canada's telephones and related equipment.

Northern's extensive experience, creative engineering and design personnel and modern manufacturing facilities are at your command. Branches are strategically located across Canada to serve you.

Northern Electric
COMPANY LIMITED
SERVES YOU BEST

2060-4

For complete details check No. 42 on handy card, page 73

ACKNOWLEDGMENTS

In the preparation of this Export Issue of ELECTRONICS AND COMMUNICATIONS, the publishers wish to acknowledge the co-operation of the Electronic Industries Association of Canada in the provision of material upon which the story — "Canada's Electronics Industry" — was based. This material originally appeared in "Electronics — A New Way of Life for Canada", a presentation to the Royal Commission on Canada's Economic Prospects.

We further wish to acknowledge the co-operation of the Department of Trade and Commerce in providing us with the names and addresses of Canada's Trade Commissioners abroad appearing in the article "Canada's Foreign Trade Service Represented In Many Lands".

Acknowledgment is also due the Canadian Section, Institute of Radio Engineers, for the use of material appearing in the 1958 Canadian Convention Record, i.e. "A Simple Design Technique for High Performance Transistor AC Amplifiers" by D. G. W. Mace and R. N. Blunt, p. 50 and "The Choice of a Universal Logic Element" by N. L. Carlson, p. 64.

Plan to attend the I.R.E. Communications Symposium, Queen Elizabeth Hotel, Montreal, November 4 and 5.

HOW TO WIN FRIENDS AND INFLUENCE PEOPLE

Lesson 1. If you know someone holding a responsible position in the electronics field who is not receiving **Electronics & Communications,** hand him the free subscription card on page 74. He will be indebted to you for life!

Lesson 2. If the address on the cover of this magazine is incorrect, please notify us as soon as possible. We will be indebted to you for life!

READY FOR ACTION—ALWAYS!

The Marconi DQ58B is a long haul line-of-sight relay equipment with a tuning range of 1700 to 2400 Mcs.

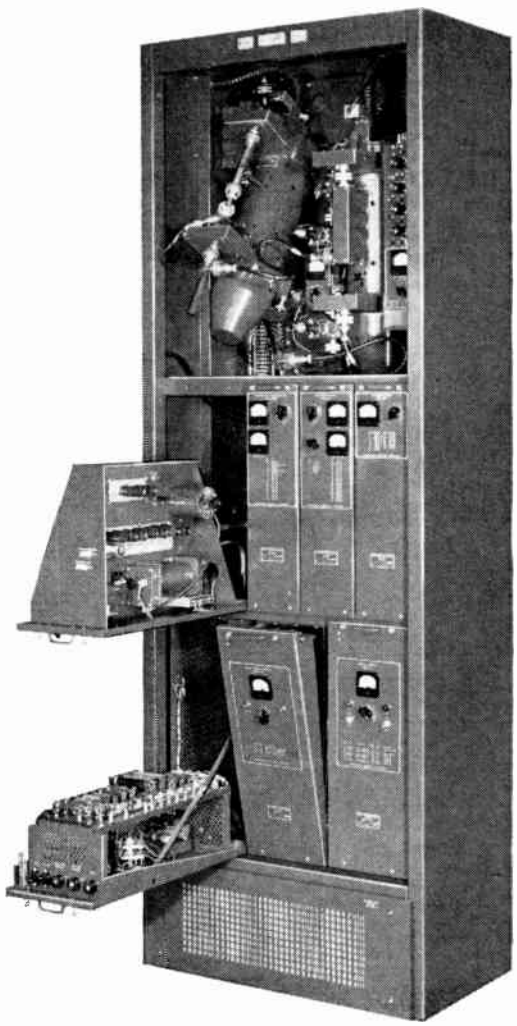
In the design of this new equipment the Canadian Marconi Company had taken every precaution to ensure utmost reliability and easy maintenance so vitally necessary in such systems as the large Canadian air defence network. The reliability and easy maintenance of the DQ58B now offer the common carrier and telephone authorities a modern and proven means for long haul toll quality telecommunications.

