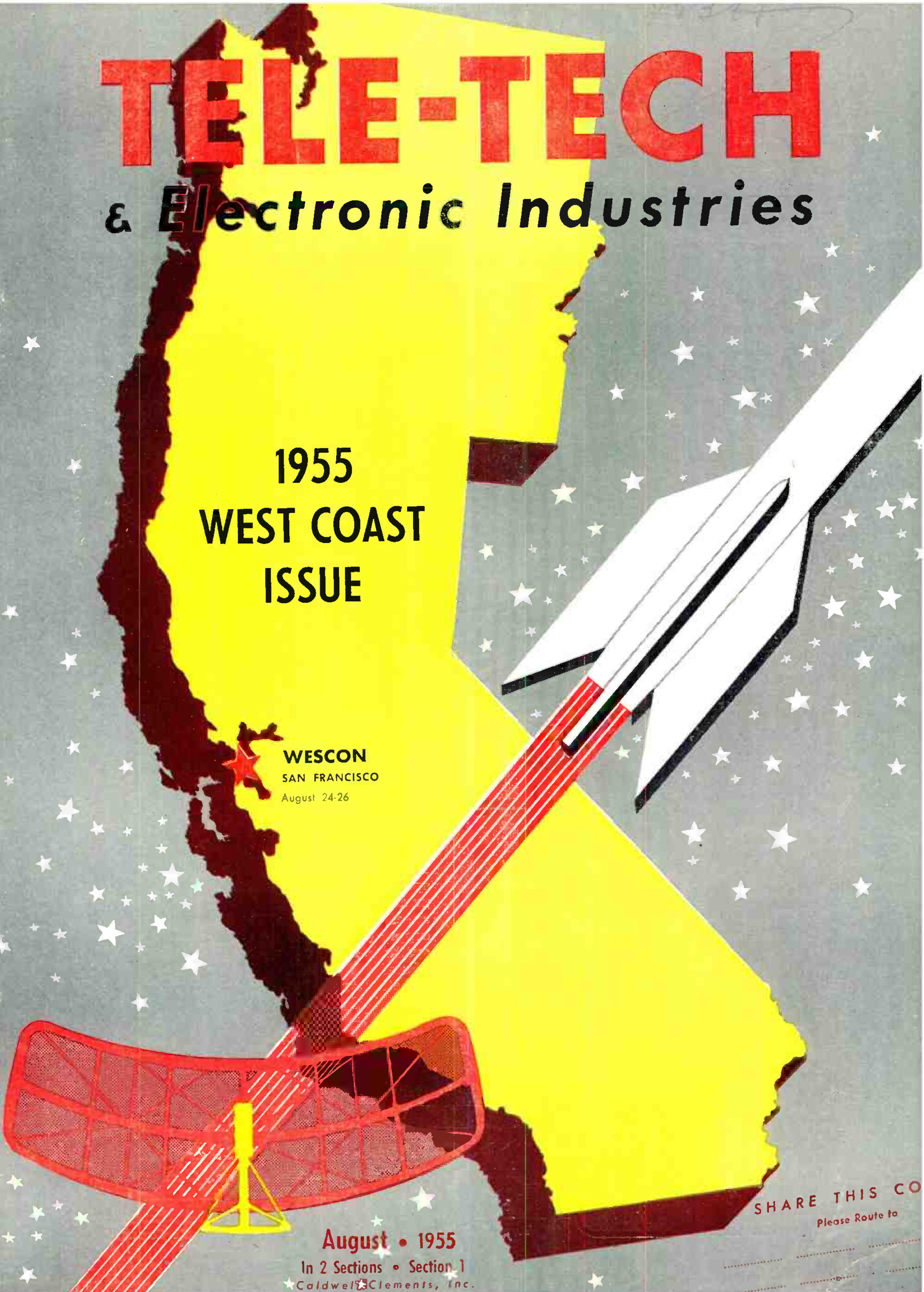
# TELE-TECH

## & Electronic Industries



# 1955 WEST COAST ISSUE

WESCON
SAN FRANCISCO
August 24-26

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In 2 Sections • Section 1

Caldwell-Clements, Inc.

# Using Ceramic Capacitors?

# Specify RMC DISCAPS

## Temperature Compensating


These DISCAPS meet all electrical specifications of the RTMA standard REC-107-A. Small size, lower self inductance and greater dielectric strength adapt them for VHF and UHF applications. Type C DISCAPS are rated at 1000 working volts providing a high safety factor. Available in six sizes in all required capacities and temperature coefficients.

## Heavy-Duty

RMC Type B "Heavy-Duty" DISCAPS are designed for all by-pass or filtering applications and meet or exceed the RTMA REC-107-A specifications for type Z5Z ceramic capacitors. Rated at 1000 V.D.C.W., Type B DISCAPS cost no more than lighter constructed units. Available in standard capacities between 470 MMF and 40,000 MMF.


## Type JL

Type JL DISCAPS afford exceptional stability over an extended temperature range. They are especially engineered for applications requiring a minimum capacity change as temperature varies between −60°C and +110°C. The maximum capacity change between these extremes is only ±7.5% of capacity at 25°C.


## Wedg-loc


The exclusive wedge design of the leads on these DISCAPS lock them in place on printed circuit assemblies prior to the soldering operation. "Wedg-Loc" DISCAPS are available in capacities between 2 MMF and 20,000 MMF in TC, by-pass and stable capacity types. Suggested hole size is an .062 square.

## High Voltage


Special high voltage DISCAPS are available in a wide range of capacities for color television and other electronic applications. RMC DISCAPS for deflection yokes insure the voltage safety factor required in this application. They are available in all capacities between 5 MMF and 330 MMF.

## Plug-in

RMC Plug-in DISCAPS will speed up production time in printed circuit operations. Leads are constructed of No. 20 tinned copper (.032 diameter) and are available up to 1½" in length. Manufactured in TC, by-pass and stable capacity types, Plug-in DISCAPS have all the electrical and mechanical features of standard DISCAPS.


**Write today on your company letterhead for expert engineering help on any capacitor problem.**

DISCAP
CERAMIC
CAPACITORS

RMC

**RADIO MATERIALS CORPORATION**

**GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.**

**FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.**

**Two RMC Plants Devoted Exclusively to Ceramic Capacitors**

In 2 Sections • Section 2

August • 1955

TELE-TECH

& Electronic Industries

CALDWELL CLEMENTS, INC. • 480 LEXINGTON AVENUE, NEW YORK 17, N.Y.

# 1955 Directory of the West Coast Electronic Industries

**This directory contains the latest and most complete alphabetical listing of some 462 leading manufacturers in the West Coast electronic industries. Each listing contains the company name, address, name of chief engineer or key person to contact, telephone number. The principal proprietary items (p) and avionic items (a) manufactured are also indicated. Companies preceded with an asterisk are Eastern or Midwestern firms with manufacturing facilities on the West Coast. This is the fourth consecutive annual directory of the western electronic industries published by TELE-TECH & ELECTRONIC INDUSTRIES.**

Acme Camera 2704 W Olive Ave Burbank Calif-John Kiel-VI 9-3144 (p) TV Recdg Cameras

*Acme Electric 1375 W Jefferson Blvd Los Angeles 7 Calif-RE 4-3194 (p) Transformers

Acousti Craft 14122 Aetna St Van Nuys Calif-G L Burch-ST 6-0676 (p) Spkr Enclosures

Adel Precision Products Div General Metals Corp 10777 Van Owen St Burbank Calif-J W Kelly-SU 2-1131 (p) Precision Aircraft Equip (a) Precision Aircraft Equip

Advance Electric & Relay 2435 N Naomi St Burbank Calif-V C Huckabee-TH 2-8191 (p) Relays (a) Relays

*Aerovox Corp Pacific Coast Div 2724 Peck Rd Monrovia Calif-Morgan Harris-RY 1-5621 (p) Amplifiers

Airad Co 5956 Kester Ave Van Nuys Calif-Geo Hewitt-ST 0-2531 (p) Sheet Metal Fabr

Airborne Electronics Co 6813 Troost Ave N Hollywood Calif-L W Cannon-PO 5-1351 (p) Test Equip

Air Transport Mfg 1114 N Sycamore Ave Los Angeles 38 Calif-E L Hollywood Jr-HO 7-5175 (a) Harness Assemblies

Allied Electronic Equip Bldg 604 Oakland Airport Oakland 14 Calif-E Crandall-LO 2-1400 (p) Headsets (a) Headsets

Allison Labs 14185 Skyline Dr Puente Calif-C L Stevens-OX 4-4056 (p) Passive Network Filters

Aloha Radio 330 W Bdwy Long Beach 2 Calif-H Putnam-747-16 (p) Marine Bcst Receivers

Alpar Mfg 2910 Spring St. Redwood City Calif-C B Parmenter-EM 8-4701 (p) Cable Analyzer (a) Cable Analyzer

Altec Lansing 9356 Santa Monica Blvd Beverly Hills Calif-Dr E M Honan-CR 5-5101 (p) Spkrs, Amplifiers (a) Transformers

Alto Scientific 4037 El Camino Way Palo Alto Calif-L L Libby-DA 4-4733 (p) Grid Dip Osc.

Ameico Inc 2040 Colorado Ave Santa Monica Calif-G A Carlson-EX 3-7281 (p) Continuity Meter

American Elect Mfg Co 9503 W Jefferson Blvd Culver City Calif-J Yablonka-TE 0-5581 (p) Control Motors

American Helicopter Div Fairchild Engine & Airplane 1800 Rosecrans Ave Manhattan Beach Calif-Lewis Emmerich-OS 6-1138 (p) Bridge Balance Units

American Microphone Affl Elgin National Watch 370 S Fair Oaks Ave Pasadena Calif-J Brown-SY 6-9008 (p) Microphones

American Thermo-Electric 7269 Santa Monica Blvd Los Angeles 46 Calif-Abraham Levy-HO 4-1632 (p) Vacuum Thermocouples (a) Vacuum Thermocouples

Ampex Corp 934 Charter St Redwood City Calif-John Leslie-EM 8-1471 (p) Tape Recorders (a) Data Recorders

Applied Electronics 1246 Folsom St San Francisco 3 Calif-S S Konigsberg-MA 1-2634 (p) Marine Radiotelephones

Applied Physics 362 W Colorado St Pasadena Calif-Howard Cary-SY 6-0197 (p) Electrometers

Arnoux Corp 1357 Hawthorne Blvd Hawthorne Calif-R W Hodgson-OS 5-4483 (p) Temp Measuring System (a) Temp Indicating Systems

*Assembly Products Desert Hot Springs Calif-John Saint-Armour (p) Contact Meter Relays

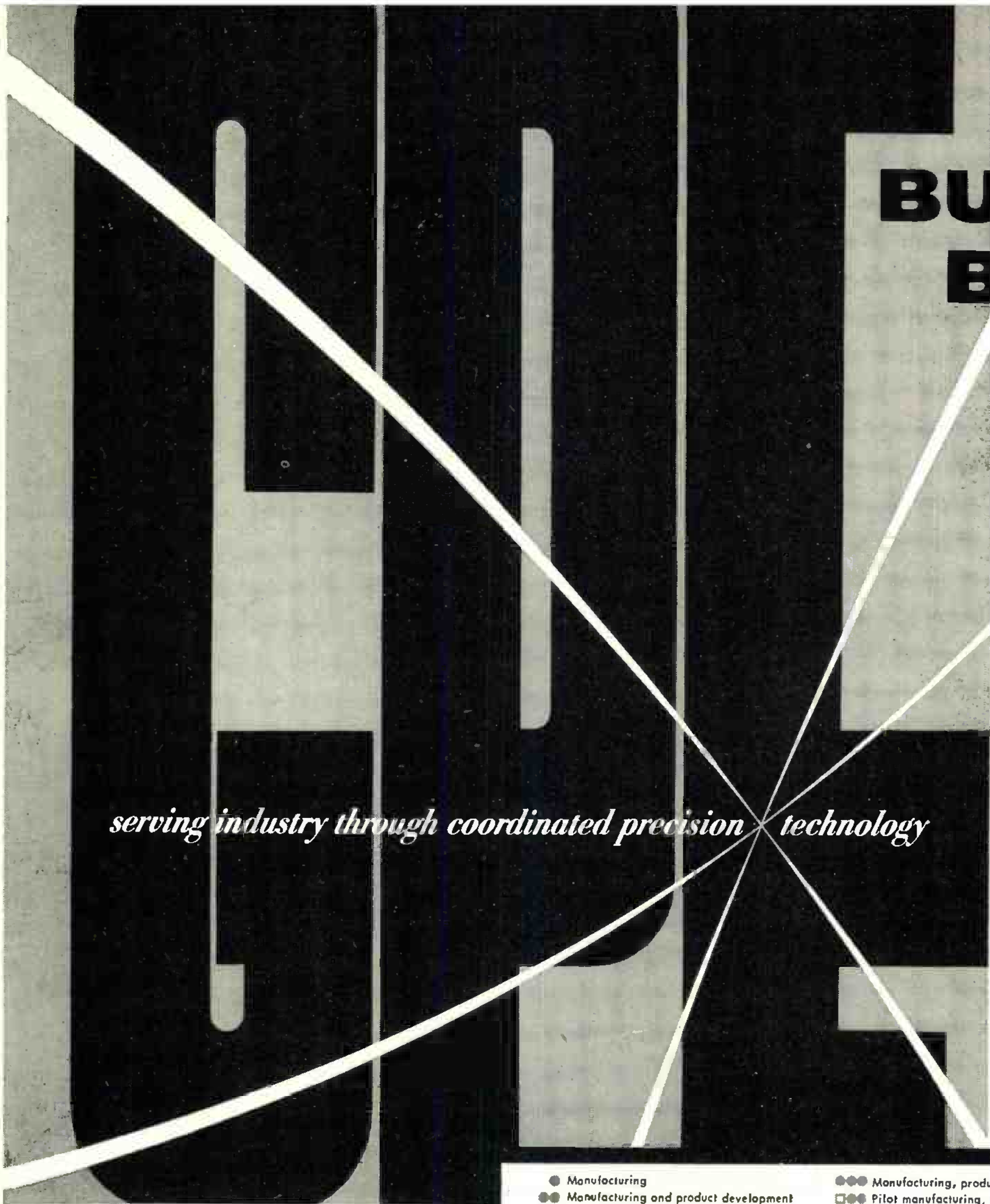
Associated Missile Products 2709 N Garey Ave Pomona Calif-R F Crisp-LY 4-0104 (p) Tube Comparator (a) Missile Product Test Equip

Audio Products 2265 Westwood Blvd Los Angeles 64 Calif-F H Pruss-BR 2-4266 (p) Voltage Controlled Oscillators (a) Telemetering Systems

Avery Adhesive Label 1616 S California Ave Monrovia Calif-Harry Hoffman-EL 8-2524 (p) Pressure-sensitive Tapes

Avionex Electronics 2838 N Naomi St Burbank Calif-L G Davidson-TH 2-2381 (p)

# BUILDING BLOCKS




● Manufacturing
●● Manufacturing and product development
●●● Manufacturing, product development and research
□●● Pilot manufacturing, product development and research

| | KEARFOTT COMPANY, INC. | INTERNATIONAL PROJECTOR CORPORATION | BLUDWORTH MARINE DIVISION | GENERAL PRECISION LABORATORY INCORPORATED | THE GRISCOM-RUSSELL COMPANY | LINK AVIATION, INC. | THE HERTNER ELECTRIC COMPANY | THE STRONG ELECTRIC CORPORATION | J. E. McAULEY MFG. CO. | ASKANIA REGULATOR COMPANY | AMPRO CORPORATION | LIBRASCOPE, INCORPORATED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PRECISION MECHANICS, OPTICAL DEVICES, CERAMICS | ●●● | ●● | ●● | □●● | ●● | ●●● | ●● | ●●● | ●● | ●● | ●● | ●●● |
| ELECTRICAL EQUIPMENT and COMPONENTS | ●●● | ● | ● | | | ●●● | ●●● | ●● | ● | ●● | ● | ●●● |
| ELECTRONICS | ●●● | ●● | ●●● | ●●● | | ●●● | ● | ●● | | ●●● | ●● | ●●● |
| HYDRAULICS, LIQUIDS PROCESSING, HEAT EXCHANGE | | ●● | | | ●●● | | | | | ●●● | | |
| TELEVISION Studio, Theatre, Educational, Business, Industrial | ● | ● | | ●●● | | ● | | | | ● | | |
| INSTRUMENTS, SERVOS, CONTROLS Hydraulic, Pneumatic, Magnetic, Electronic | ●●● | ● | ●● | □●● | | ●●● | ●● | ●● | | ●●● | ● | ●●● |
| AIRCRAFT and MISSILE GUIDANCE, CONTROL, SIMULATION | ●●● | ● | | ●●● | | ●●● | ● | | | ●● | ● | ●●● |
| AUTOMATIC COMPUTERS and COMPONENTS | ●●● | ● | ● | □●● | | ●●● | | | | ●●● | | ●●● |
| RADAR, MICROWAVE, ULTRASONICS | ●●● | ● | ●● | ●●● | | ●● | | ● | | ● | | |
| MOTION PICTURE and AUDIO EQUIPMENT | | ●●● | | □●● | | | ●● | ●●● | ●●● | | ●●● | |
| NUCLEAR POWER COMPONENTS and CONTROLS | ●●● | | | | ●● | | | | | ●● | | ●●● |
| SYSTEMS ENGINEERING Aeronautical, Naval, Industrial | ●●● | | | ●●● | ●●● | ●●● | | | | ●●● | | ●●● |

**THE GPE PRODUCING COMPANIES**

One of a series telling
how the producing companies of
General Precision Equipment Corporation
are contributing to America's progress.

# advanced techniques & resources

The producing companies of General Precision Equipment Corporation are engaged in the development, production and sale of advanced technological products. Each of these companies specializes in particular areas of advanced competence and possesses highly developed techniques and resources in its particular field or fields. These are the building blocks of GPE Coordinated Precision Technology, through which GPE serves more than a dozen important industries.

The chart at the left shows the areas in which each GPE Producing Company works. But it cannot show the high degree of specialization and the important position each GPE Company occupies in its field or fields.

Take **TELEVISION,** for instance, and the work of General Precision Laboratory Incorporated, the GPE leader in the field. GPL's research, development and manufacturing activities in TV are concerned with quality equipment for theatre, studio, business, industrial, institutional and military TV and do not relate to the home TV field.

¶ GPL equipment was used for all video recording of the Coronation, both U. S. and Canadian. It is used by 90% of the studios equipped for video recording.

¶ The first appearance of a President on closed-circuit TV—President Eisenhower speaking from the White House to distinguished guests at the dedication of the Ford Research Center in Dearborn—was projected on GPL theatre equipment, producing fine quality pictures up to 65 feet wide.

¶ The same large-screen GPL equipment—and high quality, portable, intermediate size projection equipment newly developed by GPL—enabled guests assembled in several separate ballrooms of the Waldorf-Astoria to see and hear the Queen Mother at two New York dinners last Fall; made possible the historic 53-city TV hook-up which was a feature of GM's fifty-millionth car celebration. Both these types of GPL projection equipment also played key roles in the nationwide "heart-video-clinic"—the largest meeting of its kind ever held—attended by over 20,000 specialists in 35 cities. This GPL equipment is rapidly making closed-circuit TV a practical, everyday business and institutional meeting medium.

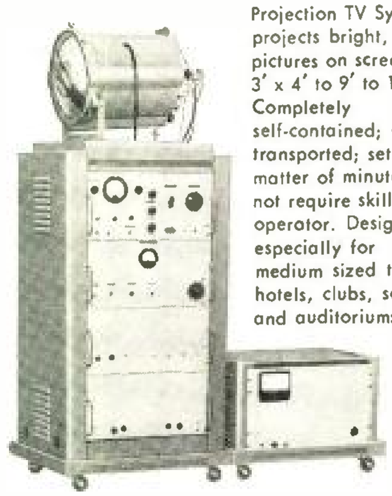
¶ Many broadcast studios, including CBS's famous TV 61—the largest in the East, are exclusively equipped with GPL cameras and control equipment.

¶ New uses are developing steadily for GPL's "Bullet," the new, portable, easily operated, industrial television camera: in banks to speed service, eliminate congestion and reduce personnel costs; in railroads to better control and speed train make-up and freight car loadings; in industry to monitor and improve manufacturing processes, for surveillance and security, and to view hazardous operations.

GPL is a leader in military TV with its special and exacting requirements for airborne, shipboard and under-water uses and is also at work on color TV. A color film camera chain of high quality, for studio use, is in production and additional color equipment will be announced in 1955.

A broad description of the work of GPL and the other GPE Companies is contained in the GPE brochure, "Serving Industry Through Coordinated Precision Technology." For a copy, or other information, address:

The "Bullet" TV Camera; for industrial, institutional and educational use. Produces useful pictures under conditions of poor light; feeds any TV receiver or monitor; unique packaging permits placement in ordinarily inaccessible areas; unitized construction with plug-in component chassis minimizes maintenance requirements.



Intermediate Size Projection TV System; projects bright, clear pictures on screens from 3' x 4' to 9' to 12' Completely self-contained; easily transported; set up in matter of minutes; does not require skilled operator. Designed especially for medium sized theatres, hotels, clubs, schools and auditoriums.


Remote Control TV Camera; for broadcast and industrial use. Pre-set control permits memory of 6 different shots. Mounted on servo-operated pedestal, provides complete remote control of lens selection, iris, pan and tilt. Highly useful for observing dangerous phenomena; permits broadcasting without use of camera man.

*General Precision Equipment Corporation*

**92 GOLD STREET, NEW YORK 38, NEW YORK**

# 1955 Directory of West Coast Electronic Manufacturers

Receivers (a) Control Panels
Babcock Radio Eng'g 7942 Woodley Ave Van Nuys Calif-D A Gehlke-St 5-8648 (p) Radio Guidance Control Equip (a) Radio Recvrs & Transmitters
Background Engineers 7313 Santa Monica Blvd Hollywood 46 Calif-B M Bodde Jr-HO 5-4161 (p) Rear Projection Screens & Projectors
Bardwell & McAllister Div Hall Scott Motors 2950 N Ontario St Burbank Calif-L H Cooper-VI 9-2341 (p) TV Lighting Equip
Bartells Marine Radio 800 W Coast Hwy Newport Beach Calif-J A Bartell-LI 8-6242 (p) Marine Radiotelephones
Baughman Co E J 1914 N Cogswell Rd El Monte Calif-E C Baughman-FO 0-7586 (p) Microphone Booms
Beckman Div Beckman Instruments 2500 Fullerton Rd Fullerton Calif-J F Bishop-OX 7-1771 (p) Measuring & Recording Instruments
Beckman & Whitley 985 San Carlos Ave San Carlos Calif-E M Whitley-LY 3-7824 (p) Camera Controls (a) Guided Missile Destructors
Benchmaster Mfg 1835 W Rosecrans Ave Gardena Calif-J A Matzdorff-PL 6-8134 (p) Punch Presses
Bendix Aviation Pacific Div 11600 Sherman Way N Hollywood Calif-C D Perrine-ST 7-2651 (p) Radar, Telemetering, Sonar
Bendix Aviation Bendix Computer Div 5630 Arbor Vitae St Los Angeles 45 Calif-Dr D C Evans-OR 8-2128 (p) Digital Computers
Bennett Laboratories 2700 Bay Rd Redwood City Calif-A E Bennett-EM 6-6845 (p) TV Optical Filters
Bennett Products P O Box 1055 Palo Alto Calif-John Dodenhoff-YO 7-7249 (p) Hermetic Compression Seals (a) Rocket Hermetic Seal Components
Benson-Lehner Corp 2340 Sawtelle Blvd Los Angeles 64 Calif-B S Benson-BR 2-1198 (p) Oscillograph Trace Readers (a) Oscillograpn Trace Readers
Berkeley Div Beckman Instruments Inc 2200 Wright Ave Richmond Calif-W M Harger-LA 6-7730 (p) Counters & Timers (a) Analog Computers
Berlant Instruments 4917 W Jefferson Blvd Los Angeles 16 Calif-Paul Letl-RE 1-2141 (p) Magnetic Tape Recorders (a) Data Recorders
Berndt-Bach Auricon Div 6926 Romaine St Hollywood 38 Calif-Walter Bach-HO 2-0931 (p) Sound-On-Film Recording Magnetic & Optical Motion Picture Cameras
Bill Jack Scientific Instrument 143 S Cedros Ave Solana Beach Calif-U A Patchett-SK 5-1551 (p) Servo Torque Units (a) Camera Control System
Birtcher Corp 4371 Valley Blvd Los Angeles 32 Calif-C J Birtcher-CA 2-9101 (p) Medical Equip
Bone Eng'g Corp 701 W Broadway Glendale 4 Calif-Myron Orbaugh-CI 1-5442 (p) Fuel Flow Test Stands & Meters (a) Flowmeter Calibration Equipment
Bourns Laboratories 6135 Magnolia Ave Riverside Calif-M E Harrison-OV 4-1700 (p) Trimmer Potentiometers (a) Trimmer Potentiometers
Braunson Electronics 411 Rose Ave Venice Calif-R O Bronson-TE 0-1825 (p) Solenoids (a) Solenoids
Brubaker Electronics Inc 9151 Exposition Dr Los Angeles 34 Calif-R V Keeran-TE 0-6441 (p) Delay Lines (a) Radar Systems
*Burnell & Co Pac Div 720 Mission St S Pasadena Calif-L G Burnell-PY 1-2841 (p) Band Pass Filters (a) Sub Miniature Filters & Toroids
Burnett Radio Lab Wm W L 4814 Idaho St San Diego 16 Calif-Wm W L Burnett-AT 2-2740 (p) Piezo-electric Crystals, Holders & Ovens
Burton Mfg. 11201 W Pico Blvd Los Angeles 64 Calif-E A Pecker BR 2-3445 (p) Zirconium Arc Lamps & Power Supplies (a) Measuring Instruments
Byron Jackson Co Electronic Div 2010 Lincoln Ave Pasadena 3 Calif-J E Stankey-RY 1-7134 (p) Signal Generators (a) Digital Pressure Gauges

Calbest Eng'g & Electronics 828 N Highland Ave Hollywood 38 Calif-Herbert Fremont-HO 3-2119 (p) Amplifiers
Califone Corp 1041 N Sycamore Ave Hollywood 38 Calif-R G Metzner-HO 2-2353 (p) Phonographs
Calif Chassis 5445 E Century Blvd Lynwood Calif-W S NcNeal-NE 6-7777 (p) Chassis, Cabinets
Calif Magnetic Control 7245 Atoll Ave N Hollywood Calif-H C Hornickel-ST 7-1104 (p) Transformers, Inductors, Coils (a) Transformers, Inductors, Coils
Calif Plasteck Inc 225 E 4 St Los Angeles 13 Calif-J N Dupree-MA 9-3561 (p) Annunciator Panels (a) Panels, Dials, Nameplates
Caltron Products 1310 S Hobart Blvd Los Angeles 6 Calif-Leo Klein- RE 4-6144 (p) Solenoid Valves
Cal-Tronics Corp 11307 Hindry Ave Los Angeles 45 Calif-R H Floyd-OR 1-7694 (p) Test Equip (a) Slideback Voltmeter
Calvideo Tube Corp 5232 W 104 St Los Angeles 45 Calif-S H Newton-OR 8-3979 (p) Cathode-Ray Tubes
Cannon Electric 3201 Humboldt St Los Angeles 31 Calif-Roger Bowen-CA 5-1251 (p) Connectors (a) Connectors
Canoga Corp 5955 Sepulveda Blvd Van Nuys Calif-G E Hewitt-ST 7-1156 (p) Amplifiers
Carad Corp 2850 Bay Rd Redwood City Calif-Wallace Burton-EM 8-2969 (p) Pulse Transformers (a) Filters
Carruthers & Fernandez 1501 Colorado Ave Santa Monica Calif-F C Fernandez-EX 4-6768 (p) Solenoids (a) Solenoids
Carstedt Research 8276 Phlox St Downey Calif-Donald White-TO 9-1091 (p) Transformer Cores (a) Transformer Cores
Cascade Research 53 Victory Lane Los Gatos Calif-J S Jaffe-EL. 4-9900 (p) Microwave Load Isolators (a) Microwave Load Isolators
Century Engineers 2741 N Naomi St Burbank Calif-George Rice-TH 8-6614 (p) Simulation & Automation Systems
Chemalloy Electronics Gillespie Airport Santee Calif-Samuel Freedman-HI 4-7661 (p) Microwave Calorimeters (a) Microwave Calorimeters
*Chromatic TV Labs West Coast Development Lab 1476 66 St Emeryville 8 Calif-C S Nunan-PI 5-8081 (p) Color CR Picture Tubes (a) Color CR Tubes
Cinema Eng'g Co Div Aerovox Corp 1100 Chestnut St Burbank Calif-Chas Broneer-VI 9-5511 (p) Amplifiers
Circon Component Co 17544 Raymer St Northridge Calif-D B O'Rork-DI 3-3089 (p) Connectors (a) Instr Hardware
Clark Electronic Labs P O Box 165 Palm Springs Calif-D B Clark-8-3011 (p) Silicon Rectifiers (a) Rectifiers
Clary Corp 408 Juniro St San Gabriel Calif-R E Boyden-CU 3-2724 (p) Readout Machines & Input Keyboards
Clear Beam Antenna 21341 Roscoe Blvd Canoga Park Calif-Jerry Fisher-DI 7-2255 (p) TV Antennas
Coast Coil Co 5333 W Washington Blvd Los Angeles 16 Calif-C H Adams-WE 4-0442 (p) Toroidal Windings
Coleman Eng'g 6040 W Jefferson Blvd Los Angeles 16 Calif-E A Gardner-TE 0-6931 (p) Analog-to-Digital Converters
*Collins Radio 2700 W Olive Ave Burbank Calif-VI 9-3361 (p) Comm Equip (a) Comm Equip
Color Television 973 E San Carlos Ave San Carlos Calif-John Adkins-LY 3-8466 (p) Test Equip (a) Test Equip
Computer Research Corp 3348 W El Segundo Blvd Hawthorne Calif-H H Sarkissian-OS 5-1171 (p) Computers
Connector Corp of America 3223 Burton Ave Burbank Calif-R R Thomas-VI 9-2129 (p) Connectors
Conrac Inc 19217 E Foothill Blvd Glendora Calif-J G Jones-ED 5-1241 (p) Custom TV Chassis
Consolidated Eng'g 300 N Sierra Madre Villa Pasadena Calif-Joseph Lancor-SY 6-0173 (p) Data Processing & Recording Instr (a) Recording Oscillographs
Control Specialists 115 E Arbor Vitae St Inglewood 1 Calif-I L Ashkenas- OR 8-4688 (p) Analog Computer (a) Flight Control Systems
Convair Div General Dynamics Corp 3165 Pacific Hwy San Diego 12 Calif-R C Sebold-CY 6-6611 (p) Special Cathode Ray Tubes (a) Guided Missiles
*Cornell Dubilier Elec Corp West Coast Div 4144 Ocean Park Ave Venice Calif-P M Kuefler-TE 0-6681 (p) Capacitors (a) Capacitors
Crawford's Inc 456 N Rodeo Dr Beverly Hills Calif-Fred Nussbaum-CR 1-8124 (p) TV Receivers
Creative Eng'g 10816 Burbank Blvd N Hollywood Calif-R F Blaine-ST 7-4759 (p) Antennas (a) Antennas
Crescent Eng'g & Research 11632 McBean St El Monte Calif-G S Van Sickle-FO 0-8882 (p) Transducers (a) Position Transmitters
Crittenden Transformer Works 1220 Nadeau St Los Angeles 1 Calif-R M Power-LU 8-6173 (p) Transformers
Crosby Enterprises Bing 9028 Sunset Blvd Los Angeles 46, Calif-F C Healey-CR 1-1171 (a) Airborne Magnetic Tape Equip
Cryco Inc 1138 Mission St S Pasadena Calif-E W Johnson-PY 1-1174 (p) Freq Control Crystals
Cubic Corp 2841 Canon St San Diego 6 Calif-L G Dameson Jr-AC 3-8191 (p) Calorimetric Wattmeters (a) Distance Measuring Equipment
Culbertson Co G K 2515 Novato Pl Palos Verdes Estates Calif-G K Culbertson-FR 5-6062 (p) Record Players

Dallons Laboratories 5066 Santa Monica Blvd Los Angeles 29 Calif-Franz Dallons-NO 4-1951 (p) Crystals
Dalmotor Co 1375 Clay St Santa Clara Calif-Karl Hummel-AX 6-5958 (a) DC Miniature Motors
Dalmo Victor Co 1414 El Camino Real San Carlos Calif-W F Gates-LY 3-3131 (p) Wave Guide & RF Components (a) Radar Antennas
Davis Electronics 4002 Burbank Blvd Burbank Calif-Bob Taylor-VI 9-1815 (p) Mobile Comm Equip
*Daystrom Pacific Corp 3030 Nebraska Ave Santa Monica Calif-D J Santogrossi-EX 3-6755 (p) Potentiometer (a) Floated Rate Gyro
De Coursey Eng'g Lab 11828 W Jefferson Blvd Culver City Calif-S C Baden-EX 7-9668 (p) Toroids (a) Low Pass Filters
DeMornay-Bonardi Corp 780 S Arroyo Pkwy Pasadena Calif-G Fonda-Bonardi-RY 1-7416 (p) Microwave Lab Test Equip (a) Radar Components
Detectron Corp 5528 Vineland Ave N Hollywood Calif-P F Swain-ST 7-0401 (p) Counters (a) Radiation Survey Instr
*Detroit Controls Corp Research Div 1650 Bdwy Redwood City Calif-H R Hulett-EM 8-5360 (p) Commutating Switches (a) Commutating Switches
Deutsch Co 7000 Avalon Blvd Los Angeles 3 Calif-C C Douglas-PL 1-4131 (a) Connectors
Diacoustic Lab 4545 Encino Ave Encino Calif-E C Knight-ST 4-0881 (p) Diamond Pivot Bearings for Guided Missiles (a) Diamond Pivot Bearings for Guided Missiles
Digital Products 7643 Fay Ave La Jolla Calif-G S MacDonnell-GL 4-7216 (p) Etched Circuit Boards
*Dilectron Div Gudeman Co 2661 S Myrtle Monrovia Calif-F T Reischel-DO 6-3101 (p) Capacitors (a) Capacitors
Dollar Co Robt Comm Equip Div 50 Drum St San Francisco 11 Calif-R W Bruce-YU 2-4479 (p) Audio Comp
Donner Scientific Co 2829 7 St Berkeley 10 Calif-Dr V B Corey-TH 5-3150 (p) Analog Computer (a) Servo Accelerometer
Dressen Barnes Corp 250 N Vinedo Ave Pasadena 8 Calif-B F McNamee-SY 3-0691 (p) Regulated Power Supplies (a) Regulated Power Supplies
D & R Ltd 402 E Gutierrez St Santa Barbara Calif-G M Kingman-WO 5-4511 (p) R-F Equip (a) High-Freq Power Alternators
Duncan-Rohne 11310 Sherman Way N Hollywood Calif-D D Malcomb-ST 7-3433 (a) Radar Wave Guides
Dynamic Air Eng'g 7512 Maie Ave Los Angeles 1 Calif-J Lowrey-LU 8-3292 (p) Blowers (a) Blowers
Dynamic Analysis Inc Box 2188 So Annex Van Nuys Calif-W Woodson-ST 6-2301 (p) Analog Computers

Edcliff Instruments 383 N Foothill Blvd Pasadena 8 Calif-E H Rehnborg-SY 6-3302 (p) Linear Motion Pot (a) Linear Motion Pot
Eeco Production Co 827 S Vermont Ave Los Angeles 5 Calif-Fay Temple-DU 5-3026 (p) Plug-in Units (a) Strain Gage Amplifier Plug-In
Eitel-McCullough 798 San Mateo Ave San Bruno Calif-Gordon Howes-JU 8-1212 (p) Power Vacuum Tubes (a) Power Vacuum Tubes
Eldema Corp 9844 Remer St El Monte Calif-Dan Simkins-FO 0-7077 (p) Neon Indicator Lights (a) Neon Indicator Lights
Electrical Communications 765 Clementina St San Francisco 3 Calif-E H Cogill-KL 2-1947 (p) Radio Pulsing Unit
Electrical Facilities 4224 Holden St Oakland 8 Calif-Fred Krauss-OL 3-1661 (p) Selenium Battery Chargers (a) 400 Cycle Transformers
Electrocircuits Inc 401 E Green St Pasadena 1 Calif-B F Grimm-SY 3-8169 (p) Potentiometers (a) Potentiometers
ElectroData Corp 717 N Lake St Pasadena 6 Calif-L P Robinson-SY 8-6761 (p) Data Processing Machines
Electro Development Co 14701 Keswick St Van Nuys Calif-R L Finch-ST 6-3660 (p) Slip Ring Assemblies (a) Precision Components
Electro Instruments 3794 Rosecrans San Diego 10 Calif-Jon Edwards-CY 8-6144 (p) Digital Voltmeter (a) Digital Voltmeter
Electro-Measurements 4312 S E Stark St Portland 15 Ore-M L Morgan-FI 9235 (p) Impedance Bridges (a) Potentiometers
Electro-Mechanical Specialties 6819 Melrose Ave Los Angeles 38 Calif-J P Schwartz-WE 3-5866 (p) Relays (a) Relays
Electromec Inc 5121 San Fernando Rd Los Angeles 39 Calif-C M Brown-CH 5-3771 (p) Oscilloscopes
Electronic Control Systems 2136 Westwood Blvd Los Angeles 25 Calif-A F Brewer-BR 2-0845 (p) Statistical Analyzer (a) Data-handling Systems
Electronic Eng'g Co of Calif 180 S Alvarado St Los Angeles 57 Calif-R B Bonney-DU 2-7353 (a) Data Handling Systems
Electronic Industries 7649 San Fernando Rd Burbank Calif-W T Holmes-ST 7-8546 (p) Radiation Detecting Equip
Electronic Mfg 227 W Chestnut Ave Monrovia Calif-A H Fester-EL 8-6149 (p) Environmental Testing Equip
Electronic Organ Arts Box 41084 Los Angeles 41 Calif-R L Eby-SY 3-9367 (p) Electronic Organ Kits
Electronic Production & Development 138 Nevada St El Segundo Calif-W M Thomas-EA 2-1515 (p) D C Power Supplies
Electronic Products 322 State St Santa Barbara Calif-D E Hildreth-WO 5-8541 (p) Plug-in Modules
Electron Products 919 Riverside Dr Los Angeles 31 Calif-J G Stevens-CA 6116 (p) Capacitors (a) Capacitors
Electro-Pulse Inc 11861 Teale St Culver City Calif-J S Johnson-TE 0-8006 (p) Long Time Delay Generator
Electro-Switch & Controls 5755 Camille Ave Culver City Calif-A T Beals-TE 0-4643 (p) Relays (a) Relays
Elgin-Neomatic Inc 9010 Bellanca Ave Los Angeles 45 Calif-Ben McCannon-OR 3-3814 (p) Relays (a) Relays
El Ray Motor Co 11747 Vose St N Hollywood Calif-C H Adams-ST 7-1686 (p) Motors
Endevco Corp 689 S Fair Oaks Pasadena Calif-T C Woodward-RY 1-5231 (p) Measuring Instruments
Engineered Instruments 815 Soto St Hayward Calif-D R Callow-JE 7-1545 (p) Chokes Coils
*Essex Electronics 7303 Atoll Ave N Hollywood Calif-W J Hirschberg-St 7-5451 (p) Coils (a) Encapsulated Assemblies

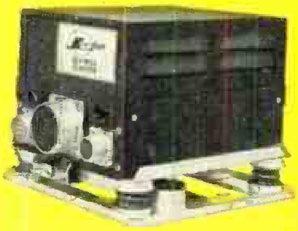
Faber Mfg Merle 35 Stillman St San Francisco 7 Calif-M F Faber-EX 2-7302 (p) Vacuum Tube Components
Feay Co Neal 427 Olive St Santa Barbara Calif-Jerry Kucera-WO 2-0722 (p) Dials, Panels, Scales (a) Dials, Panels, Scales
Federal Equipment 38 Brady St San Francisco 3 Calif-R W Randolph-UN 3-3607 (p) Photoelectric Traffic Counting Equip
Ferroprint 7070 Santa Monica Blvd Hollywood 38 Calif-S G Ellis-HO 9-8374 (p) Magnetic Sound Recording Tape
Fischer & Co R A 517 Commercial St Glendale 3 Calif-Ralph DeVries-CH 5-2404 (p) Transformers
Fisher Research Lab 1961 University Ave Palo Alto Calif-G F Fisher-DA 2-4646 (p) Measuring Instruments
Fluke Mfg Co John 1111 W Nickerson St Seattle 99 Wash-J M Fluke-AL 3322 (p) Wattmeter (a) Wattmeter
F & M Sales 1054 Cahuenga Blvd Hollywood 38 Calif-Harold Furno-HO 3-1959 (p) Crystal Processing Equip
Ford Eng'g Co 129 East A St Upland Calif-R L Gach-YU 322 (p) Potentiometers
Furane Plastics 4516 Brazil St Los Angeles 39 Calif-Julian Delmonte-CH 5-1153 (p) Potting & Encapsulating Resins (a) Tooling Resins

Garrett Corp AiResearch Mfg Div 9851 Sepulveda Blvd Los Angeles 45 Calif W R Ramsaur OR 8-9211 (p) Computers (a) Servo Systems
General Cybernetics 1751 N Coronado St Los Angeles 26 Calif-Geoffrey Post-NO 3-1300 (p) Card to Tape Converter (A) Linear Displacement Transducer
Genisco Inc 2233 Federal Ave Los Angeles 64 Calif-R E Brown-BR 2-9749 (a) Accelerometers
Gertsch Products 11846 Mississippi Ave Los Angeles 25 Calif-L S Cutler-BR 2-0568 (p) Frequency Meters (A) Frequency Meters
Giannini & Co G M 918 E Green St Pasadena 1 Calif-C F Sardou-SY 3-2101 (p) Potentiometers (a) Pressure Transmitters
Girard-Hopkins 1000 40 Ave Oakland 1 Calif-J C Hopkins-KE 2-8477 (p) Capacitors (A) Capacitors
Glass Eng'g Labs 601 O'Neill Ave Belmont Calif-H M Warden-LY 3-8276 (p) Specialized Glass Products
Globe Electrical Mfg Co 1729 W 134 St Gardena Calif-Alex Glassman-PL 7-1881 (p) Relays
G & M Equipment 7309 Varna Ave N Hollywood Calif-Steve Taylor-PO 5-4185 (p) Spectrum Analyzer (a) Spectrum Analyzer
Goldak Co 1544 W Glenoaks Blvd Glendale 1 Calif-Edwin Kaufman-CH 5-6571 (p) Relay Amplifier (a) Relay Amplifier
Gonset Co 801 S Main St Burbank Calif-W W Smith-VI 9-2222 (p) Comm Equip (a) VHF Radio Equip
Good Inc Don 1014 Fair Oaks S Pasadena Calif-Don Good-PY 1-1884 (p) Wire, Cable
Gordon Enterprises 5362 N Cahuenga Blvd N Hollywood Calif-W W Low-ST 7-5267 (p) Photo Processing Equip (a) Camera Test Panel
Goslin Electric & Mfg 2921 W Olive St Burbank Calif-A J Goslin-TH 8-0776 (p) Transformers
Graef Eng'g Co 15010 S Downey Ave Paramount Calif-O K Graef-NE 6-2816 (a) Insulators, Coil Forms
*Graphik-Circuits Div Cinch Mfg 221 S Arroyo Pkwy Pasadena 1 Calif-H R Gillespie-RY 1-9667 (p) Printed Circuit Boards (a) Printed Circuit Boards
*Gudeman Co of Calif 2669 S Myrtle Ave Monrovia Calif-D H Allen-RY 1-9364 (p) Pulse Transformers (a) Pulse Transformers
Guild Radio & TV 460 N Eucalyptus Ave Inglewood 3 Calif-H Fremont-OR 8-7771 (p) Radios

# PRECISION SYSTEMS AND COMPONENTS *in production*

## NAVIGATION SYSTEMS

Kearfott Systems include 3 gyro, 3 and 4 gimbal platforms. They provide precise azimuth and vertical reference. Also Directional Gyro Compass Systems.



The Gyro Guide System shown provides Latitude Corrected Gyro and Magnetic Slaved Heading information. Weighs 17 lbs. Max. random drift 2°/hour.

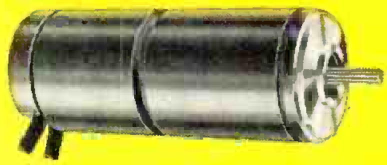
**FROM THE EAST COAST**

## GYROS, SERVO MOTORS, SYNCHROS

Kearfott produces a complete line of gyros, servo motors, and synchros to satisfy every aircraft control requirement.

**FLOATED INTEGRATING GYRO**

3 Gyro Platforms, Floated Rate Integrating Gyros, Vertical, Free, Directional, Rate Gyros and Gyro operated rate switches—compact, lightweight, hermetically sealed.



**SERVO MOTORS, SYNCHROS**

High torque, low inertia Servo motors, Servo-motor-Generators, inertial and viscous damped Servo motors 3/4" to 1-3/4" diameter, Synchro Transmitters, Control Transformers, Resolvers, Repeaters and Differentials in size 8, 11 and 15.

**AND FROM THE WEST COAST**

## MICROWAVE EQUIPMENT

Kearfott offers engineering-design service, manufacturing facilities and a wide experience in the production of microwave components and test sets.

**COMPONENTS**

Including attenuators, directional couplers, crystal mixers, twists and tees for S, C, Xb, X and Ku bands.

**TEST SETS (for X, C, and Ku)**

A four-in-one instrument for functional testing of radar or beacon. Includes Wavemeter, Spectrum Analyzer, Power Monitor, and signal generator.

Bulletins giving physical and technical data on the various Kearfott Products will be sent on request. The Kearfott organization is available to assist in the development and manufacture of other precision components you may require.

KEARFOTT COMPANY, INC., Little Falls, N. J.

Sales and Engineering Offices: 1378 Main Ave., Clifton, N. J.
Midwest Office: 188 West Randolph Street, Chicago, Ill.
South Central Office: 6115 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

WESTERN MANUFACTURING DIVISION:
14844 Oxnard Street, Van Nuys, Calif.