Among the many high quality components used are, two Eimac type 3CX100A5 Triodes per set, as quadruple frequency multipliers.

These triodes are planar premium quality ceramic type and withstand extraordinary thermal and physical shock. They feature long life and consequently lowest cost per operating hour of any 2C39 type tube. The long pulse cathode evaluation test guarantees electrical uniformity as well as longevity.

The 3CX100A5 is available in quantity today for new designs and replacements. It is unilaterally inter-changeable in nearly all cases with the 2C39A and supersedes the 2C39B. The Canadian Marconi designers have made the right choice—have you?

Call or write for full information.



Eimac

EITEL-McCULLOUGH, INC.

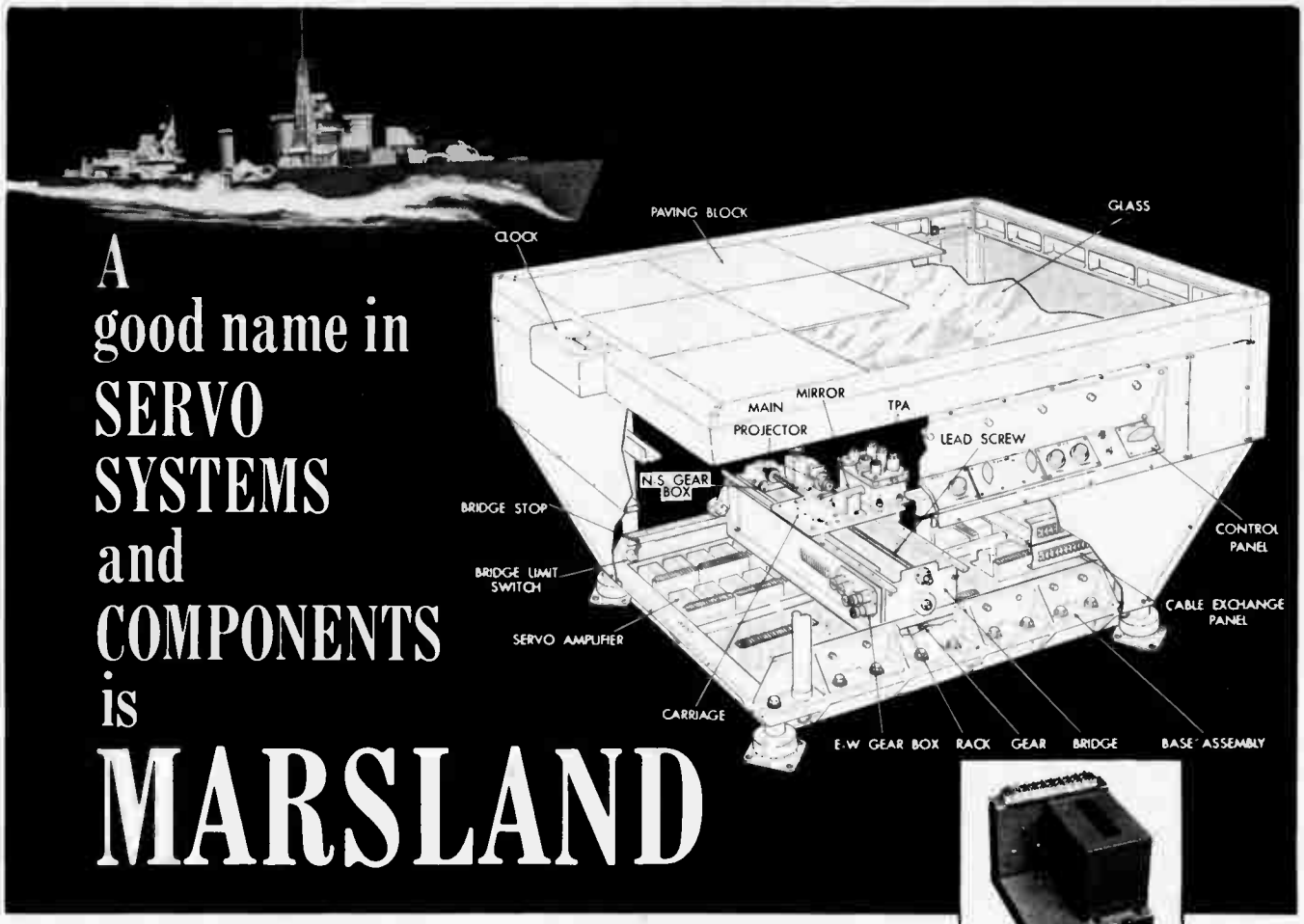
San Carlos **California**

The World's Largest Manufacturer of Transmitting Tubes

Canadian Representative:

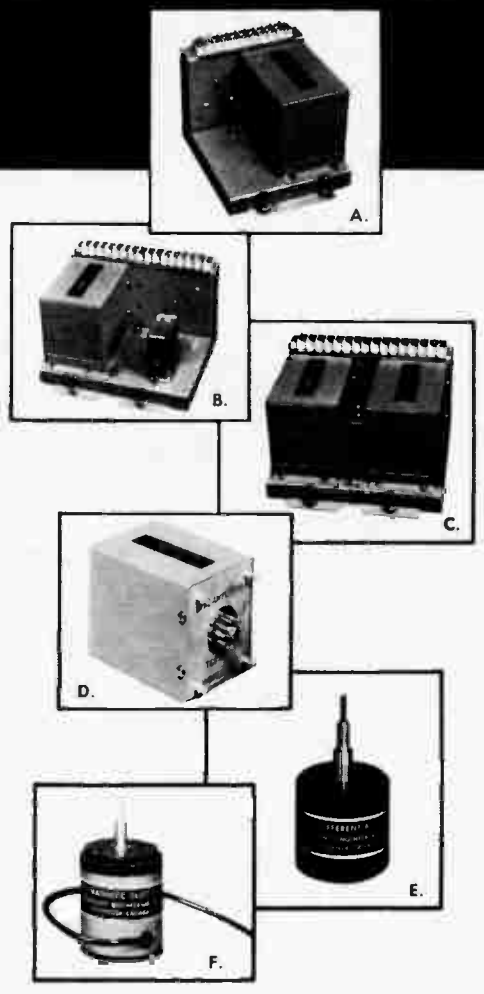
R. D. B. SHEPPARD 2036 Prince Charles Rd., Ottawa 3, Canada 5913-R

For complete details check No. 23 on handy card, page 73



This precision electro-mechanical-optical computer, used to display the geographical position of a ship and its target satellites, is a current system design by Marsland. From a statement of requirement to a design concept, to a working prototype and to approved production assemblies, Marsland engineers servo-systems meeting the most rigid specifications.

Wide experience and comprehensive facilities enable Marsland to manufacture most of the various system components.



A. Transistor Servo Amplifier, Mod. AM-103. *Application:* Single channel, 400 c. synchronous positioning servo loop. Up to size 18 Bu. Ord. motor, with built-in 400 c. power supply and feed-back damping control.

B. Transistor Servo Amplifier, Mod. AM-102. *Application:* Two channels, 400 c. precision positioning servo loop, (i.e. Resolver). Up to size 18 Bu. Ord. motor, built-in 400 c. power supply, transfer input network, feed-back damping and stick-off voltage controls.

C. Transistor Servo Amplifier, Mod. AM-101 (AM-104 + AM-105). *Application:* High gain, 400 c. synchronous amplifier for highest accuracy velocity integrating servo-loop, using up to size 18 Bu. Ord. motor/tachometer generator. *Built-in:* power supplies, null voltage suppressor, tachometer generator phasing network, speed adjustment and quadrature rejection circuit.

D. Transistor Amplifier, (Pre-Amplifier) Mod. AM-104. *Class A*, all transistor voltage and low power amplifier combined. Voltage gain between rated impedances is adjustable between 50 and 150 V. Built-in power supply, 400 c. (Power Amplifier AM-105 packages in same manner: *Class B*, all transistor synchronous power amplifier-application as positioning and integrating servo amplifier.)