Kearfott

GPE — A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

# 1955 Directory of West Coast Electronic Manufacturers

Hadley Co Robert M 5112 S Hoover St Los Angeles 37 Calif-A H Hadley-AD 4-0131 (p) Transformers, Reactors

Hallamore Electronics 2001 E Artesia St Long Beach 5 Calif-Herbert Karsh-20-1428 (p) Closed Circuit TV (a) Transponder

Hallen Corp 3503 W Olive Ave Burbank Calif-Roger Anthes-TH 8-6976 (p) Magnetic Film Recorder/Reproducers (a) Magnetic Film Recorder/Reproducers

Hallett Mfg Co 1601 W Florence Ave Inglewood Calif-Harry Shore-OR 8-4751 (p) Interference Control Equip (a) Interference Control Equip

Hansen Electronics 7117 Santa Monica Blvd Los Angeles 46 Calif-H R Hansen-HO 9-3052 (p) Tape Resistors (a) Tape Resistors

Harder Co Donald C 3338 India St San Diego 1 Calif-D C Harder-CY 8-2180 (p) Toroidal Coil Winder (a) Toroidal Coil Winder

Helipot Corp S Pasadena Calif-O C Bixler-PY 1-2164 (p) Potentiometers (a) Potentiometers

Hewlett-Packard Co 275 Page Mill Rd Palo Alto Calif-Brunton Bauer-DA 5-4451 (p) Test Equip

Hoffman Laboratories 3761 S Hill St Los Angeles 7 Calif-Carlton Wasmansdorff-RI 7-9661 (p) Communications & Radar Equip (a) Navigation Equip

Hoffman Radio Div Hoffman Electronics Corp 3761 S Hill St Los Angeles 7 Calif-M G Whitney-RI 7-9661 (p) Radio & TV Receivers

Holl Audio Inc 5020 N Encinita Ave Temple City Calif-J W F Holl-AT 7-2902 (p) Audio Equip

Hopkins Eng'g Co 2082 Lincoln Ave Altadena Calif-C W Wieland-SY 8-1185 (p) Capacitors (a) Capacitors

Houston Fearless Div of Color Corp of America 11801 W Olympic Blvd Los Angeles 64 Calif-H W Houston-BR 2-4331 (p) Film Processing Machines

Hufco Industries 2815 W Olive Ave Burbank Calif-O F Hoffman-VI 9-2118 (p) Relays

Hufford Machine Works Inc Electronics Div 2201 Carmelina Ave W Los Angeles 64 Calif-H A Wood-BR 2-1627 (p) Power Supplies (a) Power Supplies

Huggins Laboratories 711 Hamilton Menlo Park Calif-L A Roberts-DA 3-0013 (p) Traveling Wave Tubes

Hughes Aircraft Florence Ave & Teale St Culver City Calif-R J Shank-TE 0-7111 (p) Semiconductors (a) Guided Missile Systems

Hughey & Phillips 3300 N San Fernando Blvd Burbank Calif-J H Ganzenhuber-VI 9-1104 (p) Code Beacons

Hycon Mfg 2961 E Colorado St Pasadena 8 Calif-W C McFadden-SY 6-8135 (p) Digital VTVM (a) Guided Missile Test Equip

Hyeor Co 11423 Vanowen St N Hollywood Calif-Dean Fullmer-ST 7-5389 (p) Wave Filters

Hydro-Aire Inc 3000 Winona Ave Burbank Calif-H H Rhoads-VI 9-1331 (p) Transistors

Industrial Electronic Engineers 3973 Lankershim Blvd N Hollywood Calif-D G Gumpertz-SU 3-7303 (p) Industrial Controls

Inet Div Leach Corp 4441 S Santa Fe Los Angeles Calif-J L Elliott-LO 8-4771 (p) Rectifiers

Instrument Development & Mfg 3018 E Foothill Blvd Pasadena 8 Calif-L Mager-SY 5-5941 (p) Motor Gen & Freq Regulator Test Set (a) Pressure Transducer

Int'l Electronic Research Corp 177 W Magnolia Blvd Burbank Calif-Leroy Woods-VI 9-2802 (p) Tube Shields (a) Tube Shields

Int'l Rectifier Corp 1521 E Grand Ave El Segundo Calif-Eric Lidow-OR 8-6281 (p) Selenium Rectifiers (a) Selenium Rectifiers

Int'l Research Assoc 2221 Warwick Ave Santa Monica Calif-W R Courtney-TE 0-4415 (p) Aircraft & Marine Comm Equip (a) VHF Transmitter-Receiver

Int'l Telemeter 2000 Stoner Ave Los Angeles 25 Calif-G W King-GR 8-7751 (p) System of Pay TV

I Q Industries 6110 Wilshire Blvd Los Angeles 48 Calif-Stewart Tongret-WE 3-8204 (p) Photo-electric Controls (a) Photo-electric Smoke-Fire Detectors

Ircal Industries 2242 S Sepulveda Blvd Los Angeles 64 Calif-Gustav Geiger-GR 7-9449 (p) Encapsulated Resistors (a) Encapsulated Resistors

*Iron Fireman Mfg Electronics Div 2838 S E 9 Ave Portland 2 Ore-A L Judson-FI 6551 (p) Relays (a) Gyroscopes

Irwin Labs 1238 S Gerhart Ave Los Angeles 22 Calif-W W Irwin-RA 3-1819 (p) Testing Equip (a) Magnetometers

JaMae Products 8845 N E Sandy Blvd Portland 20 Ore-J W Jackson-AT 2-4418 (p) Antennas (a) Antennas

Janco Corp 3111 Winona Ave Burbank Calif-T A Andrew-VI 9-2107 (p) Jumpers, Bus Bars (a) Shunts

Javex P O Box 646 Redlands Calif-C J Reimuller-4-5752 (p) TV Installation Equip

Jennings Radio Mfg 970 McLaughlin Ave San Jose Calif-J E Jennings-CY 2-4025 (p) Vacuum Capacitors (a) Vacuum Capacitors

Jobbins Electronic Enterprises 771 Hamilton Ave Menlo Park Calif-C W Jobbins-DA 2-7661 (p) Transformers

Johnson-Williams Inc 2625 Park Blvd Palo Alto Calif-K W Johnson-DA 2-1531 (p) Gas Detectors (a) Icing-Severity Indicators

Kaar Eng'g P O Box 1320 Palo Alto Calif-A B Simpkins-DA 3-9001 (p) Radio Telephones (a) Radio Transmitters

Kahl Scientific Instrument P O Box 1166 El Cajon Calif-G Wolter-HI 4-5944 (p) Electrical Thermometers

Kaiser Aluminum & Chemical 1924 Broadway Oakland Calif-M D Eisele-TA 3-4600 (p) Capacitor Foil

Kartron 7882 Kartron St Huntington Beach Calif-T B Linton-LE 9-4606 (p) Shorted Turn Indicators

Kay Lab 5725 Kearney Villa Rd San Diego 12 Calif-R E Langworthy-BR 7-6700 (p) DC Power Supplies

*Kearfott Co Western Area Office 253 N Vinedo Ave Pasadena 8 Calif-J R Harkness-SY 6-9139 (p) Gyros, Synchros (a) Navigational Systems

K-F Development 2606 Spring St Redwood City Calif-Paul Keeler-EM 8-5670 (a) Potentiometers

Kinevox Inc 116 S Hollywood Way Burbank Calif-L H Roos-VI 9-3291 (p) Sound Recorders

Kwikheat Mfg 3732 San Fernando Rd Glendale Calif-E E Wachter-CH 5-2376 (p) Soldering Irons

Lambda-Pacific Eng'g 14725 Arminta St Van Nuys Calif-L W Mallach-ST 6-1801 (p) Microwave Link & Aux Equip

Landsverk Electrometer 550 W Garfield Ave Glendale 4 Calif-D L Collins-CI 1-2954 (p) Radiation Detection Equip

Lane Electronics 7254 Atoll Ave N Hollywood Calif-R J Scholiard-ST 7-3267 (a) Transmitter Access

Lansing Sound Inc James B 2439 Fletcher Dr Los Angeles 39 Calif-W H Thomas-NO 3-3218 (p) Loudspeakers (a) Loudspeakers

Leach Relay Div Leach Corp 5915 Avalon Blvd Los Angeles 3 Calif-E K Neale-AD 8221 (p) Rectifiers

Lear Inc 3171 S Bundy Dr Santa Monica Calif-C J Breitwieser-EX 8-6211 (p) Flight Control Systems (a) Flight Control Systems

Lee Electric & Mfg 2806 Clearwater St. Los Angeles 39 Calif-L P Tuttle-NO 3-1295 (a) Mag Amp Regulated DC Power Equip

Lenkurt Electric 1105 County Rd San Carlos Calif-K E Appert-LY 3-2161 (p) Carrier Telephone & Telegraph Systems (a) Carrier Telephone & Telegraph Systems

Leonard Precision Products 9200 Bolsa Ave Santa Ana Calif-Leonard Zerlaut-WE 5261 (p) Tube Fabricating Equip (a) Tube Fabricating Equip

Lereo Div Lynn-Deatriek Inc 501 S Varney St Burbank Calif-C E Lynn-VI 9-5556 (p) Terminal Lugs (a) Terminal Lugs

Leupold & Stevens Instruments 4445 N E Glisan St Portland 13 Ore-L E Rinker-VE 4147 (p) Water Level Registering Systems

Levinthal Electronic Products 2821 Fair Oaks Ave Redwood City Calif-A J Morris-EM 8-2963 (p) Microwave Transmitters (a) Microwave Transmitters

Lewis & Kaufman 17320 El Rancho Ave Los Gatos Calif-N V Bramley-EL 4-3540 (p) Power Transmitting Tubes (a) Power Transmitting Tubes

Librascope Inc 808 Western Ave Glendale 1 Calif-D C Webster-CH 5-2677 (p) Computers & Controls (a) Computers & Controls

Lipps Eng'g Edwin A 5485 W Washington Blvd Los Angeles 16 Calif-C V Olson-WE 5-4141 (p) Magnetic Recording Heads (a) Telemetering Heads

Litton Industries of Calif 336 N Foothill Rd Beverly Hills Calif-Harry Gray-CR 4-7344 (p) Test Equip (a) Test Equip

Litton Industries of Calif Power Tube Div 1025 Brittan Ave San Carlos Calif-St. George Lafitte-LY 3-3124 (p) Magnetrons, Klystrons

Lockheed Aircraft Corp Van Nuys Calif-E R Quesada-ST 7-5421 (a) Missile Systems

Loge Sound Engineers J M 2171 W Washington Blvd Los Angeles 18 Calif-J M Loge-RE 4-9178 (p) Intercom Systems

Luther Electronic Mfg 5728 W Washington Blvd Los Angeles 16 Calif-C L Johnson-WE 9-5826 (a) Pulse Forming Networks

Lynch Carrier Systems 695 Bryant St San Francisco 3 Calif-D E Campbell-EX 7-1471 (p) Carrier Telephone System Equip

McAllster Inc J G 1117 N McCadden Pl Hollywood 38 Calif-R L Logan-HO 9-5317 (p) TV Lighting Equip

McColpin-Christie Corp 3410 W 67 St Los Angeles 43 Calif-S L Christie-PL 3-2607 (p) D C Power Supplies (A) D C Power Supplies

McCormick Selph Assoc P O Box 6 Hollister Calif-Frank LaHaye-1185 (p) Explosive Actuator Devices

McKenna Labs 2503 Main St Santa Monica Calif-A G McKenna-EX 9-8846 (p) Ultrasonic Cleaning Equip (a) Ultrasonic Cleaning Equip

McLaughlin Corp J L A 367 Bird Rock Ave La Jolla Calif-J L A McLaughlin-GL 4-0141 (p) Radio Receivers (a) Telemetering Receivers

Macson Co 3260 Motor Ave Los Angeles 34 Calif-J D MacDonald-TE 0-3000 (p) Cable Connectors

Mag-Electric Products 12822 Yukon Ave Hawthorne Calif-R L Phillips-OR 8-6248 (p) Mag Regulators & Power Supplies (a) Mag Regulators & Power Supplies

Magna Electronics 9810 Anza Ave Inglewood 1 Calif-George Gott-OR 8-5675 (p) Audio Amplifiers

Magnasync Mfg 5523 Satsuma Ave N Hollywood Calif-J W Green-ST 7-5493 (p) Magnetic Film Recorders/Reproducers

*Magnavox Research Labs Div Magnavox Co 2255 Carmelina Ave Los Angeles 64 Calif-Dr R Thorensen-GR 9-7796 (p) Data Processing Systems (a) Missile Guidance & Flight Control Systems

Magnetic Research 200 Center St El Segundo Calif-Dr Hugo H Woerdemman-OR 8-8921 (p) DC Magnetic Power Supplies (a) DC Power Supplies

Mann Co Wm I 104 E Foothill Blvd Monrovia Calif-F E Jasmine-EL 8-3206 (p) Optical Comparator (a) Potentiometers

Manufacturers Lab 10610 Keswick St Sun Valley Calif-H P Stark-WE 8-9045 (p) Custom Recording Installations

Marcnant Research 1475 Powell St Oakland 8 Calif-G B Greene-OL 2-6500 (p) Digital Computers

Marco Industries 207 S Helena St Anaheim Calif-F A Harrington-KE 5-6037 (a) Light Assemblies

Mattson-Cowley Corp 1487 Lincoln Ave Pasadena 3 Calif-P F Scnieke-RY 1-6386 (p) FM Receivers

May Eng'g Co 6055 Lankershim Blvd N Hollywood Calif-D M May-ST 7-2189 (p) Delay Lines (a) Delay Lines

Menlo Research Lab P O Box 522 Menlo Park Calif-Charles Weeks-DA 5-8450 (p) Radiation Det Instr

Merit Short Wave Diathermy 2758 Whittier Blvd Los Angeles 23 Calif-G S Mogilner-AN 1-7521 (p) Welder

Mesa Plastics 11751 Mississippi Ave Los Angeles 25 Calif-P F Fowler-GR 8-2311 (p) Molding Compounds (a) Molding Compounds

Microdot Div Felts Corp 1826 Fremont Ave S Pasadena Calif-Dr H Tejada-PY 1-2782 (p) Coax Connectors (a) Coax Connectors

Miller Dial & Name Plate 4400 N Temple City Blvd El Monte Calif-Les Madansky-CU 3-5111 (p) Panels (a) Panels

Miller Electronics 2840 Naomi St Burbank Calif-Lew Brown-VI 9-1659 (p) TV Antennas

Miller Instruments Wm 325 N Halstead Ave Pasadena 8 Calif-E E Hoskins-RY 1-6317 (p) Oscillographs

Miller Co J W 5917 S Main St Los Angeles 3 Calif-W R Courtney-AD 3-4297 (p) Inductances

Moisture Register 1510 W Chestnut St Alhambra Calif-M L McBrayer-CU 3-3143 (p) Moisture Testing Instr

Mole-Richardson Co 937 N Sycamore Ave Hollywood 38 Calif-W K Parker-OL 4-3660 (p) Lighting Equip

Monitor Products 815 Fremont Ave S Pasadena Calif-H E Blasier- PY 1-1174 (p) Quartz Crystals (a) Quartz Crystals

Moran Instrument 170 E Orange Grove Ave Pasadena 3 Calif-H E Ohanian-SY 6-7158 (p) Gamma Logger

Morgan Instruments Div Westwood Research & Development Labs 921 Westwood Blvd Los Angeles 24 Calif-H C Morgan-GR 8-4111 (p) Radiation Det Instr

Morrow Radio Mfg 2794 Market St Salem Ore-Wm Wane-3-6952 (p) Forestry Equip

Moseley Co F L 409 N Fair Oaks Ave Pasadena 3 Calif-F L Moseley-RY 1-8998 (p) DC Servo Voltmeters

Motordyne Inc 2661 S Myrtle Ave Monrovia Calif-J J Marino-DO 6-2121 (p) Motors (a) Motors

Mueller Lab 1052 N Allen Ave Pasadena Calif-Fred McClure-SY 7-0909 (a) Counters

Mullenbach Div of Electric Machinery Mfg 2100 E 27 St Los Angeles 58 Calif-R F Cline-LO 5-5331 (p) Relays (a) Relays

Mytron Mfg 4504 Brazil St Los Angeles 39 Calif-F Temple-CH 5-4931 (p) Hi-Freq Preheaters

National Hollywood 1475 El Mirador Dr Pasadena Calif-F C Hoffman-RY 1-6374 (p) Recording Discs (a) Recording Tape Reels

Natural Lighting 612 W Elk Ave Glendale 4 Calif-Vinnie Howarth-CH 5-5551 (p) Lighting Equip

Nelson Vacuum Pump Geo F 2133 4 St Berkeley 10 Calif-H A Alston-AS 3-2277 (p) Vacuum Pumps (a) Vacuum Pumps

Networks Electronic Corp 14806 Oxnard St Van Nuys Calif-Mike Patrichi-ST 5-8805 (a) Delay Lines

Neucor Inc 45 W Union St Pasadena Calif-A T Anderson-SY 3-2316 (p) Oscillators (a) Oscillators

Newcomb Audio Products 6824 Lexington Ave Hollywood 38 Calif-Donald Warner-HO 9-5381 (p) Sound Equip

Non Linear Systems Del Mar Airport Del Mar Calif-A F Kay-SK 5-1134 (p) Digital Voltmeters (a) Digital Voltmeters

North American Aviation 12214 Lakewood Blvd Downey Calif-S H Nelson-LO 5-8651 (a) Guided Missile Systems

North American Instruments 2420 N Lake Ave Altadena Calif-P S Chase-SY 8-1145 (p) Freq Meter (a) Pressure Transducers

Northrop Aircraft 1001 E Broadway Hawthorne Calif-Edgar Schmued-OR 8-9111 (a) Weapon Systems

Oberline Inc 6411 Hollywood Blvd Hollywood 28 Calif-Oliver Berliner-WE 3-9128 (p) Audio Equip

O'Brien Electric 6514 Santa Monica Blvd Hollywood 38 Calif-Lew Levin-HO 4-1117 (p) Sound Systems

Olesen Co Otto K 1534 Cahuenga Blvd Hollywood 28 Calif-S S Romans-HO 5-5194 (p) Sound Consoles

Olympic Plastics 5741 W Jefferson Blvd Los Angeles 16 Calif-Willard Lundberg-TE 0-1121 (p) Terminal Blocks (a) Terminal Strips

Opto Eng'g Co 3524 W Washington Blvd Los Angeles 18 Calif-J Sehmidt-RE 1-2259 (p) Test Equipment (a) Telemetering Equipment

Oregon Electronic Mfg 2232 E Burnside St Portland 15 Ore-C W McPherson-EM 9292 (p) Power Supplies

Osborne Electric 712 S E Hawthorne Blvd Portland 14 Ore-G L Osborne-FI 6448 (p) Transformers (a) Transformers

Owen Labs 412 Woodward Pasadena 10 Calif-W H Paap-SY 6-5167 (p) Transistor Test Sets

Pacific Mercury TV Mfg Corp 8345 Hayvenhurst Ave Sepulveda Calif-Stanley Cutler-EM 2-3131 (p) TV Receivers (a) Missile Equip

Pacific Relays Inc 7116 Laurel Canyon Blvd N Hollywood Calif-N F Leo-ST 7-0209 (p) Relays

Pacific Scientific Co 1430 Grande Vista Ave Los Angeles Calif-J E Glauser-AN 2-1123 (a) Gyroscopes

Pacific Semiconductors Inc 10451 W Jefferson Blvd Culver City Calif-J N Carman-VE 9-2341 (p) Diodes (a) Diodes

Pacific Transducer Corp 11836 W Pico Blvd Los Angeles 64 Calif-G A Argabrite-GR 8-1134 (p) Audio Products (a) Thermometers

Pacific Universal Products Corp 168 Vista Ave Pasadena 8 Calif-Charles Chopnick-RY 1-7646 (p) Optical Coatings (a) Optical Coatings

Packard-Bell Co 12333 W Olympic Los Angeles 64 Calif-Kay Padock-AR 7-6721 (p) TV Receivers (a) IFF Equip

Page-Fogwell Corp 1311 Riverside Dr Los Angeles 31 Calif-H E Page-CA 1-1166 (p) Control Devices

Palmer Inc M V 4002 Fruit Valley Rd Vancouver Wash-Martin Palmer-OX 5-2894 (p) Dial Telephones (a) Telemetering Systems

Palo Alto Eng'g Co 440 Olive Ave Palo Alto Calif-R E Lee-DA 5-3251 (p) Transformers (a) Transformers

Pancro Mirrors Inc 2958 Los Feliz Blvd Los Angeles 39 Calif-J W Dougherty-NO 1-2141 (p) Resistive Coatings

Pantek Co Box 212 El Segundo Calif-E Swarthe-WH 7909 (p) Frequency Dividers (a) Frequency Dividers

Par Products Corp 926 N Citrus Ave Hollywood 38 Calif-P A Roos-HO 5-6298 (p) Motors (a) Landing Simulator

Parsons Co Ralph M 617 S Olive St Los Angeles 14 Calif-P H Reedy-MA 9-2484 (p) Telemetering Equip (a) Instrumentation Services

Pathfinder Electronics Co 6836 Lexington Ave Los Angeles 38 Calif-Robert Newcomb-HO 9-5384 (p) P A Amplifiers

PCA Electronics Inc 2180 Colorado Ave Santa Monica Calif-K H Dendy-TE 0-6716 (p) Delay Lines

Peeco Corp 2760 Whittier Blvd Los Angeles 23 Calif-M D Preston-AN 9-4164 (p) Dielectric Heaters

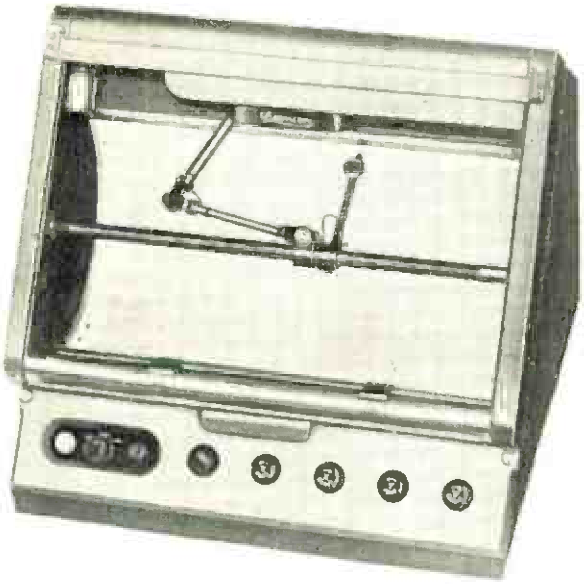
Peerless Electrical Products Div Altec Lansing Corp 9356 Santa Monica Blvd Beverly Hills Calif-A A Emlen-CR 5-5101 (p) Transformers (a) Transformers

Penta Laboratories 312 N Nopal St Santa Barbara Calif-R L Norton-WO 5-4581 (p) Electron Tubes

Perkin Eng'g Corp 345 Kansas St El Segundo Calif-J W Horton-DR 8-7215 (p) Power Supplies (a) Power Supplies

*Permoflux Corp 4101 San Fernando Rd

## COMPUTERS
## CONTROLS
## COMPONENTS
## BY LIBRASCOPE



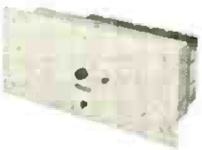
### X-Y PLOTTER AND RECORDER

A compact desk or rack-mounted instrument for recording two independent variables on standard graph paper. Two basic input sections allow continuous curve recording from low level D.C. signals with essentially infinite input impedance, or point by point plotting from a variety of digital inputs. Special inputs to meet customer applications are available.

### INPUTS TO PLOTTERS OR FOR OTHER DIGITAL SYSTEMS APPLICATIONS

**PUNCHED CARD OR PUNCHED TAPE CONVERTERS**
Units available to convert output from IBM Summary Punch or any code from Punched Paper Tape Readers.

**DECIMAL KEYBOARDS**
For manual insertion of tabulated data.



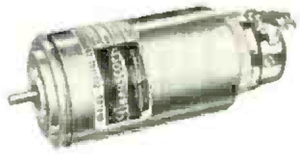
**BINARY CONVERTER**
Converts 9 bit, 2 channel data from thyratron buffer storage of parallel digital computers.

**SINE WAVE GENERATOR**
Used in frequency syntheses to determine data on transfer functions of automatic control systems and components.

### SPECIAL COMPUTERS OR DATA HANDLING EQUIPMENT

*Librascope manufactures mechanical and electrical analog computers and digital computers for military and commercial purposes. You are invited to submit your special computer requirements to our engineering staff.*

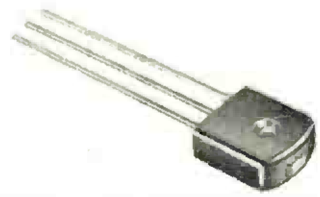
## ELECTRONIC COMPONENTS



**ANALOG-DIGITAL CONVERTERS**
A series of shaft position to digital encoders featuring serial/parallel time sharing, non-ambiguous brush systems. The following codes are available: Gray, Binary or Binary-Coded Decimal.

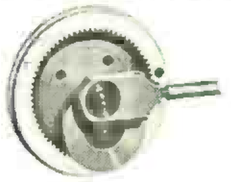
**MAGNETIC AMPLIFIERS**
Librascope manufactures high performance magnetic amplifiers and transistor magnetic amplifier combinations for industrial servo-controls, analog and digital computers and servo-stabilization networks.

**MAGNETIC LABORATORY DRUMS**
A 5" diameter drum with provisions for eight channels. Includes two machined clocks. Packing density up to 150 bits per inch. Variable speed motor, heads and adjustable mounts included. Special drums to meet your specifications.

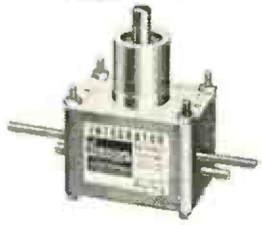


**READ AND RECORD HEADS**
For recording or reading of magnetic drum memory systems in digital computers. High read-back signal, low noise factor. Many models.

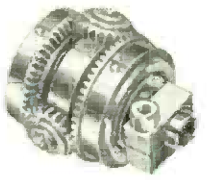
## MECHANICAL COMPONENTS



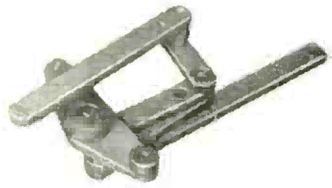
**SINE-COSINE MECHANISM**
Self-contained unit converts angular rotation into linear sine and cosine movements or solves many trigonometric functions.



**BALL & DISC INTEGRATOR**
Precision unit with lifetime lubrication. Used in totalizing, rate determination, differential analysis. Also serves as closed loop servo-element or variable speed drive.



**HOLLOW SHAFT DIFFERENTIAL**
Precision computer component for measuring angular positions or velocity sums. May be installed or removed without disassembly of unit or differential itself.



**LINKAGES**
Various linkage computing elements are available, including: addition-subtraction linkages, linkage multipliers and function generators to express exponential, logarithmic and square root functions.

**ENGINEERS, PHYSICISTS AND MATHEMATICIANS:** For a rewarding career with a company that offers optimum stability with job diversification, write Librascope today. Address inquiries to Mac McKeague, Personnel Director.

*For complete catalog information on any of the above products, write:*

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# 1955 Directory of West Coast Electronic Manufacturers

Glendale Calif-Robert Guthrie-CH 5-5135 (p) Transformers (a) Transistor Amplifiers

Phaostron Co 151 Pasadena Ave S Pasadena Calif-E W Carlson-CL 5-1471 (p) Multimeters (a) Meters

Photo Chemical Products of Calif 1715 Berkeley St Santa Monica Calif-J T Cain-TE 0-8451 (p) Dials (a) Dials

Photocon Research Products 421 N Foothill Blvd Pasadena 8 Calif-C E Grinstead-SY 2-4131 (p) Pressure Measuring Equip

Photo Research Corp 127 W Alameda Ave Burbank Calif-F F Crandell-VI 9-2891 (p) Measuring Instruments

Pioneer Broach Co 6434 Telegraph Rd Los Angeles 22 Calif-E A Clark-RA 3-4536 (p) Broaching Machines (a) Broaches

Pomona Electronics Co 1126 W Fifth Ave Pomona Calif-J J Musarra-LY 2-6570 (p) Socket Adapters (a) Socket Adapters

Ponder & Best 814 N Cole St Hollywood 38 Calif-J C Best-HO 9-6251 (p) TV Lenses

Precision Radiation Instruments 4223 W Jefferson Blvd Los Angeles 16 Calif-George Hare-RE 1-7321 (a) Scintillator

Prescott Television Co 7350 Beverly Blvd Los Angeles 36 Calif-B W Reagan-WE 3-7193 (p) TV Receivers

Printed Cellophane Tape Co 521 N LaBrea Ave Los Angeles 36 Calif-Sydney Gevirtz-WE 8-2134 (p) Printed Tapes (a) Printed Tapes

Product Associates 1046 S Olive St Los Angeles 15 Calif-J T Blakistone-RI 7-4519 (p) Tape Recorders

Pruyn-Moore Inc 1338 Cota Ave Long Beach 13 Calif-C C Moore Jr-357-417 (p) Antennas

P S P Eng'g Co 8420 Otis South Gate Calif-C B Pearson-LO 7-1451 (p) Solenoids (D C) (a) Solenoids (D C)

"Q" Circuits Co 32 Laskie St San Francisco 3 Calif-Bernard Silverman-MA 1-5734 (p) Printed Circuits (a) Printed Circuits

QRK Electronic Products 445 N Circle Dr Fresno Calif-Bert Williamson-7-1423 (p) Turntables

Qualitron Inc 2945 Hollywood Way Burbank Calif-E P King-ST 7-5963 (a) Control Panels

Radar Engineers 4528 5th NE Seattle 5 Wash-W T Harrold-ME 8079 (p) Cable Test Instr (a) Cable Test Instr

Radiaphone Co 600 E Evergreen Ave Monrovia Calif-Chas Petry-EL 8-2586 (p) Potentiometers (a) Potentiometers

*Radio Corp of America 11819 W Olympic Blvd Los Angeles 64 Calif-T L Gottier-BR 2-8841 (p) Radar (a) Radar

Radioplane Co 8000 Woodley Ave Van Nuys Calif-S E Weaver-ST 6-7020 (a) R-C Drones

Radio Specialty Mfg Co 2023 S E 6th Ave Portland 14 Ore-Harold Sterne-ES 8123 (p) Portable FM Recvrs

Ransom Research P O Box 382 San Pedro Calif-D H Ransom-TE 2-6848 (p) Digital Counters (a) Regulators

Ratigan Electronics 3614 Maple Ave Los Angeles 11 Calif-E C Rau-AD 3-4141 (a) Coils

Rea Co J B 1723 Cloverfield Blvd Santa Monica Calif-D T Gundersen-EX 3-7201 (p) Computer (a) Hovering Control

Rectifier Eng'g Co 1803 E 7 St Los Angeles 21 Calif-L B Lester-TU 5169 (p) Battery Chargers

Red Point Products 1907 Riverside Dr Glendale 1 Calif-R P Craig-TH 2-4623 (p) Impregnating Machinery (a) Impregnating Machinery

Reed & Reese 697 No Lake Ave Pasadena 6 Calif-N J Rosen-RY 1-9646 (p) Solenoids (a) Potentiometers

Regulator Eng'g & Devel 11545 W Jefferson Blvd Culver City Calif-R E Lloyd-EX 8-5733 (p) Power Supplies

Reiter Co F 3340 Bonnie Hill Dr Hollywood 28 Calif-F Reiter-HO 2-2913 (p) Tape Splicer

Remler Co Ltd 2101 Bryant St San Francisco 10 Calif-H A Greene-VA 4-3435 (p) Announcing Systems (a) Announcing Systems

Repath Co Paul R 641 E 61st St Los Angeles 1 Calif-P R Repath-AD 3-7262 (p) Laminations (a) Laminations

Resdel Eng'g Corp 330 S Fair Oaks Ave Pasadena Calif-J L De Diemar-SY 5-5197 (p) Velocimeters (a) Velocimeters

Reynolds Industries 2105 Colorado Ave Santa Monica Calif-A M Griffin-TE 0-4803 (p) Cable Connectors (a) Connectors

RHO Eng'g Co 4205 Sepulveda Blvd Culver City Calif-B L Hamby-TE 0-8441 (p) Resistors (a) Resistors

Richardson Co 5860 Spring Oak Dr Hollywood 28 Calif-Sidney Richardson-HO 7-5332 (p) Conectors (a) Connectors

Richomatic Inc 820 N Fairfax Ave Los Angeles 46 Calif-H N Parker-OL 3-1920 (p) Remote Control TV

Risco 265 Minna St San Francisco 3 Calif-H N Kalb-EX 2-7820 (p) Carrier Equip (a) Condensers

Robertshaw Fulton Controls Co Aeronautical Div 401 N Manchester Blvd Anaheim Calif-R H Wehril-KE 5-8151 (p) Positioners (a) Synchros

Robey Rotor Inc 6006 Washington Blvd Culver City Calif-O B Robey-VE 8-3271 (p) Gyroscopes

Robinette Co W C 802 Fair Oaks Ave S Pasadena Calif-W C Robinette-PY 1-1594 (p) Servos

Robuck Labs 1431 S La Brea Ave Los Angeles 19 Calif-E R Robuck-WE 6-0444 (p) Control Ovens (a) Control Ovens

Roesch Inc Douglas 2200 S Figueroa St Los Angeles 7 Calif-A P Jacobs-RI 7-9361 (p) Missile Cables (a) Missile Cables

Rototest Labs 2803 Los Flores Blvd Lynwood Calif-E A Raney-NE 6-9238 (p) Component Testing

R & R Tool & Die Co 1112 Chestnut St Burbank Calif-G P DelFaro-VI 9-3611 (p) Stampings

RS Electronics Corp 435 Portage Ave Palo Alto Calif-Robert K-F Scal-DA 3-9063 (p) Radar Components (a) Radar Antennas

Rumple Inc 2308 Beloit Ave Los Angeles 64 Calif-W W Brockway-BR 2-1741 (p) Choppers

Rutherford Electronics 3707 S Robertson Blvd Culver City Calif-M F Clapp-TE 0-4362 (p) Generators (a) Generators

Rytel Div Cal-Lee Mfg Co 5653 W Adams Blvd Los Angeles 16 Calif-C C Howard-WE 5-5883 (p) Hi Fi Equip

San Fernando Electric Mfg West-Cap Div 1509 First St San Fernando Calif-Frank LaFetra-EM 1-8681 (p) Capacitors (a) Capacitors

Santa Monica Bay Sheltered Workshop 2521 5 St Santa Monica Calif-J E Anthony-EX 9-7741 (p) Toroidal Windings (a) Toroids

Sargent-Rayment Co 1401 Middle Harbor Rd Oakland 20 Calif-Will Rayment-GL 1-7045 (p) AM-FM Tuners

Scantlin Electronics P O Box 24561 Los Angeles 24 Calif-L D Wilson-OR 8-7913 (p) Radio Paging Equip

*Seaboard Coil Spring Div Associated Spring Corp 15001 S Bdwy Gardena Calif-Glen Sumpter-PL 6-8141 (p) Coil Windings

Semco Electronics Co 8407 S Hoover St Los Angeles 44 Calif-G A Korkos-PL 2-7657 (p) TV Receivers

Semler Industries 6853 Lankerhim Blvd N Hollywood Calif-N N Semler-ST 7-1554 (p) Test Equip (a) Communications Equip

Sequoia Process Corp 871 Willow St Redwood City Calif-J R Hughes-EM 8-4651 (p) Plastic Insulated Wires (a) Plastic Insulated Wires

Servonic Instruments 11145 S Fair Oaks Pasadena 2 Calif-J A De Julio-SY 9-1332 (p) Pressure Transducers (a) Pressure Transducers

Shannon Luminuos Materials Co 7356 Santa Monica Blvd Hollywood 46 Calif-J R Alburger-HO 7-5509 (p) Inspection Lamps

Shasta Div Beckman Instruments P O Box 296 Station A Richmond Calif-G H Bruns Jr-LA 6-7730 (p) Voltmeters (a) Freq Meters

Shelby Instrument Co 1701 Magnolia Long Beach 13 Calif-Ira Bayless-HE 7-6300 (p) Sub Sub Miniature Electronics

*Sheldon Electric Co Div of Allies Elect Prods 2724 Leonis Blvd Los Angeles 58 Calif-Walter Wichowski-LO 5-5427 (p) Cathode Ray Tubes (a) Cathode Ray Tubes

Short Wave Plastic Forming Co 2921 W Alameda Ave Burbank Calif-Frank Wilborn-TH 8-9606 (p) Hi Freq Generators (a) Woodwelders

Shrader Co F W 5788 Washington Blvd Culver City Calif-F W Schrader-WE 8-6277 (p) Electromagnets (a) Electromagnets

Sierra Electronic Corp 1050 Brittan Ave San Carlos Calif-Paul Byrne-LY 1-0711 (p) Power Monitor

Signal Equipment Co 2706 Third Ave Seattle 1 Wash-J F Johnson-SE 4712 (p) VTVM'S (a) Cathode Followers

Silver Bay Equip Co 5004 20th N W Seattle 7 Wash-M F Kerr-DE 4960 (p) Communication Products (a) Nameplates

Skyway Precision Tool Co 1107 S Fremont Ave Alhambra Calif-J J Cornwell-CU 3-4181 (p) Torque Test Equip

Soderberg Mfg Co 628 S Palm Ave Alhambra Calif-W W Hulke-CU 3-3382 (a) Light Assemblies

Solar Mfg Corp E 46 & Seville Ave Los Angeles 58 Calif-Keith Clark-LO 8-1411 (p) Capacitors

Southern Electronics Corp 239 W Orange Grove Ave Burbank Calif-Norman Schwartz-VI 9-3193 (p) Capacitors (a) Capacitors

Specific Products 14515 Dickens St Sherman Oaks Calif-James Sherman-ST 7-9615 (p) WWV Receivers

Spinco Div Beckman Instruments 743 O'Neill Ave Belmont Calif-P F Scofield-LY 3-7693 (p) Power Supplies

*Sprague Electric Co 12870 Panama St Los Angeles 66 Calif-TE 0-7491 (p) Capacitors (a) Capacitors

Stancil-Hoffman Corp 921 N Highland Ave Hollywood 38 Calif-S Salat-HO 4-7461 (p) Tape Recorder

*Standard Coil Products 1919 Vineburn Ave Los Angeles 32 Calif-E P Thias-CA 2-8161 (p) TV Toners (a) Motors

Standard Plastics & Electronics Co 21343 Roscoe Blvd Canoga Park Calif-H M Greene-DI 7-8500 (p) Amplif-Modulator (a) Amplif-Modulator

Standard Wire & Cable Co 3440 Overland Ave Los Angeles 34 Calif-M E Harris-TE 0-4647 (p) Hookup Wire (a) Wire Cable

Stanford Labs 1661 Bdwy Redwood City Calif-E W Van Buskirk-EM 8-4127 (p) Accelerators (a) Microwave Tubes

Star Engraving Co 223 E 4 St Los Angeles 13 Calif-Burril Manis-MA 9-3561 (p) Panels

Statham Labs 12401 W Olympic Blvd Los Angeles 64 Calif-M diGiovanni-BR 2-6284 (a) Accelerometers

Stephens Mfg Corp 8538 Warner Dr Culver City Calif-R C Tetherow TE 0-3775 (p) Loudspeakers

Sterling Electric Motors 5401 Telegraph Rd Los Angeles 22 Calif-J Eastman-RA 3-6211 (p) Motors

Stewart Eng'g Co P O Box 277 Soquel Calif-R F Stewart-GR 5-4790 (p) Travelling Wave Tubes (a) Travelling Wave Tubes

Stoddart Aircraft Radio 6644 Santa Monica Blvd Hollywood 38 Calif-A T Parker-HO 4-9294 (p) Interference Meas Equip

Summers Gyroscope Co 2328 Broadway Santa Monica Calif-J W Brubaker-EX 3-6711 (p) PAR Gyro (a) Flight Control Systems

*Sylvania Electric Products 2936 E 46 St Los Angeles 58 Calif LO 5-8121 (p) Diodes, Test Equip

Ta-Mar Inc 11571 W Jefferson Blvd Culver City Calif-Marioano Orenge-TE 0-7479 (p) Remote Control (a) Isolation Units

Tartak Electronics 2979 N Ontario St Burbank Calif-A A Tallis-VI 9-2414 (p) Transformers (a) Transformers

Technical Associates 140 W Providencia Ave Burbank Calif-Sheldon Knoch-TH 8-8133 (p) Nuclear Instruments

Technical Development Corp 4060 Ince Blvd Culver City Calif-P R Masson-TE 0-5461 (p) Synch Motors

Technical Devices Co 2340 Centinela Ave Los Angeles 64 Calif-Arthur Lambert-GR 7-0708 (p) Wire Cutter

Technical Training Institute 5018 N E Union Ave Portland 11 Ore-A F Bruschi-TR 8732 (p) Trainer Boards

Teksum Inc 11368 W Olympic Blvd Los Angeles 64 Calif-H G Hoffer-BR 2-4504 (p) Servo Amplifiers

Tektronix Inc P O Box 831 Portland 7 Ore-R L Ropiequet-CY 2-2611 (p) Oscilloscopes

*Telautograph Corp 1128 Cranshaw Blvd Los Angeles 19 Calif-R G Leitner-WE 3-7168 (p) Graphic Transmission Systems

Telecomputing Corp 12838 Saticay St N Hollywood Calif-P W Simms-(p) Computing Equip

Tempo 21341 Roscoe Blvd Canoga Park Calif-Jerry Fisher-DI 7-2255 (p) TV Masts

Testa Mfg Co 10130 E Rush St El Monte Calif-R E Eisele-CU 3-6022 (p) Optical Components (a) Optical Components

Thermador Elec Mfg Co Electronics Div 2000 S Camfield Los Angeles 22 Calif-J W Wardell-RA 3-5189 (p) Transformers (a) Motors

Thermo Instruments 1310 Old County Rd Belmont Calif-D M Comb-LY 3-5139 (p) Control Equip

Thor Transformer & Electronics 750 San Antonio Rd Palo Alto Calif-H J Birdsell-YO 7-9116 (p) Transformers

Timely Instruments & Controls Co 1645 W 135 St Gardena Calif-W Kastan-PL 6-8153 (a) Servo Amplifiers

Transco Products 12210 Nebraska Ave Los Angeles 25 Calif-Harold Baoman-GR 8-4241 (p) Co-Axial Switches (a) Co-Axial Switches

Transformer Engineers 161 E California St Pasadena 1 Calif-J P Whistler-RY 1-6906 (p) Transformers (a) Transformers

Transonic Inc 808 16 St Bakersfield Calif-R M Hanson-FA 4-0794 (p) Transformers (a) Transformers

Triad Transformer Corp 4055 Redwood Ave Venice 3 Calif-E M Kellior-TE 0-5381 (p) Transformers (a) Transformers

Tri-Dex Co P O Box 1207 Lindsay Calif-K B Howard-2-4051 (p) Etched Circuits

Triplett & Barton 831 N Lake St Burbank Calif-R E Hiller-VI 9-1291 (p) X-Ray Unit (a) X-Ray Unit

Trutone Electronic Eng'g 812 N Highland Los Angeles 38 Calif-H M Cohen-HO 4-1202 (p) Audio Equip

Tubing Seal Cap 808 W Santa Anita San Gabriel Calif-W F Gresham-AT 9-5111 (p) Metal Stampings

Tub-Lok Mfg Co 767 Loma Verde Palo Alto Calif-J Boitos-DA 5-3950 (p) Tube Clamps (a) Tube Clamps

Ultra-Violet Products 5114 Walnut Grove Ave San Gabriel Calif-I R Pfister-CU 3-3193 (p) Short Wave Lights

U M & F Mfg Corp 10929 Vanowen St N Hollywood Calif-Dick Tice-ST 7-5526 (p) Circuit Chassis Assembler

Ungar Electric Tools 4101 Redwood Venice Calif-A R Knowles-EX 8-5718 (p) Soldering Irons

United Control Corp 4540 Union Bay Pl Seattle 5 Wash-R L Hancock-PL 9200 (a) Temp Control Systems

United Geophysical Corp 1200 S Marengo Ave Pasadena 5 Calif-BW Sorge-PY 1-1134 (p) Amplifiers

*United Transformer Pac Div 4008 W Jefferson Blvd Los Angeles 16 Calif-A J Kornblum-RE 1-6313 (p) Transformers (a) Transformers

Unitek Corp 275 N Halstead Ave Pasadena 8 Calif-Dr Frank Page-SY 5-2377 (p) Welders

Universal Electronics Co 1720 22nd St Santa Monica Calif-Edward Lacey-EX 3-7707 (p) Power Supplies (a) Power Supplies

U S Eng'g Co 521 Commercial St Glendale 3 Calif-C B Thornton-CH 5-5777 (p) Etched Circuits

U S Relay Co 1744 Albion St Los Angeles 31 Calif-Paul Chamberlin-CA 2-9146 (a) Relays

Up-Right Inc 1013 Pardee St Berkeley 10 Calif-R E Fisher-TH 3-0770 (p) Towers (a) Towers

Vacuum Tube Products 506 S Cleveland St Oceanside Calif-H W Ulmer-SA 2-6567 (p) Vacuum Gauges (a) Welding Equip

Vanguard Electronics 3384 Motor Ave Los Angeles 34 Calif-S A Golbert-TE 0-7344 (p) Inductances (a) Control Components

Vapor Recovery Systems 2820 N Alameda Compton 1 Calif-Wilbur Hein-NE 6-1211 (p) Gauging Systems

Varian Associates 611 Hansen Way Palo Alto Calif-Sigurd Varian-DA 5-5631 (p) Klystrons

Vector Electronics Co 3352 San Fernando Rd Los Angeles 65 Calif-R R Scoville-CL 7-8237 (p) Plugs (a) Plugs

Viking Electric Div Viking Industries 21341 Roscoe Blvd Canoga Park Calif-H M Greene Jr-DI 7-8500 (p) Connectors (a) Connectors

Vinson Co E R 1401 Middle Harbor Rd Oakland 20 Calif-E R Vinson-GL 1-2357 (p) Photoelectric Control

Vought Co 9278 Santa Monica Blvd Beverly Hills Calif-G H Hearon-CR 6-2621 (p) Photographic Recorders

Walkirt Co 145 W Hazel St Inglewood 3 Calif-H W Beckwith-OR 8-2873 (p) Plug-In Circuits

Walsco Electronics 3602 Crenshaw Blvd Los Angeles 16 Calif-Frank Hurd-AX 3-7201 (p) Hardware

Walton Tool & Die 3210 Vanowen St Burbank Calif-John Crawford-VI 9-1914 (a) Sub-Assemblies

West Coast Electronics 5873 W Jefferson Blvd Los Angeles 16 Calif-H P Gates Jr-TE 0-7211 (p) S Band Beacon (a) S Band Beacon

Western Coil Products 2989 Middlefield Rd Palo Alto Calif-J M Kaar-DA 5-2718 (p) Coils

Western Gear Electro Products 132 W Colorado St Pasadena 1 Calif-J R David-RY 1-6604 (p) Rotary Elect Equip (p) Rotary Elect Equip

Western Gold & Platinum 589 Bryant St San Francisco 7 Calif-Walter Hack-SU 1-2065 (p) Brazing Alloys

Western Insulated Wire 2425 E 30 St Los Angeles 58 Calif-Geo Hunsinger-LU 7-7103 (p) Cords & Cables

Western Radiation Lab 1107 W 24 St Los Angeles 7 Calif-G L Locher-RI 7-8355 (p) Scintillation Counters

Westline Products Div Western Lithograph Co 600 E 2 St Los Angeles 54 Calif-Bruno DeToffol-TR 2641 (p) Wire Markers (a) Markers

Westport Electric 149 Lomita St El Segundo Calif-R E Hupp-EA 2-0726 (p) Counters

Whittaker Gyro 16217 Lindbergh St Van Nuys Calif-ST 5-2131 (p) Gyroscopes (a) Gyroscopes

Wiancko Eng'g Co 255 N Halstead Ave Pasadena 8 Calif-T H Wiancko-RY 1-5226 (p) Measuring Systems (a) Sensing Elements

Wildberg Bros 742 Market St San Francisco 2 Calif-A A Wildberg-DO 2-3505 (p) Alloys

Woodwelding Inc 3000 W Olive Ave Burbank Calif-Frank Wilburn-VI 9-1841 (p) RF Woodwelders (a) Woodwelder

Wyco Metal Products 6918 Beck Ave N Hollywood Calif-John Hoffman-ST 7-5579 (p) Cabinet Racks (a) Cabinet Racks

Zenith Aircraft Div Zenith Plastics Co 1600 W 135 St Gardena Calif-W E Braham-PL 6-8111 (a) Radomes

Zero Mfg 1121 Chestnut St Burbank Calif-A P Gambee-VI 9-5521 (p) Instrument Cases (a) Cabinets

# TELE-TECH
## & Electronic Industries

AUGUST, 1955

FRONT COVER: Radar and guided missiles are symbolic of today's great electronic activities by West Coast manufacturers. And this of course is the time of year when all eyes are focused on the Golden West. On August 24-26 it will be time for WESCON 1955! The western electronic industries continue to grow and to expand. This year we surveyed over 850 companies to develop the most complete and up-to-date Directory of West Coast manufacturers. It appears in this issue as Section Two. The Directory of West Coast Reps and Distributors is on page 122. See also pages 69, 72 and 73 for other topics of West Coast interest.