E. Differential, Model M-134. *Body and Mounting:* Similar to size 18 Bu. Ord. motor. All ball bearings. *Application:* Servo mechanisms and computors. *Speed/Torque:* symmetrical mechanical differential max. speed of any shaft 4000 r.p.m.; max. torque output 10 oz. inch.

F. Magnetic Clutch, Model M-133. *Body and Mounting:* Similar to size 18 Bu. Ord. motor. All ball bearings. Max. speed 4000 r.p.m. *Application:* Servo mechanisms and computors. Energizing Power: 24 V.D.C., 3 watts. *Min. Torque:* 35 oz. inch.

MARSLAND ENGINEERING LIMITED

KITCHENER, ONTARIO, CANADA

M/3

For complete details check No. 35 on handy card, page 73

opportunities

These classified advertisements are published to assist those in the trade who have articles for sale, positions available, positions desired, sales agency openings or business opportunities. Charges are 25c per word or figure, not including heading or box number. Minimum charge is $5.00 payable on submission. No agency commission paid. There is absolutely NO CHARGE for "positions desired" advts.

Send all material to the attention of the advertising manager of ELECTRONICS AND COMMUNICATIONS, 450 Alliance Ave., Toronto 9, Ontario.

RELAY SALES ENGINEER

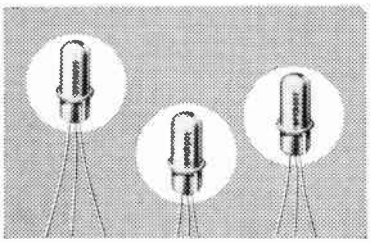
A major supplier of telephone type, electromagnetic relays, requires an experienced sales engineer for the Toronto area. A professional engineer, with experience in the design, manufacture, sales and application of telephone type relays, is preferred, but not essential if technical qualifications and experience are equal. Duties will be to assist the sales force in the application and sale of the products. Reply in confidence giving a full résumé to —

Box 5035
Electronics and Communications
450 Alliance Avenue, Toronto 9, Ontario.

REPRESENTATIVES WANTED

Sales organizations to handle Canadian manufactured Stedivolt AC line voltage regulators in Eastern and Western provinces of Canada. Must be well-established in electronic, electrical and government circles. Reply giving details of history, size, facilities, coverage and commission expected.

George Kelk Ltd.,
5 Lesmill Road,
Don Mills, Ontario



Super High-Speed Switching Transistors Type 2N501

Sprague Type 2N501 germanium micro-alloy diffused-base transistors are the fastest mass-produced transistors available anywhere! Their ultra-low rise, storage and fall time cannot be matched by any other transistor.

SPRAGUE®

CANADIAN MANUFACTURING REPRESENTATIVE

Micarta Fabricators Limited

18 Toronto Street
Toronto, Ontario

Phone EMpire 8-4251

For complete details check No. 55

PURCHASING AGENT

Senior buyer, 33, desires change. Over 12 years' experience, mainly in electronics. Experienced also in material control and production control. Presently employed in Southern Ontario, but willing to re-locate.

Box 5044
Electronics and Communications
450 Alliance Avenue, Toronto 9, Ontario

SALESMAN

required, preferably with experience in electronic components sales, to call primarily on industrial accounts, mainly in the Montreal area. Basic salary and commission. Excellent opportunity for right party. Apply for further details:

Desser E-E Ltd.
441 St. Francois Xavier St., Montreal, P.Q.
Tel: Victor 2-5295-5296

INSTRUMENTATION SALES ENGINEER

required for the Toronto area. An excellent opportunity for a young, aggressive and experienced sales engineer. For local interview apply —

Radionics Limited,
8230 Mayrand Street,
Montreal 9, Quebec.

ENGINEERING TECHNICIAN

Engineering or technical assistant position sought by young man seeking more challenging work. Seven years' telecommunications background, both theoretical and practical. Presently employed Montreal area.

Box 5042
Electronics and Communications
450 Alliance Avenue, Toronto 9, Ontario

For complete details check No. 61

HOLD LINE VOLTAGE STEADY

WITH

STEDIVOLT

A. C. LINE VOLTAGE REGULATORS

Stedivolt Line Voltage Regulators ensure 0.5% regulation accuracy for line variations up to ± 20%, with no wave distortion; no relays.

Single Phase or Three Phase

2 KVA to 100 KVA

Models for every application

Write for Stedivolt Bulletin and Price List

MAOE IN CANADA BY

GEORGE KELK LIMITED

5 Lesmill Rd. Don Mills, Ont.

KELK

For complete details check No. 34 on handy card, page 73

CLIP AND MAIL THIS COUPON

Beatty

COMMUNICATION MASTS

for AM-FM Broadcasting
HF-VHF-UHF Communications
VHF-UHF Television

Please send complete information on the following masts I have checked.

- ☐ SINGLE MASTS for heights up to 300 feet.
- ☐ H MASTS for heights up to 250 feet.
- ☐ PORTABLE ALUMINUM MASTS for heights up to 150 feet.
- ☐ VERTICAL RADIATORS for heights up to 300 feet.

We will design and manufacture custom made masts and towers to suit your specific requirements.

NAME.....

COMPANY.....

ADDRESS.....

467

BEATTY BROS. LIMITED FERGUS, ONT.

For complete details check No. 11 on handy card, page 73

Foreign Exchange Rates

The following nominal quotations may prove useful in checking prices. Canadian traders should consult their banks before making any firm commitments.

Conversions into Canadian dollar equivalent and units of foreign currency per Canadian dollar have been made at cross rates with sterling or the United States dollar on the date shown.

Except when buying and selling rates are specified, the mid rates only are quoted. The buying rate is that at which the banks purchase exchange from exporters. The selling rate is that at which banks sell exchange to importers.

When several rates are indicated, the rate applicable depends on the commodity traded. Information on the rate for any specific commodity may be obtained from the International Trade Relations Branch, Department of Trade and Commerce, Ottawa.

Rates used exclusively in non-merchandise trading are *not* included in the table.

For conversion to United States dollar equivalent multiply by 1.01943294.

Country	Unit	Type of Exchange	Can. dollar equivalent July 4	Units per Canadian dollar	Notes (See below)
Argentina	Peso	Free	.01190	84.03	(1)
Austria	Schilling		.03777	26.48	
Australia	Pound		2.2029	.4539	
Bahamas	Pound		2.7536	.3632	
Belgium, Belgian Congo and Luxembourg	Franc		.01968	50.81	
Bermuda	Pound		2.7536	.3632	
Bolivia	Boliviano	Free	.00008586	11,646.87	
British Guiana	Dollar		.5737	1.74	
British Honduras	Dollar		.6884	1.45	
Brazil	Cruzeiro	General Category*	.004323	231.33	*June 21 (2)
		Special Category	.002123	470.90	
		Official selling	.05184	19.29	(3)
Burma	Kyat		.2064	4.84	
Ceylon	Rupee		.2065	4.84	
Chile	Escudo	Free	.9325	1.07239	(4)
Colombia	Peso	Certificate	.1464	6.83	
Costa Rica	Colon	Official	.1747	5.72	
		Controlled free	.1475	6.78	
Cuba	Peso		.9809	1.01947	tax 2%
Czechoslovakia	Koruna		.1362	7.34	
Denmark	Krone		.1424	7.02	
Dominican Republic	Peso		.9809	1.01947	
Ecuador	Sucre	Official	.06540	17.43	
		Free	.05736	15.29	
Egyptian Region, United Arab Rep.	Pound	Official	2.8168	.3550	
		Export account selling	2.5525	.3918	
El Salvador	Colon		.3924	2.55	
Fiji	Pound		2.4807	.4031	
Finland	Markka		.003065	326.26	
France, Monaco, etc.	New Franc		.2002	4.99	(5)
French colonies	Franc		.004004	249.75	(6)
French Pacific	Franc		.01101	90.83	(7)
Germany	D Mark		.2352	4.25	
Ghana	Pound		2.7536	.3632	
Greece	Drachma		.03269	30.59	
Guatemala	Quetzal		.9809	1.01947	
Haiti	Gourde		.1962	5.10	
Honduras	Lempira		.4905	2.04	
Hong Kong	Dollar	Free*	.1706	5.86	*June 24
		Official	.1721	5.81	
Iceland	Krona	Official	.02581	38.74	(8)
India	Rupee		.2065	4.84	
Indonesia	Rupiah	Official	.02180	45.87	(8)
Iran	Rial		.01295	77.22	
Iraq	Dinar		2.7466	.3641	