### SECTION ONE:



### DEPARTMENTS



### SECTION TWO: West Coast Electronic Industries Directory


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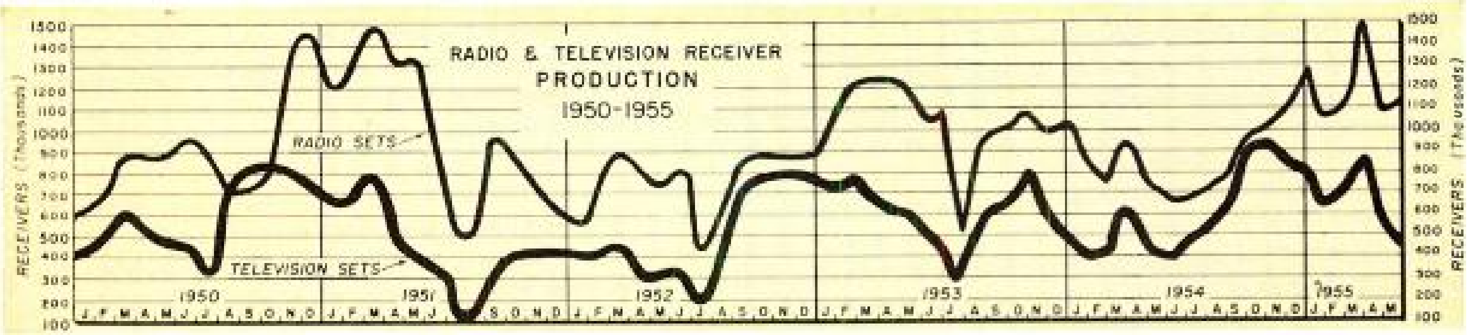
# TOTALS




## AVIATION INDUSTRY SURVEY

Here are some preliminary results from a survey now being made to all airframe manufacturers:

Number questionnaires sent out ..... 35
Number returned at presstime ....... 15

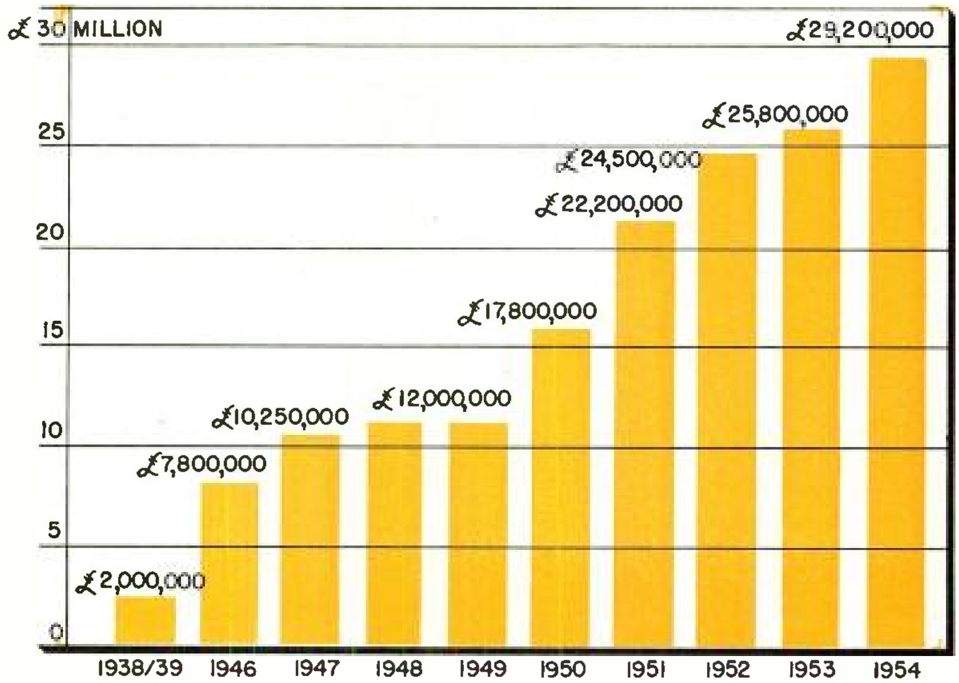
Questions & Answers:

1. We (are) (are not) a prime weapon system contractor . . . 9 are . . . 6 are not
2. We (do) (do not) manufacture electronic equipment/components for our own aircraft . . . 4 manufacture both; 5 manufacture equipment only; 6 do not manufacture either
3. We (do) (do not) manufacture electronic equipment/components for aircraft other than our own manufacture . . . 2 manufacture both; 2 manufacture equipment only; 11 do not
4. We (do) (do not) manufacture electronic equipment/components for non-aircraft applications . . . 3 manufacture both; 2 manufacture equipment only; 9 do not; 1 no reply

Total number of electronic engineers employed from all cos. . . . . . . . . . 2245

## Post WW II British Radio Exports

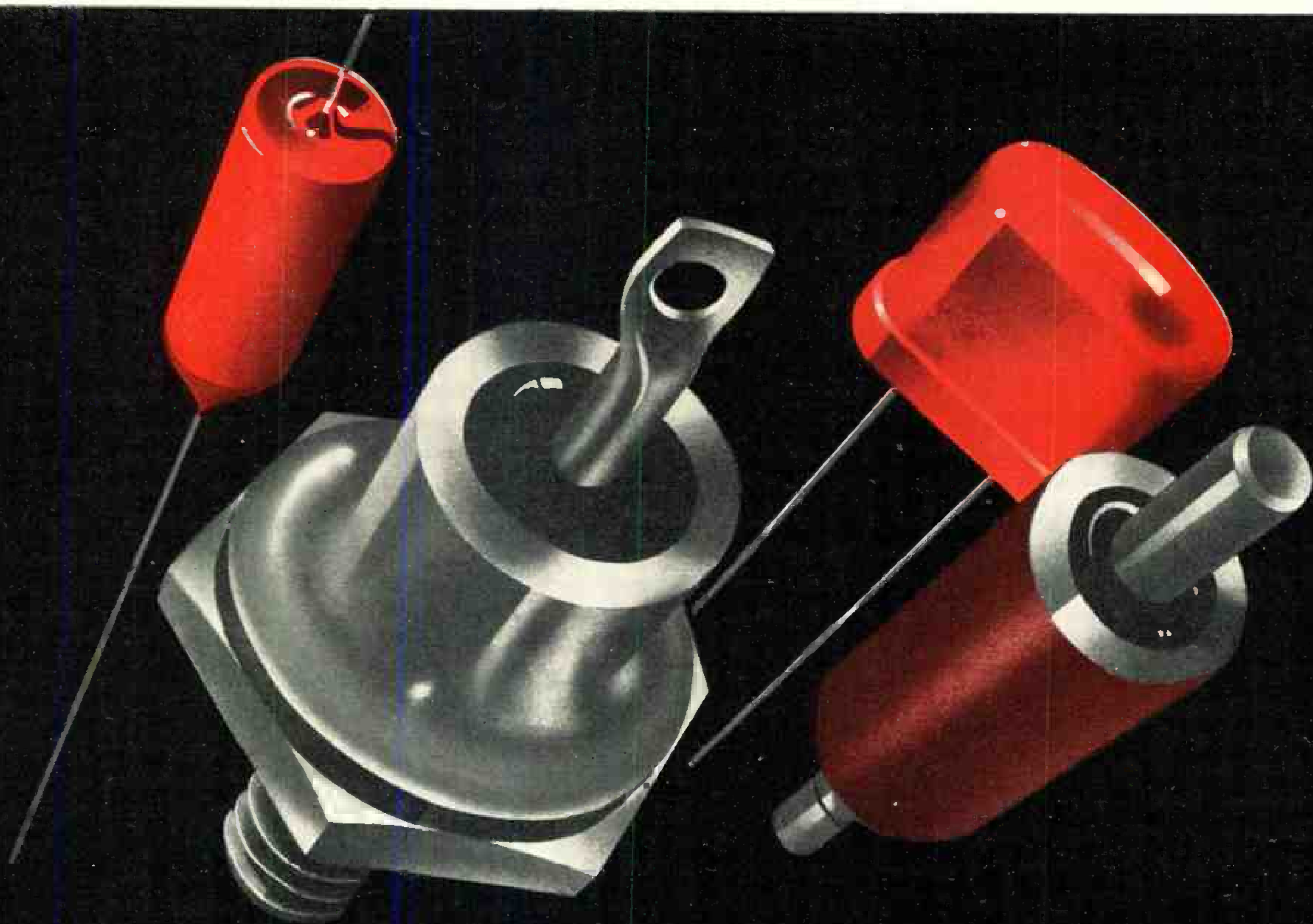
As provided through the Radio Industry Council, London, England

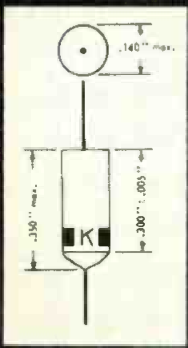



## GOVERNMENT ELECTRONIC CONTRACT AWARDS

**This list classifies and gives the value of electronic equipment selected from contracts awarded by government procurement agencies in June 1955.**

| | |
|---|---|
| Actuators, etc. | 55,443 |
| Adapters | 180,000 |
| Amplifier, indicator, etc. | 119,000 |
| Amplifiers | 85,377 |
| Analyzers, digital | 29,995 |
| Antennas | 93,134 |
| Antenna Assys, etc. | 1,982,583 |
| Antenna Filter Assys | 84,481 |
| Batteries, dry | 2,399,030 |
| Battery Chargers | 566,655 |
| Brushes, Rotors, Shunts, generator | 420,411 |
| Cable | 225,623 |
| Cable Fittings, etc. | 250,000 |
| Coil Assys | 98,920 |
| Coils | 28,200 |
| Components | 4,117,511 |
| Components, interphone system | 880,595 |
| Components, radio altimeter | 39,814 |
| Controls, radio set | 45,105 |
| Control Systems, rocket combustion chamber | 43,186 |
| Covers, battery | 35,808 |
| Coupler, directional | 80,304 |
| Crystal Unit | 45,991 |
| Deceptive Jammers | 116,265 |
| Digital Reduction Systems | 33,784 |
| Direction Finder Sets | 154,894 |
| Dynamometers, etc. | 37,094 |
| Enclosure, electromatically shielded | 199,792 |
| Exciter Systems | 212,153 |
| Frequency Converters | 61,582 |
| Generators | 3,414,761 |
| Generators, acft. | 192,607 |
| Generator Assys | 29,520 |
| Generators, signal | 906,750 |
| Generators, signal and oscilloscope, CRT. | 32,068 |
| Generators, tachometer | 28,594 |
| Generators, training | 64,245 |
| Gunfire Control Systems | 3,693,887 |
| Handset-Headset | 48,875 |
| Headset, microphone | 319,780 |
| Indicators | 1,561,268 |
| Indicators, control | 80,057 |
| Indicators, Spare Parts, etc. | 281,502 |
| Indicators, temperature | 192,429 |
| Indicators, tachometer | 141,585 |
| Inverters | 69,888 |
| Kit, microphone, dynamic | 117,309 |
| Loop Assys, Indicators, etc. | 1,176,175 |
| Loudspeakers | 40,673 |
| Magnetos, telephone | 51,376 |
| Magnetrons | 51,750 |
| Meters, of power | 75,650 |
| Meters, frequency | 201,433 |
| Modifications, computer | 34,405 |
| Modifications, twin mount | 288,134 |
| Motor Generators | 91,872 |
| Motors | 44,100 |
| Multiplexers | 564,725 |
| Oscillators | 542,217 |
| Oscillators, test | 150,204 |
| Panels, Controls, etc. | 65,491 |
| Power Meter, frequency | 150,726 |
| Power Supplies | 757,678 |
| Power Supplies, dynamotor | 32,787 |
| Processing Equipment, pulse data | 60,000 |
| "Q" Meters | 27,198 |
| Radar Sets | 15,386,745 |
| Radar, Signal Simulators, etc. | 302,510 |
| Radio Equipment | 94,475 |
| Radio Sets | 1,774,328 |
| Radiosondes | 1,183,716 |
| Radomes, arctic | 64,400 |
| Receivers, radio | 911,433 |
| Receiver-Transmitters | 646,759 |
| Receiving Sets, radio | 230,643 |
| Recorder-Reproducers | 412,427 |
| Regulators and Generators | 452,792 |
| Relays | 142,752 |
| Repair Parts, gyro compass | 27,120 |
| Repair Parts, indicating equipment | 26,526 |
| Repair Parts, turbine generators | 38,050 |
| Resolver Equipment, infrared | 71,560 |
| Servos | 38,674 |
| Sets, sound measuring | 45,105 |
| Shield Assys | 82,527 |
| Soldering Equipment, induction | 31,808 |
| Sonobuoy Dispensers | 2,043,632 |
| Spare Parts, etc., radar set | 1,775,725 |
| Stroboscopes | 35,937 |
| Switches | 34,413 |
| Switches, tilt | 39,652 |
| Switchboards, telephone | 44,115 |
| Switch-Presses | 104,264 |
| Tapes, "Univac" | 32,125 |
| Teletypewriter Sets | 88,968 |
| Testers | 94,690 |
| Testers, auto pilot | 40,897 |
| Testers, gun, bomb, rocket | 102,598 |
| Testers, flight direction system | 203,733 |
| Test Sets | 412,580 |
| Training Equipment, electronic | 191,913 |
| Transformers | 116,980 |
| Transmitters | 410,281 |
| Transmitters, fuel flow | 473,970 |
| Transmitters, pressure | 52,032 |
| Transmitters, radio | 30,105 |
| Transmitters, radiosonde | 29,582 |
| Transmitting Sets | 7,164,735 |
| Tubes, electron | 895,458 |
| Vibrators | 485,824 |
| Wire, electric | 141,197 |
| X-Ray Apparatus | 34,800 |



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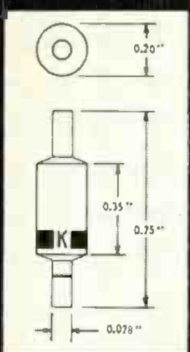


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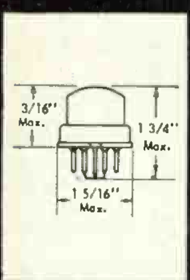


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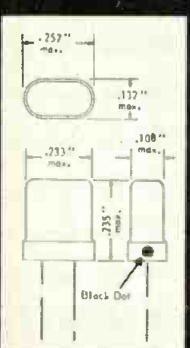


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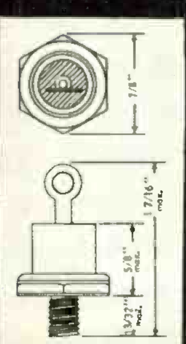


E

# RAYTHEON POINT CONTACT GERMANIUM DIODES

These diodes combine good transient response, low capacity and high frequency capabilities with low cost and dependability. Ambient temperature range −50 to +100°C.

| Type | Dimension Outline | Peak Inverse Volts | Average Rectified mA (max.) | Peak Rectified mA (max.) | Maximum Inverse Currents in μA at −5v | at −10v | at −50v | at −100v | Forward mA at +1v |
|---|---|---|---|---|---|---|---|---|---|
| **General Purpose** | | | | | | | | | |
| 1N66 (CK705) | A | 60 | 50 | 150 | | 50 | 800 | | 5. |
| 1N67 | A | 80 | 35 | 100 | 5 | | 50 | | 4. |
| 1N68 (CK708) | A | 100 | 35 | 100 | | | | 625 | 3. |
| 1N294 (CK705A) | A | 60 | 50 | 150 | | 10 | 800 | | 5. |
| 1N297 (CK707) | A | 80 | 35 | 100 | 10 | | 100 | | 3.5 |
| 1N298 (CK713A) | A | 70 | 50 | 150 | | 250μA (max.) at −40v. | | (50°C) | 30mA (min.) at +2v. |
| CK801 | A | 60 | 50 | 150 | | | 50 | | 5. |
| CK802 | A | 80 | 50 | 150 | | | 100 | | 7.5 |
| **VHF and UHF** | | | | | | | | | |
| 1N82A | B | 5 | 50 | 150 | UHF mixer | 14 db max. noise — see data sheet for test circuit | | | |
| 1N295 (CK706A) | A | 40 | 35 | 125 | | 200 | Video detector | | |
| CK715 | A | 40 | 35 | 125 | | Special tests for VHF to UHF freq. multiplier | | | |
| **Multiple Assemblies** | | | | | | | | | |
| CK709 | C | Four 1N66 matched within 2.5% at +1.5 and −10 volts for bridge circuits | | | | | | | |
| CK711 | C | Four 1N67 matched from 0 to +3 volts. 30μa (max.) at −50v. for bridge circuits | | | | | | | |
| CK717 | C | Four 1N66 matched within 2.5% at +1.5 and −10 volts for common anode circuits | | | | | | | |
| CK719 | C | Four 1N67 matched from 0 to +3 volts. 30μa (max.) at −500 | | | | | | | |

# RAYTHEON GOLD BONDED GERMANIUM DIODES

This group of diodes features small size, high forward conduction, high back resistance, and good temperature characteristics. Because junction area is increased over that of point contact types, capacity is slightly higher, transient response slightly slower.

| Type | Dimension Outline | Peak Inverse Volts (max.) | Average Rectified mA (max.) | Peak Rectified mA (max.) | Maximum Inverse Currents in μA at −10v | at −20v | at −50v | at −100v | Forward mA at 0.8v | at 1.0v | Ambient Temperature Range °C |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1N305 (CK739) | D | 60 | 125 | 300 | 2.0 | | 20 | | 100 | | −55 to +70 |
| 1N306 (CK740) | D | 15 | 150 | 300 | 2.0 | | | | 100 | | −55 to +70 |
| 1N307 (CK742) | D | 125 | 50 | 300 | 5.0 | | | 20 | | 100 | −55 to +70 |
| 1N308 (CK741) | A | 10 | 100 | 350 | | 500μA at −8 volts | | | | 300 | −55 to +90 |
| 1N309 (CK747) | A | 40 | 100 | 300 | | 100 | | | | 100 | −55 to +90 |
| 1N310 (CK745) | A | 125 | 40 | 100 | | 20 | | 100 | | 15 | −55 to +90 |
| 1N312 (CK748) | A | 60 | 70 | 250 | | | 50 | | | 30 | −55 to +90 |
| 1N313 (CK749) | A | 125 | 40 | 100 | | 10 | | 50 | | 15 | −55 to +90 |

Note: 1N305-6-7 have very high back to forward ratio, high back resistance, sharp Zener characteristic, average transient response
1N308-13 have good transient response with good forward characteristics, high back resistance

# RAYTHEON BONDED SILICON DIODES

Raytheon Bonded Silicon diodes provide high back resistance, a sharp Zener characteristic and fair transient response (large overshoot, fast recovery) over an ambient temperature range of −55 to +150°C.

| Type | Dimension Outline | Peak Inverse Volts | Average Rectified mA | Peak Rectified mA | Maximum Reverse Currents in μA at −5v | at −10V | at Volts shown | Forward mA at −1v | 100°C Average Rectified mA | Max. Reverse mA at −10v |
|---|---|---|---|---|---|---|---|---|---|---|
| 1N300 (CK735) | D | 15 | 40 | 120 | | 0.001 | | 8 | 15 | 0.01 |
| 1N301 (CK736) | D | 70 | 35 | 110 | | 0.01 | 0.05 at −50 | 5 | 12 | 0.2 |
| 1N302 (CK737) | D | 225 | 25 | 80 | | 0.01 | 0.2 at −200 | 1 | 8 | 0.2 |
| 1N303 (CK738) | D | 125 | 30 | 100 | | 0.01 | 0.1 at −100 | 3 | 10 | 0.2 |
| 1N432 (CK856) | D | 40 | 40 | 120 | | 0.005 | | 10 | 20 | 0.05 |
| 1N433 (CK860) | D | 145 | 30 | 100 | | 0.03 | 0.3 at −125 | 3 | 15 | 0.5 |
| 1N434 (CK861) | D | 180 | 30 | 100 | | 0.05 | 0.5 at −160 | 2 | 15 | 1.0 |
| 1N438 (CK852*) | D | 7 | 100 | 200 | 10 | | | 50 | 50 | |

*8 volt Zener regulator

Note: All ratings at 25°C unless otherwise indicated.

# RAYTHEON SILICON POWER RECTIFIERS

This new Raytheon silicon rectifier is the first to give high current rectifying capacity in extremely small volume. The rectifiers operate to 175°C, to 200 volts peak and to over 99% efficiency. Back to forward resistance ratio is over 100,000.

| Type | Dimension Outline | | Maximum Voltage RMS Volts | Peak Volts | Maximum Current Peak Amperes | Average Amperes | Typical Dissipation Watts |
|---|---|---|---|---|---|---|---|
| CK775 | E | Case Temp. 30°C* | 40 | 60 | 50 | 15 | 40 |
| | | Case Temp. 170°C* | 40 | 60 | 15 | 5 | 10 |
| | | No Heat Radiator | | | | | |
| | | Ambient Temp. 25°C | 40 | 60 | 6 | 2.0 | 3.0 |
| | | Ambient Temp. 170°C | 40 | 60 | 2.0 | 0.5 | 0.5 |
| CK776 | E | Case Temp. 30°C* | 125 | 200 | 50 | 15 | 40 |
| | | Case Temp. 170°C* | 125 | 200 | 15 | 5 | 10 |
| | | No Heat Radiator | | | | | |
| | | Ambient Temp. 25°C | 125 | 200 | 6 | 2.0 | 3.0 |
| | | Ambient Temp. 170°C | 125 | 200 | 2.0 | 0.5 | 0.5 |

**ADDITIONAL RATINGS (25°C)**
Both CK775 and CK776 have maximum drop at 5 amperes of 1.5 volts
CK775 has maximum reverse current at −60 volts of 25 mA
CK776 has maximum reverse current at −200 volts of 25 mA

*maintained by external heat radiator

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**CIRCULATION NOW 27,000**

An increase of 5,000, effective with the January 1955 issue, provides greater penetration of plants, stations and laboratories in the primary markets of the industry—Manufacturing, Broadcasting and Armed Forces procurement.

These are the markets with greatest buying power and greatest expansion, industrially and geographically.

The circulation of TELE-TECH is increasing in two ways:

1—Growth of TELE-TECH's Unit Coverage of top-ranking engineers—the magazine's basic readership, presented for complimentary subscriptions.

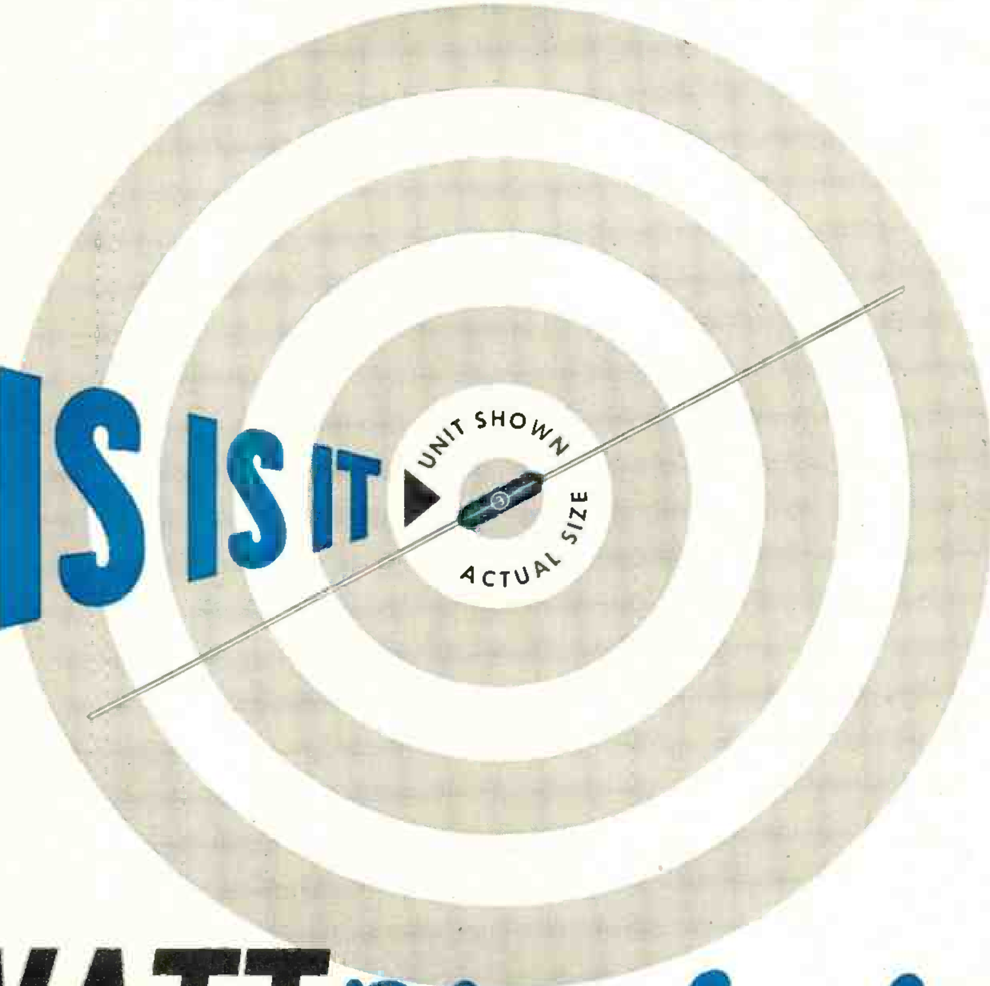
2—Making paid subscriptions available to other engineers in research, design, production, operation and maintenance.

Although currently effective, the increased circulation cannot appear in audit statements until the first half of 1955 is audited.

**THE ELECTRONIC INDUSTRIES DIRECTORY**

**Published annually as an integral section of TELE-TECH in June**

# THIS IS IT




# NEW 3-WATT Blue Jacket®

## miniaturized axial-lead wire wound resistor

This power-type wire wound axial-lead Blue Jacket is hardly larger than a match head *but it performs like a giant!* It's a rugged vitreous-enamel coated job—and like the entire Blue Jacket family, it is built to withstand severest humidity performance requirements.

Blue Jackets are ideal for dip-soldered sub-assemblies . . . for point-to-point wiring . . . for terminal board mounting and processed wiring boards. They're low in cost, eliminate extra hardware, save time and labor in mounting!

Axial-lead Blue Jackets in 3, 5 and 10 watt ratings are available without delay in any quantity you require. ★ ★ ★

| SPRAGUE TYPE NO. | WATTAGE RATING | DIMENSIONS L (inches) | D | MAXIMUM RESISTANCE |
|---|---|---|---|---|
| 151E | 3 | 1 7/32 | 13/64 | 10,000 Ω |
| 27E | 5 | 1 1/8 | 5/16 | 30,000 Ω |
| 28E | 10 | 1 7/8 | 5/16 | 50,000 Ω |

Standard Resistance Tolerance: ±5%

# SPRAGUE


WRITE FOR ENGINEERING BULLETIN NO. 111B

**SPRAGUE ELECTRIC COMPANY • 233 MARSHALL ST. • NORTH ADAMS, MASS.**

# As We Go To Press...

## Ariz. Electronic Industry Hit by Tax Ruling

In a decision immediately greeted as a blow to development of Arizona's budding electronics industry, the Arizona Tax Commission upheld (June 28) a state sales tax assessment against AiResearch Manufacturing Co., producer of electronics devices, on the contention that sales to the federal government are taxable.

Stanley Womer, manager of the Arizona State Development Board, predicted there would be a "tendency for electronics firms, planning to move here, to remain where they are until the law is changed." The assessment of 2% sales tax on sales to the federal government will put Arizona firms on a "competitive disadvantage" with companies from other states.

The state agency's assessment was based on a 1954 state law which omitted a previous exemption on sales to the federal government. The firm must now pay about $14,000 for the sales period starting July 9, 1954, when the new law went into effect until Dec. 31, 1954. Amount of sales taxes AiResearch must pay this year have not yet been determined. Some 200 machine shops in the Phoenix area have been supplying the firm with tax-free parts, and the company presumably will have to absorb the taxes.

## Automatic Transistor Factory At Westinghouse

A new Westinghouse Electric Corporation manufacturing plant, described as "the most highly automatic of any of the company's plants," will be built at Youngwood, Pa. and will employ between 400 and 500 persons by the end of 1956. Bruce D. Henderson, Westinghouse vice president, said the multi-million dollar plant is expected to be completed by late 1955. It will be devoted to the manufacture of semi-conductor devices such as transistors, power rectifiers, high frequency detectors, and photocells.

Manager of the new semi-conductor department and plant will be L. R. Hill. Other key appointments announced include: Dr. S. J. Angello, manager of engineering; Dr. L. L. Friend, manager of manufacturing; W. L. James, manager of sales; and C. H. Hildebrand, purchasing agent.

## Britain's Commercial TV Opens Next Month

On Sept. 22 the first independent commercial television station in Britain will start transmitting its programs. At Beaulieu (pronounced Bewley) Heights, Croydon, a suburb of London, the new station will serve an area in which about 10 million people live. By March, 1956, two other commercial stations will open, in the Midlands and Lancashire. These three commercial stations will bring almost 60% of the total population of the United Kingdom within reach.

## Bendix Expands

Construction of a new $2,000,000 engineering building at Towson, Md., devoted to expanded research and development on commercial and military radar and other communications and navigation devices, has been announced by the radio division of Bendix Aviation Corporation. The ultra-modern structure is designed to accommodate 500.

## GE Pushes Broadcast Sales

An all-out sales push in the highly competitive television-broadcasting-equipment industry is promised by the General Electric Co. with disclosure of the reorganization of its national sales force. The reorganization involves creation of three new positions, northeast, southern and western regional sales managers, appointment of men to fill two of these positions, and naming of three new district sales managers. Territorial sales assignments have also been changed to increase sales effectiveness.

The new appointments are John Wall of Cincinatti as northeast regional manager; Charles T. Haist of San Francisco as western regional manager; Lewis F. Page of Washington, D. C. as district manager in the Virginia-Maryland area; Earl H. Platt of Syracuse, New York, as district manager in the Kentucky-West Virginia area; and Vernon H. Russell of Seattle, Washington, as district manager for the northwestern states.

## GE Producing Image Orthicons

Factory production of image orthicons is now under way at GE's Schenectady tube plant. Here operator is shown adjusting target and mesh section in tube using 17-in. screwdriver. Previously RCA was sole producer.

# As We Go To Press . . . (Continued)

## Thompson $ $ $ for Ramo-Wooldridge

The Ramo-Wooldridge Corporation, 8820 Bellanca Avenue, Los Angeles 45, California, electronic and guided missile affiliate of Thompson Products, Inc. announces a $20 million financial arrangement between the two companies. Through preferred stock and long term revolving credit, made available by Thompson Products this money will finance the continued rapid expansion of the Los Angeles firm, which in less than two years has grown to an employment level of nearly 1000.

With 150,000 sq. ft. of completed laboratory space in Los Angeles, two new buildings under construction, and plans already drawn for a manufacturing plant in the midwest, Ramo-Wooldridge appears destined to move rapidly into such commercial and military fields as automation, electronic computers, guided missiles, transistors and semi-conductors, weapons control systems, and advanced communications. While majority ownership and control of Ramo-Wooldridge remains in the hands of its key employees, terms of the new agreement provided Thompson Products with option rights which in the future could increase the Thompson interest in Ramo-Wooldridge to 84%.

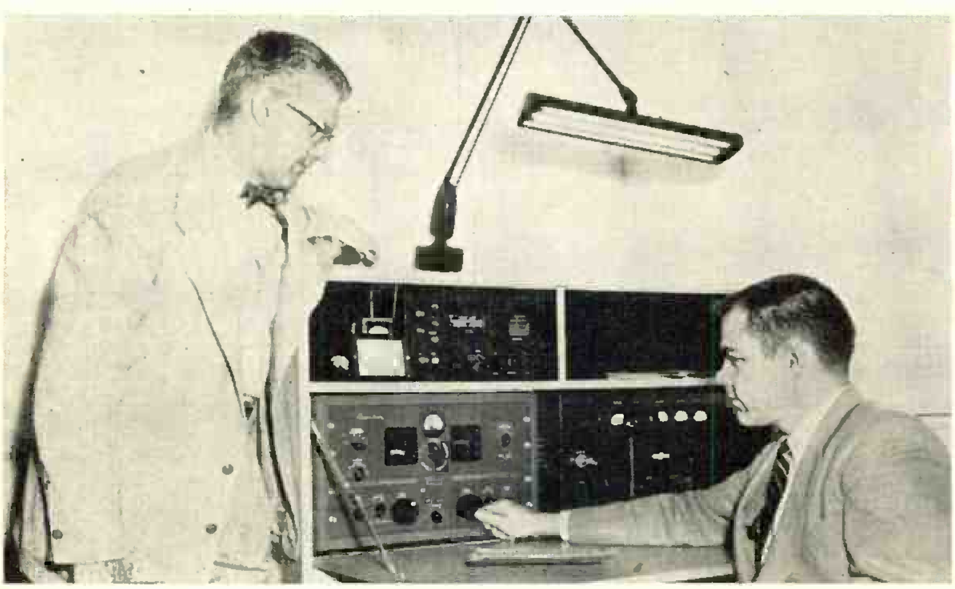
## High Accuracy Tube-Tester

A tube-testing instrument reportedly with versatility and accuracy approaching that of factory tube testing equipment, has been introduced by the RCA Tube Division.

Intended primarily for production-line and laboratory tube testing of receiving and small industrial and transmitting tubes, the WT-100A MicroMhoMeter makes it possible for the user to test tubes under actual operating voltage and current conditions. This feature permits a direct correlation of test results with data supplied by tube manufacturers. In addition, the WT-100A can be set up to provide the operating voltages of a circuit of specific design to determine quickly and accurately the performance of a tube under desired voltage conditions.

The new instrument measures transconductance with an accuracy of better than 5%. Measurements can be made up to 100,000 micromhos in 6 ranges. In addition, the WT-100A permits the measurement of ac heater currents including 600-ma series-string tubes at rated voltages. The meter, which is protected electronically from burnout, measures electrode currents up to 300 ma in 11 ranges, including an ultra-sensitive range of 0 to 3μ amp, and voltages up to 300 volts in 15 ranges.

## Western Gear Personnel Form Electronic Club



The Western Gear Electronic Club has been formed to provide amateur liaison in emergency civil defense programs as well as participation in normal "ham" activities. The club will also tie in with appropriate Army and Navy amateur activities. Jennings David, chief engineer of Western Gear's Electro Products Div., has been named president. Glenn W. Malme is at left.

## New Color-TV Dolly

Under the guidance of Chief Engineer Lindsey Riddle, (left), WDSU-TV, New Orleans outlet is now broadcasting with complete color TV facilities. John Newton, (right) representing Studio Television Products Sales Corp. of New York, inspects the new pneumatic color-dolly manufactured by his firm, used in conjunction with one of the studio cameras. The new unit reportedly has held programming costs down significantly. One man can achieve the effects of a two-man dolly shot and simulate the "boom" action of a camera crane. A 33-in. wheelbase and wider steering guide, plus an electric column brake for pre-selected or free-wheeling elevation adjustment, combined with the inherent advantage of pneumatic-balance, make the dolly versatile.

## Cabinet TV Antenna

A lesson learned in the development of radar has been applied profitably in television set design. Faced with the old problem of overcoming the shielding action of metal television cabinets on built-in antennae, GE engineers have come up with the simplest type of solution. Not only have they overcome the original problem, but the solution offers superior built-in antenna performance.

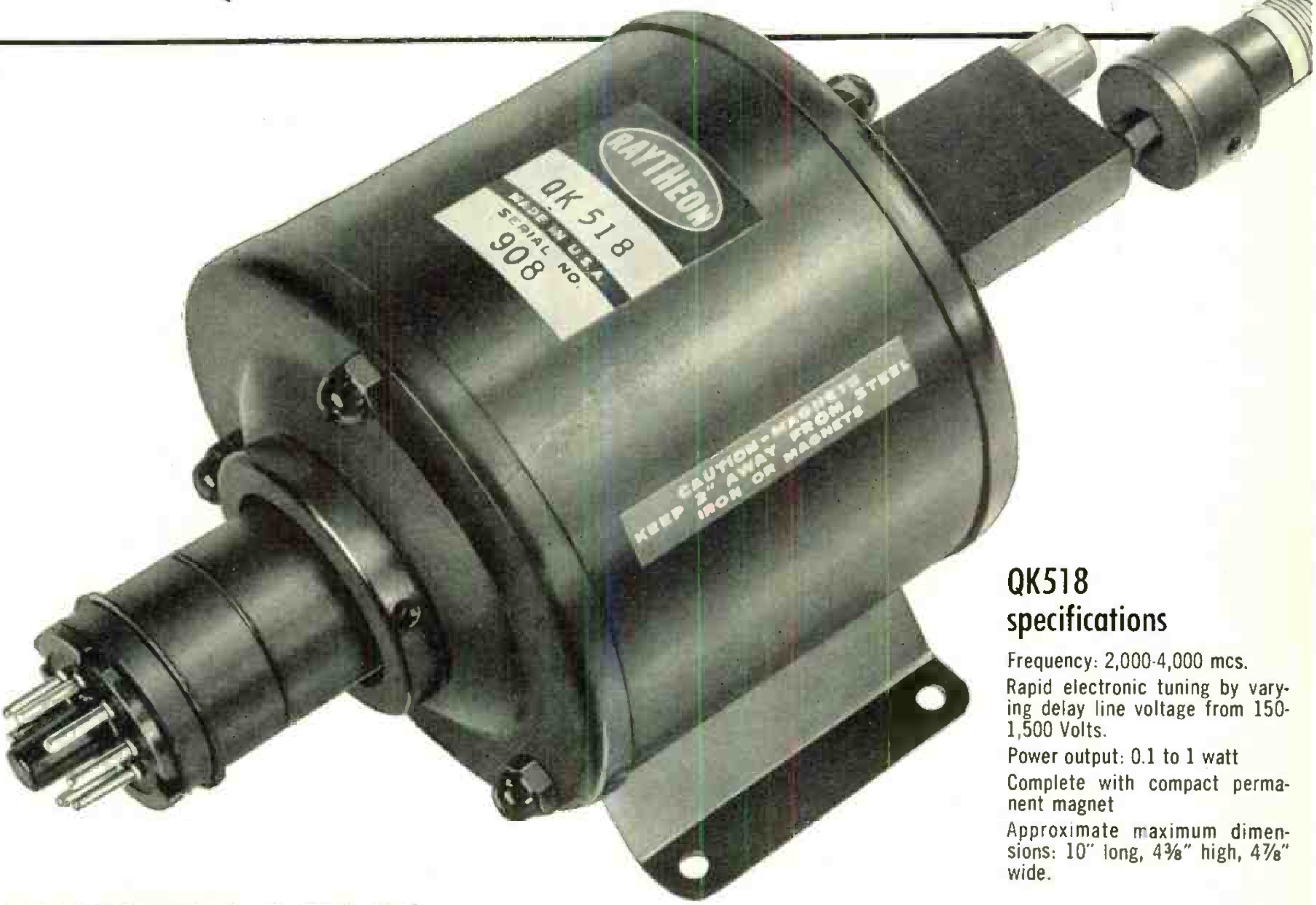
Rather than installing the familiar loop antenna in their metal cabinet TV sets in such a way as to minimize the shielding action of the cabinet, they have made the entire cabinet an integral part of the antenna system. Thus, the table and console models in metal cabinets, just announced, have a much larger antenna area than had ever been thought possible. Radiation from the set, engineers say, presents no unusual problem. The final solution was suggested by the cavity resonators used in radar equipment.

MORE NEWS on page 12

*Raytheon — World's Largest Manufacturer of Magnetrons and Klystrons*

VOLTAGE TUNABLE

1,000 mc. ⟵ ⟶ 16,000 mc.




### QK518 specifications

Frequency: 2,000-4,000 mcs.

Rapid electronic tuning by varying delay line voltage from 150-1,500 Volts.

Power output: 0.1 to 1 watt

Complete with compact permanent magnet

Approximate maximum dimensions: 10" long, 4⅜" high, 4⅞" wide.

# NEW Raytheon Backward Wave Oscillator Series

## for wide, rapid electronic tuning—1,000 mc. to 16,000 mc.

The tubes in this revolutionary new line of Raytheon Backward Wave Oscillators give you four outstanding performance advantages:

1. Electronically tunable over an *extremely* wide range of frequencies
2. Frequency insensitive to load variations
3. High signal-to-noise ratio
4. Can be operated under conditions of amplitude or pulse modulation

These new tubes are finding fast-growing applications in microwave equipment, including radar and signal generators.

Write today for free Data Booklet on the QK518 (above) which is available for delivery. We'll also be happy to answer any questions you may have on this new line.

RAYTHEON

**RAYTHEON MANUFACTURING COMPANY**

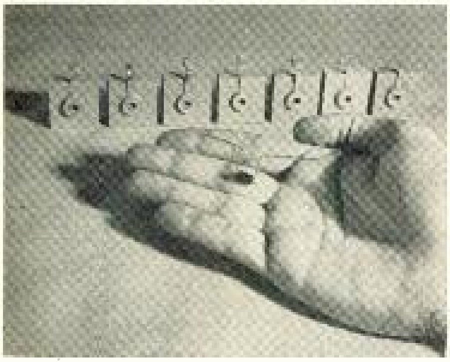
Microwave and Power Tube Operations, Section PL-38, Waltham 54, Mass.

*Excellence in Electronics*

Raytheon Makes: Magnetrons and Klystrons, Backward Wave Oscillators, Traveling Wave Tubes, Storage Tubes, Power Tubes, Receiving Tubes, Transistors

# As We Go To Press . . . (Continued)

## Power Plus



New silicon power rectifier in foreground developed at Bell Telephone Labs does same job as seven selenium units shown in rear

## Electronic Golf Ball

Latest in the way of inventions to ease the burdens of modern man is a non-loseable "golf ball" used by Dan Noble, vice-pres. of the Communications and Electronics Div. of Motorola, Inc., to demonstrate the possibilities of transistors.

Mr. Noble had his engineers produce a complete broadcasting set using one of the standard transistors manufactured by Motorola. The set was designed to fit inside a plastic "golf ball" just about the size of a regulation ball.

Bouncing the ball on the floor demonstrates the shock resistance of transistors. The size feature is obvious, for a single tube used in a standard transmitter is larger than the golf ball, transmitter and all.

Despite its size, this unit transmits a sufficiently strong radio frequency signal to be picked up by a portable, pocket-size receiver. By merely rotating the receiver as a direction finder, the location of the lost "electronic golf ball" can easily be determined.

## New Ocean Cable

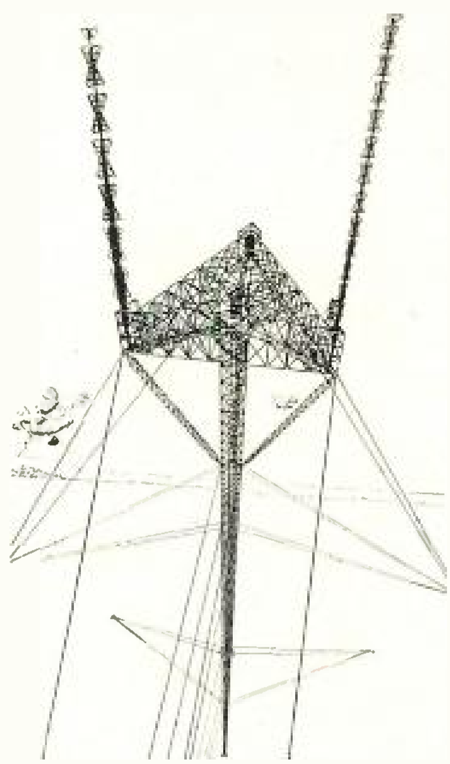
HMTS Monarch has left Clarenville, Newfoundland, laying the world's first transoceanic repeater telephone cable at the rate of about six nautical miles an hour following the Great Circle course eastward over a 2,000 nautical mile route to Oban, Scotland. The telephone cable system, scheduled for service late in 1956, is a joint undertaking of American Telephone and Telegraph Company, the British Post Office and the Canadian Overseas Telecommunication Corporation.

J. S. Jack, Scarsdale, N. Y., A. T. & T. engineer-in-charge said the Monarch would pay out cable to the edge of the Continental Shelf, a distance of about 200 miles and buoy the end. "After we buoy the end, we will proceed to Erith, England, and load 1,200 miles of deep-sea cable." With the additional cable picked up at Erith, the vessel will return to the buoyed end about August 11 and lay the second segment, spanning the Atlantic to a point about 500 miles off Scotland. More cable will then be picked up in England and the Gap to Scotland closed by late September or early October.

Next summer the laying operation will be repeated in reverse, from Scotland to Newfoundland, to provide the second cable needed for the first physical voice link between this continent and Europe. Transatlantic telephone service is now provided by radio circuits.