*Latest available quotation date.

Country	Unit	Type of Exchange	Can. dollar equivalent July 4	Units per Canadian dollar	Notes (See below)
Ireland	Pound		2.7536	.3632	
Israel	Pound		.5450	1.83	
Italy	Lira		.001581	632.51	
Japan	Yen		.002725	366.97	
Lebanon	Pound	Free	.3081	3.24	
Mexico	Peso		.07848	12.74	
Netherlands	Florin		.2602	3.84	
Netherlands Antilles	Florin		.5243	1.91	
New Zealand	Pound		2.7536	.3632	
Nicaragua	Cordoba	Effective buying	.1486	6.73	
		Official selling	.1391	7.19	
Norway	Krone		.1375	7.27	
Pakistan	Rupee		.2065	4.84	
Panama	Balboa		.9809	1.01947	
Paraguay	Guarani	Official	.008040	124.38	
Peru	Sol		.03574	27.98	
Philippines	Peso		.4905	2.04	
Portugal & Colonies	Escudo		.03423	29.21	(9)
Singapore and Malaya	Straits Dollar		.3213	3.11	
Spain and Dependencies	Peseta		.01635	61.16	
Sweden	Krona		.1902	5.26	
Switzerland	Franc		.2272	4.40	
Syrian Region, United Arab Rep.	Pound	Free	.2740	3.65	
Thailand	Baht	Free	.04635	21.57	(8)
Turkey	Lira		.1090	9.17	(8)
Union of South Africa	Pound		2.7536	.3632	
United Kingdom	Pound		2.7536	.3632	
United States	Dollar		.9809375	1.01943294	
Uruguay	Peso	Free	.08608	11.62	(10)
Venezuela	Bolivar		.2928	3.41	
West Indies Fed.	Dollar		.5737	1.74	(11)
	Pound		2.7536	.3632	(12)
Yugoslavia	Dinar	Official	.003269	305.90	(8)
		Settlement rate	.001552	644.28	

*Latest available quotation date.

Notes

1. Argentina: effective Jan. 1, 1959, a single fluctuating exchange rate was introduced. Exports are subject to retention taxes of either 10 or 20 per cent ad valorem under this system.
2. Brazil: exporters receive cruzeiros at official buying rate of Cr.$18.36 plus (a) an exchange premium of Cr.$57.64 per U.S. dollar for coffee, cocoa beans and cake, and castor seeds, and (b) Cr.$81.64 per U.S. dollar for all other exports except sugar, cotton and cocoa butter, and a few other products, export returns from which may be sold on the free exchange market.
3. For imports of wheat, newsprint and petroleum, the effective rate of exchange is the official selling rate of Cr.$18.92 per U.S. dollar plus a surcharge of Cr.$81.08 per U.S. dollar.
4. Chile: free rate applies to exports and imports. Chilean importers must make prior deposits in amounts ranging from 5 to 1,500 per cent, depending on product, prior to shipment of goods. Beginning January 1, 1960, one escudo equals 1,000 pesos.
5. France: territory includes Algeria, Tunisia, Guiana, Guadeloupe, Martinique. The new heavy franc (worth 100 old francs) became effective on Jan. 1, 1960. In Tunisia the rate of the franc is reduced by 20 per cent on most foreign exchange transactions.
6. Equatorial Africa, West Africa, Cameroons, Togoland, Somaliland, Madagascar, Reunion, St. Pierre and Miquelon.
7. New Caledonia, New Hebrides, Oceania.
8. Additional rates are in effect.
9. Portugal: approximately same rate for Portuguese territories in Africa.
10. A new exchange system was introduced in December 1959 under which exchange transactions take place at free market rates.
11. Barbados, Trinidad, Tobago, Leeward and Windward Islands.
12. Jamaica.

editorial

Markets abroad for Canadian products

At no time in Canada's industrial history has the need been greater to find new markets for Canadian manufactured goods than at the present. This is particularly true of the Canadian electronics industry.

The postwar domestic demand for both consumer type products and industrial equipment has long ago been satisfied, at least to a point well within the capacity of the Canadian manufacturing ability to meet Canadian requirements. In addition the increasing dependence on U.S. manufactured defense equipment for the Canadian Armed Services has contributed greatly of late to a slackening of activity in many Canadian industries.

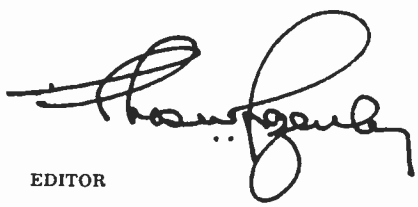
While there is plenty of blue sky ahead for secondary industry in Canada, it is only common sense that management should be ever on the alert for those opportunities that will permit expansion of markets and it would seem to us that there is a need for a greater appreciation on the part of management with respect to the possibility of building up our export markets.

True, there are Canadian industries to which the export of products is nothing new, but they would seem to be in the minority and comprised largely of manufacturers of heavy industrial equipment. For the most part those engaged in secondary Canadian industry would appear to suffer from an inferiority complex. Their businesses have been established with a view to supplying domestic demands and the thought of winning foreign export markets in competition with such countries as the United Kingdom, the United States and other exporting giants of the world seems to overwhelm them and crush any seed of aspiration they may ever have entertained in this direction.

That Canadian companies can compete successfully in the export markets of the world has been amply demonstrated in recent months by more than a few Canadian electronic firms. Forced to the wall by local conditions, they have sought outlets for their products abroad and to their surprise have discovered the fact that foreign buyers hold the products of Canada in high esteem. What has been missing in the past has been a serious attempt on the part of Canadians to sell their goods abroad.

Apart from the esteem with which Canadian goods are regarded abroad there are economic and other factors why foreign buyers may elect to do business with Canadian concerns. Commonwealth preferential tariffs, early delivery ability, and the willingness of Canadian manufacturers to build to special specification requirements, are but a few.

It is on behalf of the Canadian electronics industry that *Electronics and Communications* has published this Export Issue. Thousands of copies of this issue will be circulated to potential buyers abroad from a list selected and compiled for us by the Foreign Trade Service of the Department of Trade and Commerce. It is our hope that this issue will contribute to a further appreciation of the capabilities of the Canadian electronics industry and the unquestionable quality of its products in the more than twenty countries in which this issue will be circulated.



EDITOR

Solve your telecommunications problems

with this range of MARCONI EQUIPMENTS

DQ 48 SERIES Medium Haul 132 Channel
750-960 Mc/s and 1,700 - 2,000 Mc/s
FM Microwave Equipment.

The equipment provides high quality performance over medium distances with full drop and insert facilities at all repeaters. Features are high reliability at lowest cost and utilization of standard components for maximum systems economy.

Duplicated equipments are available with twin path, hot or cold standby operation and completely automatic changeover facilities.

A compact, built-in fault alarm system capable of reporting up to 5 functions from 10 stations, or equivalent, is available.

DQ 58 SERIES Long Haul Multichannel
1,700 - 2,300 Mc/s FM Microwave and
Television Equipment.

This series of very high quality equipments is designed for long distance relay applications. Versions of the equipment are available for medium and high capacity multichannel systems and television relay systems. Channel drop and insert facilities are available.