When the cable system is in operation, about 4,000 volts, or approximately two volts a mile, will be needed to make voice transmission over the sprawling system possible. Half of this power will be generated in Clarenville and half at Oban, the eastern terminus.

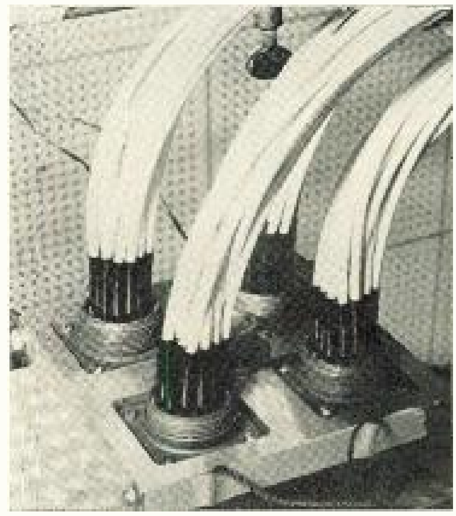
## New TV Tower



Here is an artist's conception of a helicopter view of the 1521 foot tall TV antenna tower now under construction for stations WFAA-TV and KRLD-TV at Dallas, Texas. When completed in August, the structure will be taller than the Empire State. It was designed and fabricated by the Dresser-Ideco Company of Columbus, Ohio, one of the Dresser Industries.

## Aircraft Firms Test Solderless Connectors

A series of tests was recently conducted over a two week period at the Aircraft Marine Products plant in Harrisburg, Pa. to provide the nation's five major airframe manufacturers with information on how to determine the applications of connector devices equipped for taper pin solderless connectors.



Connectors undergoing vibration test

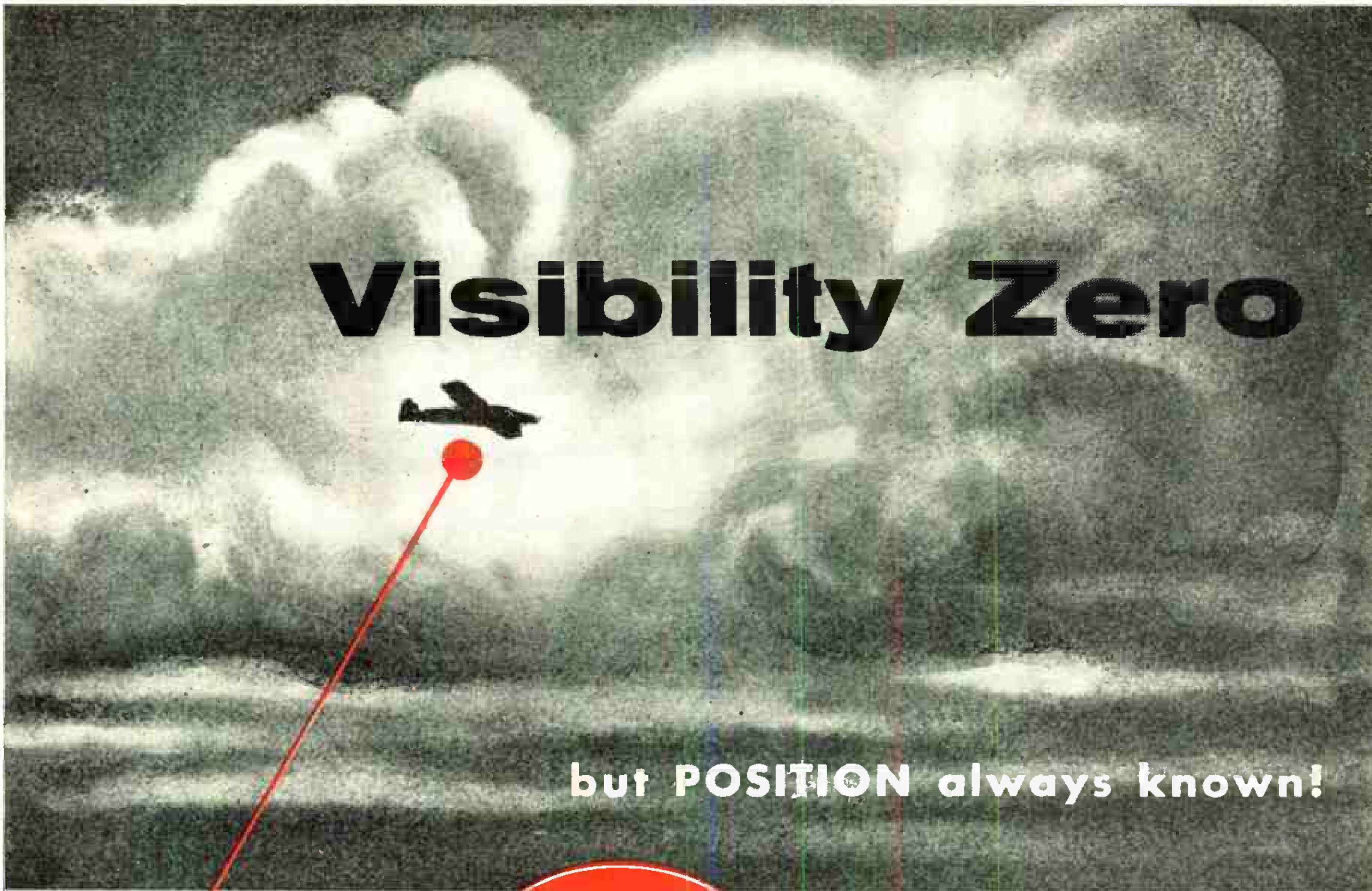
The use of taper pins with A-N connectors does away with soldering and the attendant problems of wires breaking at the solder pots and the limitations of ambient temperature.

Automatic machinery demonstrated by A-M P crimps pins to wire at rates of up to 4,000 per hr. The final joint, made when the pin is seated in its receptacle in the connector, is claimed to be equal to or better than soldered connections.

The taper pins, which have already received military approval for use in guided missiles, are now being considered for more widespread applications.

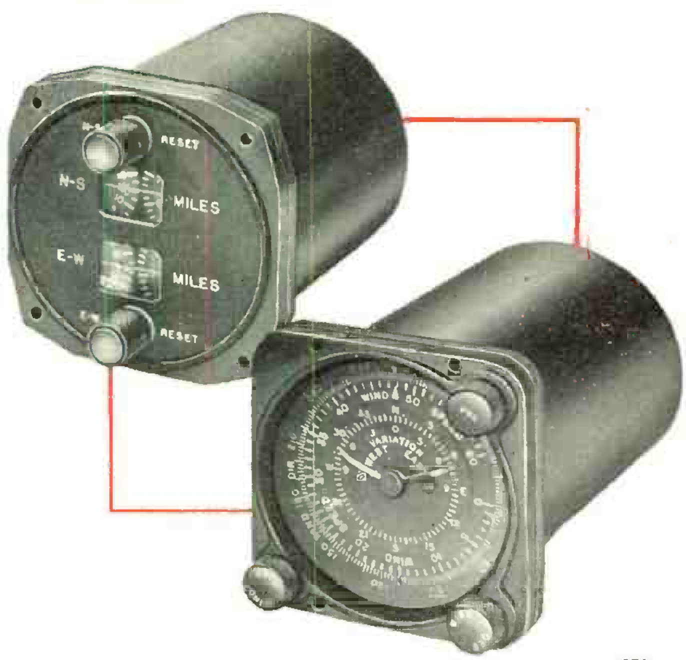
## Computer Automates At Allstate Insurance

Allstate Insurance Co. has announced installation of a "Datatron" digital computer at its Skokie, Ill. home office to simplify the paperwork involved in automobile, personal liability and fire insurance operations for over 3,000,000 policyholders. Manufactured by ElectroData Corp. of Pasadena, Calif. the quarter-million dollar data processing machine has been operating at Allstate for four months.




Thanks to the NEW **LORAL** *AUTOMATIC* SHORT-RANGE

# GROUND POSITION INDICATOR




### *ACCURATE!*
### *INSTANTANEOUS!*

Developed Specifically for LIGHT AIRCRAFT and HELICOPTERS.

A new dead reckoning navigational computer — AUTOMATICALLY indicating ground position — derived from airspeed, heading and wind.

**TOTAL SYSTEM WEIGHT — 18 LBS.**

**LORAL**—*Serving in AVIONICS*

- AIRBORNE NAVIGATIONAL EQUIPMENT
- COMMUNICATION SYSTEMS
- RADAR EQUIPMENT
- TEST EQUIPMENT

TT8

## LORAL ELECTRONICS CORPORATION

794 EAST 140th STREET • NEW YORK 54, N. Y.

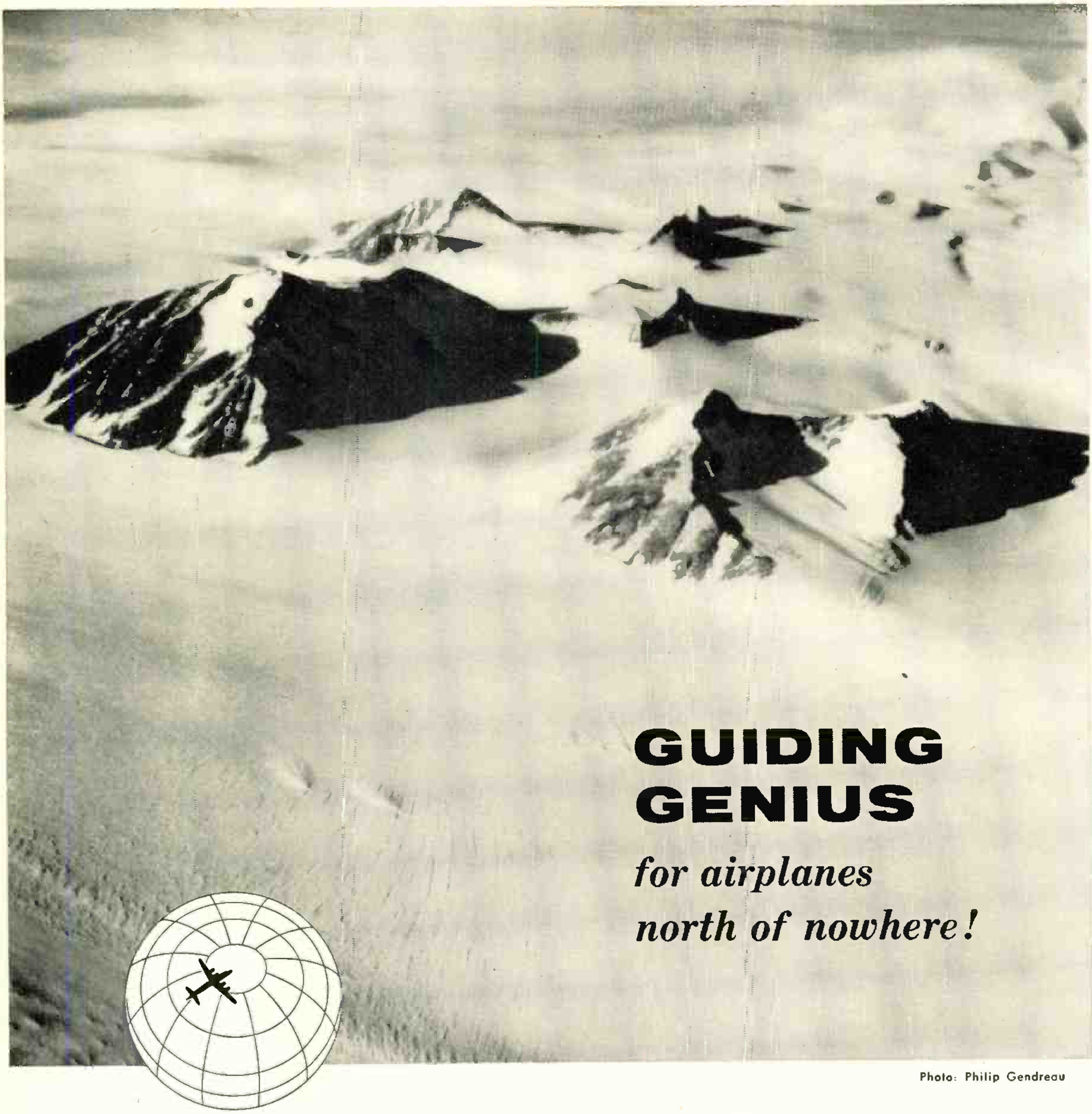



Photo: Philip Gendreau

In all the geography of the skies, no long-range aircraft need ever again lose its way . . . even if earth and stars zero out, and the radio beam has said good-bye . . . even if the plane flies hundreds of miles off course to evade sudden storm or interception.

A new navigation device, with a cybernetic brain and a "take-it-or-leave-it" attitude to the magnetic pole, tells crew members exactly where in the world they are at any instant of the flight.

Developed by General Precision Laboratory in cooperation with the Air Force, this complex electronic-mechanical device keeps a minute by minute diary of the plane's speed — in cruising, descent or climb . . . records faithfully every shift in course direction . . . notes each change in wind velocity . . . and then displays aircraft position continuously from instantaneous calculations.

To the nation, this GPL development means even stronger air defenses, aided by a guiding genius that reads global skies like an open book.

To engineers and the aviation industry, it indicates the leadership of GPL in research and advanced instrumentation.

Engineers: Write for employment information

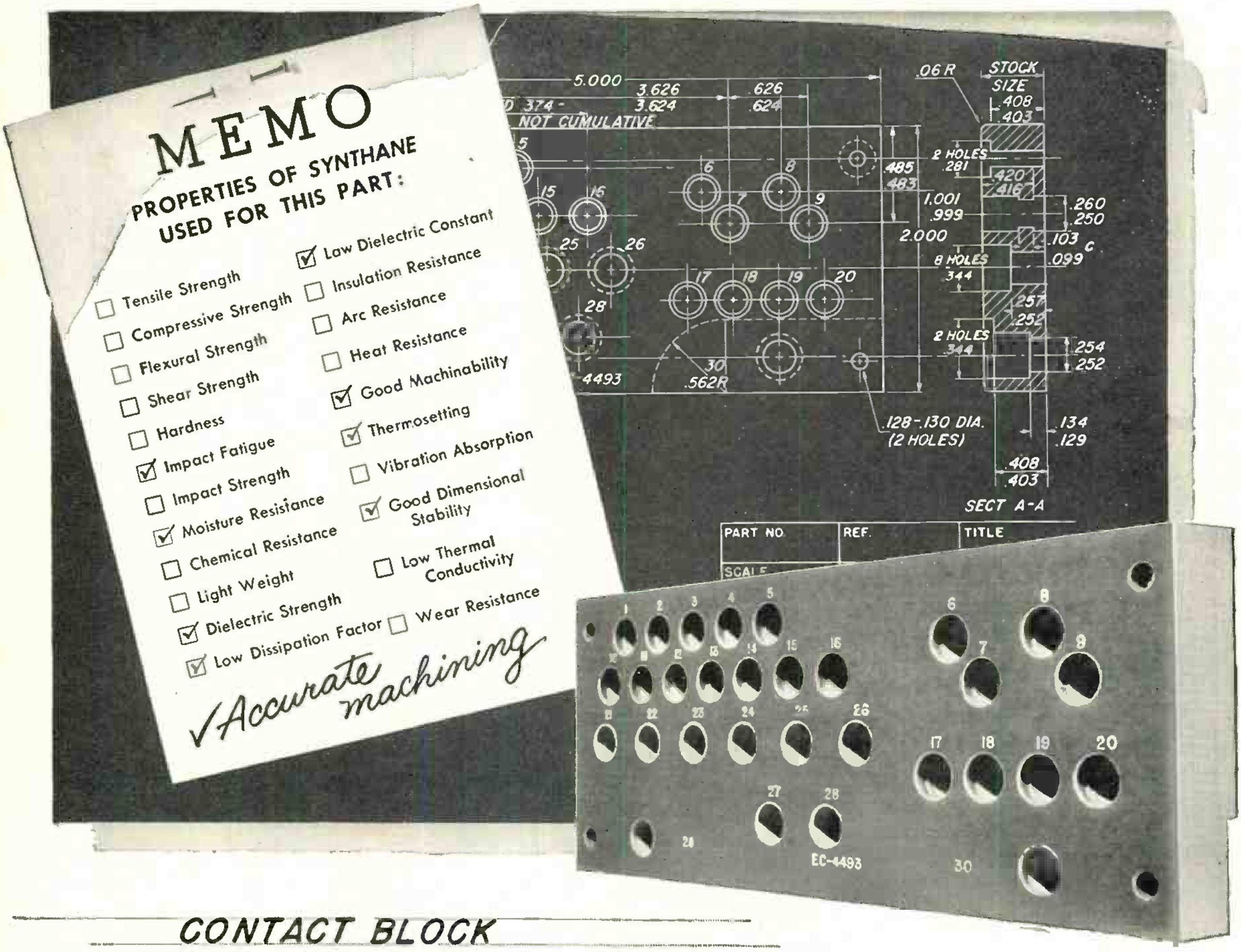
**GENERAL PRECISION LABORATORY**

Incorporated • Pleasantville, New York

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

For product information, use inquiry card on last page.

# YOU FURNISH THE PRINT, WE'LL FURNISH THE PART




## CONTACT BLOCK
## OF SYNTHANE LAMINATED PLASTIC
## MEETS MANY ELECTRICAL, MECHANICAL REQUIREMENTS

This contact block—for an electronic device—illustrates the rising demand for materials with many properties in combination. High dielectric strength, mechanical strength and dimensional stability are essential for the application; accurate machining is a must for proper mating of components.

**SYNTHANE CORPORATION, 11 River Road, Oaks, Pa.**

Please send me more information about *Synthane* laminated plastics and the *Synthane* fabrication service.

Name________________

Title________________

Company________________

Address________________

City________ Zone______ State________

The customer supplied the blueprint; Synthane Corporation did the rest—first producing the proper grade of material and then fabricating—accurately and without waste or delay.

The more than 33 grades of *Synthane* laminated plastics offer *you* a very wide range of properties in combination—physical, mechanical, electrical, and chemical. And good service and quality characterize *Synthane* fabrication. The coupon will bring you further information and technical data covering *Synthane* sheets, rods, tubes, and molded parts, and *Synthane* service.

**SYNTHANE**
LAMINATED S PLASTICS

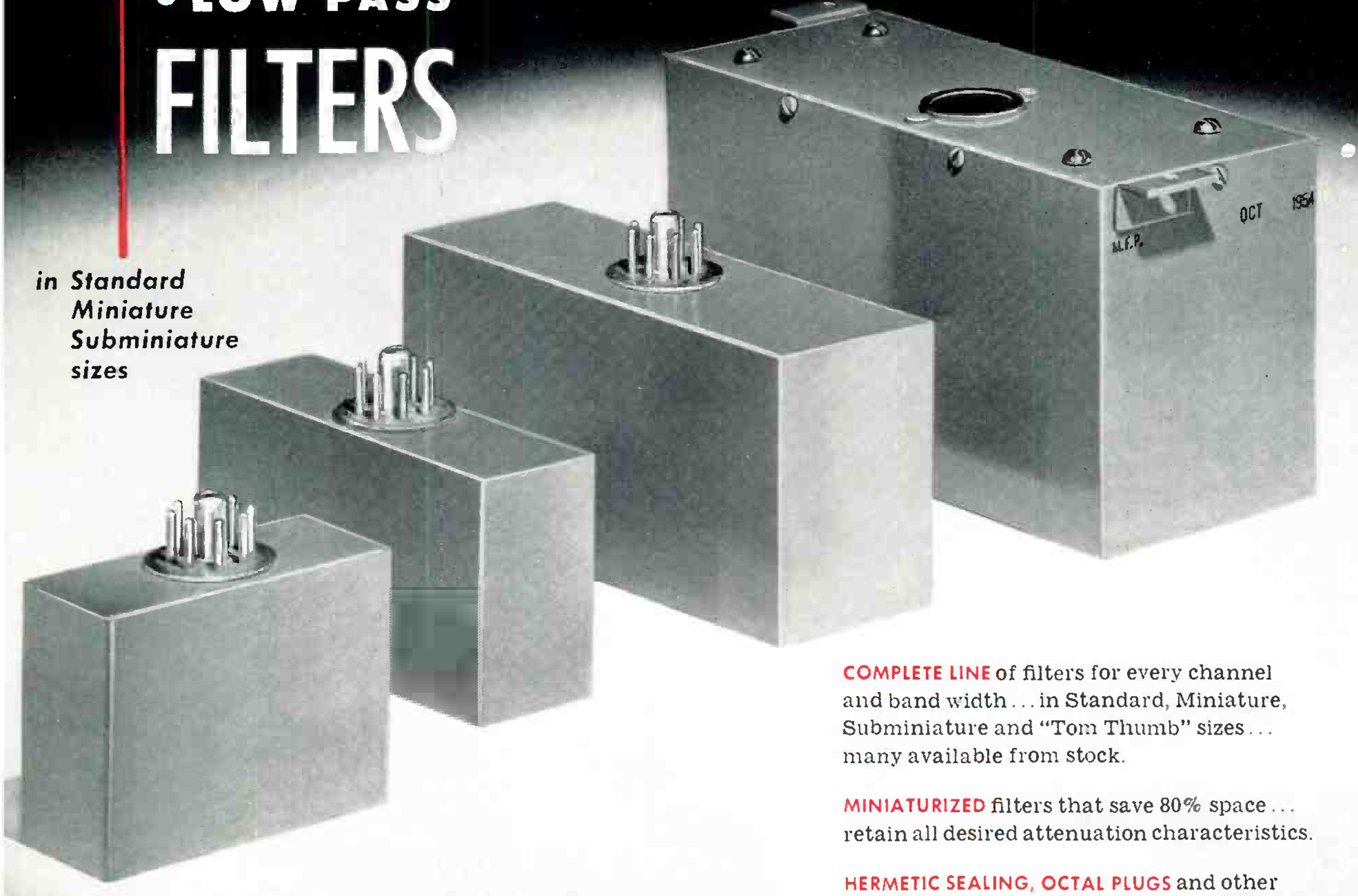
**SYNTHANE CORPORATION • OAKS, PENNSYLVANIA**

# TELEMETERING

## • BAND PASS
## • LOW PASS

# FILTERS

*in Standard*
*Miniature*
*Subminiature*
*sizes*




**COMPLETE LINE** of filters for every channel and band width . . . in Standard, Miniature, Subminiature and "Tom Thumb" sizes . . . many available from stock.

**MINIATURIZED** filters that save 80% space . . . retain all desired attenuation characteristics.

**HERMETIC SEALING, OCTAL PLUGS** and other new features.

## *only Burnell offers you . . .*

**SPECIAL PHASE LINEARITY** characteristics to conform to new concepts of high accuracy telemetering practice.

**SPECIFICALLY DESIGNED** for telemetering, these filters have found great utility in a wide variety of communications and control applications.

**APPLICATION ENGINEERING** service plus complete technical literature. Write Dept. 45. ., for Catalog 102A.

PARTIAL LISTING OF MINIATURE TELEMETERING BAND PASS FILTERS

| Channel Freq. | | 15% Band Width | 30% Band Width | Case Size | Approx. Weight | Attenuation | |
|---|---|---|---|---|---|---|---|
| | | Type No. | Type No. | W- L- H- | | 15% B. W. | 30% B. W. |
| 400 | CPS. | S-15456 | | 2 x 6 x 2¾ | 3 lbs. | 4DB — 15%<br>20DB — 23%<br>40DB — 27% | 4DB — 30%<br>20DB — 46%<br>40DB — 54% |
| 560 | " | S-15457 | S-15477 | | | | |
| 730 | " | S-15458 | S-15478 | | | | |
| 960 | " | S-15459 | | | | | |
| 1300 | " | S-15460 | | 1⅜ x 4½ x 2¼ | 1 lb. 7 oz | 3.5DB — 15%<br>20DB — 23%<br>40DB — 27% | 3.5DB — 30%<br>20DB — 46%<br>40DB — 54% |
| 1700 | " | S-15461 | | | | | |
| 2300 | " | S-15462 | | | | | |
| 2570 | " | S-15463 | | 1⅜ x 3 x 2¼ | 9¾ oz. | 3DB — 15%<br>20DB — 23%<br>40DB — 26% | 3DB — 30%<br>20DB — 46%<br>40DB — 52% |
| 3000 | " | S-15464 | | | | | |
| 3900 | " | S-15465 | S-15479 | | | | |
| 4500 | " | S-15466 | | | | | |
| 5400 | " | S-15467 | S-15480 | | | | |
| 7350 | " | S-15468 | S-15481 | | | | |
| 10500 | " | S-15469 | S-15482 | | | | |
| 12300 | " | S-15470 | S- | | | | |
| 14500 | " | S-15471 | S-15483 | | | | |
| 22000 | " | S-15472 | S-15484 | | | | |
| 27000 | " | | S-15485 | | | | |
| 30000 | " | S-15473 | S-15486 | | | | |
| 40000 | " | S-15474 | S-15487 | | | | |
| 52500 | " | S-15475 | | | | | |
| 70000 | " | S-15476 | S-15488 | | | | |

OPTIMUM OPERATING IMPEDANCES — SOCKET TERMINAL CONNECTIONS

| INPUT | | OUTPUT | |
|---|---|---|---|
| Terminals 1 & 2 | 500 ohms | Terminals 1 & 6 | 500 ohms |
| Terminals 1 & 3 | 10000 ohms | Terminals 1 & 7 | 50000 ohms |

Teletype: Yonkers, N. Y. 3633

**BURNELL & CO., INC.**
YONKERS 2, NEW YORK
Pacific Division: 720 Mission St., S. Pasadena, Calif.

*First in Toroids and Related Networks*

# ONE OF THESE HOWARD FRACTIONAL H.P. MOTORS

# WILL FIT YOUR ELECTRONIC APPLICATION

**why not investigate today?**

**Howard 2900**
Induction motor.
For facsimile equipment, tape recorders, blowers—used by many leading manufacturers.

**Howard 3700**
Induction motor.
Movie projectors, TV cameras, tape recorders—Resilient mounted.

**Howard 2500**
Induction Motor.
For instruments, tuning devices, light switching, metering devices, recordiographs, damper controls, telefax equipment and a host of other applications.

**Howard 512** Universal Motor. Widely used in business machines, projectors, automatic tuning equipment, photo developing and printing, automatic pilots, photo copy machines.

**Howard 100 & 200**
Universal & D. C. Motors.
For blowers, radio and radar equipment, aircraft pumps, aircraft cooling fans.

Lots of power in a small package.

**Howard 2400**
Capacitor or 2-Phase Servo Motor. Used in servo type applications—tuning, instruments, meters, controls, etc.

Make today your D day buy United States Defense Bonds

**UNIVERSAL AND D. C. MOTORS**
1/1000 to 1/2 h.p.

**SHADED POLE MOTORS**
1/2000 to 1/8 h.p.

**INDUCTION MOTORS**
1/1400 to 1/4 h.p.

Here are just a few of the many fractional h.p. motors Howard can offer you for your quantity applications. To date, Howard motors have been used by leading manufacturers in more than 85,000 applications. Chances are there's a specification in our file that will work for you and at the right price. If you use fractional h.p. motors, write and tell us your needs today. We'll handle your inquiry promptly.

**HOWARD**

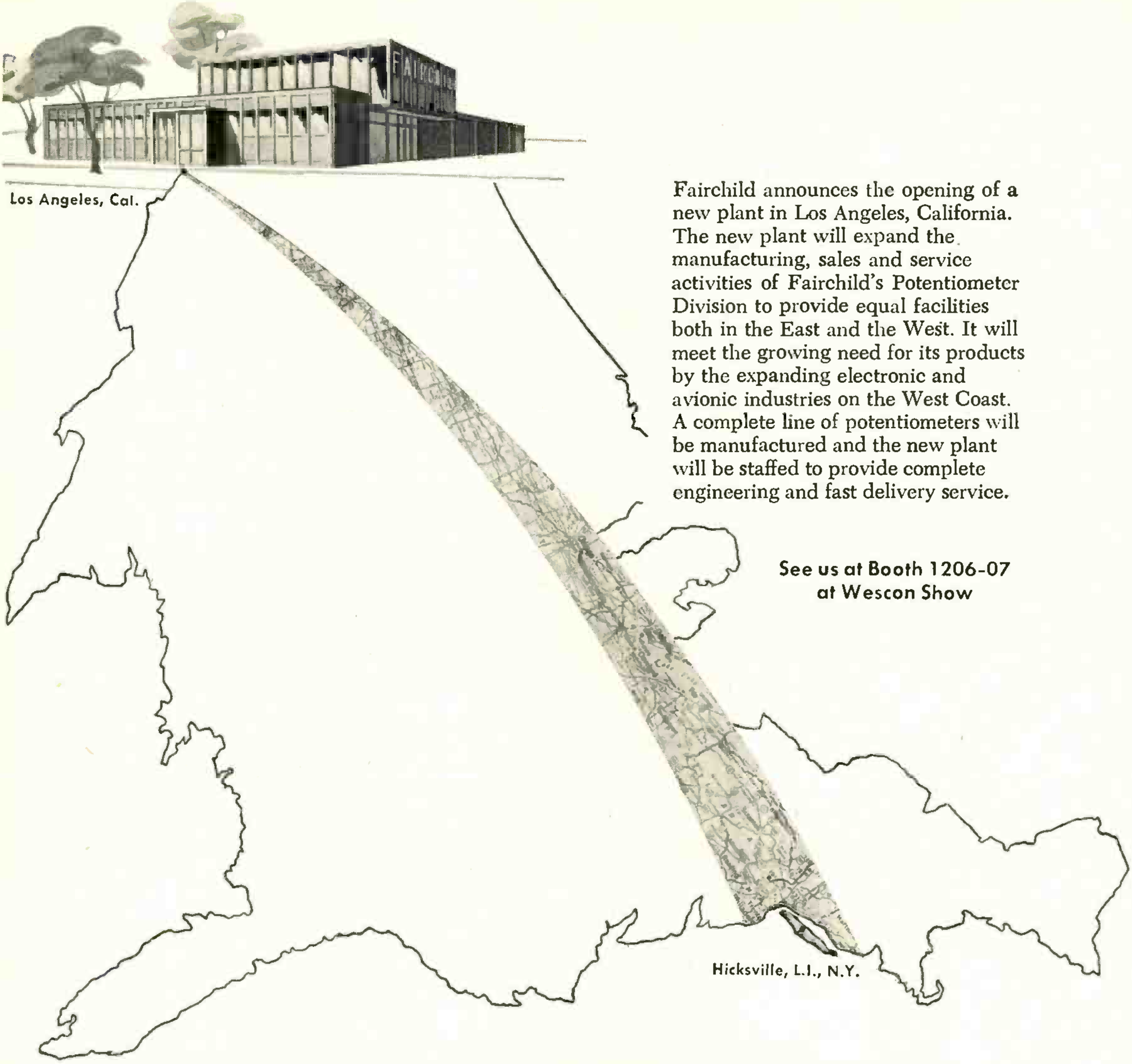
**DEPT. TT-8, HOWARD INDUSTRIES, INC., RACINE, WIS.**

*SALES OFFICES: 208 S. La Salle St., Chicago 4 • 942 S. La Brea Ave., Los Angeles 36 • Room 4822, Empire State Bldg., New York 1*

DIVISIONS: EMC ELECTRIC MOTOR CORPORATION · CYCLOHM MOTOR CORPORATION · REP RACINE ELECTRIC PRODUCTS



For product information, use inquiry card on last page.



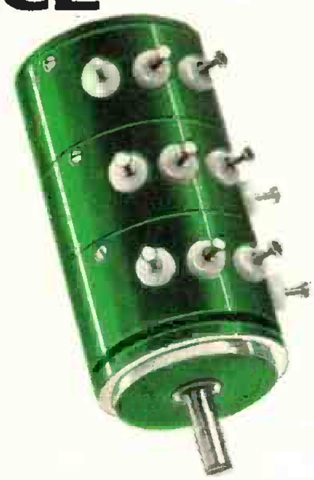

Fairchild announces the opening of a new plant in Los Angeles, California. The new plant will expand the manufacturing, sales and service activities of Fairchild's Potentiometer Division to provide equal facilities both in the East and the West. It will meet the growing need for its products by the expanding electronic and avionic industries on the West Coast. A complete line of potentiometers will be manufactured and the new plant will be staffed to provide complete engineering and fast delivery service.

**See us at Booth 1206-07 at Wescon Show**

# AVAILABILITY AND SERVICE

## from L.I. to L.A.

The opening of Fairchild's new West Coast plant means that henceforward the name Fairchild will not only stand for the finest in precision potentiometers . . . it will mean faster delivery and better service, too. You will be able to get complete engineering service, quotations, order handling, delivery and repair from either plant, whichever is most convenient to you. This is another example of how Fairchild can always give you the answers, no matter what factors govern your choice of precision potentiometers. Write Potentiometer Division, Fairchild Controls Corp., a subsidiary of Fairchild Camera and Instrument Corp., Dept. 140-66E.



**EAST COAST**
225 Park Avenue
Hicksville, L.I., N.Y.

**WEST COAST**
6111 E. Washington Blvd.
Los Angeles, Cal.

**FAIRCHILD**
**PRECISION POTENTIOMETERS**

# INCOMPARABLE *Frequency Stability...*

## *for Airborne X-Band Radar Receivers*

**Now — at a New Low Cost —** Varian announces the rugged VA-203 . . . most advanced reflex klystron ever developed for airborne radar and beacon local oscillator service. The exclusive brazed-on external tuning cavity provides frequency stability obtainable in no other klystron. This construction provides outstanding stability during shock, vibration and temperature cycling . . . takes punishing 50 to 100 G shocks and provides absolutely reliable operation at high altitude WITHOUT pressurization.

**For Super-Rugged Service** (Shocks to 250G) . . . Varian offers the VA-201 klystron. This tube is equipped with integral molded silastic leads, is similar to the VA-203 and performs with the same absolute reliability.

### All these exclusive Varian features . . .

- ★ **Unique brazed-on external tuning cavity assures exceptional frequency stability.**
- ★ Reliable operation at low voltage and from poorly regulated power supplies.
- ★ Negligible microphonics.
- ★ Slow tuning rate . . . long tuning life . . . single shaft tuner adapts easily to motor tuning.
- ★ Withstands 50 to 100 G shocks (up to 250 G's for the VA-201)
- ★ VA-203 weighs less than 4 ounces. Both tubes mate directly to standard waveguide flanges.

GUARANTEED SPECIFICATIONS

| 8500 to 9600 mc | VA-203 | VA-201 |
|---|---|---|
| Resonator Voltage | 300 V | 250 V |
| Heater Voltage | 6.3 V | 6.3 V |
| Heater Current | 0.45 Amp | 1.2 Amp |
| Power Output | 20mW, Min | 15mW, Min |
| Electronic Tuning Range | 30 Mc, Min | 30 Mc, Min |
| Vibration FM at 10 G | 1 Mc, p-p, Max | 0.2 Mc, p-p, Max |

GET COMPLETE TECHNICAL DATA and specifications on the outstanding new VA-203 and its companion VA-201 . . . finest klystrons made for airborne radar. Write to our Applications Engineering Department today.

*THE MARK OF LEADERSHIP*

**VARIAN associates**

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*KLYSTRONS, TRAVELING WAVE TUBES, BACKWARD WAVE OSCILLATORS, R.F. SPECTROMETERS, MAGNETS, STALOS, U.H.F. WATERLOADS, MICROWAVE SYSTEM COMPONENTS, RESEARCH AND DEVELOPMENT SERVICES*



For product information, use inquiry card on last page.

# RCA DATA FOR


## NEW TEST INSTRUMENT ENABLES ACCURATE MEASUREMENT OF ELECTRON-TUBE TRANSCONDUCTANCE

**RCA-WT-100A** MICROMHOMETER . . . unique in design, it makes possible the testing of tubes under actual operating voltage and current conditions. This feature permits direct correlation of test results with manufacturers' published data. Measures true transconductance, both control-grid-to-plate (gm) and suppressor-grid-to-plate. Also measures electrode currents: plate, suppressor-grid, screen-grid and control-grid; ac heater current; voltage drop across electron tubes, dry-disc rectifiers and crystal diodes.

**RCA-WT-100A** is a laboratory-quality instrument designed for production-line and laboratory testing, and circuit design engineering. The versatility and accuracy of the RCA-WT-100A closely approaches that of tube factory equipment for measuring transconductance.

The WT-100A features obsolescence-proof plug-in assemblies, switching for sockets with as many as 14 pins, burnout-proof metering, and electronically regulated, heavy-duty power supply.

## RCA "PREMIUM" TUBES FOR CRITICAL MILITARY APPLICATIONS

**RCA-OA2-WA** (Voltage Regulator), OB2-WA (Voltage Regulator), 5751-WA (High-Mu Twin Triode), 5814-WA (Medium-Mu Twin Triode), 5727/2D21-W (Thyratron, Gas Tetrode), 5654/6AK5-W/6096 (Sharp-Cutoff Pentode) . . . six types recently added to the group of RCA "Premium" tubes produced under rigid quality-control standards. For government end use; supplied only against orders giving government contract number.

## HIGH-MU TRANSMITTING TRIODE IS TIME-PROVED RCA ORIGINAL

**RCA-833-A** . . . improved version of the 833 originally developed by RCA more than 15 years ago. The outstanding and continuing popularity of this tube is typical of the many time-proved transmitting, receiving, and special-purpose types originated, developed, and sponsored by RCA. The RCA-833-A is designed for use as an rf power amplifier, oscillator, or class B modulator. It has a maximum plate dissipation rating of 450 watts under ICAS operating conditions with forced-air cooling.

## FOR TECHNICAL INFORMATION . . .

Write RCA, Commercial Engineering, Section H-50-R, Harrison, N. J.
Use this coupon. *Circle types you are interested in.*

6161 6383 6448 3RP1-A 6CM7 833-A WT-100A

Name__________
Position__________
Company__________
Address__________

Call your RCA representative:

**EAST** — HUmboldt 5-3900, 744 Broad St., Newark I, N. J.

**MIDWEST** — WHitehall 4-2900, Suite 1181, Merchandise Mart Plaza, Chicago 54, Ill.

**WEST** — MAdison 9-3671, 420 S. San Pedro St., Los Angeles 13, Calif.

For product information, use inquiry card on last page.

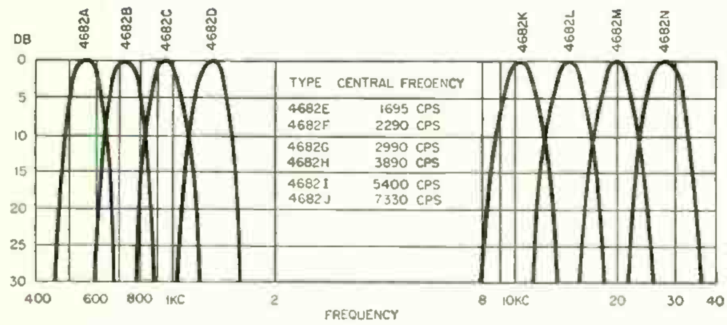
)UR MILLIONTH FILTER SHIPPED THIS YEAR...

# FILTERS

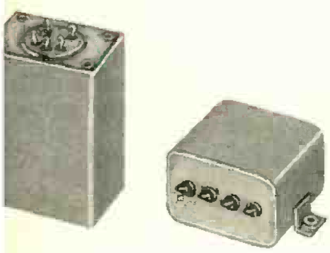
## -OR EVERY APPLICATION

### ELEMETERING ILTERS

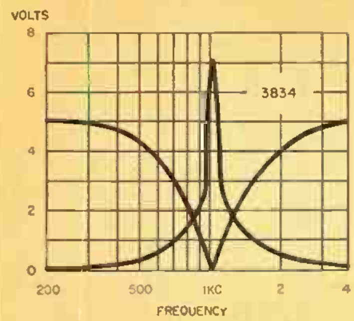
'C manufactures a wide variety of nd pass filters for multi-channel lemetering. Illustrated are a group filters supplied for 400 cycle to KC service. Miniaturized units ve been made for many applica-ns. For example a group of 4 cubic h units which provide 50 channels tween 4 KC and 100 KC.

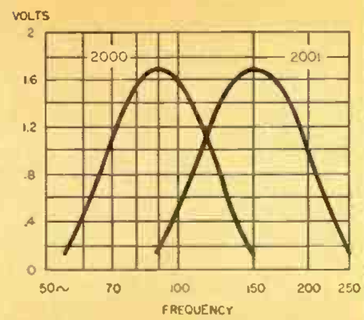



Dimensions:
(4682A) 1½ x 2 x 4"



nensions:
!34) 1¼ x 1¾ x 2-3/16".
!00, 1) 1¼ x 1¾ x 1⅝".



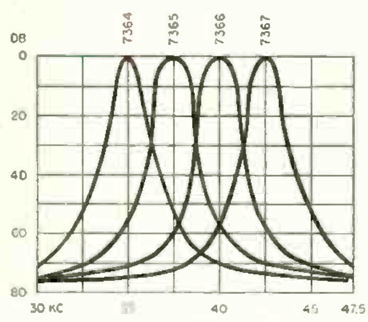

### AIRCRAFT FILTERS

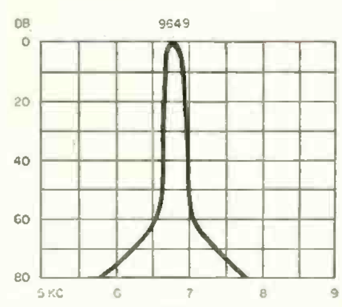
UTC has produced the bulk of filters used in aircraft equipment for over a decade. The curve at the left is that of a miniaturized (1020 cycles) range filter providing high attenuation between voice and range frequencies.

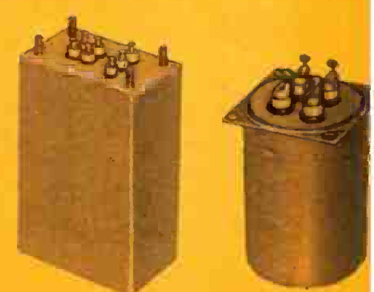
Curves at the right are that of our miniaturized 90 and 150 cycle filters for glide path systems.

### ARRIER ILTERS

wide variety of carrier filters are ailable for specific applications. is type of tone channel filter can supplied in a varied range of band dths and attenuations. The curves own are typical units.



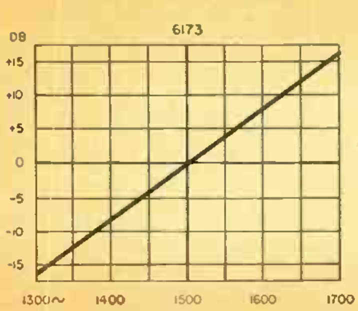



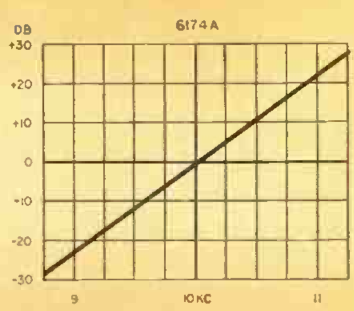



Dimensions:
(7364 series) 1⅝ x 1⅝ x 2¼".
(9649) 1½ x 2 x 4".

### ISCRIMINATORS

ese high Q discriminators provide ceptional amplification and linear-. Typical characteristics available e illustrated by the low and higher equency curves shown.




Dimensions:
(6173) 1-1/16 x 1⅜ x 3".
(6174A) 1 x 1¼ x 2¼".

UNITED TRANSFORMER CO.

# Electronic Industries News Briefs

*Capsule summaries of important happenings in affairs of equipment and component manufacturers*

**AERONCA MANUFACTURING CORP.** of Middletown, Ohio, is looking into unexplored fields in the aircraft industry to build the company into a major producer. Aeronca will expand its services to the U.S. Armed Forces into new fields of maintenance and electronic development.

**AIRBORNE INSTRUMENTS LABORATORY, INC.**, Mineola, N.Y. has announced its entry into the metal-working and machine-tool industry with the appointment of the **BURLEIGH** and **STOCKER MACHINE TOOL CO.** of Pleasant Ridge, Mich., as Sales Agents.

**BELL TEL LABS**, New York, N.Y., announced recently the establishment of a fellowship program through which it will grant funds for students doing graduate study in electrical communications. To be known as the Bell Telephone Laboratories Fellowships, the awards are for study of one or two years, leading to a doctorate. It carries a grant of $2,000 to the fellow, and an additional $2,000 to cover tuition, fees and other costs to the institution at which he chooses to study.

**CARGO PACKERS, INC.**, Brooklyn, N.Y., specialists in climate-proof and shock-proof packaging, has leased 65,000 square feet of new space in the three-story industrial building at 3720 14th Ave., Brooklyn, N.Y. to permit further expansion of its shipments of extra-heavy industrial machinery overseas.

**CHEM-ETCHED CIRCUITS, INC.**, 121 S. Cowen St., Garrett, Indiana, has been formed to develop and manufacture etched circuits by the photoengraving method.

**CINCH MANUFACTURING CORP.** of 1026 So. Homan Ave., Chicago, Ill. have announced the purchase of Graphik Circuits, located at 221 S. Arroyo Blvd., Pasadena, Calif. The addition of this plant enlarges the Cinch coverage of the electronic industry to include today's most talked of phase, printed circuits.

**DU MONT** closed-circuit television was recently used as an aid in welding operations at a demonstration at the American Welding Society & Allied Industry Exposition in Kansas City, Mo. The Du Mont cameras televised closeup views of latest types of welding techniques and relayed them by cable to television viewing screens.

**EATON ASSOCIATES, INC.** of Moodus, Conn., is already in production as a newly organized company for the manufacture of printed circuit asemblies.

**ELECTRO DATA CORP.**, computer affiliate of **CONSOLIDATED ENGINEERING CORP.** of Pasadena, has established a Southwestern Regional sales and service facility located at 4515 Prentice St., Dallas, Texas.

**EMERSON RADIO AND PHONOGRAPH CORP.**, New York 19, N.Y., has organized the Emerson Associate Management Committee in a move designed to strengthen and broaden the base of executive operations by discovering and developing executive talent within the company.

**ETHYL CORP.** of Detroit has given permanent protection to their 850,000 research records, and have condensed these vital documents into one filing cabinet through microfilming. The entire operation is described in a 2-page folder released by **REMINGTON-RAND, INC.**

**THE HEILAND DIVISION** of **MINNEAPOLIS-HONEYWELL REGULATOR CO.** recently announced plans for the construction of a new $1,000,000 manufacturing plant in Denver. The plant's 45,000 sq. feet will house general sales offices and manufacturing facilities.

**ILLINOIS INSTITUTE OF TECHNOLOGY** and **ARMOUR RESEARCH FOUNDATION**, in cooperation with a group of engineering societies and nearly 100 industrial organizations, will demonstrate the use of electronic analog computers in the solution of hydraulic problems at the 11th annual National Conference on Industrial Hydraulics to be held Oct. 27 and 28 in the La Salle hotel in Chicago.

**KESTER SOLDER CO.** of Chicago has recently expanded its plant facilities at Newark, N.J. by more than 50%. All phases of the factory have been enlarged—manufacturing operations, warehouse, and shipping areas. The plant is located at 88 Ferguson St. in Newark.

**THE KULJIAN CORP.**, Philadelphia engineers and constructors, have constructed five Mass Vibrometers of unique design for **E. I. DU PONT DE NEMOURS & CO. INC.**, which can automatically check the uniformity of thread over the entire range from 10 to 5700 denier in textile operations.

**MAGNAVOX**, Fort Wayne, Ind., president Frank Freimann recently announced that the company has consummated new contracts in the amount of $5,900,000 for its industrial and defense products division.

**MAGNETICS, INC.**, Box 230T, Butler, Pa. is now offering molybdenum permalloy powder cores, graded according to inductance and color-coded to facilitate assembly. Color-coding allows the proper numbers of turns to be put on individual cores without special testing.

**MAGNETIC TAPE STORY** and its contributions to the growth of radio industry are told in new book "Brand of the Tartan." 250-page volume traces history of Minnesota Mining and Manufacturing Co. Published by Appleton-Century Crofts Inc. at $3.50.

**NEW HAMPSHIRE BALL BEARINGS, INC.**, Peterborough, N. H., has announced plans for the construction of a new 40,000 sq. ft. plant for bearing manufacture. It will be erected on a twenty-seven acre site south of the business section at an estimated cost of $350,000.

**NORDEN-KETAY CORP.** and **SCIENTIFIC SPECIALTIES CORP.** recently reached an agreement for the acquisition of all of the stock of Scientific Specialties Corp. of Boston, Mass. by the Norden-Ketay Corp. Scientific Specialties is engaged in the design, development, and manufacture of precision laboratory and testing instruments used in the medical field and by electronic and precision laboratories.

**NORTHERN ENGINEERING LABORATORIES**, 434 Wilmot Ave., Barlington, Wisc., has recently been formed in Burlington, Wisc. to manufacture quartz crystals, specializing in glass-sealed, low frequency and high precision types. The company was organized by John D. Holmbeck, formerly Chief-Engineer at James Knights; Ernest E. Overbey, formerly Production Engineer at Knights and Robert F. Holzrichter, formerly Operations Manager at Knights.

**D. W. ONAN & SONS, INC.** of Minneapolis, Minn. have announced two new series (25EC, 25,000-watt and 35ED, 35,000-watt) of Ford-powered electric generating plants. These new generators have been specially designed to handle the many unusual electrical requirements demanded of modern emergency equipment.

**PANELLIT, INC.**, Skokie, Ill. has announced the formation of a Canadian affiliate, **PANELLIT OF CANADA, LTD.** The new affiliate will be located at 60 Newcastle St., Toronto 14, Ontario.

**PERFECTION MICA CO.** of Chicago, manufacturers of a new magnetic shielding material, has announced the creation of a new division, the **MAGNA-SHIELD DIVISION**, to handle its product, Magna-Shield. The company is located at 1322 No. Elston Ave., Chicago.

**PYRAMID ELECTRIC CO.**, 1445 No. Bergen, N.J., has made available in the solid dielectric glasseal capacitor line capacitors capable of withstanding vibrational stresses of high acceleration and frequency as well as severe shock conditions.

**SANDERS ASSOCIATES, INC.**, Nashua, N.H., designers and manufacturers of electronic and hydraulic servo components and systems, have purchased new office and plant facilities totaling almost 500,000 sq. feet of space in Nashua.

**SOLAR ENERGY CORP. OF AMERICA** has been formed to explore the commercial possibilities of solar energy. Its address is at 103 Park Ave., New York 17, N.Y.

**SPERRY GYROSCOPE CO.**, Great Neck, N.Y., was recipient of an order for 2K25 klystron tubes, totaling more than $200,000, placed with them by the U.S. Army Signal Corps.

**TELREX, INC.**, Asbury Park, N.J., recently signed two patent license agreements involving their conical antennas. The agreements were signed with **C-O MFG. CO.**, Brockton, Mass., and **LA POINTE ELECTRONIC, INC.** of Rockville, Conn.

**TEXAS INSTRUMENTS, INC.**, 6000 Lemmon Ave., Dallas 9, Texas, is planning to open a Los Angeles sales office as the first step in establishing marketing headquarters throughout the U.S. The Los Angeles office will be headquarters for the Western district and will be the first of several to be opened this year.

**JAMES VIBRAPOWER CO.** is currently constructing a new one-story factory building which will triple the present Chicago manufacturing space they now occupy. The new plant will be located at 4060 No. Rockwell St. in Chicago.

**VIBRO-CERAMICS CORP.**, an affiliate of **GULTON INDUSTRIES, INC.**, Metuchen, N.J., has inaugurated a comprehensive consulting service in all phases of ultrasonics for industrial and scientific programs of any scope.

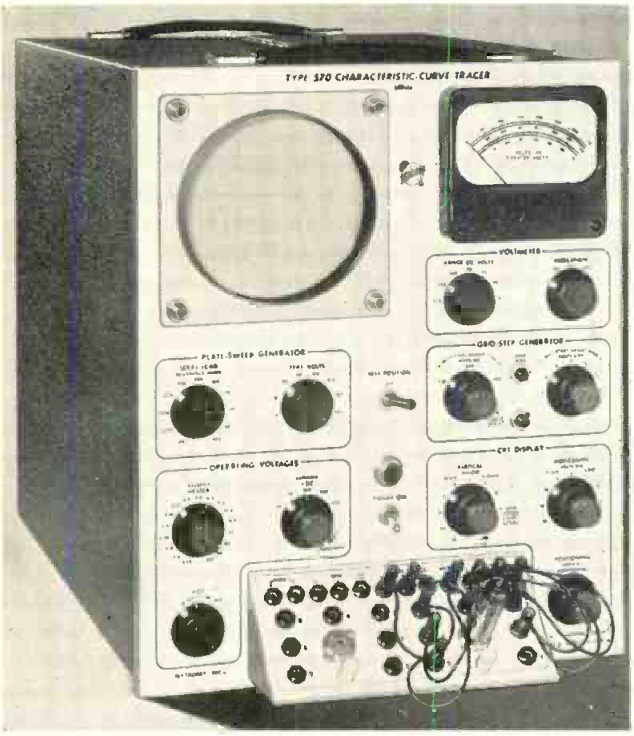
**WESTINGHOUSE RESEARCH LABORATORY**, Pittsburgh 30, Pa., scientists have developed a new insulating enamel for copper wire. Tests on electric motors insulated with the new enamel show that the motors can operate continuously for 10 years at a temperature of 325 degrees F. without damage to the insulation.

**WHEELCO DIVISION'S** Chicago office will soon move into new and expanded facilities to be located at 6610 No. Sheridan Road, Chicago 26, Ill. This was announced recently by R. A. Schoenfeld, sales manager of the Wheelco Instruments Div., Barber-Colman Co.

# *Save Time in Circuit Design*

**Get advance information... in graphic form... on vacuum-tube behavior in new circuitry—**

## *with the Type 570 Characteristic-Curve Tracer*



**The Tektronix Type 570** Characteristic-Curve Tracer can save you many hours in circuit-development work by providing quick, accurate pictures of vacuum-tube characteristics. You have complete control of the operating-condition setup, permitting a realistic approach to actual circuit conditions, whatever they may be. You get curves that can be very important in a particular circuit problem; but are rarely, if ever, published in handbooks.

The Type 570 can also be used for rapid preselection of vacuum tubes, either by comparison with another vacuum tube, or with curves outlined on a crt mask.

***Please call your Tektronix Field Engineer or Representative or write direct for new booklet, Type 570 Technical Description.***

**Displays Families of Curves on CRT Screen**

Choice of four to twelve characteristic curves per family—with as many as 8 positive-bias curves per family.

**Plots All Important Characteristics**

Plate current against plate voltage.
Plate current against grid voltage.
Screen current against plate voltage.
Screen current against grid voltage.
Grid current against plate voltage.
Grid current against grid voltage.

**Calibrated Controls**

Accurate current and voltage readings directly from the crt screen.

**Wide Display Range**

11 current ranges from 0.02 ma/div to 50 ma/div.

9 voltage ranges from 0.1 v/div to 50 v/div.

11 series-load resistors from 300 ohms to 1 megohm.

7 grid-step values from 0.1 v/step to 10 v/step.

**Price — $925**

*f.o.b. Portland (Beaverton), Oregon*

***See and try the Type 570 at WESCON, Booths 915 and 916, and at the ISA SHOW, Booths B461 and B462.***

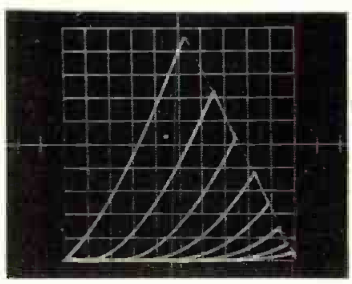


**Fig. 1** — *Plate current plotted against plate voltage for one triode section of a 12AU7. Plate load is 5 k, peak plate-supply voltage is 500 v. Grid voltage is changed 5 v between curves, from —35 v. to zero. Vertical sensitivity is 5 ma/div, horizontal sensitivity 50 v/div. Calibrated controls permit accurate current and voltage readings directly from the screen.*

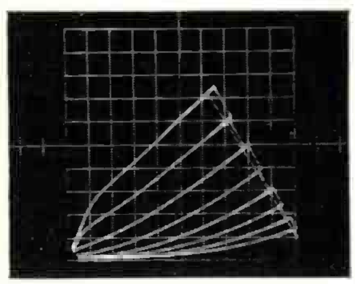


**Fig. 2** — *Same triode section of 12AU7 with only 20-v peak plate supply and sensitivities increased to 0.2 ma/div vertical and 2 v/div horizontal. Grid voltage is changed 2 v between curves, from —14 v to zero. This is essentially a 25-times magnification of the lower left portion of Fig. 1, showing the operating characteristics at low plate-supply voltage.*

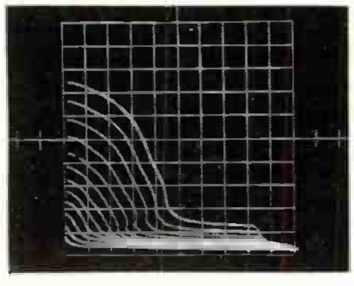


**Fig. 3** — *Screen current plotted against plate voltage with positive grid bias on a 6AQ5. Plate load is 300 ohms, peak plate voltage is 100 v, screen-grid voltage is 100 v, with grid voltage changing 2 v/step from +16 v to below zero. Vertical scale is 10 ma/div, horizontal scale 10 v/div.*

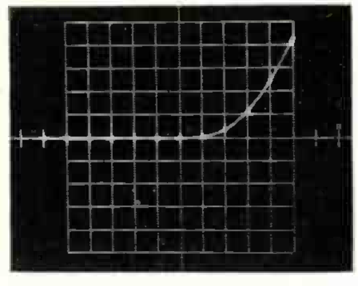
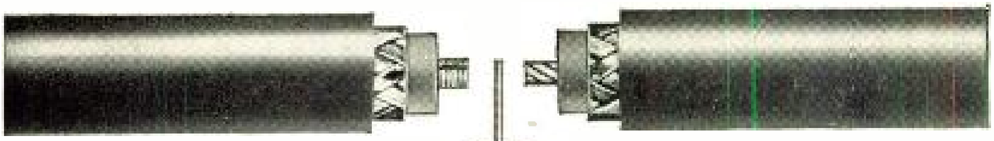


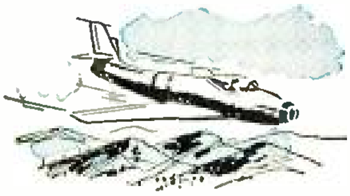
**Fig. 4** — *Typical Germanium Diode curve. Inherent flexibility of the Type 570 permits accurate evaluation of diode characteristics and detailed examination of any part of the curve. Calibrated scales above are 0.2 v/div horizontal, 0.5 ma/div vertical, with zero points at center of screen.*

# Tektronix, Inc.

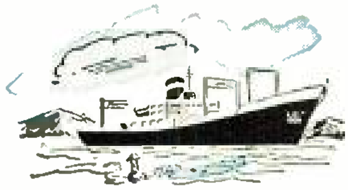
**P. O. Box 831, Portland 7, Oregon**

**CYpress 2-2611** **Cable: TEKTRONIX**

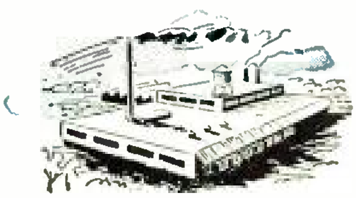




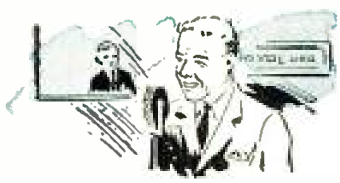
AVIATION



MARINE

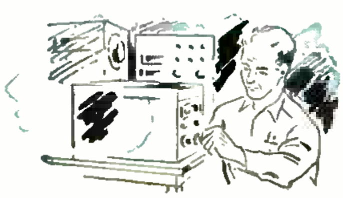


INDUSTRIAL

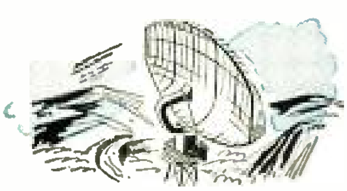


BROADCASTING

RADIO-TV LEAD-INS



TEST EQUIPMENT



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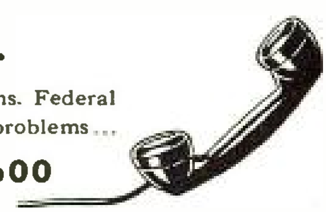

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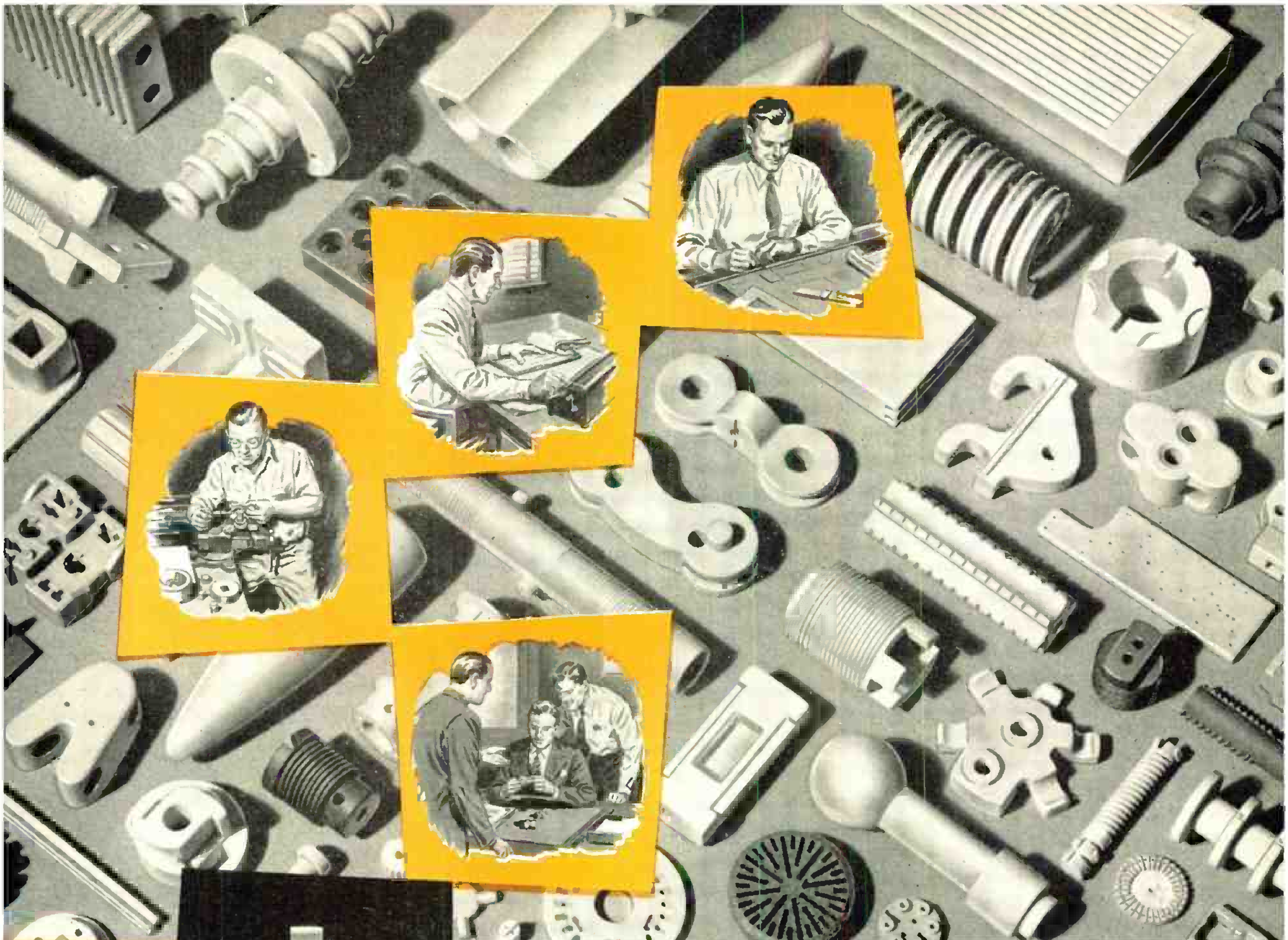

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# New Tech Data for Engineers

## Resumes of New Catalogs and Bulletins Offered This Month by Manufacturers to Interested Readers

### Turret Punch Press

Bulletin No. 61, a 15-page booklet, presents the construction details, operation features, and time-saving principles of the R-61 turret punch press made by the Wiedemann Machine Co., 4272 Wissahickon Ave., P.O. Box 6794, Philadelphia 32, Pa. Gives performance specifications. (Ask for B-8-1)

### Curve Tracer

A 7-page brochure, issued by Tektronix, Inc., Sunset Highway and Barnes Road, P.O. Box 831, Portland 7, Ore., gives a technical description of the Type 570 characteristic-curve tracer. Illustrates the unit and its curve displays; gives specifications and modifications notes. (Ask for B-8-2)

### Paper Capacitor

A 4-page brochure, released by Astron Corp., 255 Grant Ave., E. Newark, N.J. presents the "Comet," Type MBP, molded-plastic, tubular, metallized-paper capacitor with performance characteristics, test specifications, and price list. (Ask for B-8-3)

### Power Supplies

Bulletin RMPS-854, "Radar & Missile Power Supplies," illustrates and describes low-voltage, high-current, tubeless, magnetic-amplifier-regulated types of power supplies for ground and airborne missile and radar applications made by Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif. (Ask for B-8-4)

### Motor-Gear-Train

A new catalog sheet issued by John Oster Manufacturing Co., 1 Main St., Racine, Wis., gives technical data, including dimensional drawings, performance features, and a table of motor and gear train lengths with related data. (Ask for B-8-5)

### RF Connectors

A new D3 catalog devoted entirely to radio frequency connectors has been released by American Phenolic Corp., 1830 South 54th Ave., Chicago 50, Ill. The 64-page catalog contains the following r-f connector series, N, BN, C, LC, UHF, BNC, HN, between series adapters, coaxial cable fittings, push-on and "Subminax." Dimensions, mounting holes, weights, impedance, materials, and matching cable types are given for each connector. (Ask for B-8-6)

### Channel Recorder

Bulletin 327, and attached statement of recent improvements and changes, illustrates and describes the 200-channel, automatic strain gauge recorder made by Beckman Instruments, Inc., Fullerton, Calif. Presents the instruments operation and applications. (Ask for B-8-7)

### Electron Tubes

A 24-page booklet on the Advisory Group on Electron Tubes can be obtained on request to the New York University, Advisory Group on Electron Tubes, 346 Broadway, New York 13, N. Y. The booklet describes the purpose, organization, membership, operation, and history of the group, an agency of the Assistant Secretary of Defense for Research and Development. (Ask for B-8-8)

### Diplexer

Bulletin No. 429, announced by Prodelin Inc., 307 Bergen Ave., Kearney, N. J. contains application features, and electrical and mechanical specifications covering the Type DNTV-25 single line VHF high-band notch diplexer (Ask for B-8-9)

### Lighting Arrangements

Technical information and prices covering the "C-lector" remote, preset, lighting arrangements control is available at Century Lighting, Inc., 531 W. 43rd St., New York, N. Y., and 1820-40 Berkeley St., Santa Monica, Calif. The new brochure describes the unit's operation and hookup method. (Ask for B-8-10)

### Induction Motor

Design data sheet released by Dalmotor Co., 1373 Clay St., Santa Clara, Calif. describes the Type AC-93 miniature, subfractional, 400 cps induction motor. Illustrates the unit, gives detailed and dimensional outlines, and technical specifications. (Ask for B-8-18)

### Transducers

"A Procedure for Transducer Evaluation," Bulletin KCE-491, is available from Crescent Engineering and Research Co., Electronics Div., 11632 McBean St., El Monte, Calif. (Ask for B-8-19)

### Motors

A 14-page booklet issued by El Ray Co., Inc., 1747 Vose St., North Hollywood, Calif., gives characteristics and performance data on their line of fractional horsepower motors in permanent-magnet, field wound, and induction types. (Ask for B-8-20)

### Electronic Equipment

Four technical literature releases issued by Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif., present the following electronic equipments: Bulletin 1402D presents the amplifier system D. Explains the system, gives operational principles, component specifications and prices. Bulletin 1537C illustrates and describes the Type 23-109 oscillograph processor, and gives technical data and prices. Bulletin CEC-1517 C illustrates and describes the coupling system "B" class, comprising the Type 8-201 matching network and Type 7-353 integrating galvanometers. Bulletin CEC-1556 covers the Type 4-315 pressure pickup. (Ask for B-8-21)

### Microwave Equipment

A series of data sheets released by Cascade Research Corp., 53 Victory Lane, Los Gatos, Calif., illustrate and give dimensions and performance data covering the power, ruggedized, and standard "Uniline" isolators, the "Gyraline" variable attenuators, and other ferrite microwave equipment made by the company. (Ask for B-8-22)

### Panel Instruments

A data sheet issued by Phaostron Co., 151 Pasenda Ave., Pasadena, Calif., presents mounting dimensions and technical data covering the company's metal-cased 4½ in. custom panel instruments. (Ask for B-8-23)

### AN Electrical Connectors

A bulletin describing the complete line of AN electrical connectors manufactured by the Deutsch Co., 7000 Avalon Blvd., Los Angeles, Calif. is available to users in the electronic and allied industries. Describes application fields and performance requirements, sizes and capacities, basic parts, and numbering system. (Ask for B-8-24)

### Metals

A booklet released by Metal Control Laboratories, Inc., chemical and metallurgical engineers, 2735 East Slauson Ave., Huntington Park, Calif., describes the ferrous and non-ferrous chemical analyses, quantometric analyses, physical tests, and metallurgical tests the organization is staffed and equipped to make. (Ask for B-8-25)

### Material Impregnators

Bulletin 2550 describes the "Red Point" dual impregnators, made by Red Point Products, Inc., 1907 Riverside Drive, Glendale 1, Calif. Gives detailed description, drawing, parts and terminology. Tells how the unit simplifies deep impregnation of porous articles and laminates under vacuum. (Ask for B-8-26)

### Magnetic Amplifiers

Bulletin MA, released by Hycor Company, Inc., 11423 Vanowen St., North Hollywood, Calif., describes the company's standard type magnetic amplifiers of toroidal construction. Also gives information regarding special designs for individual requirements. (Ask for B-8-27)

### Digital Pressure Gauges

Bulletin BJE-606 describes the miniature digital pressure gauges developed by the Byron Jackson Co., Electronic Division, 2010 Lincoln Ave., Pasadena 3, Calif. Gives specifications for "Vibrotron" model gauges and lists other electronic testing and control instruments. (Ask for B-8-30)

### Printed Circuit Connectors

Bulletin SR-DX2, issued by Cannon Promotion Dept., 3207 Humboldt St., Los Angeles 31, Calif., contains complete information on five new "Cannon" connectors ranging through 10, 18, 22, 28 to 44 contacts. (Ask for B-8-31)

### Detector Cells

A 4-page illustrated brochure covers the "Servotherm" thermistor heat detector cells produced by Servo Corp. of America, 2020 Jericho Turnpike, New Hyde Park, N. Y. One, #1317, is a low-price commercial model. Model #1312 is a laboratory unit, and #1340 is for use where high ambient vibrations are present. (Ask for B-8-32)

### Data Printers

Two new folders describe specifications and applications of two Clary Numerical Data Printers. Folders list six models of Parallel Entry and four models of Serial Entry Printers. Electronic Div., Clary Corp., San Gabriel, Calif. (Ask for B-8-33)

### Breadboards

Four page catalog describes a flexible breadboard chassis system based on plate-modules. U. M. & F. Mfg. Corp., 10929 Vanowen St., N. Hollywood, Calif. (Ask for B-8-34)

### Testing Facilities

Four-page brochure outlines the environmental and type-testing facilities and services offered by American Electronic Laboratories, Inc, 641 Arch St., Phila. 6, Pa. (Ask for B-8-35)

### Spectrum Analyzer

Type LA-17 Spectrum Analyzer, with a calibrated range from 10 to 16,000 mc and usable range from 3 to 34,000 mc, is described in a 2-page folder from Lavoie Laboratories, Inc., Morganville, N. J. (Ask for B-8-36)

### Microwave System

Bulletin 3-206, released by the Equipment and Marketing Div., Raytheon Manufacturing Co., Waltham, Mass., describes the Model TCR-12 "Telelink," an automatic, two-way telephone, telegraph, "Teletype" and telemetering microwave communications system operating in the common carrier or industrial bands. (Ask for B-8-11)

### Analyzer

A brochure released by DIT-MCO Inc., 505 W. 9th St., Kansas City 6, Mo., describes the Model 200 universal automatic electrical circuit analyzer. Presents several models of the analyzer with applicable specifications and gives an example of various circuits and components with which the analyzer is used in different tests. (Ask for B-8-12)

### "Rotoroids"

Burnell & Company, Inc., Yonkers 2, N. Y., (Pacific Division, 720 Mission St., South Pasadena, Calif.) has revisions for pages 3 and 4 of the recently released "Rotoroid" technical data sheet. Gives values for mass and shaft torque for standard units and other data. (Ask for B-8-13)


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LIBRASCOPE, INC. ................ Booths 911-912
SANBORN COMPANY ................ Booth 1008
SENSITIVE RESEARCH INSTRUMENT CORP. Booth 1016
SIERRA ELECTRONIC CORP. ............. Booth 1114
TEKTRONIX, INC. .................. Booths 915-916
VARIAN ASSOCIATES ............. Booths 918-919
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# Coming Events

***A listing of meetings, conferences, shows, etc., occurring during the period Aug. 1955 through Oct. 1956 that are of special interest to electronic engineers***

**Aug. 15-19—AIEE Pacific General Meeting,** Butte, Montana.

**Aug. 22-23—Symposium on Electronics in Automatic Production,** sponsored by Stanford Research Institute and the National Industrial Conference Board, Sheraton Palace, San Francisco, Calif.

**Aug. 23-Sept. 3—British National Radio Show,** Earls Court, London, England.

**Aug. 24-26—WESCON Western Electronic Show & Convention,** San Francisco Civic Auditiorium, San Francisco, Calif.

**August 26-28—Sixteenth Annual Summer Seminar,** sponsored by the Emporium Section of the IRE, Emporium, Pa.

**Aug. 26-Sept. 4—German Radio, Television, Gramophone and Radiogram Exhibition,** Dusseldorf, Germany.

**Sept. 6-17—Production Engineering Show and Machine Tool Show,** Navy Pier and International Amphitheatre, Chicago, Ill.

**Sept. 12-16—10th Annual Conference and Exhibit,** sponsored by ISA, Shrine Exposition Hall and Auditorium, Los Angeles, Calif.

**Sept. 14-16—ACM General Meeting,** Moore School of Electrical Eng., Univ. of Pennsylvania, Phila., Pa.

**Sept. 14-16—The Second National Annual Meeting of the IRE Professional Group on Nuclear Science (PGNS),** Oak Ridge, Tenn.

**Sept. 17—Symposium on Automation,** sponsored by the Cedar Rapids section of the IRE, Cedar Rapids, Iowa.

**Sept. 20-22—10th Anniversary Industrial Packaging and Materials Handling Show,** Kingsbridge Armory, New York, N. Y.

**Sept. 23-24—Annual BTS Meeting,** sponsored by IRE, Hamilton Hotel, Wash., D.C.

**Sept. 26-27—6th Annual Meeting and Conference of the IRE Professional Group on Vehicular Communications,** Multnomah Hotel, Portland, Ore.

**Sept. 26-27—RETMA Symposium on Automation,** University of Pa., Philadelphia, Pa.

**Sept. 26-28—Prof. Gp. on Communications Systems, IRE, Symposium,** Utica, N. Y.

**Sept. 26-30—The First Trade Fair of the Atomic Industry,** Sheraton-Park Hotel, Washington, D. C.

**Sept. 27-Oct. 1—Int'l. Analog Computation Meeting,** Brussels, Belgium.

**Sept. 28-29—Industrial Electronics Conference,** sponsored by the AIEE and IRE, Detroit Rackam Memorial Auditorium, Detroit, Michigan.

**Sept. 30-Oct 2—High Fidelity Show,** Palmer House, Chicago, Ill.

**Sept. 30-Oct. 2—International Sight and Sound Exposition, Inc.,** Palmer House, Chicago.

**Oct. 3-5—National Electronics Conference,** Hotel Sherman, Chicago, Illinois.

**Oct. 3-7—AIEE Fall General Meeting,** Morrison Hotel, Chicago, Illinois.

**Oct. 3-7—78th Semi-annual Convention of the SMPTE,** Lake Placid, New York, N.Y.

**Oct. 11-13—AIEE Aircraft Electronic Equipment Conference,** Los Angeles, California.

**Oct. 12-15—Convention of the Audio Engineering Society,** Hotel New Yorker, N. Y.

**Oct. 17-19—RETMA Radio Fall Meeting,** Hotel Syracuse, Syracuse, N. Y.

**Oct. 21-23—New England Hi-Fi Show,** Hotel Touraine, Boston, Mass.

**Oct. 24-25—Annual Technical Meeting** sponsored by the IRE Professional Group on Electron Devices, Washington, D. C.

**October 24-26—Sixth National Conference on Standards,** sponsored by the American Standards Association and the National Bureau of Standards, Sheraton Park Hotel, Washington, D. C.

**Oct. 31-November 4—East Coast Conference on Aeronautical and Navigational Electronics,** Baltimore, Md.

**Oct. 31-Nov. 4—World Symposium on Applied Solar Energy,** conducted under leadership of Stanford Research Institute, Phoenix, Arizona.

**Nov. 3-4—The Eighth Annual Electronics Conference,** sponsored by the Kansas City section of the IRE, the Town House, Kansas City, Kansas.

**Nov. 7-9—Eastern Joint Computer Conference and Exhibition,** sponsored by the AIEE, the IRE, and the Association for Computing Machinery, Hotel Statler, Boston, Mass.

**Nov. 14-16—IRE/AIEE/ASA Electronic Techniques in Biology and Medicine,** Shoreham Hotel, Wash., D.C.

**Nov. 14-17—Second International Automation Exposition,** Chicago Navy Pier, Chicago, Illinois.

**Dec. 10-16—International Atomic Exposition,** Cleveland Public Auditorium, Cleveland, Ohio.

**Dec. 12-16—Nuclear Science and Engineering Congress,** sponsored by the Engineers Joint Council, Cleveland, Ohio.

**Jan. 9-10, 1956—Second National Symposium on Reliability and Quality Control in Electronics,** sponsored by the Professional Group on Reliability and Quality Control of the IRE, co-sponsored by the American Society for Quality Control and the RETMA.

**Jan. 19-21, 1956—National Simulation Conference,** sponsored by the Dallas-Fort Worth Chapter of the IRE Professional Group on Electronic Computers (PGEC), Dallas, Texas.

**Jan. 30-Feb. 3, 1956—AIEE Winter General Meeting,** Statler Hotel, New York, N.Y.

**Feb. 2-3, 1956—Symposium on Microwave Theory and Techniques,** Univ. of Pennsylvania, Phila., Pa.

**April 15-19, 1956—The 34th annual convention of the National Association of Radio and Television Broadcasters,** Conrad Hilton Hotel, Chicago, Ill.

**April 17-19, 1956—Fourth National Conference on Electromagnetic Relays.**

**May 14-16, 1956—National Aeronautical and Navigational Electronics Conference,** Dayton, Ohio.

**Aug. 15-17, 1956—IRE/AIEE/IAS/ISA National Telemetering Conference,** Statler Hotel, Los Angeles, Calif.

**Aug. 21-25, 1956—WESCON**

**Oct. 1-3, 1956—National Electronics Conference.**

**Oct. 15-17, 1956—IRE/RETMA Fall Meeting,** Hotel Syracuse, Syracuse, New York.

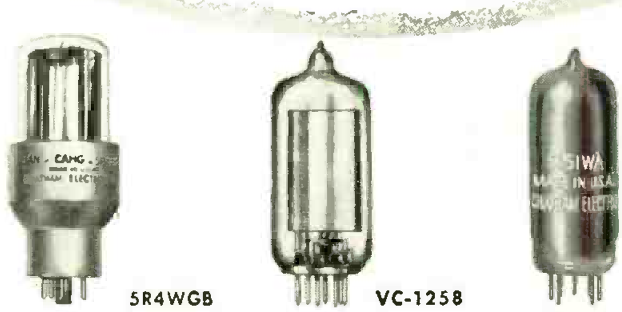
**MORE NEWS on page 34**

# CHATHAM advance-designed yesterday — in industry-wide use today!


**AMPLIFIERS • REGULATORS • INERT GAS AND MERCURY RECTIFIERS • MERCURY, INERT GAS AND HYDROGEN THYRATRONS**


6336

# CHATHAM
## SPECIAL-PURPOSE
# TUBES


5R4WGB VC-1258 5651-WA

**3B28 RECTIFIER**
Rugged half-wave Xenon filled rectifier. Operates in any position. Ambient temperature range −75° to +90°C. Inverse peak anode voltage 10,000, average current .25 amps. Filament 2.5v., 5 amp.

**4B32 RECTIFIER**
Ruggedly built, half-wave Xenon filled rectifier. Ambient temperature range −75° to +90°C. Inverse peak anode voltage 10,000, average anode current 1.25 amp. Filament 5v., 7.5 amp.

**VC-1258 MINIATURE HYDROGEN THYRATRON**
for pulse generation. Handles 10 kw peak pulse power.

**6336 TWIN TRIODE**
for voltage regulation. Features high plate dissipation, hard glass envelope.

**5R4WGB RECTIFIER**
Full wave rectifier manufactured to MIL-E-1B reliable tube specifications.

**5651-WA VOLTAGE REFERENCE TUBE**
Stable, rugged. Available in both commercial or reliable tube MIL types.

*STANDARD TYPES DIRECT FROM STOCK*
*PLUS SPECIAL DESIGNS BUILT TO REQUIREMENTS*

Chatham specializes in the development of general and special purpose tubes for both electronic and industrial applications. Many of the tubes originally developed by Chatham to fill a specialized need, now number among the most widely used tubes in the industry. For complete information on Chatham tubes—either stock items or types built to your requirements—call or write today.

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For product information, use inquiry card on last page.

# TELE-TIPS

**THE RUGGED INDIVIDUAL** who hates to work with others has no place as an electronic engineer, pointed out Dr. Mervin J. Kelly, Bell Labs' president, recently in a magazine article, "Should Your Child Be An Electronic Engineer?" More and more, Dr. Kelly said, electronic engineering has become dependent on teamwork. He added that the following characteristics should be looked for in youths choosing the science field: a scientific bent, a liking for math and physics, a fascination for experiments and a painstaking, intelligent, honest and open mind.

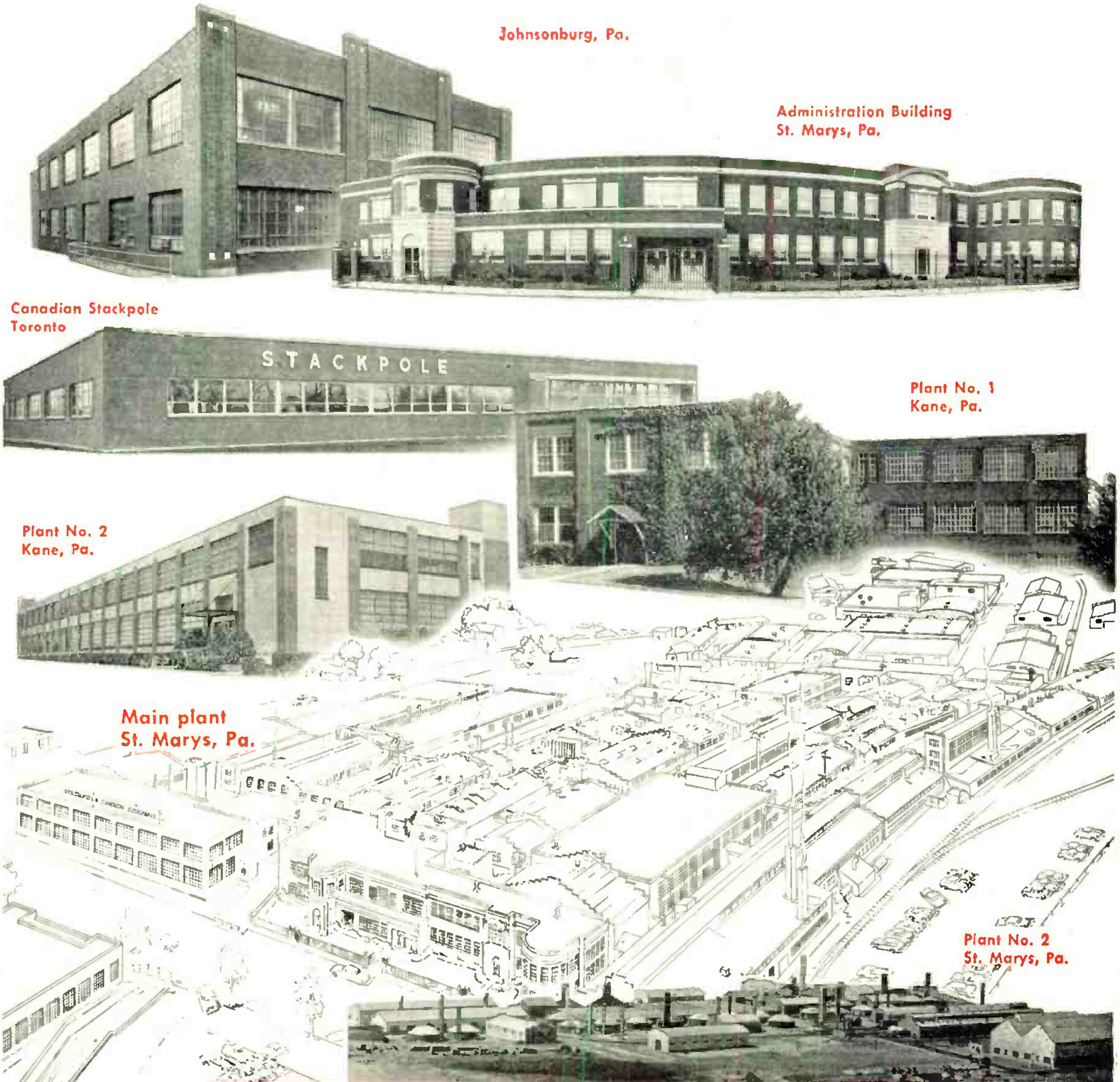
**ELECTRONIC DICTIONARIES** which turn months of problem preparation time into a matter of minutes have been developed for Remington Rand's Univac system. Actually an automatic programming system, the new development is claimed to do away with the tedious and time-consuming work of coding, writing and checking programs of instruction for electronic computers.

**NEW GUNFIRE CONTROL** equipment manufactured by Daystrom Inc. for the U.S.S. New Jersey weighs 11 tons, incorporates more than 32,000 parts and require more than 18,000 electrical connections. Navy sees it as the answer to tracking high speed jets.

**AUTOMATIC WAREHOUSING** system that operates by means of electronic controls is being demonstrated at the Colmar, Pa. plant of Link-Belt Co. In response to signals from punched cards, the carriers of an overhead trolley conveyor are tripped to discharge packages to any number of chutes in which are accumulated orders for various customers.

**A BILLION OPERATIONS** without maintenance is the claim for the new mercury-wetted contact relays being manufactured by C. P. Clare Co. for use in high-speed switching devices.

(*Continued on page* 40)

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SLIDE AND LINE SWITCHES • CERATAB® PRINTED COMPONENTS
MOLDED COIL FORMS • CERAMAGNET® PERMANENT MAGNETS
BRUSHES FOR ALL ROTATING ELECTRICAL EQUIPMENT
ELECTRICAL CONTACTS • POWER TUBE ANODES
. . . and dozens of carbon, graphite and metal powder specialties

Electronic Components Division, STACKPOLE CARBON CO., St. Marys, Pa.


For product information, use inquiry card on last page.

# *If you want "Trouble-Free" fuses in all sizes and types —*
# TURN TO BUSS!

You can depend on BUSS fuses to operate properly under all service conditions. This means that BUSS fuses will open and prevent further damage to your customers' equipment when there is trouble on the circuit.

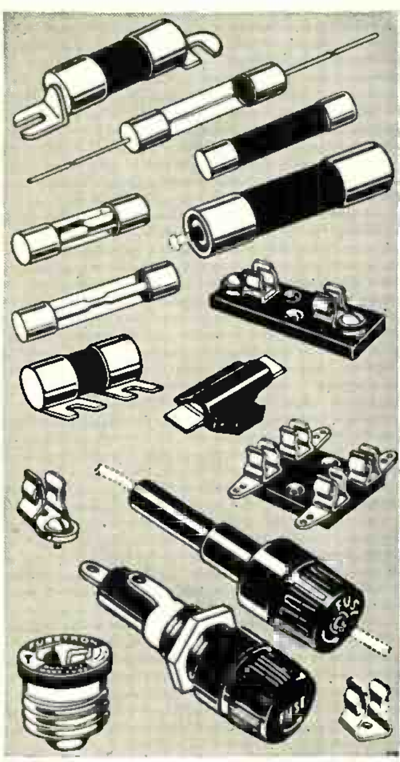
And just as important, BUSS fuses won't blow when trouble doesn't exist. Users are not annoyed with useless shutdowns caused by needless blows.

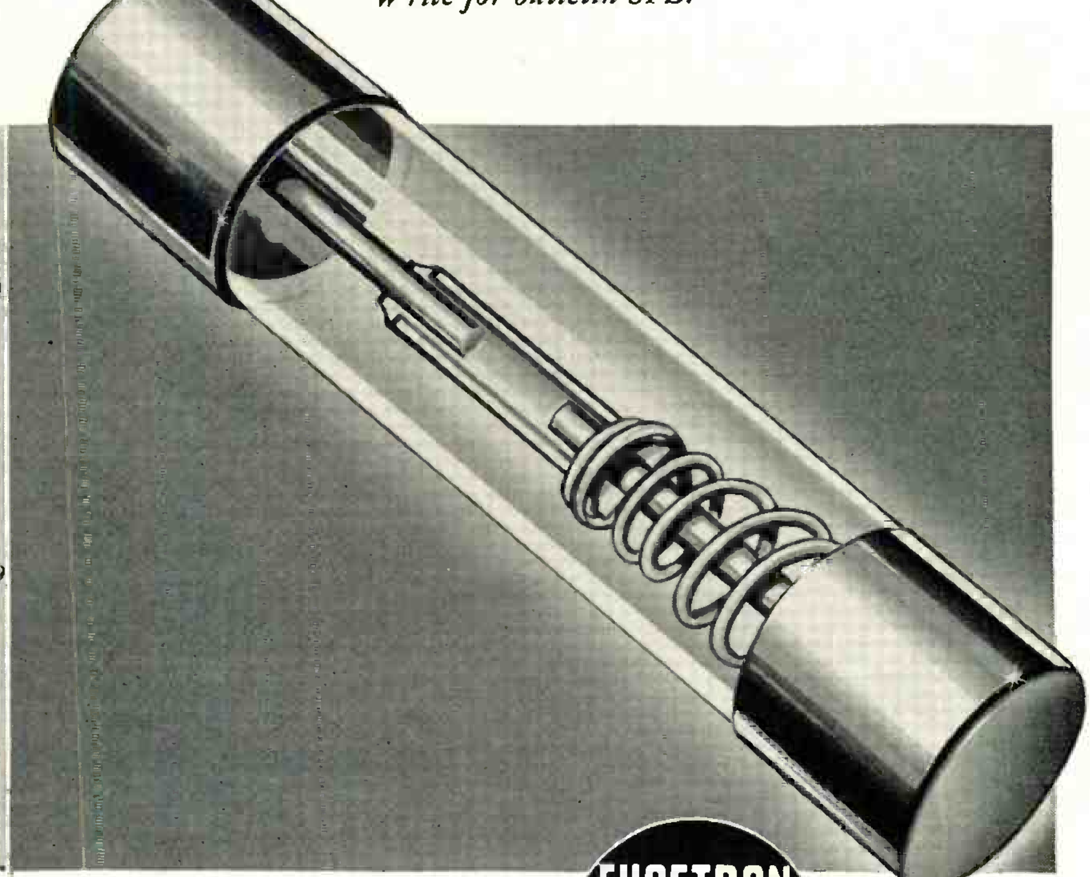
To make sure of this "trouble-free" operation — every BUSS fuse normally used by the Electronic Industries is tested in a sensitive electronic device. Any fuse not correctly calibrated, properly constructed and right in all physical dimensions is automatically rejected.

**A complete line of fuses is available.** Made in dual-element (slow blowing), renewable and one time types . . . in sizes from 1/500 ampere up — plus a companion line of fuse clips, blocks and holders.

When it's a fuse you need — think first of BUSS. You will be protecting both the product and your good name against troubles and complaints often caused by use of poor quality fuses.

*For more information on BUSS and FUSETRON small dimension fuses and fuseholders . . . Write for bulletin SFB.*





855

Makers of a complete line of fuses for home, farm, commercial, electronic, automotive and industrial use.