Rack or cabinet mounted equipment is fully front access for easy maintenance and can be supplied for hot or cold standby, twin path or multiple path operation. Each system is complete with automatic changeover or switching facilities. Systems can be engineered to provide propagation reliabilities in excess of 99.99% and equipments have been proved in service to give highly reliable trouble-free performance.

NEW DQ 78 SERIES
Economical, Expandable
5,900 - 8,200 Mc/s FM Microwave Equipment.

Designed and manufactured in Canada to fill the requirements of common carriers as well as the needs of the users such as telephone companies, power companies and pipe line companies, for whom large channel capacity equipment means uneconomical operation, wasted facilities and extra costs.

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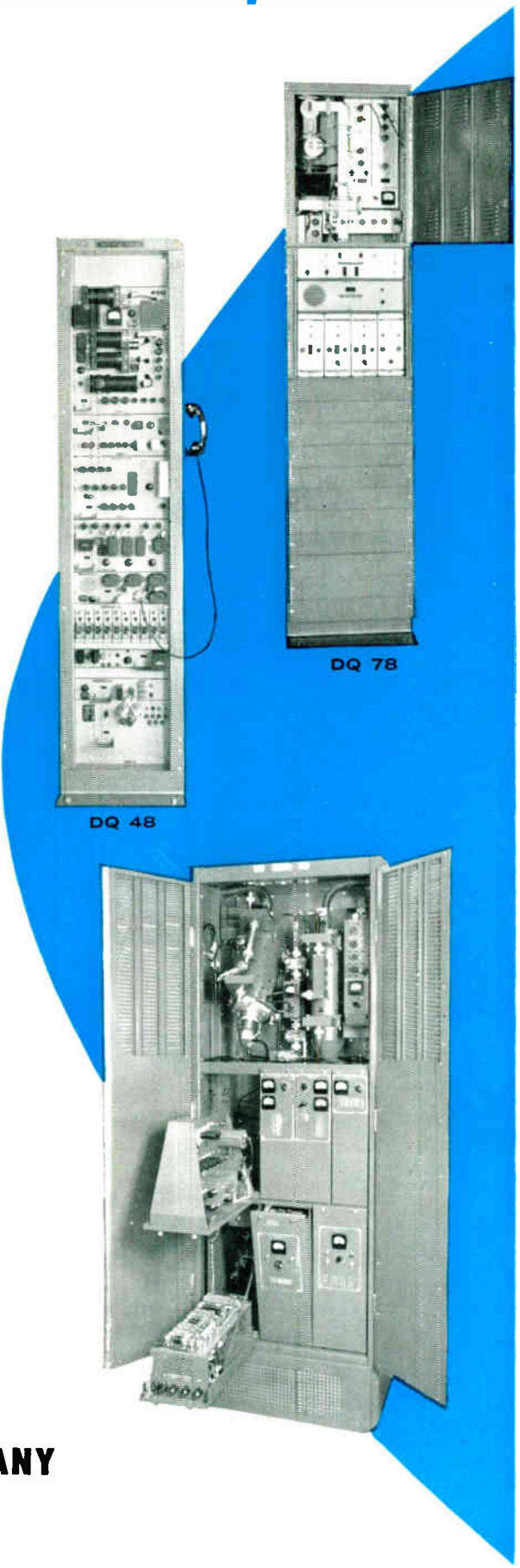
An initial installation of the very economical narrowband equipment can easily be converted to a wider band equipment at a later date, as system loading increases, by simply changing IF and baseband panels. The narrowband panels can then be used on low capacity extensions from the main system.



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For complete details check No. 16 on handy card, page 73

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Short-duration light flash (1 to 6 μsec) "freezes" motion . . . practically eliminates blur . . . lets you clearly see details that are invisible with other commercial stroboscopes.

Long-throw beam reaches into machine innards — made possible by basic new flash tube developed exclusively for this instrument.

Measures speeds directly with ±1% accuracy up to 25,000 rpm . . . useful to at least 250,000 rpm.

Unique carrying case provides full enclosure for protection against damage and doubles as an adjustable stand for convenient bench use.

Pivoting lamp rotates 360° horizontally and 180° vertically.

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