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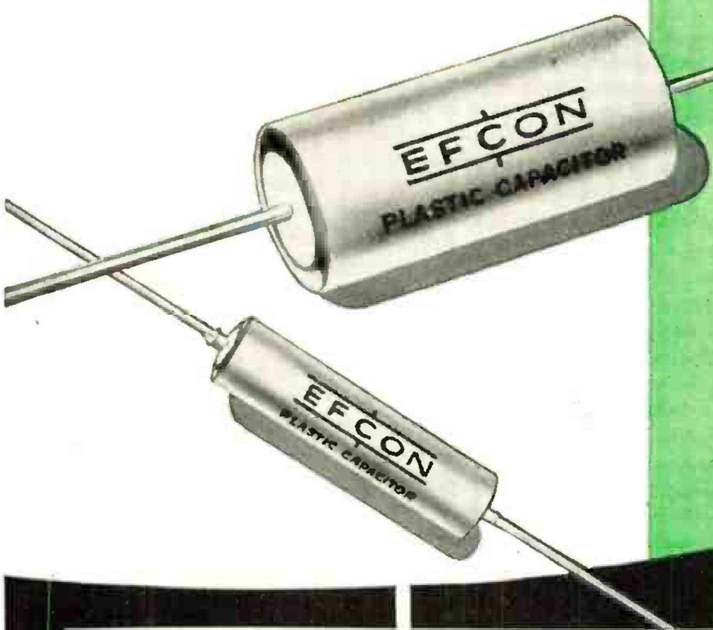
for quality...
specify...

# EFCON POLYSTYRENE

## CLOSE TOLERANCE




# MINIATURE CAPACITORS

EFCON Polystyrene Miniature Capacitors have become in two brief years the *standard* for the electronics industry . . . wherever *close tolerances* are important. They have proven exceedingly successful for filters, timing circuits, precision instruments, analog and digital computors . . . plus many other applications.

EFCON *Close Tolerance* Polystyrene Capacitors are mass produced in two styles: Type PC has a rigid cardboard tube construction: Type PH is hermetically sealed in a metal case with glass-to-metal, solder-sealed terminals. Both types feature non-inductive extended foil construction with leads soldered directly to the foil . . . assuring minimum contact resistance.

Thanks to advanced engineering and special production techniques . . . EFCON Polystyrene Capacitors are consistently made to tolerances closer than ±1%. They are available in a range of standard capacitance values from .001 to 2 Mfd. Non-standard values are made to customers' specifications.

EFCON

*...where close tolerance is standard tolerance*

## PERFORMANCE DATA

EFCON Close Tolerance Polystyrene Capacitors provide excellent stability over an extended temperature range . . . along with an extremely high insulation resistance ($10^{12}$ ohms at 25°C). They have a negative temperature coefficient of less than −100 PPM/°C). In addition to a very low dielectric absorption . . . EFCON Polystyrene Capacitors feature the lowest dissipation factor of any film capacitor. They are tested at a DC voltage of at least 250% of rated voltage at 25°C.

### OTHER EFCON CAPACITORS

**Type TH** "Teflon"* Film Capacitors . . . for high temperature applications. Hermetically sealed.

**Type MH** "Mylar"* Film Capacitors . . . hermetically sealed in metal cases and mass produced with tolerances of ±5%, ±2% and ±1%.

**Type MC** "Mylar"* Film Capacitors . . . made with wax impregnated cardboard tubes.

**Type S** Molded Silver Mica Capacitors.

*Write Dept. G for technical data which includes new charts describing average temperature characteristics . . . for capacitance . . . power factor . . . insulation resistance.*

*DuPont Trademark

**ELECTRONIC FABRICATORS, INC.**

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# POLARAD COLOR TV

## AN INTEGRATED LINE OF EQUIPMENT FOR STUDIO AND LABORATORY

Fully integrated units that combine ease of operation with maximum stability. No additional accessories or power units required for operation.

**Especially designed for:**

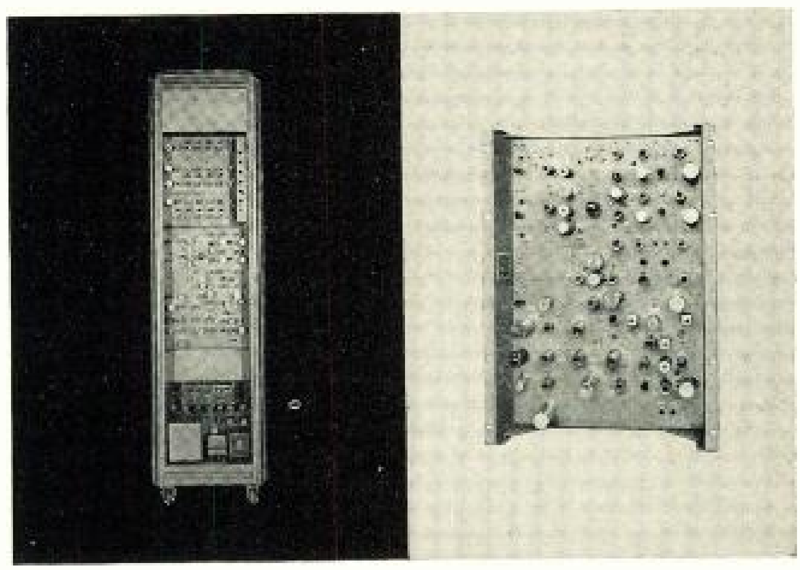
- Testing receivers, transmitters, and terminal equipment.
- Laboratory test standards for development of color TV equipment.
- Checking components used for color TV.
- Alignment and adjustment of colorplexers or encoders.
- Testing convergence of tri-color kinescopes.

**COLOR BAR GENERATOR — MODEL PT-203**

A complete instrument with a color bar pulse forming unit, a complete colorplexer unit and regulated B+ and filament supplies. Provides NTSC color TV test signals, for receivers, transmitters, networks and components. Internal switching provides 19 different test patterns in the form of a composite NTSC video signal. Special self-balancing colorplexer provides exceptional stability over long periods of operation without readjustment, with "I" and "Q" outputs. (See colorplexer details.)

**AUTO-SELF-BALANCED COLORPLEXER MODEL PT-205**

Incorporated in the Model PT-203 Color Bar Generator, available as a separate chassis for rack mounting. Designed for high stability and negligible drift, this unit replaces old encoder units of early design. This instrument multiplexes three simultaneous color video signals (R, G, B) and properly encodes them into color information and then combines them with sync pulses and color sync signals to form a standard NTSC color TV signal. Pulse or video signals to drive colorplexer may be obtained from special (R, G, B) pulse generators, color camera or color slide scanner. Subcarrier balance is stable and dynamically independent of signal level changes over long periods of operation. Driving signals are Subcarrier, Blanking, Sync and Vertical pulses. Full bandwidth "I" and "Q" modulation is used in the chrominance channel of the colorplexer. "I" and "Q" or "B-Y" and "R-Y" video test signals are available for receiver and monitor matrix alignment. Both positive and negative polarity signals are available at high and low impedance.



**COLOR BAR GENERATOR—MODEL PT-203**

Output Signals: NTSC Composite Video 2 Outputs 0—1.4 v. pk-pk
Output Signal Information:
Color Bars—6 Bars of Color (R, G, B, C, Y, M) plus Blk/Wht
Gamma Bars—10 step grey scale Black to White
Dots—White dots on a black field
External Video—Positive or negative (Provision for mixing ext. video with above).
System Bandwidth: Luminance Channel 6 mc
Chrominance: "I" and "Q" Channel per NTSC standard
Subcarrier balance stability: Drift not greater than 6 mv (1.4 v. pk-pk signal), 8 hour operation.
Residual Subcarrier Unbalance: 1% Signal Level
Power Requirements: AC 105-125 volts 7 amps., 60 cps.

**COLORPLEXER-MODEL PT-205**

Output Signals: NTSC Composite Video 2 Outputs 0—1.4 v. pk-pk
Available Test Signals: I, Q, Y, R-Y, B-Y, (Neg. and Pos.) Video
Input Signals: Subcarrier 20-30 v. pk-pk, 3.579545 mc
Sync. 3.0 v. pk-pk, negative
Vertical Drive 3.0 v. pk-pk negative, R, G, B; 1 v. pk-pk
System Bandwidth: Luminance Channel 6 mc
Chrominance: "I" and "Q" Channel per NTSC standard
Subcarrier Balance Stability: Drift not greater than 6 mv (1.4 v. signal), 8 hour operation
Power Requirements: AC 6.3 v. @ 12 amps., DC 280 v. @ 470 ma

POLARAD PROVEN RELIABILITY

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**SYNCHRONIZING GENERATOR — MODEL PT-201**

Compact unit provides RTMA standard driving, blanking and synchronizing pulses, as well as a composite video signal comprising vertical and horizontal dots for receiver tests (positive and negative). Used to drive color bar generators, or any other NTSC color TV generating equipment. Utmost stability assured through use of delay lines and by driving all pulses from leading edge of a crystal controlled oscillator. Unit may also be locked to synchronize with 60 cps line. External drive input jack permits operation with Color Subcarrier Generator. Complete with power supply.

**COLOR SLIDE SCANNER — MODEL PT-210**

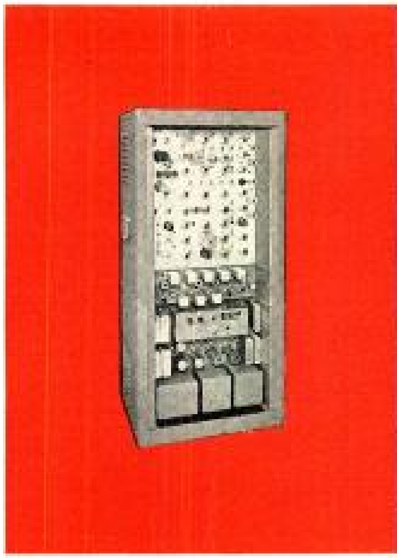
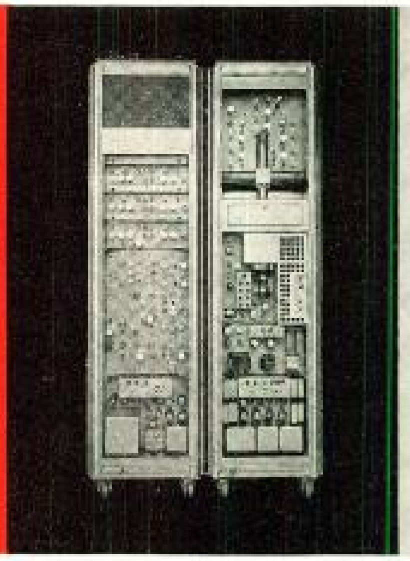
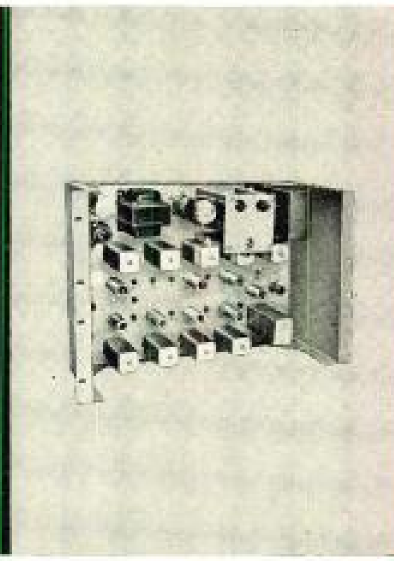
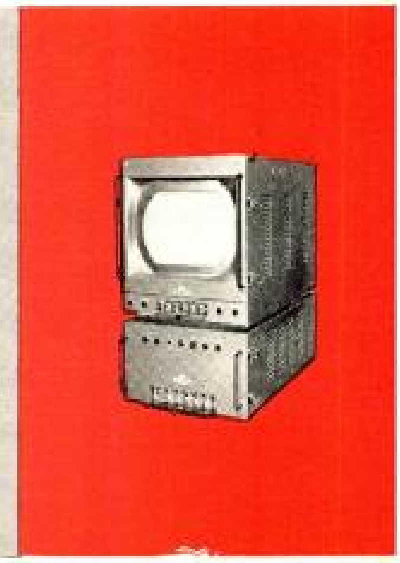
A complete equipment integrated into only two racks which provides a high resolution NTSC composite color video signal obtained from standard 2 x 2 (35mm) transparencies. Designed for maximum stability and high signal to noise ratio. The optical head is complete with lenses employing IN-LINE dichroic mirrors and Fresnel condensing lenses. The R, G, B signals obtained from three channel photo amplifiers are gamma corrected to give proper rendition to high lights and shading. Utilizes a highly stabilized colorplexer. (See complete description of Model PT-205 Colorplexer above.)

The scanning kinescope has fine resolution and is combined with the deflection and high voltage unit. The remaining chassis components contain regulated low voltage power units, a regulated filament power unit and a regulated photo multiplier power supply.

**COLOR SUBCARRIER GENERATOR AND FREQUENCY DIVIDER UNIT — MODEL PT-202.** This rugged unit complete with regulated B+ and filament power provides standard NTSC subcarrier frequency with dual outputs and includes a frequency divider to provide a sync generator driving signal (31.5 KC) to convert standard B/W sync generators for color TV use. High stability achieved by temperature controlled crystal oscillator. All adjustments accessible at front of unit. Adapts any sync generator to NTSC color operation.

**COLOR TV VIDEO MONITOR — MODEL M-200**

Two portable units supplied with brackets for standard rack mounting. High definition color picture with exceptionally good color rendition is displayed on a 15 inch tri-color kinescope. Excellent for checking the quality of NTSC color video signals in the studio, on transmission lines or in the receiver factory. Special test jacks and switches are provided for analyzing R, G, B signals, matrixing and phase of color signals. Exceptionally good synchronizing capabilities over a wide range of signals. Special convergence circuits are employed to give maximum utilization of color kinescope. Model M200 has good color stability and is relatively insensitive to line voltage changes. Excellent dynamic circuit linearity assures good color stability over a wide range in signal level.

**SYNCHRONIZING GENERATOR— MODEL PT-201**

Output Signals: Sync. (Neg. and Pos.) 4 v. pk-pk across 75 ohms
Blanking (Neg. and Pos.) 4 v. pk-pk across 75 ohms
Horiz. Drive (Neg. and Pos.) 4 v. pk-pk across 75 ohms
Vert. Drive (Neg. and Pos.) 4 v. pk-pk across 75 ohms
Composite Video Output (Neg. and Pos) 1.4 v. pk-pk across 75 ohms
Internal Dot Pattern or External Video—1.4 v. pk-pk across 75 ohms
Input Power: 105-125 v. 4.5 amps., 60 cps.

**COLOR SLIDE SCANNER— MODEL PT-210**

Output Signals: NTSC Composite Video 2 Outputs 0—1.4 v. pk-pk
Optical Head: Lens—F. 2.0 50 mm, Xenon lens in tractica mount
IN-LINE dichroic mirrors
Color Slide 2 x 2 color Transparencies
Gamma Amplifier:
Three Channels (R, G, B)
Input Signal—1.4 v. pk-pk across 75 ohms
Output Signal—1.4 v. pk-pk across 75 ohms
Colorplexer: (See Model PT-205 above)
Deflection and High Voltage Unit: Kinescope type 5AUP24;
Operating Voltage: 27 KV regulated
Linearity: 2% across raster Horizontal and Vertical
Photomultiplier Power Supply: Electrically regulated. Filament Supply—AC line Regulated
Input Signals: Hor. Drive—3 v. pk-pk Ver. Drive—3 v. pk-pk. Blanking Drive—3 v. pk-pk Sync. 3 v. pk-pk
Power Requirement: AC 105-125 v., 16 amp., 60 cps.

**COLOR SUBCARRIER GENERATOR AND FREQUENCY DIVIDER UNIT—MODEL PT-202**

Subcarrier Frequency Dual Output: 3.579545 mc/sec. ± 0.0003% with maximum rate of frequency change not exceeding 1/10 cps./sec.
Subcarrier Output Voltage: 25 to 40 volts
Frequency Divider Output: 31,468 cps.
Divider Output Voltage: 0 to 100 volts
Ambient Temperature: 40° F. to 110° F.
Power Requirements: AC 105-125, 2A, 60 cps.

**COLOR VIDEO MONITOR—MODEL M-200**

Input Video Signal: 0.5 to 2.0 volts, pk-pk
Signal Polarity: Pos., Neg., Bal.
Input Impedance: 66 mmf across 2.2 megohms or 75 ohms
Resolution: 250-300 lines min. (Full utilization of NTSC Color Signal Bandwidth)
Linearity: (Hor. and Vert.) 2% across raster
Tricolor Kinescope: 15″
Focus: Electro Static
Net Weight: 175 lbs.
Power Requirements: 105-125 v., 4 amps., 50/60 cps.

**AVAILABLE ON EQUIPMENT LEASE PLAN**

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For product information, use inquiry card on last page.

# TELE-TIPS

(*Continued from page* 34)

**LEARNING TO LISTEN.** A group of ambitious adults in Philadelphia are going back to school to learn how to become better listeners. Listening, according to school director C. L. Scheetz, is the most abused and neglected tool of man-to-man communication. So 100 employees of Minneapolis-Honeywell's Industrial Division are participating in a comprehensive training program which covers all phases of communications: listening, writing, reading and speaking.

**THE INTERNATIONAL ORGANIZATION FOR STANDARDIZATION**, at a five-day meeting held recently in Stockholm on Cinematography, adopted several proposals to help further international exchange of film products. Safety film definition and methods of testing were agreed upon as well as a U.S. proposal for the cutting and perforating of 35mm film for use in Cinemascope.

**SUPERSONIC VIBRATIONS** may be the answer to a problem which has intrigued scientists for many years—how to tap the ocean's supply of plankton, microscopic sea life. The plan, proposed by a young Worcester Polytech Inst. student, is to pump sea water through a cylindrical crystal at the precise frequency necessary to cause the tiny particles to collide with one another, to bunch up and to stick together.

**KODAK OPAL PAPER**, V, is proving to be a real boon to photographers making prints for reproduction on TV. Suede surface on this paper adds to the illusion of depth and provides a surface which is virtually reflection-free. The latter is of prime importance when a print is to be placed in front of the camera.

**TV TUBE SURVEY** of 150 different TV receivers used in 1954 and 1955, revealed 119 different tube types found to be in use in these sets. This was the result of a survey conducted recently by G. E. Co. to insure availability of replacements in the G.E. tube line.

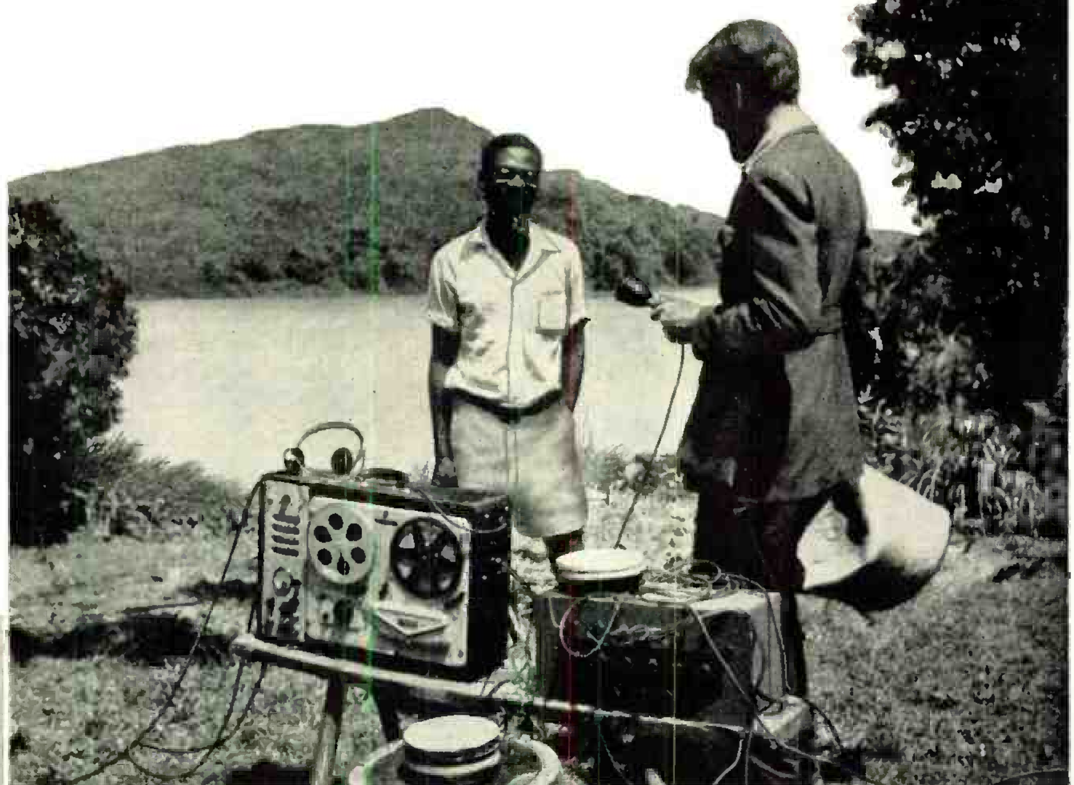
(*Continued on page* 44)

# African Torture Test

## proves L onger R ecording audiotape

## immune to extreme heat and humidity

"The Ituri Forest provides the worst possible conditions for recording work. Our camera lenses grew mushrooms, even on the inner surfaces. All leather molded in four days. Our acetate-base tapes became unuseable. But the LR Audiotape always unwound without sticking and showed no tendency to stretch or curl."



**Colin M. Turnbull,** noted explorer, made the above comments on his recent return from a year-long recording expedition through the arid deserts and steaming jungles of Africa, where Audiotape on "Mylar" polyester film was subjected to the "worst recording conditions in the world." Its performance speaks for itself.

Here's positive proof that all hot-weather recording problems can be entirely eliminated by using the new LR Audiotape on Mylar* polyester film.

During his trip from Morocco to East Africa, through the Gold Coast and the Congo, Mr. Turnbull recorded 45,000 ft. of Audiotape on 1 and 2 mil "Mylar". Not an inch of it gave any trouble, either in desert sun (125° temperature, 25% humidity) or in the Congo forests (85° temperature, 90% humidity).

That's a real torture test for tape and proof of the superiority of the new, longer recording Type LR Audiotape. Made on tough but thin 1-mil "Mylar", it gives you 50% more recording time per reel, yet is actually far *stronger* than 1½-mil acetate-base tape under humid conditions. For better recording in *any season*, ask your dealer for "Mylar" Audiotape—now available in 1, 1½ and 2 mil base thickness. Write or ask for a copy of Bulletin No. 211 containing complete specifications.

Table I — TESTS AT 75°F, 50% RELATIVE HUMIDITY

| | Yield Strength | Breaking Strength |
|---|---|---|
| 1 mil Acetate | 3.7 lb. | 3.9 lb. |
| 0.9 mil "Mylar" | 4.2 lb. | 7.6 lb. |
| 1.45 mil Acetate | 5.0 lb. | 5.5 lb. |

Table II — TESTS AT 75°F, 90% RELATIVE HUMIDITY

| | Yield Strength | Breaking Strength |
|---|---|---|
| 1 mil Acetate | 1.8 lb. | 2.5 lb. |
| 0.9 mil "Mylar" | 4.1 lb. | 7.6 lb. |
| 1.45 mil Acetate | 3.0 lb. | 4.1 lb. |

The above test data, taken under conditions of both winter and summer humidity, show the marked superiority of 1-mil "Mylar," not only over the thin cellulose acetate base, but over the standard 1.45-mil acetate as well.

**AUDIO DEVICES, Inc.**

444 Madison Avenue, New York 22, New York
Offices in Hollywood — Chicago
Export Dept., 13 E. 40th St., N.Y. 16, N.Y., Cables "ARLAB"

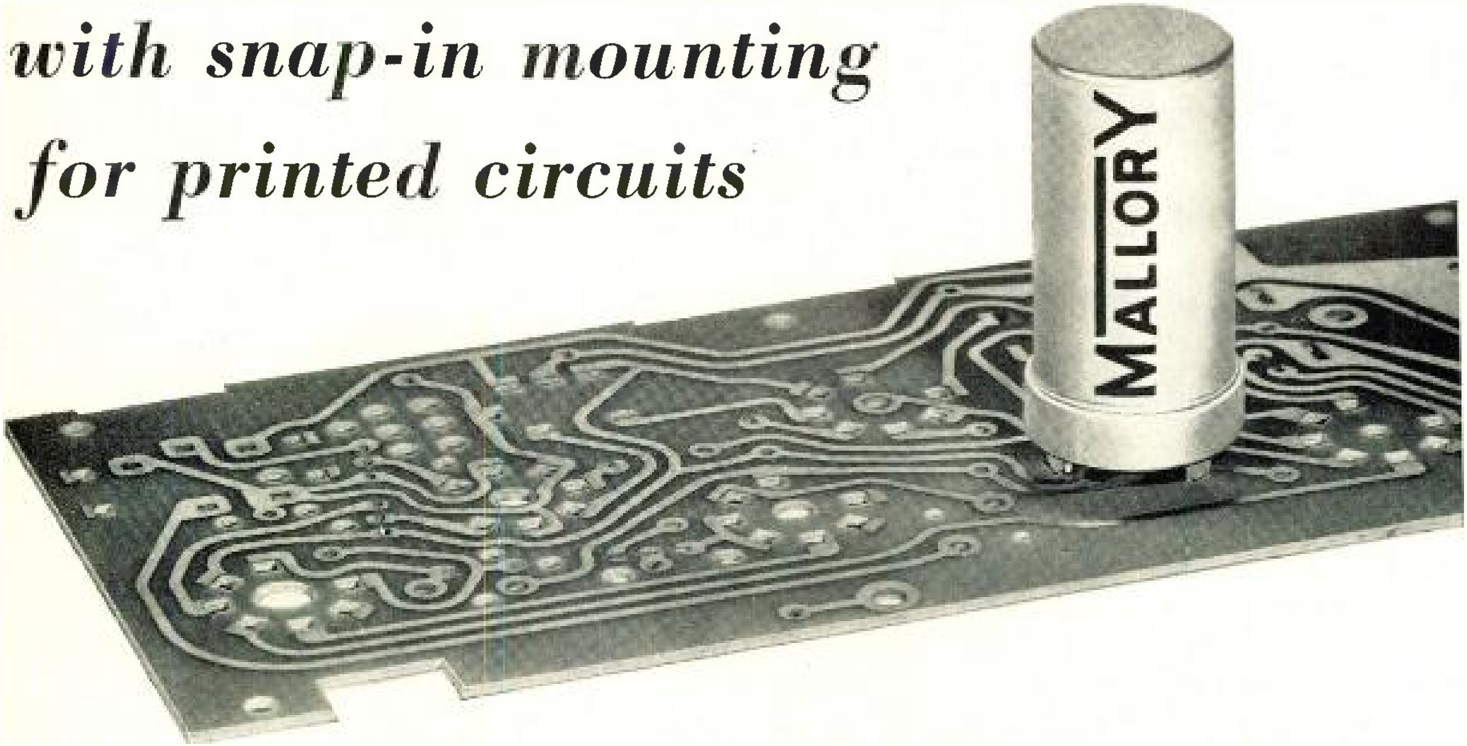
*DuPont Trade Mark

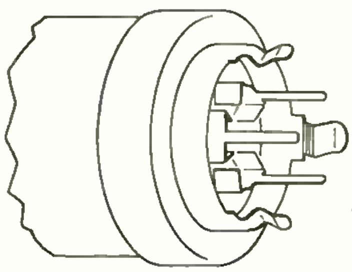


For product information, use inquiry card on last page.

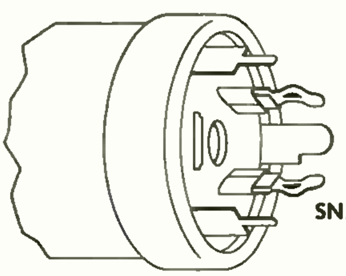
# New MALLORY FP Capacitors

## *with snap-in mounting for printed circuits*



SNAP-IN MOUNTING TABS



SNAP-IN TERMINALS

If you are using printed circuits, Mallory can supply electrolytic capacitors with the terminal construction you need. During nearly two years of developing and manufacturing capacitors especially for printed circuit use, Mallory has created a diversified group of designs that cover most applications.

The latest additions to the line of FP Capacitors for printed circuits are designed for snap-in mounting. Just push the capacitor into its slots in the circuit panel, and spring-formed tabs hold it in place, ready for soldering.

You have a choice of either snap-in mounting tabs or snap-in terminals. In addition, you can select models with straight tabs and terminals. All are available in six-slot or eight-slot terminal configurations.

*Keyed tabs* make mounting foolproof.

*Circuits can be printed on both sides.* Shoulders on the mounting tabs hold the capacitor case clear of the printed sheet. Clearance ranges up to .137″.

*Positive soldering.* Possibility of aluminum contamination is eliminated because the connections from the foil stop well short of the solder area.

Added to these time-saving design features are the superior electrical characteristics and long life at high temperatures which have made Mallory FP Capacitors the standard of performance throughout the industry. Write or call us today for technical data, and for an analysis of your circuit requirements by a Mallory capacitor engineer.


### MALLORY Metal Tubular Electrolytics for Printed Circuits

In addition to the FP line of capacitors, Mallory produces a special series of metal tubular electrolytics for printed circuits. One terminal is a bare wire, and the other a flat tab for orientation. Write or call for technical data and available ratings.

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NUMBER 3 OF A SERIES


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# TELE-TIPS

(*Continued from page* 40)

**PRINTED CIRCUITS** assembled by automation have eliminated 425 hand soldered connections from Admiral Corp's new TV receivers.

**AN EARMUFF** that fits over the head like a phone set and covers each ear to muffle sound of every frequency, has been developed at Worcester Polytechnic Institute by Prof. William D. Wadsworth, several graduate students, and the David M. Clark Co. It is useful in jet engine testing where sound alone can vibrate the leather soles on a man's shoes.

**PARACHUTES** are in great demand today if they can withstand the pressures for which they are being put to use in the aviation industry, according to a report of the Air Force's Wright Air Development Center. Used in the recovery and operation of guided missiles, and used for deceleration of near sonic and supersonic aircraft, the present so-called "marginal" materials are fast creating the need for better and stronger parachute materials.

**MATHEMATICIANS ASSOCIATED** with Cook Labs had this to say on earthquakes and music: "If 5000 Earthquake records are sold each week for 50 weeks per year for 5 years, a statistical analysis will show that the moment must arrive when exactly 97,256 hi-fi systems or more will play the earthquake together. At this time, if the woofers are in phase, the western hemisphere should disintegrate. This is High Fidelity's answer to the Hydrogen bomb.

**SCRAP-HAPPY** Poles are a headache to their Communist government officials. The Voice of America quotes a Polish provincial newspaper as reporting that unknown parties in the small seaport city of Szczecin (Stettin) are cutting up telephone cables and selling them for scrap. Particular damage is being done to the local government's inter-agency phone system.

(*Continued on page* 50)


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Selenium Rectifiers
high voltage cartridges
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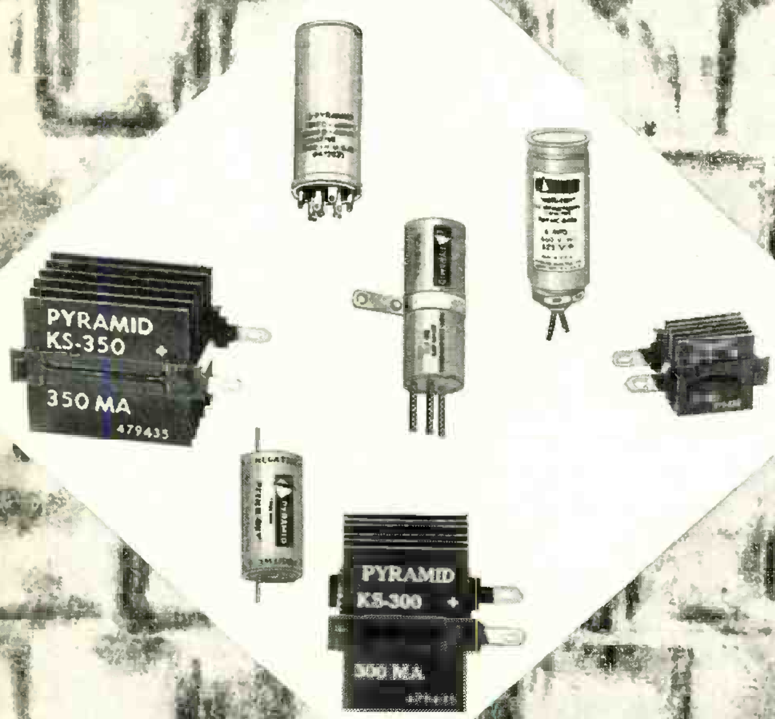


# these INDUSTRIAL JOBBERS offer A COMPLETE LINE of PYRAMID capacitors and rectifiers

In your design development and your pilot production even minutes an be important. For your convenience the jobbers listed at the right carry in stock a complete assortment in adequate quantities of Pyramid's line of highest quality electrolytic and paper capacitors, both commercial and MIL-C-25B types, metallized paper capacitors and a complete range of *Kool-sel* selenium rectifiers, the first new design in over 20 years.

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**Arrow Electronics, Inc.**
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**Art Electronic Supply Co.**
145 South Park Street, Tucson, Arizona

**Burstein-Applebee**
1012-14 McGee Street, Kansas City 6, Missouri

**California Electronic Supply, Inc.**
11801 W. Pico Boulevard, West Los Angeles 64, Calif.

**Capitol Radio Wholesalers, Inc.**
2120 Fourteenth Street, N.W., Washington, D. C.

**Cramer Electronics, Inc.**
811 Boylston Street, Boston 16, Massachusetts

**Dalton-Hege Radio Supply Co.**
924 W. Fourth Street, Winston-Salem, North Carolina

**Dean's Electronics**
969 American Avenue, Long Beach, California

**Durrell Distributors**
222 Mystic Avenue, Medford, Massachusetts

**East Coast Radio & Television**
1900 N. W. Miami Court, Miami 36, Florida

**Electronics Center, Inc.**
211 West 19th Street, New York, New York

**Electronic Equipment Distributors**
1228 Second Avenue, San Diego, California

**Federated Purchaser, Inc.**
66 Dey Street, New York, New York

**Herbach & Rademan, Inc.**
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**Hughes-Peters, Inc.**
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227 Fulton Street, New York, New York

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**Lukko Sales Corp.**
5024 West Irving Park Road, Chicago, Illinois

**Milgray Electronics, Inc.**
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**Milo Radio & Electronics**
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**Newark Electric Co.**
23[illegible] West Madison Street, Chicago, Illinois

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**Peerless Radio Distributors**
92-32 Merrick Road, Jamaica 33, New York

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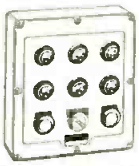
TINNERMAN Speed Nut SAVINGS STORIES

## Time-saver, space-saver, money-saver ...Tinnerman tubular SPEED CLIP®!



Here's how the General Electric Company is keeping costs and space requirements low on its G-E oiltight Indicating Lights. They use Tinnerman tubular-type SPEED CLIPS to assemble the resistor to its support. This one-piece, spring-steel fastener reduces assembly time, material costs, parts handling and inventory by eliminating a long bolt, centering washer, lock washer and nut. It also reduces the dimension across the resistor support and saves valuable space when the lights are used close to pushbuttons and other components.

A wide variety of types and sizes of tubular-type SPEED CLIPS are used on everything from toys to autos—on metal, plastic or wood. They snap into punched or molded holes by hand; are self-retained in stud-receiving position. SPEED CLIPS are also ideal for blind attachments where only one side of an assembly is accessible.

Possibly Tinnerman SPEED NUT brand fasteners can help you improve your present fastening methods. See your Tinnerman representative soon and write for your copy of "SPEED NUT Savings Stories".

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*Canada:* Dominion Fasteners, Limited, Hamilton, Ontario. *Great Britain:* Simmonds Aerocessories, Limited, Treforest, Wales. *France:* Aerocessoires Simmonds, S. A., 7 rue Henri Barbusse, Levallois (Seine). *Germany:* Hans Sickinger GmbH "MECANO", Lemgo-i-Lippe.

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# COPPER-CLAD PHENOLITE

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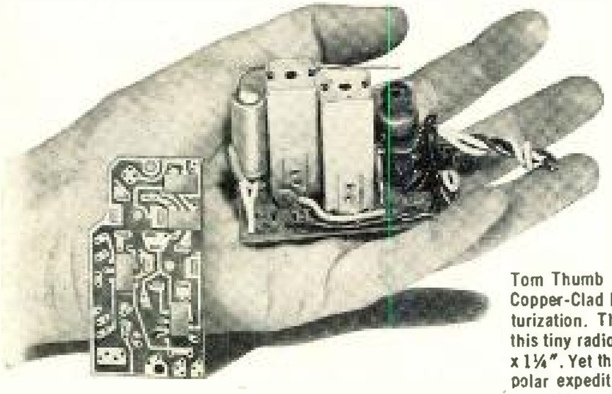
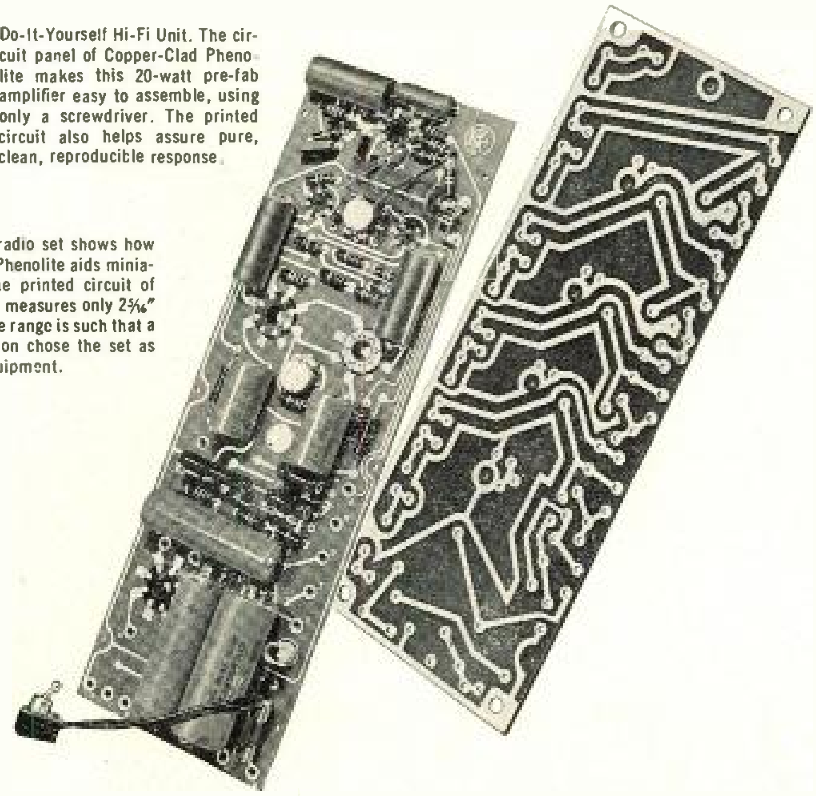
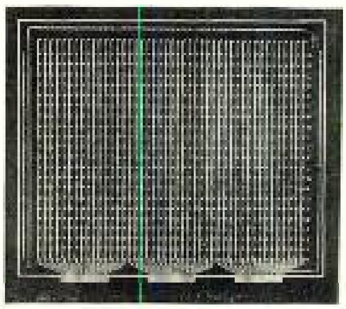


Do-It-Yourself Hi-Fi Unit. The circuit panel of Copper-Clad Phenolite makes this 20-watt pre-fab amplifier easy to assemble, using only a screwdriver. The printed circuit also helps assure pure, clean, reproducible response.



Tom Thumb radio set shows how Copper-Clad Phenolite aids miniaturization. The printed circuit of this tiny radio measures only 2$\frac{5}{16}$" x 1$\frac{1}{4}$". Yet the range is such that a polar expedition chose the set as part of its equipment.

Printed circuit—18" x 21"—for a modern computor. The panel contains more than 1,000 through-holes for connection soldering, all of which are pierced in one operation! This shows the fine workability of Copper-Clad Phenolite and its ability to eliminate complex wiring, costly operations, expensive components.



Switch plates, commutator discs, and drum commutators with printed circuits have proved themselves in many diversified applications. Low-cost printed circuit switches are ideal for simple switching, and show up to best economical advantage in complex switching functions.

## *You know it's best for any printed circuit*

The most widely used foundation material for printed circuits is Copper-Clad Phenolite by National.

Reason? Copper-Clad Phenolite—in its many grades—possesses all the properties and characteristics demanded for the job. This scientifically compounded laminate has high dielectric and mechanical strength, resistance to heat, moisture, solvents, oils, acids, alkalies. Also, it's light in weight—easy to machine, punch, saw, drill and solder.

You can't buy a more dependable, versatile, cost-cutting material than Copper-Clad Phenolite. Write us today.

***YOUR GUIDE TO PRINTED CIRCUIT SIMPLIFICATION.*** *You'll find this booklet a most helpful tool in achieving miniaturization or automation. Complete coverage of basic technical facts and design data related to applied printed circuitry. Methods of producing printed circuits and economies in design are fully treated. For your free, personal copy of "Mechanize Your Wiring," write Dept.* K-8

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# going...

# going...



# gone!

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# TELE-TIPS

(*Continued from page 44*)

**TELEMETERED INFORMATION** from high-flying balloons is providing Air Force scientists with a picture of the electrical fields and currents produced by thunderclouds, and also on the changes caused by lightning discharges to the ground or other charged centers. The balloons are being launched from Orlando AFB, Florida.

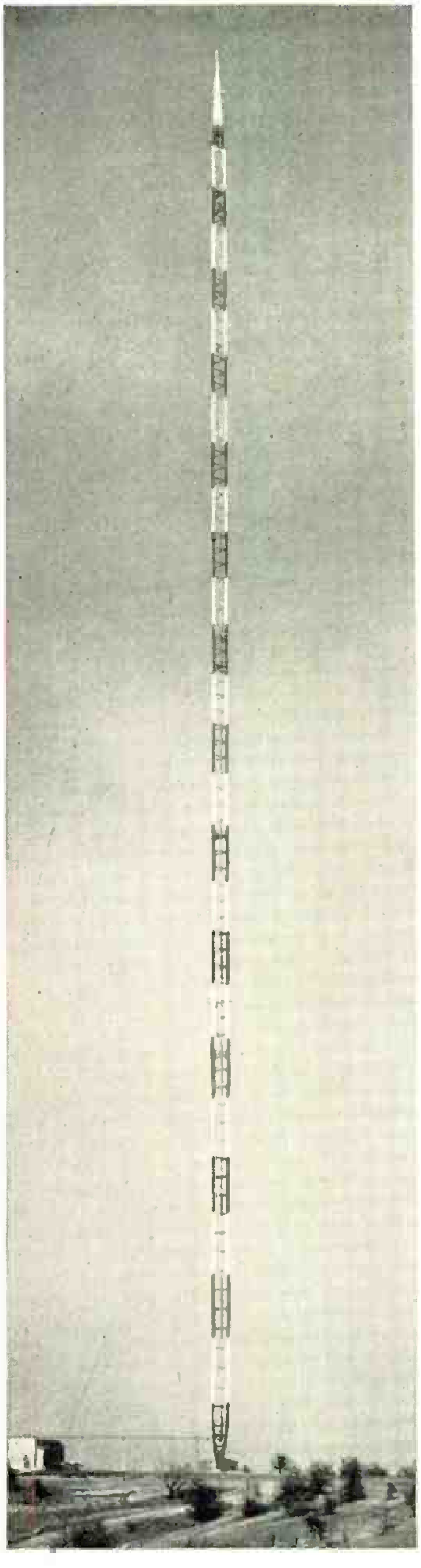
**RADIOACTIVE DIRT** is being used by scientists at Westinghouse Research Labs to determine what physical and chemical forces hold dirt to cloth and how detergents, agitation and water temperature break down these forces. Dirt is "tagged" by incorporating radioactive carbon as an ingredient, then radiation is measured before and after washing.

**NUCLEAR ENGINEERING** specialists of Minneapolis-Honeywell have designed and built a working mock-up model of an automatic electronic control system for nuclear reactors which they will exhibit at the International Atoms-For-Peace Conference to be held in Geneva, Switzerland, Aug. 8 to 20.

**THE AUDIO BUG** is breeding its own type of petty larceny. Cook Labs reports a number of cases in which customers are paying for diamond cartridges or stylii but are actually receiving sapphire. The report warns that only an expert in precious stones can distinguish the difference, then advises: avoid "bargains," and trade at a reputable dealer.

**NEW TOOL MATERIAL** that provides good tool life at speeds of 2,000 ft./min. has been developed by the Carboloy Dept. of G.E. Still in the laboratory stage, the new cutting tool is made entirely of inexpensive materials available in abundant supply.

# for tall towers talk to Truscon

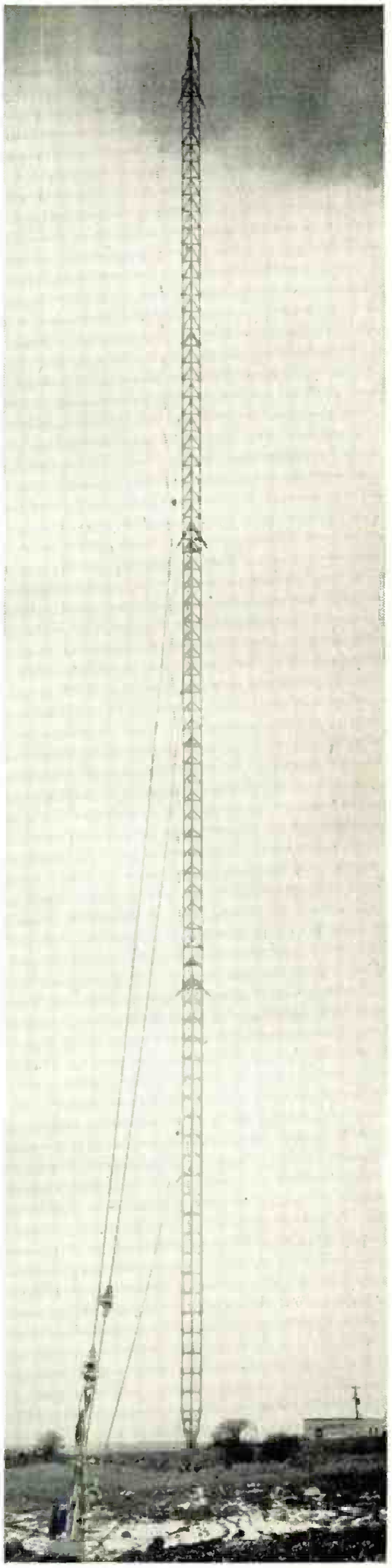


Truscon builds them tall (and small, too) for all types of topography . . . to withstand the extremes in wind and weather.

Whatever your requirements, Truscon, with modern and efficient manufacturing facilities, can create the tower you want . . . guyed or self-supporting . . . tapered or uniform in cross-section . . . for AM, FM, TV and Microwave transmission.

And no matter what forces are exerted upon them, they stay in the air to keep you on the air day-in and day-out, year-in and year-out. In recent East Coast hurricanes *not a single Truscon Tower was damaged by the terrific onslaught of high winds*—a dramatic demonstration of their great stability and dependability.

You can get this kind of dependable performance every time with a Truscon Tower. Our engineers have designed and built hundreds which today stand sturdy and straight and tall in all parts of the world. They can design one for you, too. To get your tower program started, just write or call your nearest Truscon district office or "tower headquarters" in Youngstown.



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**withstands HIGH TEMPERATURE • VACUUM IMPREGNATION**
**HEAVY WINDING STRESSES • SHOCK and VIBRATION**

This is a development which calls for immediate changes in purchasing specifications for Tape Wound Cores, because introduction of the Aluminum Core Box means designing your toroids around four important new advantages:

1. Use of an aluminum core box means the new Magnetics, Inc. tape wound cores will withstand temperatures of *at least* 450° F.
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4. Cushioned with an inert material, the tape winding in the core box is protected against vibration and shock. In most cases it is so completely minimized that it is no longer a problem.

Because of the many advantages of these new Magnetics, Inc. Tape Wound Cores, it will pay you many times over to specify "Aluminum Core Boxes" on your next order.

†PATENT PENDING

Immediately available in 109 standard sizes, using all commercially available magnetic materials.

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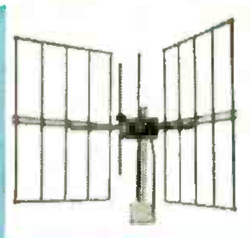

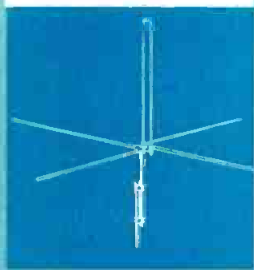

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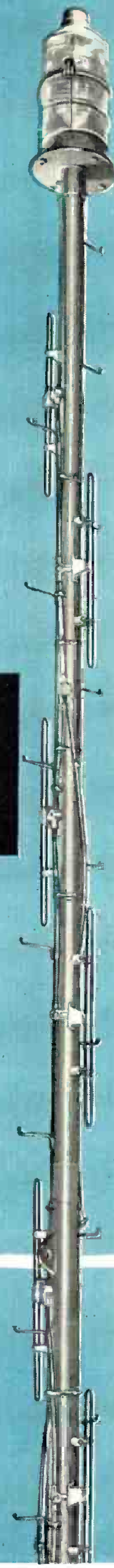
One of the less expensive components in a radio communications installation is the antenna. Yet the antenna, which usually represents less than ten per cent of the total equipment cost, can multiply the effective power of every transmitter in the system *several hundred per cent.* Equally true, a poorly designed or inappropriate antenna can waste the power produced by the costly equipment behind it.

**Manufacturers of the UNIPOLE, High Gain, Corner Reflector, Parabolic and Yagi Antennas**

In planning a new system, selection of the proper antenna often will allow a lower power transmitter to achieve desired signal range. For existing systems, the use of a higher gain antenna will reduce "dead spots."

Andrew is a pioneer in designing and developing antennas. We make over 30 standard types for microwave, broadcast and mobile communications. Special models or adaptions of standard models are readily made to order.

Write or phone Andrew for a dollars-and-cents evaluation of the type of antenna that can give your installation the greatest bargain in power.



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# NEW R-C Oscillator

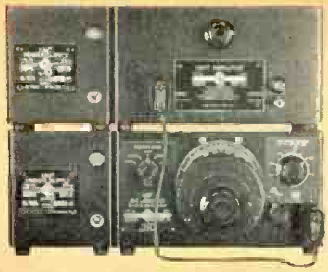

**Type 1210-B Unit R-C Oscillator, $140, with Type 1203-A Unit Power Supply, $40.**

**The new Type 1210-B Unit R-C Oscillator** is a unique audio, supersonic a radio-frequency generator . . . providing both square waves and sine wav over the range from 20 cycles to 0.5 Mc. Its wide range, multiple output s tem, easy adaptability to sweep operation and extreme versatility, make a must for every development and measurement laboratory. Features incluc

- ★ Slow-Motion Frequency Control: for small frequency increments; each decade covered by 4½ turns of knob.
- ★ Precision Dial: can be motor driven by Type 908-P Synchronous-Dial Drives for automatic display of amplitude-frequency characteristics; 908-P1 covers one frequency decade in 50 sec, 908-P2 takes 6⅔ sec per decade . . . $27.50 for either.
- ★ Three Outputs:
  - Low-Voltage, Low-Impedance (0 to 7 v, 50 Ω); constant within ±1 db to 200 kc; less than 1% no load distortion from 200 c to 20 kc, less than 1.5% over entire range; hum at least 60 db down.
  - High-Voltage, High-Impedance (0 to 45 v, 12.5 kΩ): constant within ±1 db and less than 5% distortion at no load from 200 c to 200 kc (decreases to 2.5% under load); hum at least 50 db below maximum output.
  - Square waves (0 to 30 v peak-to-peak): 2500 Ω output impedance; less than 0.25μs rise time and 1% overshot; hum at least 60 db down.
- ★ Adjustable Output Control: logarithmic, calibrated 0-50 db.
- ★ AVC System: fast response, insures constant output under fluctuating line voltage.
- ★ Power Supply: Type 1203-A recommended for use on 115 v, 50-60 cycle power; Type 1202-A Unit Vibrator Power Supply for field operation from standard 6 v or 12 v storage battery.
- ★ Rack Mounting Provision: Type 480-P4U3 Relay Rack Panel, $12.50, for laboratory use.

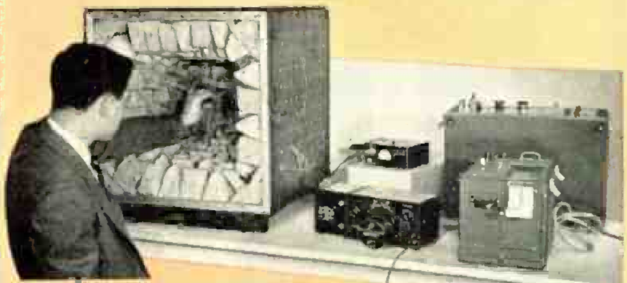
The G-R Unit R-C Oscillator is the latest addition to the ever growing, e more useful line of G-R Unit Instruments.

G-R Unit Oscillators are now available for coverage from 20 cycles to 2000 Mc . . . the Unit Pulse Generator provides pulse durations of 0.2-60,000 μsec with repetition rates from 30 c–100 kc, and rise times of 0.05 μsec . . . the Unit Null Detector has better than 40 μv sensitivity . . . a Unit Amplifier is available with 3-watt maximum output and 20 c-to-250 kc range . . . the Unit Crystal Oscillator has short-term stability of 1 ppm . . . the Unit I-F Amplifier is a basic component in the 50-5000 Mc G-R High-Frequency Null Detector . . . this apparatus, compact, interconnectable, rugged and reliable in performance, represents the most in instrumentation value per dollar available anywhere.



**For More Power** . . . Type 1210-B becomes 3-watt R-C Oscillator with Type 1206-B Unit Amplifier, $85 and Unit Power Supply, $40.

**Becomes Sweep Generator** . . . with easy-to-attach Type 908-P Synchronous-Dial Drive, $27.50, and Type 1210-P1 Discriminator, $75 (at right), for supplying CRO voltages.



**Automatic Data Taking** . . . with pen-type recorder or CRO eliminates laborious point-by-point measurements . . . in photo, frequency response of small loudspeaker is recorded.

**Network Transient Investigations** . . . with R-C oscillator square waves; one measurement gives information on both amplitude and phase characteristics . . . in photo, engineer observes and records filter characteristics of G-R Type 1550-A Octave-Band Noise Analyzer.

**As Bridge Generator** . . . shown with new G-R Universal Audio-Frequency Bridge and Type 1212-A Unit Null Detector, $145.

**As Modulator** . . . Unit R-C Oscillator square-wave modulates the recently announced Type 1218-A UHF Unit Oscillator, $465., with 900-2000 Mc range.

Five G-R Unit Oscillators.

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# BOOKS

## Amplitude Frequency Characteristics of Ladder Networks

*By E. Green, M.Sc. Published by Marconi's Wireless Telegraph Co., Ltd., Marconi House, Chelmsford, Essex. 155 pages, price $6.50.*

One of the first books published dealing with the synthesis and analysis of filter type networks by means of modern network theory. It is of particular value to the design engineer who is most in need of this modern network theory design information, since he must not only deal with the general concepts and qualitative ideas required by modern electronic systems but must also be concerned with the actual numerical performance of the circuits. The circuits the author considers are the much-used inverse arm low pass and band pass ladder networks plus the many circuits equivalent to these ladders. Much information is supplied to all types of engineers who use these networks as transfer devices, such as the reactive generative-resistive load situation; the reactive generative-reactive load situation; and the resistive generative-resistive load situation.

## TV and Radar Encyclopedia

*By W. MacLanachan. Published 1954, second edition, by Pitman Publishing Corp., 2 W. 45 St., New York 36, N.Y. 216 pages, price $6.00.*

This book was specially compiled to meet the need for a reliable guide to the principles, practice, and terminology of TV and radar. As a result of the rapid advance of television technique both in the U.S. and Great Britain, there became an increasing need for a reference book which would give a quick and reliable answer to any question which might occur to the engineer who was concerned with the design and production of TV equipment, the operation of a TV studio, and theatre television. The present edition includes such new developments as Automatic Picture Control, Compatible Color TV Systems, Flywheel Synchronization, Thermistors and Transistors, and others. Published in Great Britain, it contains several outstanding articles contributed by renowned British scientists and engineers. Some of the articles are: The Ionosphere, by Sir Edward Appleton, F.R.S.; The Fluorescent Screen, by W. Wilson, D.Sc., B.Eng., M.I.E.E.; and The Future of Theatre Television, by Sir Robert Watson-Watt, C.B., D.Sc., LL.D., F.R.S., M.I.E.E.

## Fundamental Formulas of Physics

*By Donald H. Menzel. Published 1955 by Prentice-Hall, Inc., 70 Fifth Ave., New York, N.Y. 765 pages, price $10.65.*

A practical handbook of physical for-

(*Continued on page* 60)

# BOOKS

(*Continued from page 58*)

mulas, with emphasis being placed on intermediate steps previously unavailable. Closely integrated topics such as physical chemistry and biophysics make the book indispensable to all research workers. Twenty-six sections presented in a completely modern mathematical approach, covering, in addition to basic physics, certain cross-areas where physics touches upon chemistry, astronomy, meteorology, biology, and electronics. For example, the chapter on Electromagnetic Theory has been designed to meet the needs of both engineers and physicists. Of particular interest to engineers would be such chapters on Kinetic Theory of Gases, Heat and Thermodynamics, Electronics, Electron Optics, Sound and Acoustics, and the Theory of Magnetism.

### Fundamentals of Radar

*By Stephen A. Knight, F.R.S.A. Published 1954, second edition, by Pitman Publishing Corp., 2 W. 45 St., New York 36, N.Y. 150 pages, price $3.00.*

A basic survey of the principles underlying radar, dealing with the development and methods of the technique from the last war to the present time. The author has endeavored to show how the unusual circuit techniques of pulse generators and receivers can be stripped of their complexities and be presented in the familiar aspects of radio and television engineering. Chapters on Trigger and Pulsing Circuits, Saw-Tooth Generators, Cathode-Ray Indicator Devices, Pulse Transmitters, Waveguides, and others are illustrated throughout with schematic diagrams, showing wave shapes and circuit designs.

### Dictionary of Television, Radar and Antennas

*By W. E. Clason. Published 1955 by Elsevier Publishing Co., New York, N.Y. Price $21.50.*

This dictionary is compiled and arranged on an English alphabetical base in six languages, English/American, French, Spanish, Italian, Dutch and German. For each language there is an alphabetical listing of words, referring to the corresponding numbers in the basic table, and there are over 2450 definitions of words. A system of thumb-indexing enables finding any language at once. The author and publisher have been guided by certain principles proposed by the United Nations Educational, Scientific, and Cultural Organization (UNESCO), the object being to insure that each dictionary produced shall fit into place in a pattern which it is hoped may extend over all inter-related fields of science

(*Continued on page 64*)

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|---|---|
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| 40:1 to 183:1 | 3 stages |
| 15:1 to 32:1 | 2 stages |

| TORQUE AT OUTPUT SHAFT OZ. IN. | GEAR RATIO OF GEAR TRAIN |
|---|---|
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| 100 | 15:1 to 33,000:1 |
| 300 | 15:1 to 33,000:1 |
| 400 | 15:1 to 5,500:1 |
| 600 | 15:1 to 5,500:1 |

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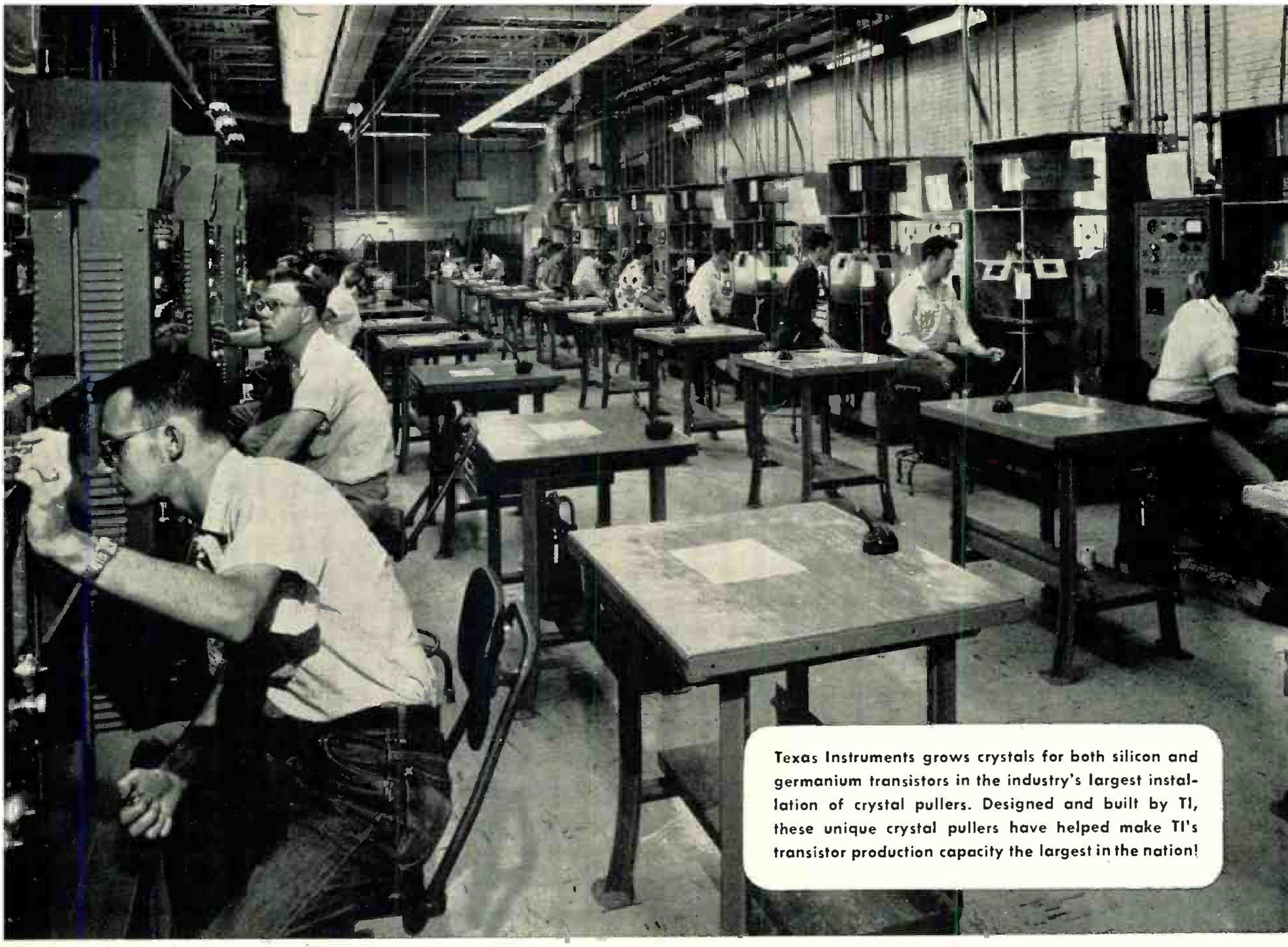

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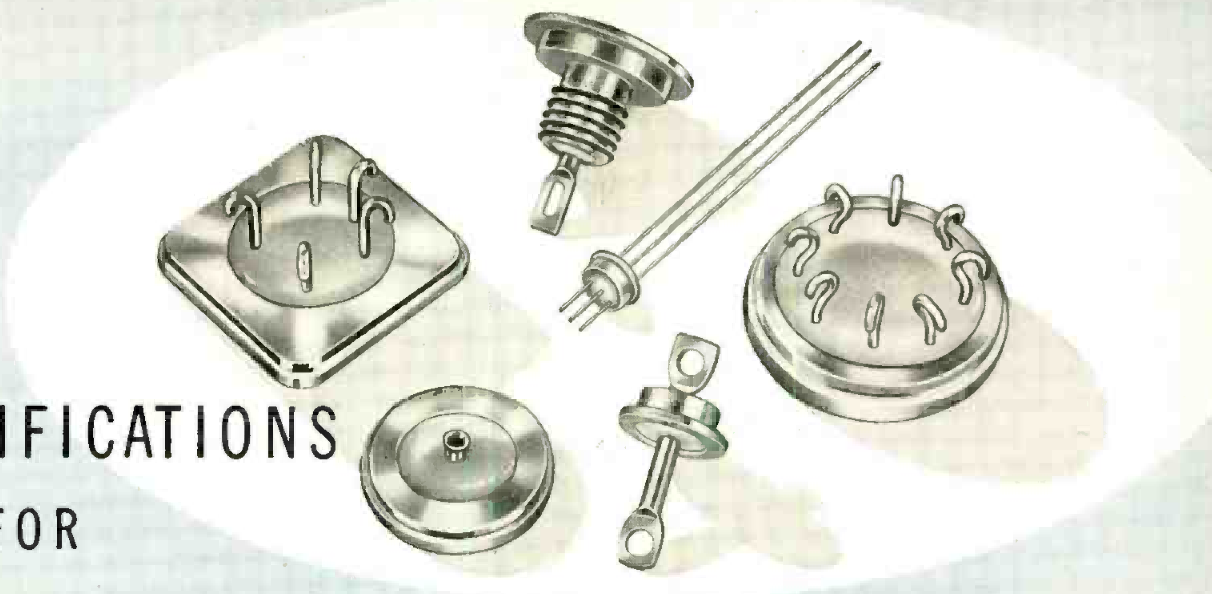

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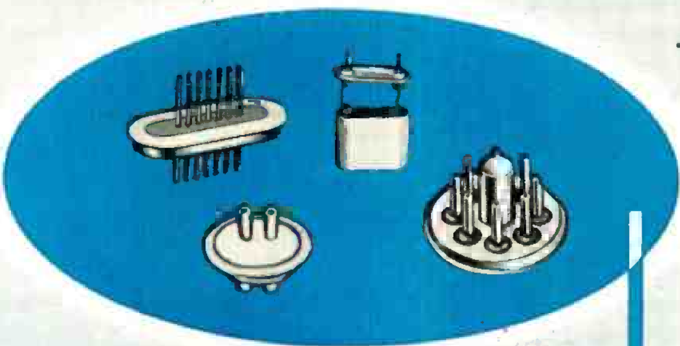

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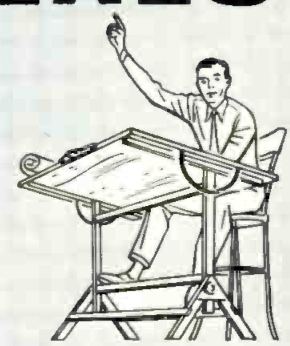

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# BOOKS

(Continued from page 60)

and technology and cover all necessary languages.

### Recent Gov't Publications For the Electronic Industry

## SERVOMECHANISMS

### Research in Non-Linear Mechanics as Applied To Servomechanisms

*Wright Air Development Center, U.S. Air Force, Dec. 1953. 148 pages, with illustrations. (Order PB 111584 from OTS, U.S. Department of Commerce, Wash., 25, D.C., price $3.75.*

### Case Study in Automation Production Control Through Electronic Data Processing: A Case Study

*52 pages, (Order from OTS, U.S. Dep't. of Commerce, Wash., 25, D.C. Price $1.50)*

### New Oscilloscope Components A Wide-Band Pulse Amplifier for High Speed Oscillography

*Naval Research Laboratory, Sept. 1954. 23 pages. (Order from OTS. U.S. Dep't. of Commerce, Wash., 25, D.C. Price 75c.)*

### Development of the Optical Imaging Oscilloscope (Optimascope)

*Naval Research Lab., Oct. 1954. 6 pages. PB111554, OTS, U.S. Dep't. of Commerce, Wash., 25, D.C. Price 50c.*

## TUBES

### Techniques for Application of Electron Tubes in Military Equipment

*PB 111644, is available from OTS, U.S. Dep't. of Commerce, Wash., D.C. Price $2.50. This report presents 100 pages of tube information from the point of view of the electronic design engineer.*

### Tropospheric Propagation Research

*Cheyenne Mountain Tropospheric Propagation Experiments. By A. P. Barsis, J. W. Herbstreit, and K. O. Hornberg, National Bureau of Standards Circular 554, 39 pages, 46 figures, 3 tables, 30c. (Order from the Gov't. Printing Office, Wash., 25 D.C.*

### Radio Interference Suppression Techniques

*PB 111611, Nov. 1953, may be obtained from OTS, U.S. Dep't. of Commerce, Wash., 25, D.C. Price $6.75. A 270 page manual to assist manufacturers of equipment for the Armed*

(Continued on page 66)

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# BOOKS

(Continued from page 64)

*Forces to meet the requirements of radio-interference specs.*

### Cooling Fluids for Aircraft Heat-Transfer Fluids for Aircraft Equipment Cooling Systems

*PB 111593, (Order from OTS, U.S. Dep't. of Commerce, Wash., 25, D.C. Dated Feb. 1954, 183 pages, price $4.75.)*

### Sonic Treatment and Wood Testing Application of Ultrasonic and Sonic Vibrations for Improvement and Testing of Wood

*(Final Report 1951). PB 111556, OTS, U.S. Dep't. of Commerce, Wash., 25, D.C. 59 pages, price $1.50.*

### Formulas for Computing Capacitance and Inductance

*By Chester Snow, National Bureau of Standards Circular 544, 37 figures, 69 pages, price 40c. (Order from the Gov't Printing Office, Wash., 25, D.C.)*

## Books Received

### Servomechanisms and Regulating System Design

*By Harold Chestnut and Robert W. Mayer, published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. Vol. II, 384 pages, price $8.50. This volume blends the practical and theoretical information needed by the designer and branches off into more advanced material.*

### Properties of Large Slot Antennas

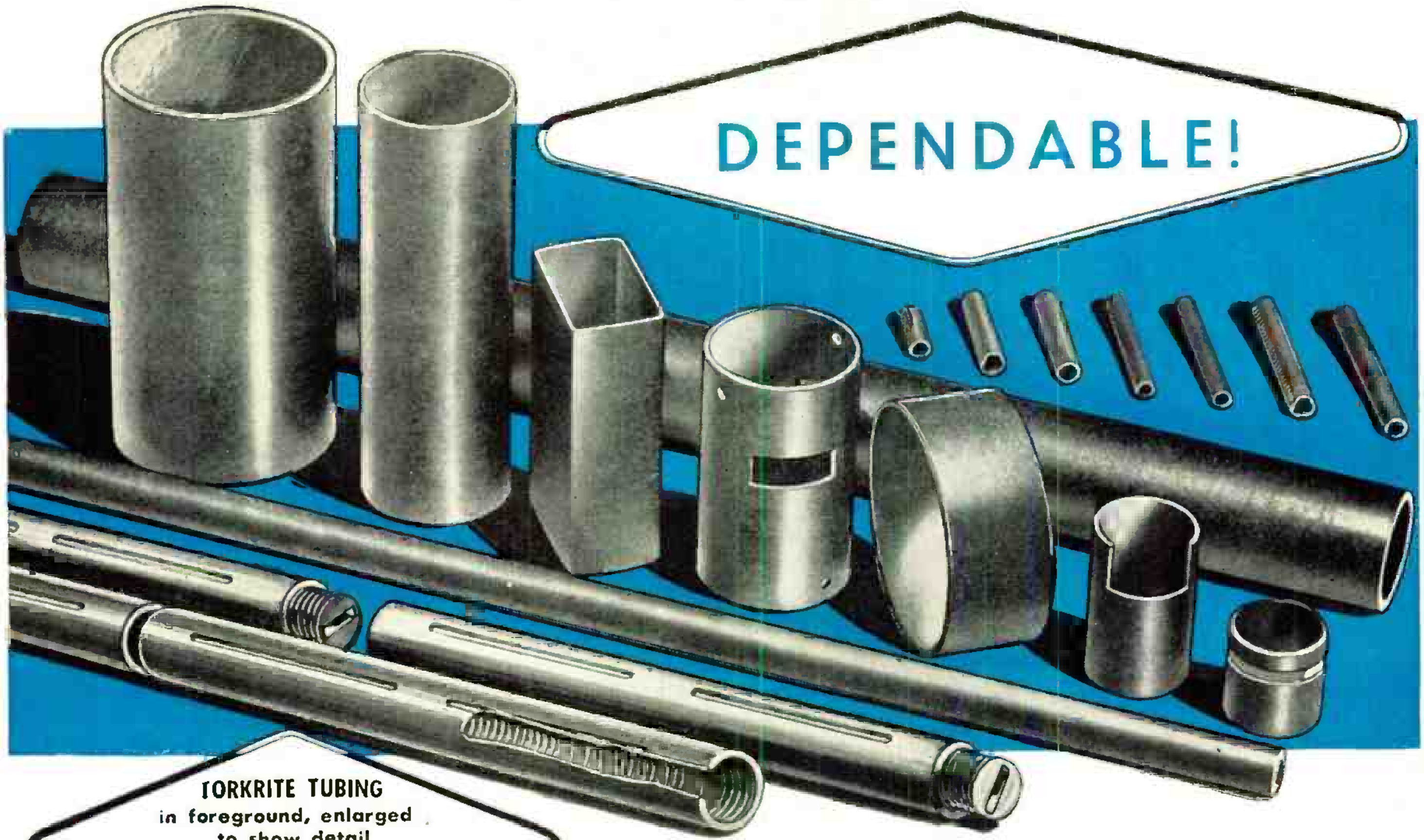
*Published by Office of Naval Research, order PB 111523, OTS, Dept. of Commerce, Washington, D. C. Price 25 cents. This study describes an investigation into the field configuration existing in slots cut in the broad side of a standard 1" x 0.5" X-band wave-guide.*

### Basic Vacuum Tubes And Their Uses

*By John F. Rider and Henry Jacobwitz. Published by John F. Rider Publisher, Inc., 480 Canal St., New York 13, N.Y. 208 pages. Price $3.00 paper bound, $4.50 cloth bound. Well illustrated with comprehensive line drawings, charts, curves, etc., this book contains chapters on electrons & electron emissions, diodes, triodes, and multielectrode tubes.*

### Summary of Joint Nomenclature System ("AN" System) for Communications Electronic Equipment

*A 2-page fold issued by the Joint Communications-Electronics Committee. Order PB 111-581 from OTS U.S. Dept. of Commerce, Washington, D.C. Price 25 cents. A useful chart that summarizes a coordinated system of nomenclature for communications.*




TORKRITE TUBING
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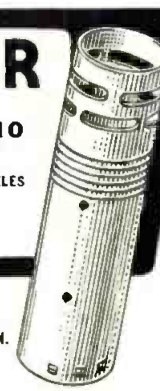

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# TELE-TECH
## & Electronic Industries

O. H. CALDWELL, Editorial Consultant ★ M. CLEMENTS, Publisher ★ 480 Lexington Ave., New York 17, N. Y.

# On Conventions and Shows

This month, August 24-26, WESCON holds its fifth annual show and convention in San Francisco, Calif. The phenomenal growth of this event over these last few years (22,396 registrations in 1954) leaves little doubt that WESCON has now become one of the important annual functions for the electronic industries. To the co-sponsors of this event, WCEMA (West Coast Electrical Manufacturers Association) and IRE (Institute of Radio Engineers—7th Region) our congratulations for a job well done and best wishes for even bigger (but we doubt better) conventions in the future. WESCON and the present IRE National Convention are regional events that serve the basic needs of the industry. One additional regional event . . . in the midwest . . . would be most desirable.

**Too Many Shows?**

Our suggestion for another show and convention may seem somewhat incongruous because from time to time industry executives have voiced the opinion that there are too many shows and conventions taking place during the year now . . . that many of these events are a costly drain of company funds for sometimes very questionable returns. In some instances, organizations have been known to enter an exhibit at a show, not because they wanted to, but because they feared becoming conspicious by their absence. Then there is the constant upheaval in every-day business routine occasioned by the delegates or those assigned leaving to attend the event.

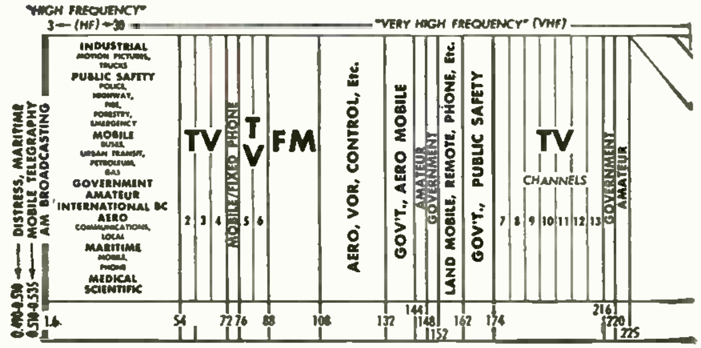
Conventions and shows have long been recognized as being very necessary. The personal contacts made at these events and the interchange of technical information is lifeblood to our electronic industries. But too much is not good either and we are inclined to agree with those gentlemen who say that we have too much now!

**Regional Shows**

We checked the 1955 Roster of Associations Serving the Electronic Industries (Tele-Tech April 1955) and found that of the 62 associations listed, 48 had conventions or major annual events. Of this number, 20 listed themselves as having both conventions and exhibits. Note too that these figures do not include the annual functions of the professional groups in the Institute of Radio Engineers. There are 23 such professional groups listed and we can be sure that each will seek, if it does not now have, a major annual event of its own. And then, of course, the end of the number of professional groups is still not in sight. Three regional shows and conventions each year, eastern, mid-western, and western would, we feel, render a maximum service to the electronic industries and offer plenty of conventioning for all!

*We believe that many readers feel as we do and your comments on this topic are cordially invited. In future issues we will print views and feelings of our readers in this connection.*

# RADARSCOPE




***Revealing important developments and trends throughout the spectrum for radio, TV and electronic research, manufacturing and operation***

**ELECTRONIC INDUSTRIES IMPORTANCE** in the Nation's defense was underlined recently by Frank D. Newbury, Asst. Secretary of Defense. He points out that the Department of Defense buys almost one-half of all electronic equipment now produced. He estimates dollar volume of the electronic industries at $9 billion for 1955 and to rise to $20 billion in another ten years.

MICA FABRICATORS ASSOC. reports that Congressman Frank M. Karsten has introduced HR-6299 which would reduce the duty on unmanufactured block mica to 4¢ per pound regardless of value and would put on the free list uncut mica condenser films and splittings regardless of thickness. Anyone interested in passage of this bill should write and so inform their own congressman.

## SOLAR BATTERY

Bell Telephone Labs engineer, W. D. Gerdsen, with a model of the Bell Solar battery mounted on a section of telephone pole. The solar battery is receiving its first practical test as part of the telephone system this summer in an experimental unit—essentially identical to the model shown—installed in Americus, Ga., to supply power to terminal equipment on rural telephone lines. During daylight hours the battery will power terminal equipment directly, and at the same time charge a storage battery to provide power for nighttime operation.

**RETMA INTERNATIONAL DEPT.** is currently working with the Dept. of States to arrange for a program whereby members traveling abroad will receive all possible assistance through Embassies and Consulates.

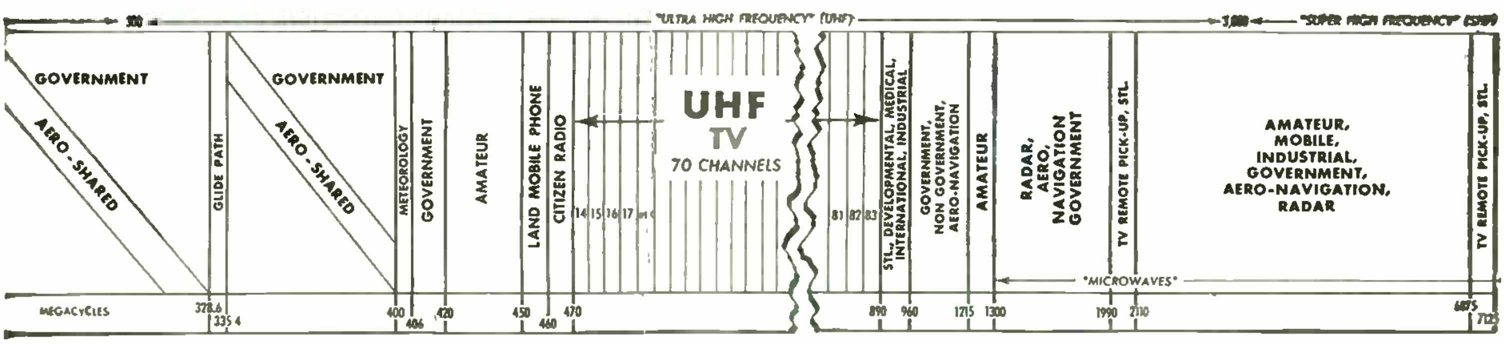
**AIRCRAFT NOISE** has been recognized by the Air Force as a national problem in scope. 120 officers have been attending a special class at MIT studying "Noise Problems in Aircraft." They are to "pass-on" information at home bases.

**STATUS OF EDUCATIONAL TV** in the United States will be surveyed the Educational Television & Radio Center, Ann Arbor, Mich. during the 1955-56 academic year. This detailed appraisal was made possible by a grant from the Fund for Adult Education. Richard B. Hull, Radio-TV Director of Iowa State College has been named director of the project. During the course of the year, Hull will gather first-hand information on the operations of all ETV stations now on the air and those scheduled to begin broadcasting in the near future. He will also meet with leading educational and civic authorities in an effort to appraise the successes, failures and potentialities of the medium to the field of education.

**CERMETS** to find important new industrial applications. This was a keynote in Dr. Paul Schwarzkopf's opening address at the recent International Assembly of Powder Metallurgists in Ruette, Tyrol, Austria. Cermets are composite materials consisting of two components, one being either an oxide, carbide or boride or similar inorganic compound, and the other a metallic binder. They originated as a result of a government-industry program for the development of high temperature materials using the techniques of powder metallurgy. New cermet materials (bordies) feature excellent corrosion resistance at high temperatures.

## STANDARDS

**NEW RETMA STANDARDS** of interest to the electronic industries include: REC-145—Packaging Tests for Television Receivers; TR-119A—Minimum standards for Land-Mobile Communication PM or FM Receivers; TR-139—Audio Transmitter Input Impedances; ET-106-C—Gauges for Electron Tube bases. A standards proposal is now being circulated on the subject "High Voltage Ceramic Dielectric Capacitors Class 2, above 7500 Volt Rating. The RETMA Engineering Department is now located at 11 West 42 Street, New York 17, N.Y.




## TRANSISTORS

**COMMERCIAL APPLICATION** of transistors in home receiver and entertainment products appears to be moving forward at an ever increasing pace. Several manufacturers have already announced completely transistorized portable radio designs. Philco is making a portable phonograph in which three transistors are used. RCA uses a transistor in a high fidelity design as a phono-pickup preamplifier. A western transistor manufacturer is circulating a printed portable receiver chassis design that uses four transistors to set makers as engineering samples. Costs of transistors are also declining and becoming more comparable to receiving tube costs. For a four transistor portable design, the transistors can be provided for about $7.50.

## INDUSTRY PRODUCTION

**PRODUCTION OF ELECTRONIC** products in 1955 is expected to reach $6.2 billion, just a shade under the 1953 record of $6.3 billion but above last year's $5.8 billion, a forecast for the last half of this year by the Electronics Division of the Department of Commerce's Business & Defense Administration stated. Television receiver production bulks large in this year's manufacturing operations with a total value of factory production for 1955 estimated to exceed $1 billion, but the BSDA division pointed out that production of color television sets is not expected to become a major factor in the total output of TV receivers. Color TV receiver sales for this year with increased demand in the fall will reach an estimated $15 million, but 1956 will provide a substantial increase in production. In the first half of 1955 the number of black and white TV receivers was at a near record level—3¾ million units, and the BSDA noted that the average unit price declined because savings from improved production techniques have been passed on to the consumer. Production of radio receivers continues at a high level for the rest of this year. Military equipment such as radar, sonar and guided missile electronic systems, together with tubes and other components, formed major segments of the industry's total production, BSDA cited.

## MAGNETIC RECORDING

**RADICALLY NEW PIONEER INVENTION** of an automatically self-aligning magnetic playback head will be revealed in the near future by Julius Konins of The Dubbings Sales Corp. It will reportedly increase the operating efficiency and accuracy of tape recording operations employed in computers and telemetering systems, and may eventually be a contributing factor in the development of high quality audio recording at 3¾ psi. As is widely known, moving tape oscillates, and also has different tensions near the beginning and end of the reel, causing a continuously changing series of small, yet critical, misalignments. The new development has the head azimuth adjusted by a piezoelectric crystal fed by a correction voltage. This voltage, which is a measure of the alignment, is derived from either a binaural head which detects tape misalignment, or from the high frequency component on the tape, whose output is a function of alignment.

## UNDERWATER SOUND

**SONAR** and other types of sonic gear used for underwater exploration have been severly limited in their applications by the "phantom layers" of reflective material that are found at depths of 500 to 1500 ft. throughout the ocean. The most prominent theory holds that these layers are composed of millions of marine organisms. Experimentation with different sound frequencies and underwater cameras is being undertaken to clear up the mystery.

## STRENGTHENING OUR DEFENSES

Radar technicians of the Royal Canadian Air Force, all veterans of service in northern radar "fence" installations, receive instruction in erection and operation of powerful U.S. Air Force MPS-14 mobile height finder radar, at Syracuse, N.Y. General Electric plant. The Canadians are studying types of G-E radars used by U.S. forces and now purchased by the Canadian government through U.S. Air Force.

# WESCON – 1955

THE 1955 Western Electronic Show and Convention will be officially opened on Aug. 24th in San Francisco with a send-off, via a coast-to-coast TV link, from Gen. Douglas MacArthur in N. Y. The 3-day festivities that will follow are expected to attract some 20,000 of the nation's scientists, engineers and industry representatives.

The Show itself will consist of more than 580 exhibits, representing the products of more than 650 manufacturers.

Convention activities will feature a technical program consisting of 160 papers and 32 technical sessions, an All-Industry Luncheon, at which Dr. E. W. Engstrom of RCA will be the principal speaker, and an ambitious program of field trips and activities for the distaff side.

WESCON (Western Electronic Show and Convention) which is held in alternate years in Los Angeles and San Francisco, is sponsored by the West Coast Electronic Manufacturers Assoc. (WCEMA) and the San Francisco and Los Angeles Sections, representing the 7th Region, Institute of Radio Engineers. NEDA, "The Reps," and other industry groups lend their active support.

Field trips have been arranged this year to Beckman Instruments plant, the Radiation Lab. of the Univ. of Calif., the tube plant and facilities of Eitel-McCullough, Ampex, Stanford Research Inst. and the Hewlett-Packard plant.

Special airline accommodations have been arranged for with United Airlines. Mainliner flights are being arranged for WESCON visitors and exhibitors from major cities to San Francisco.

*San Francisco conclave will feature more than 580 exhibits, and the presentation of 160 technical papers. Attendance of 20,000 expected*

## Technical Papers Program

**SOLID STATE DEVICES**

"Transistors Today," by J. A. Morton
"Large Signal Semi-Conductor Devices," by John Saby
"High-Frequency Power Gain of Junction Transistors," by R. L. Pritchard
"Recent Developments in Germanium Alloy Junctions," by C. W. Mueller
"A New High-Ambient Transistor," by R. R. Rutherford and J. J. Bowe

**INFORMATION THEORY**

"Limiting Frequency-Modulation Spectra," by N. Blachman
"The Definition of a General Metric of Information," by N. Abramson
"An Analysis of Optimum Sequential Detectors," by J. J. Bussgang and D. Middleton
"Analysis of Automatic Bias Control for Threshold Detectors," by E. Ackerlind
"Generating a Gaussian Sample," by S. Stein and J. E. Storer
"Proof of the Sampling Theorem for Stationary Processes," by A. Rosenbloom and J. Heilfron

**RELIABILITY AND QUALITY CONTROL**

"Engineering and Testing for Reliability," by H. G. Romig
"Parts Versus Systems: The Reliability Dilemma," by David A. Hill
"An Effective Reliability Program Based Upon 'A Triad for Design Reliability'," by F. E. Dreste
"A Basic Study of the Effects of Operating and Environmental Factors on Electron Tube Reliability," by W. S. Bowie
"Surface Contamination of Dielectric Materials," by Saul Chaikin

**PROPAGATION**

"An Explanation of Fading in Microwave Relay Systems," by H. Magnuski
"Some Notes on Propagation over a Spherical Earth," by S. J. Fricker
"Radio Power Received via Tropospheric Scattering," by A. Waterman
"Atmospheric Attenuation of Microwave Radiation," by G. R. Marner
"Theory of Deviative Absorption in the F2 Layer and Its Relation to Temperature," by R. Gallet

**BROADCAST AND TV RECEIVERS**

"A Thin Cathode Ray Tube," by William R. Aiken
"Beam Focusing and Deflection in the Aiken Tube," by R. Madey
"Radiation Measurements at VHF and UHF," by A. B. Glenn
"An Experimental Automobile Receiver Employing Transistors," by L. A. Freedman, T. O. Stanley and D. D. Holmes
"High-Efficiency, Unipotential Post Focus, Tri-Color Picture Tube," by Wilfrid F. Niklas

**TRANSISTORS AND BLOCKING OSCILLATORS**

"Advantages of Direct Coupled Transistor Amplifiers," by Richard Hurley
"Junction Transistor Blocking Oscillators," by J. G. Linville
"The Design of Blocking Oscillators as Fast Pulse Regenerators," by F. K. Bowers
"Stability of Multi-Mode Oscillating Systems," by R. W. De Grasse
"Experiments with Radio Controlled, Dynamically Similar Models," by E. G. Stout
"Role of Electronics in Engineering Flight Testing," by W. L. Howland
"Instrumentation for Rocket Engine Testing," by R. F. Gompertz

**ANTENNAS I**

"Recent Developments in Microwave Antennas," by L. C. Van Atta
"Printed Surface Wave Antennas," by H. W. Cooper
"Circularly-Polarized Slot Radiators," by A. J. Simmons
"Radiation from Ferrite-Loaded Slot Radiators," by D. J. Angelakos and M. Korman Korman
"A Large Aperture Differential Polarization Antenna for Radio Astronomy Use," by V. H. Goerke and O. D. Remmler

**INSTRUMENTATION**

"Beamplexer-High Speed Channel Multiplexing Unit," by H. Moss and S. Kuchinsky
"A Stable Diode Chopper Circuit," by H. Patton
"A Completely Automatic Impedance Plotter," by J. R. Vinding
"A Broadband Microwave Frequency Meter," by P. H. Vartanian and J. L. Melchor
"An Expanded Scale Frequency Meter," by Duane Marshall
"Measurement of Time Varying Frequencies," by Martin Graham

**ELECTRONIC COMPONENT PARTS**

"Design and Properties of High Voltage Glass Capacitors," by G. P. Smith
"Characteristics of Modular Electronic Components," by W. G. James
"Simple Electronic Transformer Design," by R. Lee
"Measurement of Parameters Controlling Pulse Front Response of Transformers," by P. R. Gillette, K. Oshima and R. M. Rowe
"Development of MIL-T-27-A: Transformers and Reactors," by E. M. Wiler

### HIGH POWER TUBES

"M-Type Backward Wave Oscillators," by J. Hull
"Considerations of Various Structures for High Average Powers in the UHF Region," by D. Preist
"Design Information on Large Signal Traveling-Wave Amplifiers," by J. E. Rowe
"A New Beam Power Tube for UHF Service," by W. B. Bennett
"An Ion Trapped High Voltage Pentode," by R. E. Hellers

### AUTOMATIC CONTROL

"Non-Linear Compensation of an Aircraft Instrument Servo-mechanism," by D. Lebell
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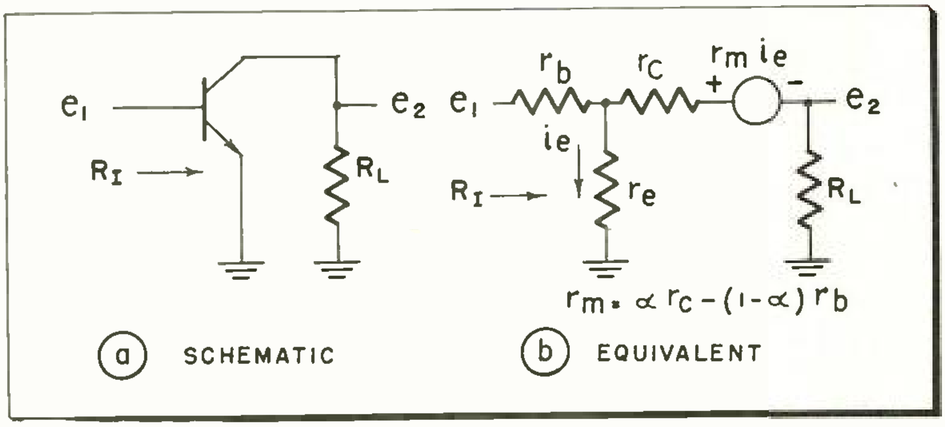
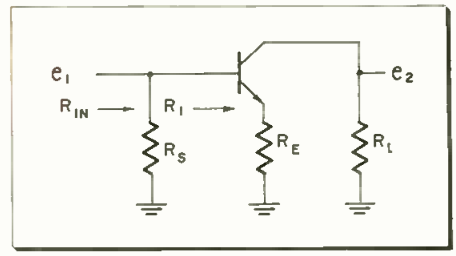



Fig. 1: Basic circuit of transistor amplifier with equivalent circuit




Fg. 2: External emitter resistance added

By RICHARD B. HURLEY

# Predictable Design Of Transistor Amplifiers

*Problems associated with the predictable and stable design of transistor amplifiers, with attention focused on the common-emitter, junction transistor as a low-frequency amplifier*

R. B. Hurley

■ The design of a system or circuit is often complicated by the lack of precise knowledge of the characteristics of devices employed. Further complications result if the characteristics of the devices used vary with time or under changing environmental conditions. Thus, in order to obtain initial desirable and predictable performance with such devices, the designer may be required to resort to the selection of particular samples or the experimental tailoring of each circuit to accommodate the particular device used. To allow for aging effects, he may have to incorporate adjustable components within the circuit. Furthermore, non-linear compensating elements may be required to automatically adjust for environmental effects upon the characteristics of the principal circuit devices. An alternate design philosophy that is sometimes practicable is to design the circuit such that the exact characteristics of the main devices are relatively unimportant to the overall system performance. For example, the characteristics of an active device may be submerged by the use of degenerative feedback, circuit configurations, and linear stabilizing techniques.

Currently available transistors fall into the category of principal circuit devices whose parameters are subject to many severe variations.[1] Here the designer must account for the following deviations of the small-signal parameters from their nominal values:

1. Variations from one transistor to another of the order of as much as 50% or more in critical parameters.
2. Variations with changes in emitter current as strongly as an inverse law.
3. Variations with changes in collector voltage to as much as a ½-power law.
4. Variations directly with temperature to a linear or even an exponential degree.

In addition to the above deviations, the designer must recognize that the reverse collector-base diode current ($I_{co}$) varies approximately exponentially with temperature (doubles every 10 to 20° C.).[2] $I_{co}$ will, through its interaction in external circuitry, affect the bias levels of the transistor.[3] Thus $I_{co}$ will create indirect temperature variations in parameters due to its variations with temperature and its effects, in turn, upon emitter current and collector voltage. Also, $I_{co}$ varies from transsistor-to-transistor even more strongly than do the small-signal parameters. It also is probably the characteristic most prone to vary with time, creating an aging problem.

Other pertinent considerations that must be given by the designer include medium and large signal aspects of performance. If, say an input voltage is to be amplified by a transistor, the approximately exponential relationship of resulting transistor currents to applied input voltage must be dealt with.[4] Also large-signal distortion and clipping must be properly evaluated, suppressed, or avoided.

The case to be treated here is that of the low-frequency junction-transistor amplifier in common-emitter orientation. While this may appear to be a rather restricted case, it does represent the most popular type transistor, orientation, and application. Furthermore, the biasing techniques to be discussed are independent of the orientation, and both the biasing and signal techniques are to a large extent transferable to other types of circuit applications. Fortunately, many of the better quality junction transistors are capable of voltage gains of the order of 1000 and power gains of the order of 10,-

RICHARD B. HURLEY, Senior Research Engr., Advanced Development, Convair, Pomona, Calif.

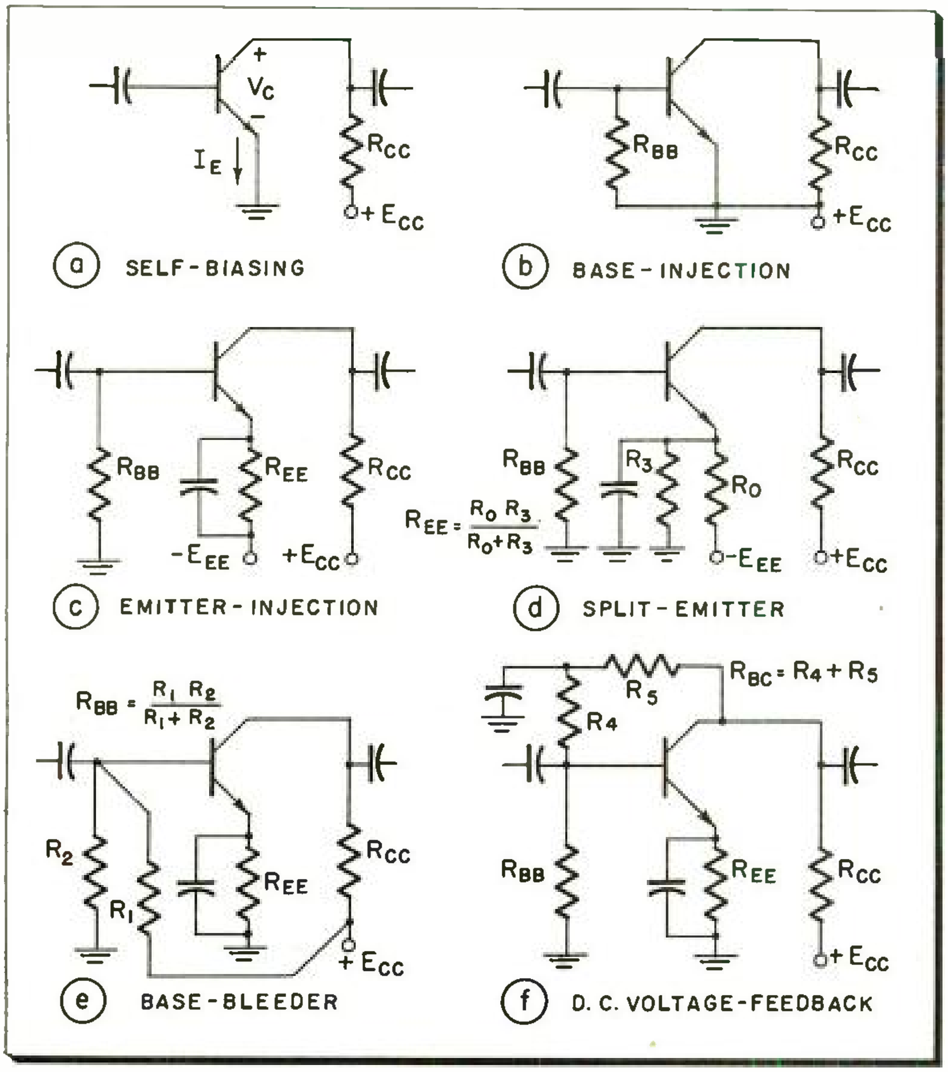



Fig. 3: Representative sampling of biasing circuits used with transistor amplifiers

000. Thus faced with a serious parameter variation problem but equipped with "gain to spare," the alternate design philosophy of submerging the importance of the exact device characteristics will be pursued.

Consider the simple amplifier of Fig. 1. The voltage gain of such an amplifier is[5]

$$\frac{e_2}{e_1} = \frac{-R_L\left[\alpha - \frac{r_e+r_b}{r_c+r_b}\right]}{r_e+r_b\,(1-\alpha) + \frac{r_e+r_b}{r_c+r_b} R_L}. \quad (1)$$

Properly designed junction transistors are generally such that

$$r_b << r_c,$$
$$r_e << r_c, \text{ and}$$
$$0.90 < \alpha < 1.0.$$

Thus Eq. 1 reduces to

$$\frac{e_2}{e_1} = \frac{-\alpha R_L}{r_e+r_b\,(1-\alpha) + \frac{R_L}{r_c}(r_e+r_b)}. \quad (2)$$

Now if an external emitter resistance, $R_E$, is inserted between the emitter terminal and ground (Fig. 2) and if $R_E$ is much larger than the denominator of Eq. 2, the voltage gain becomes

$$\frac{e_2}{e_1} \cong -\alpha\frac{R_L}{R_E} \rightarrow \frac{-R_L}{R_E}, \text{ for } \alpha \rightarrow 1.0. \quad (3)$$

The limiting form of Eq. 3 shows the voltage gain to be independent of the transistor characteristics. The success of the method is dependent upon obtaining transistors with consistently small values for $r_e$ and $r_b$, large values for $r_c$, and $\alpha$'s very near unity. Through the quality control efforts and selective procedures of manufacturers, such transistors are readily available. $R_E$ must generally be made large enough and $R_L$ small enough so that the assumptions leading to Eq. 3 will remain valid for the net effects of all variations, especially those due to temperature.

More than one stage of amplification may be required, thus making the input resistance of one stage constitute part of the load resistance of the preceding stage. Also power gain or current gain may be of importance. Therefore it is necessary to consider some additional signal function of an amplifier. Again referring to Fig. 1, the input resistance is[5]

$$R_I = r_b + r_e\left[\frac{\frac{r_c+R_L}{r_c+r_b}}{(1-\alpha) + \frac{r_e+R_L}{r_c+r_b}}\right]. \quad (4)$$

For

$$r_b << r_c \text{ and } R_L << r_c,$$

Eq. 4 becomes

$$R_I = r_b + \frac{r_e}{(1-\alpha) + \frac{r_e+R_L}{r_c}}. \quad (5)$$

If an appropriate external emitter resistance is employed for voltage gain fixing,

$$r_e << R_E << R_L,$$

then the input resistance becomes

$$R_I \cong \frac{R_E}{1-\alpha} \rightarrow \infty, \text{ as } \alpha \rightarrow 1.0. \quad (6)$$

Certainly one cannot expect the limiting form of Eq. 6, nor is the expression independent of the transistor characteristics. One can, however, make the input resistance large enough, however, that an external resistance, $R_s$, can be shunted across the input (Fig. 2), thus achieving a degree of input fixing. That is, the circuit input impedance, $R_{IN}$, would become

$$R_{IN} = \frac{1}{\frac{1}{R_s} + \frac{1}{R_I}} \rightarrow R_s, \text{ for } R_s << R_I. \quad (7)$$

A method has been presented for making the low-frequency small-signal transfer characteristics of a transistor amplifier reasonably independent of the characteristics of the transistor itself. It will be noted that the use of an external emitter resistance was essentially dictated by the normal relative sizes of transistor parameters and by the form of the transistor equations. It should also be noted that $R_E$ creates degenerative current feedback. Thus $R_E$ also yields a first-order solution to the large-signal distortion problem by tending to suppress the harmonics indicated by non-uniformity of typical grounded-emitter collector characteristics.[6,7] $R_E$, while decreasing the voltage gain of an amplifier, increases the input impedance; thus it is conceivable that the power gain might decrease as the first power rather than the second power of the

(*Continued on page* 132)

# Instrumentation for

*In the engineering and production of aircraft engines, electronic and allied measuring instruments play a vital role. This chart shows the various instruments and the quantities they measure in a typical jet engine and a typical reciprocating engine with power recovery turbines such as the Curtiss-Wright Turbo Compound engine.*

## JET ENGINE

| *Instrument* | *Function Measured* | *Range* |
|---|---|---|
| A. Thermocouple, null balance indicator | Front bearing temperature | 150°F |
| B. Potentiometer, null balance indicator and counter | Throttle position | |
| C. Thermocouples, null balance indicators, recorder strip charts | Compressor oil temperature<br>Compressor air temperature | 200°F<br>over 500°F |
| D. Thermocouples, null balance indicators | Center and rear bearing temperatures | over 150°F |
| E. Thermocouple, null balance indicator | Exhaust cone temperature | Over 1200°F* |
| F. Thermocouple, direct-writing oscillograph | Metal liner temperature | Over 1200°F |
| G. Thermocouples, direct writing oscillographs | Metal skin temperature | Over 400°F |
| H. Borden tube | Fuel pressure and oil pressure | 50 to 60 lbs. |
| I. Platform and load cell, null balance indicator | Engine thrust | Over 7220 lbs. |
| J. Frequency type electronic flowmeter | Fuel flow | |
| K. Rotating coil, tachometer pulse generator and EPUT meter | Main shaft speed | Over 6000 rpm |
| L. Thermometer and barometer | Input air temperature and atmospheric pressure | Ambient conditions |
| M. Pressure drop nozzle | Air flow input | (Classified) |

**After burner temperature, and variable nozzle position measured by potentiometer and null balance indicator, are classified.*

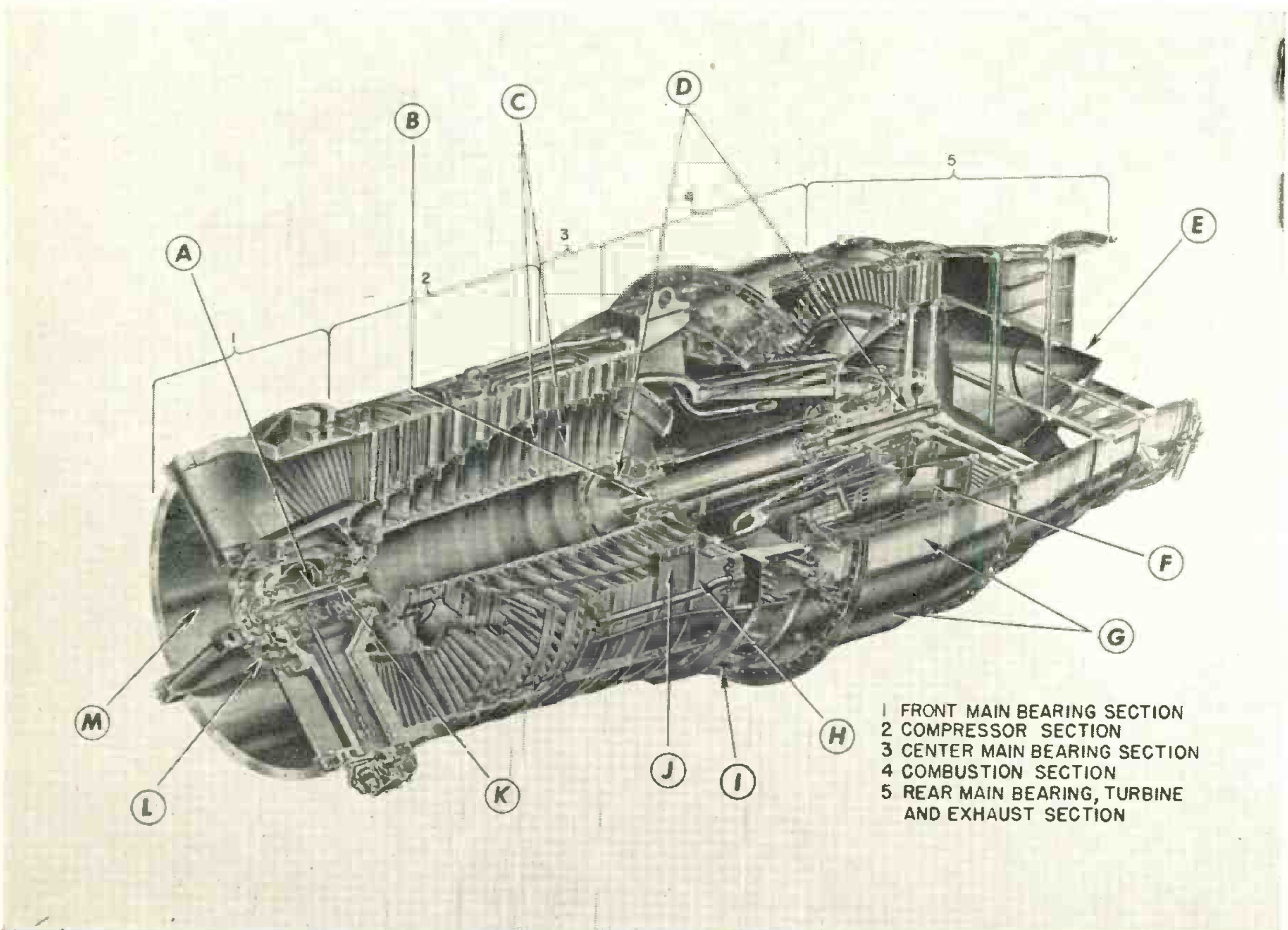



*Photo courtesy Curtiss-Wright Corp., Wood-Ridge, N. J.*

# Aircraft Engines

## CURTIS-WRIGHT TURBO COMPOUND ENGINE

| *Instrument* | *Function Measured* | *Range* |
|---|---|---|
| A. Pressure-torque meter | Horsepower measurement | 250 psi |
| B. Thermocouples, null balance indicators | Cylinder temperature | to 600°F |
| C. CRT, detonation detector-analyzer | Cylinder ignition and detonation firing sequence and waveform | |
| D. Velocity pickup, oscillograph | Engine vibration | Several mils at a few hundred cps |
| E. Electrical tachometer | "Booster" turbine speed | 17,000 rpm |
| F. Thermocouple, null balance indicator | Turbine temperature | |
| G. Manometer | Manifold pressure | 0-80" Hq absolute |
| H. Orifice nozzle | Air flow | 40,000 lbs./hr. |
| I. Thermocouple, null balance indicator | Air temperature | Ambient |
| J. Barometer | Air pressure | Atmospheric |
| K. Electrical tachometer-counter | Shaft speed | 150 to 3000 rpm |
| L. Borden tube | Oil pressure | 75 lbs./in.$^2$ |
| M. Rotometer | Fuel flow | to 2600 lbs./hr. |
| N. Velocity pickup, oscillograph | Engine vibration | Severals mils at a few hundred cycles |
| O. Bonded strain gages | Crankshaft stress | |
| P. Electrical dynamometer | Propeller shaft power | 3250 to 3700 hp |

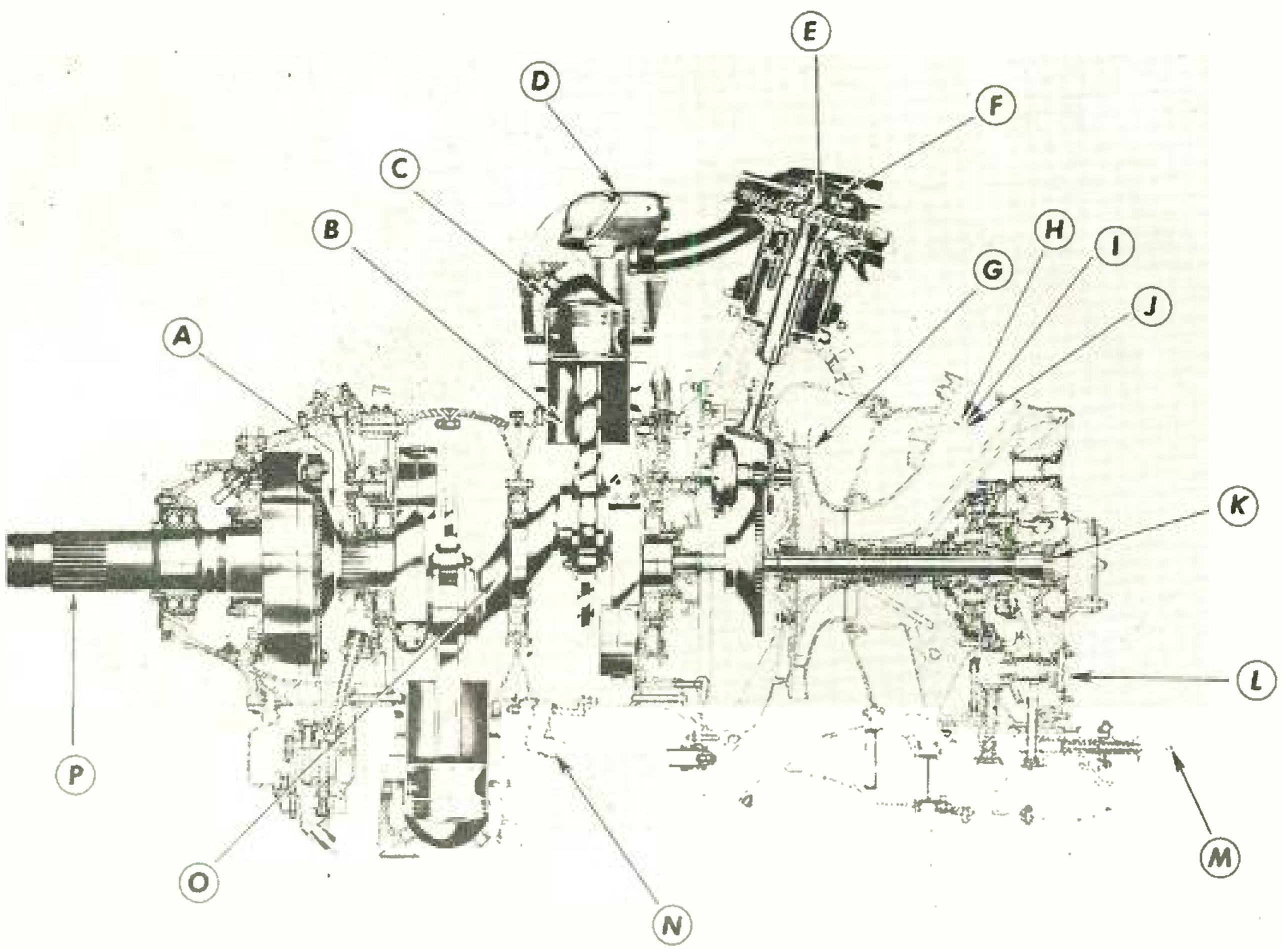



*Photo courtesy Curtiss-Wright Corp., Wood-Ridge, N. J.*

# Criteria

By NORMAN W. GAW, JR.
and DAVID SILVERMAN

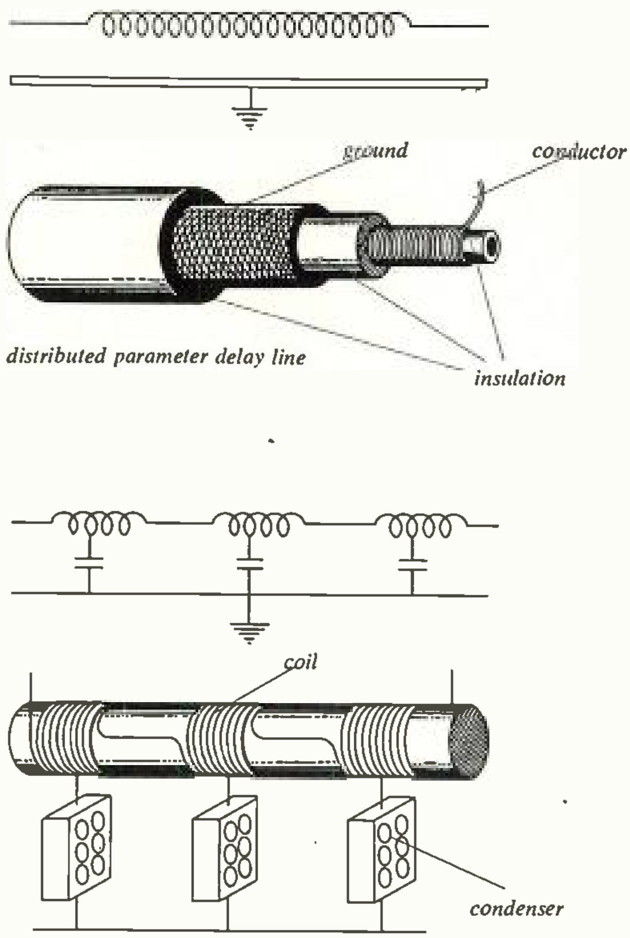



Fig. 1: The two basic types of electromagnetic delay lines

THE electromagnetic delay line should be thought of as a T or time-storage component which might be applied in the same manner as a simple R, L, or C component. Yet, unless properly understood, it could appear to be complex and difficult to apply. The increased application of many new delay-line types has caused a measure of confusion among users and manufacturers. The intent of this article is to contribute a common understanding by analysis of distortions, definitions of terminology, and description of test methods. It is hoped that this might instigate the formation of standards for electromagnetic delay lines.

Delay lines are available in a wide variety of shapes and sizes. However, in spite of apparent differences, all electromagnetic delay lines are of two general types, as illustrated in Fig. 1. In the distributed or coaxial type of line, the geometry of the two conductors is arranged to take optimum advantage of the delay characteristics of a transmission line. In the lumped line, discrete reactive elements are arranged in the form of a multiple-section filter.

Two separate approaches to delay-line design have been taken; the first derived from transmission-line and the other from filter theory. Yet it can be shown that the properties of a distributed line are approached as the number of sections of a lumped line is increased. Kimbark[1] has shown that a transmission line presents a limit case of filter theory. Therefore, by equivalence, all delay lines may be similarly evaluated and tested.

The ultimate in design is to accomplish time delay with complete freedom from distortion. However, since all circuit elements have performance limitations, this is not possible. The best of delay lines, properly applied, must necessarily suffer from distortions due to (1) deterioration of rise-time and (2) loss of amplitude.

The upper part of Fig. 2 shows an ideal pulse (dotted lines) applied to such a line, and the resultant stored signal. In comparing these two curves, note:

1. The increase in rise-time.
2. The decrease of amplitude.

Shortcomings in design and misapplication could lead to other distortions. If many should appear at once, an extreme degradation of signal would result, as shown in the lower part of Fig. 2. In spite of the complex disfiguration, a trained observer could easily distinguish the contribution made by each basic distortion illustrated in Fig. 3:

*Phase distortion:* Characterized in the

(a) Underequalized state by a leading ring.

(b) Overequalized state by a lagging ring.

Both suffer rounding of pulse leading-edge. Underequalization refers to a decrease of delay at the higher frequencies. Too much delay-compensation results in overequalization.

*Input—output coupling:* Characterized by distortions occurring at one delay time preceding and one delay time lagging the pulse rise. These are due to intercoupling of the higher-frequency portions of both applied and delayed signals.

*Discontinuity:* Characterized by waveshape irregularities occurring within two delay periods after the pulse rise. These are due to nonuniformities in the construction of the line.

*Mismatch:* Characterized by an abrupt change in step level occurring two delay periods after pulse rise. This effect is due to incorrect termination. The curves indicate the separate effects which are due to resistive and reactive mismatch.


NORMAN W. GAW, JR., project engineer, and DAVID SILVERMAN, Eastern Plant Research Director, Helipot Corp., South Pasadena, Calif.

# for Electromagnetic Delay Lines

*Designed to provide users and manufacturers of delay lines with a common basis of understanding, this article defines terminology, and describes test procedures for pulse and sinusoidal testing*

The manufacturer strives to minimize all distortions, but is often required to compromise certain qualities to effect savings in size and/or cost. As with any other component, the manufacturer's specifications indicate the extent of such compromise.

### Terminology

In order to evaluate fully such specifications, the language must be understood. Certain terminology is most often used throughout the industry:

(a) *Time delay* is the time in which an electrical signal is stored by a system or component. Pulse delay is measured at the half-amplitude point of the leading edge of the input and output pulses:

$T = \sqrt{LC}$ where: T = total delay; L = total inductance; C = total capacitance

(b) *Phase shift* is a measure of delay at a given frequency:

$\Phi = 360\ Tf$ where:
$\Phi$ = phase shift in degrees
T = total delay in microseconds
f = frequency in megacycles

(c) *Temperature coefficient of time delay* is expressed as the decimal value of total delay change per degree C.

(d) *Phase distortion* is the change of signal waveshape due to non-equal delay of its various frequency components.

(e) *Phase equalization* refers to the methods which are employed to compensate for phase distortion.

(f) *Linearity* is the time deviation from the desired value to which a tapped or variable delay line may be set. This is usually expressed as a percentage of total delay.

(g) *Pulse width* is the time duration of a pulse signal and is measured between the half-amplitude points of the leading and trailing edges (see figure 2).

(h) *Rise-time* is the time in which a unit step changes from its initial to its final amplitude level; measured from the 10% to 90% points (see figure 2).

(i) *Bandwidth* is the band of frequencies which a delay line attenuates uniformly or within 3 decibels of equality.

(j) *Insertion loss*[1] is the inverse ratio of: the power received by a receiving circuit directly connected to a source of power; to: the power received by the same circuit when an additional 4-terminal network is inserted between it and the source.[1]

(k) *Characteristic impedance*[1] is (1) the input impedance of a line of infinite length, or (2) the input impedance of a finite line terminated in an impedance of such value as to make the input impedance equal to the termination impedance:

$Z = \sqrt{\frac{L}{C}}$ where:
Z = characteristic impedance
L = inductance/unit length
C = capacity/unit length

(l) *Matching* refers to the termination of the line in its characteristic impedance and to the adjustment of the signal-source impedance to equal the characteristic impedance of the line.

(m) *Standing-wave ratio* refers to the change of RMS voltage or current at various points along the line caused by reflections due to improper matching. It is defined as the ratio of the maximum to minimum RMS value of this voltage or current.

(n) *Amplitude distortion* refers to the change of signal waveshape to the non-equal attenuation of its various frequency components.

The theory underlying delay-line test procedures is rather simple, but elaborate precautions are sometimes required to obtain conclusively accurate results.

High-frequency measurements normally require some special care.[2] In addition, to minimize distortion, special precautions must be taken regarding the manner in which the delay line is employed in test circuitry, regarding:

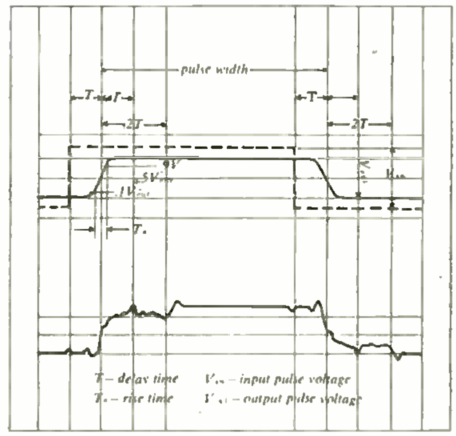



**Fig. 2: Distortions common to all delay lines (top) and extreme distortions (bottom)**

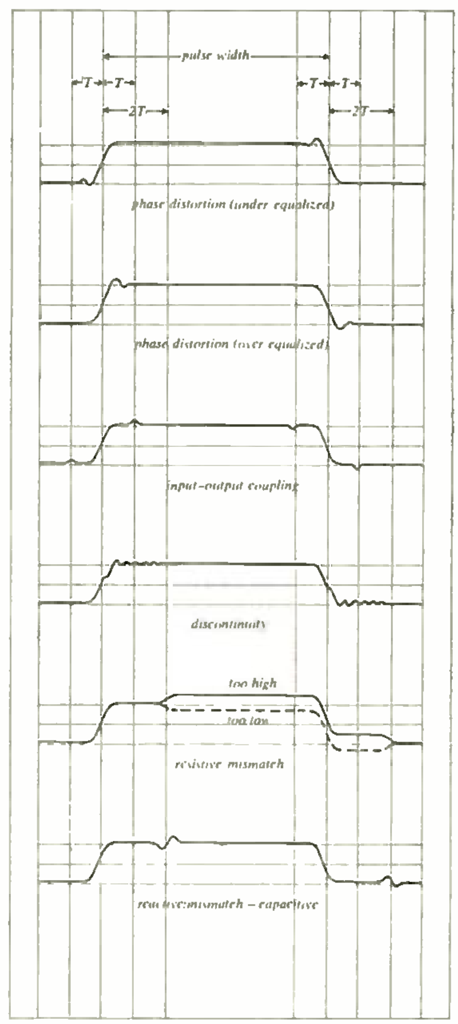



**Fig. 3: Various basic distortions identified**

# Delay Lines (Continued)

1. Proper impedance matching.
2. Decrease of loading effect, resistive and reactive, particularly in a variable or tapped delay line.
3. Isolation and decoupling between those portions of the test setup which, because of the delay line, are not in phase.

Either pulse or sinusoidal testing may be used to supply comprehensive test information, with each offering particular advantages:

1. Pulse techniques are most often used to determine rise-time, pulse delay, distortion, pulse attenuation, and characteristic impedance.
2. Sinusoidal techniques will more readily yield bandwidth and phase response. Greater accuracy may be achieved in the measurement of delay and delay linearity at a particular frequency.

### *Pulse Testing*

Fig. 5 illustrates a pulse-testing setup: A high-quality pulse or a square-wave-generator output is coupled through an impedance-matching network to the input of a delay line. A suitable high-frequency oscillograph may be used to observe the pulse waveshape, providing the amplifier (or deflection plates) into which the signal is fed has relatively low input-capacitance and high input-impedance.

Reflections will distort the input-pulse shape if the delay line is not properly matched. By adjustment of termination to minimize this reflection, the characteristic impedance may be determined and measured.

Fig. 4 illustrates how, by multiple exposure on a single print, the following is recorded:

1. Pulse input.
2. Pulse output.
3. Sweep timing markers.

Some delay-line manufacturers will, upon request, supply photographs of this type with their delay lines. From these photographs, delay time can be obtained by comparison with a known frequency of the timing marker. Input and output rise-time may similarly be measured. Delay line rise-time may then be obtained by use of the following equation:

$$Tr_{delay\ line} = \sqrt{(Tr^2_{output}) - (Tr^2_{input})}$$

where: Tr = rise-time

By comparison of the amplitudes of the input and output pulses, the attenuation is obtained as follows:

$$\text{Attenuation} = \frac{V_{in} - V_{out}}{V_{in}}$$

where: $V_{in}$ = Input-pulse amplitude
$V_{out}$ = Output-pulse amplitude

Distortions, if present, may be

(*Continued on page* 128)

Fig. 4: (below) Photo record of delay line

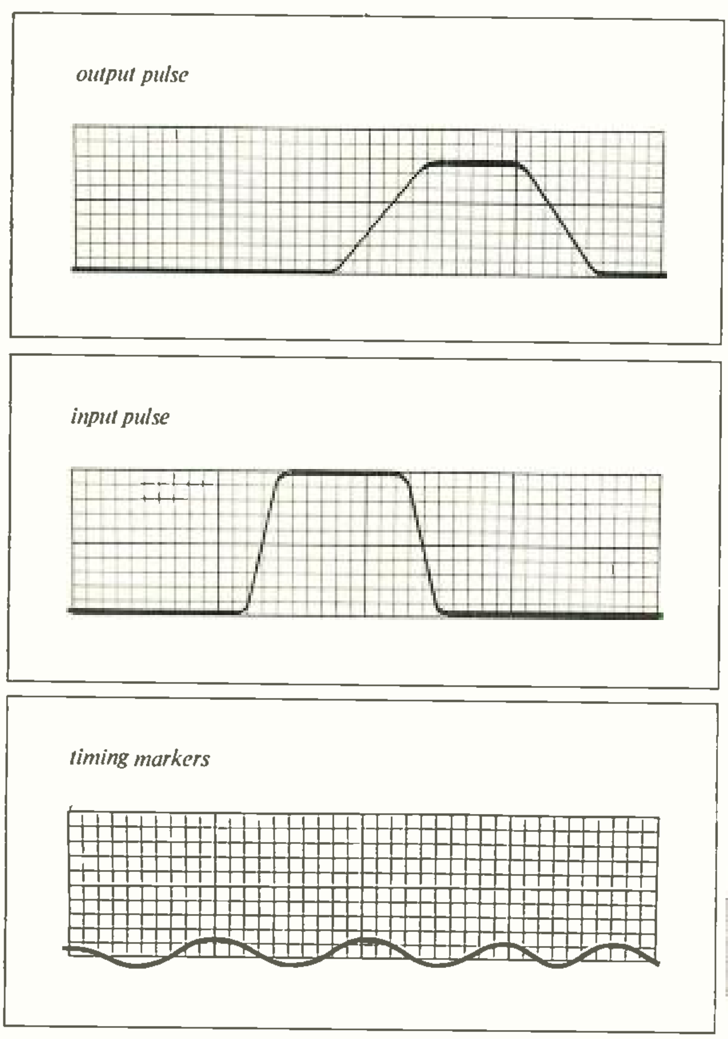



Fig. 5: (r) Schematic of pulse-testing setup

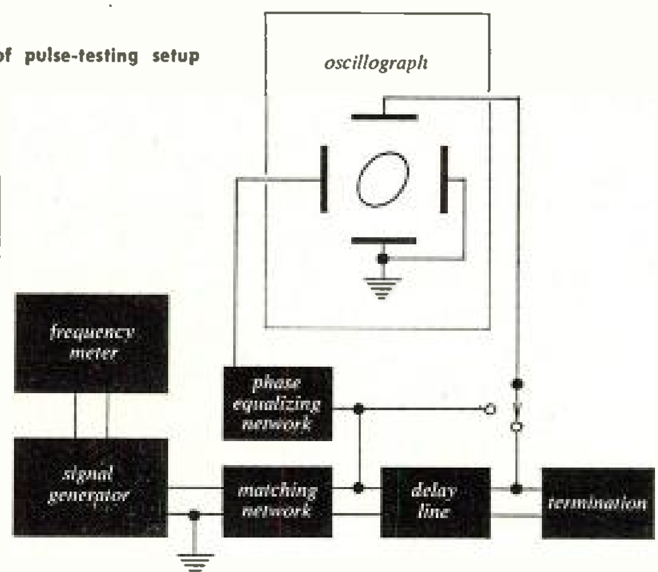
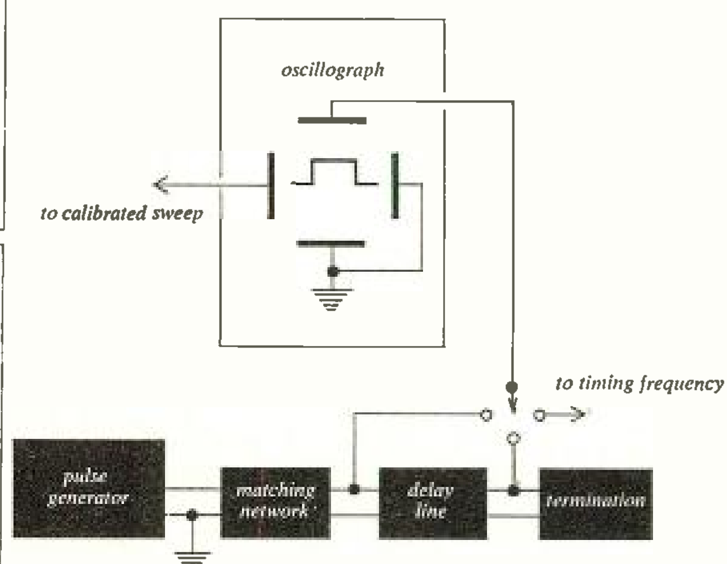



Fig. 6: (below) Sinusoidal test setup



# Page from an Engineer's Notebook

# No. 31—Calorimetric Wattmeter Nomograph

*A quick means of determining r-f and microwave output power from measurements supplied by calorimetric wattmeter*

**By JOSEPH F. SODARO**

J. F. Sodaro

A reliable method of measuring microwave power is by means of the calorimetric wattmeter. This instrument converts rf power into heat in a special dummy load. Water flow through this load absorbs the power being dissipated. The number of calories which result are measured by the temperature rise of the water stream. The quantity of water heated is measured in cubic centimeters of flow per minute. From these data, average watts are calculated by the relationship

$$W = 0.069Vt \qquad (1)$$

in which V is in cc/minute and t is the temperature difference between incoming and outgoing water in degrees C.

The accuracy of this measurement depends upon a constant flow rate. Early microwave calorimeters accomplished this by using an elevated reservoir with constantly maintained water level. Modern calorimeters are closed hydraulic loops maintaining flow by means of a pump and needle valve regulator. Cooling of the heated water is by means of a radiator and fan.

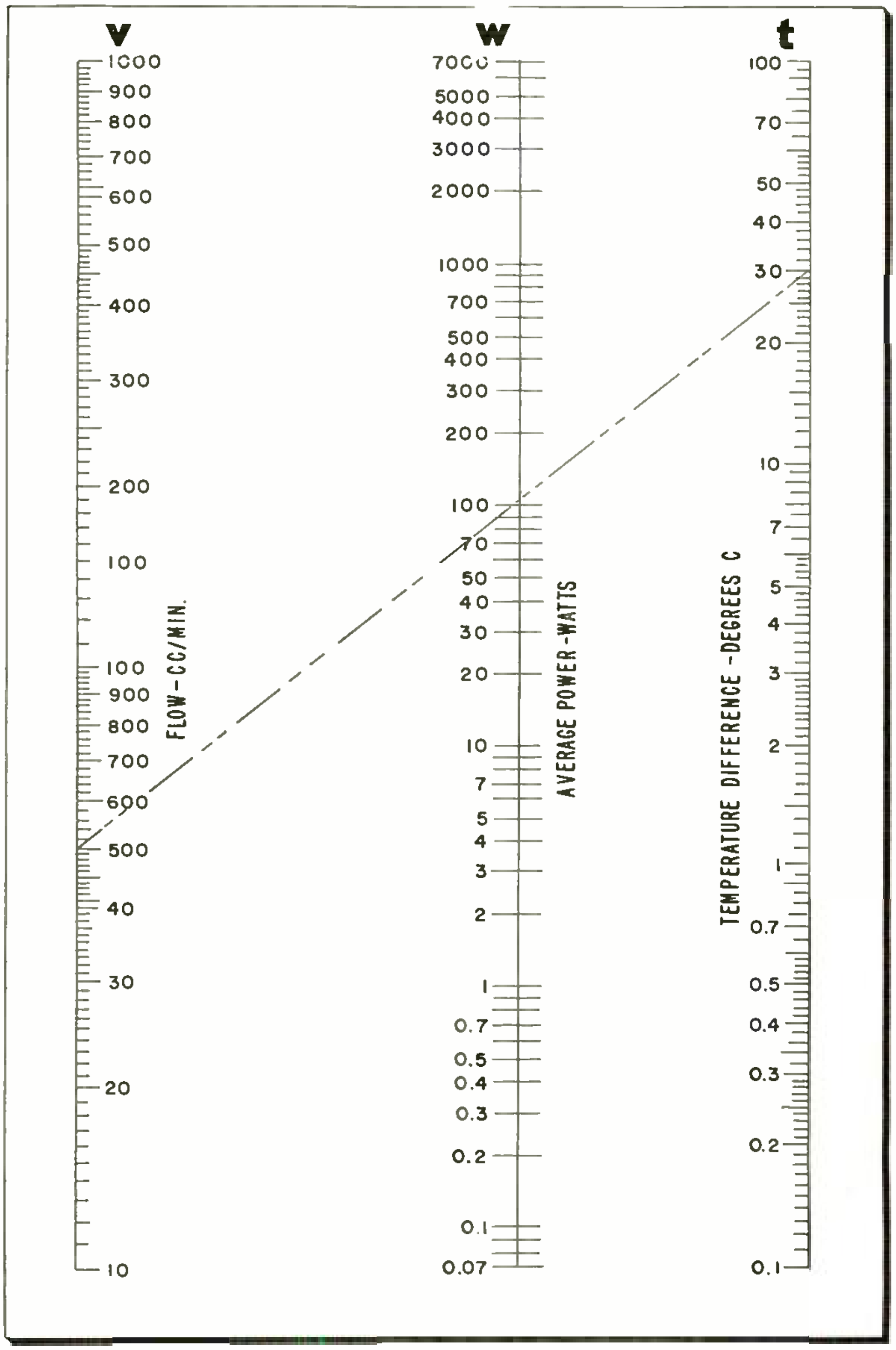
Fig. 1 is provided for the nomographic solution of Eq. (1). To use this nomograph select the volume on the V scale and the temperature difference (outgoing water temperature minus incoming water temperature) on the t scale. A straightedge placed between these points will intersect the W scale at the value of power being generated.

As an example assume that 50 cc flow into a graduated beaker in one minute. Water temperature rises 20 degrees to 50 degrees C at this flow rate, a temperature difference of 30 degrees. How much power is being generated?

Place a straightedge from 50 on V to 30 on t. Read 103 watts where the straightedge crosses the W scale.

*JOSEPH F. SODARO, California Registered Engineer, 3895 Main St., Culver City, Calif.*

Fig. 1: Nomograph equates volume of flow and temperature difference



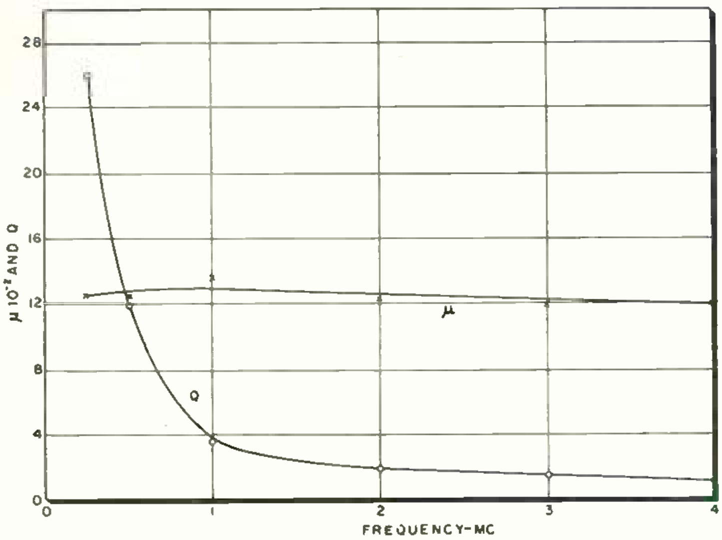



Fig. 1: Permeability and Q as a function of frequency

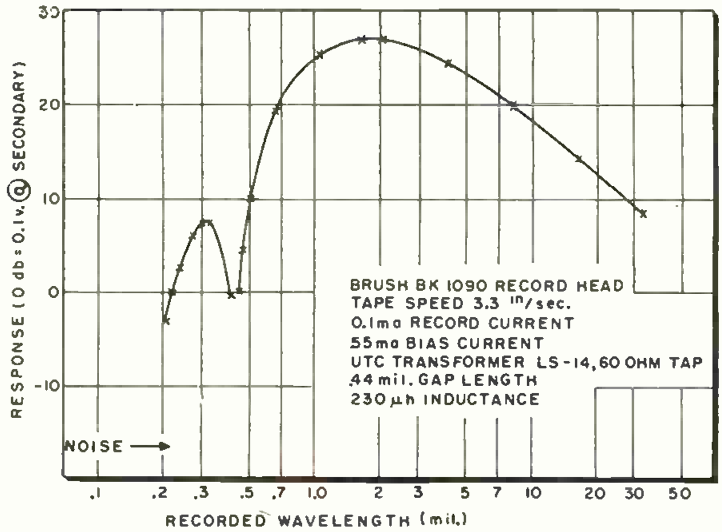



Fig. 2: Response of ferrite head with glazed gap

# Ferrite Heads for Recording In the Megacycle Range

*Ferrites are found to have resolutions comparable to metallic heads. Problem of wear, particularly at gap edges, is minimized by glazing techniques*

**By W. R. CHYNOWETH**

BECAUSE of their relative hardness and low losses, ferrites were early considered a potential core material for magnetic recording heads. As early as 1948 some ferrite heads with an effective gap of around .75 mil were built and tested. Since that time ferrite heads have appeared commercially, mostly for pulse applications where the head was spaced from the medium. In the field of contact heads, ferrites have not fared quite so well. Early thoughts seemed to indicate the following disadvantages:

1) difficulty in fabrication due to hardness

2) brittleness leading to easy chipping

3) poor resolution due to granularity

With the possible exception of the chipping, the above disadvantages have not proven serious. Ferrites can be molded and then ground and lapped, and this process could well prove to be more economical for production than the handling of thin metallic laminations.

The work described in this article was done as part of a wide band magnetic recording development. It was desired to build heads which could be operated at bias or signal frequencies in the low megacycle range with as high a resolution as possible. Ferrites seemed to satisfy the high frequency requirements.

It was thought at that time that the loss of resolution due to rough gap edges caused by granularity of the ferrite would be the most serious problem; therefore a materials development program was initiated to produce a more homogeneous and dense ferrite with satisfactory magnetic and physical

*W. R. CHYNOWETH, Electronics Lab., General Electric Co., Electronics Park, Syracuse, N. Y.*

Fig. 3: High resolution ferrite head gaps

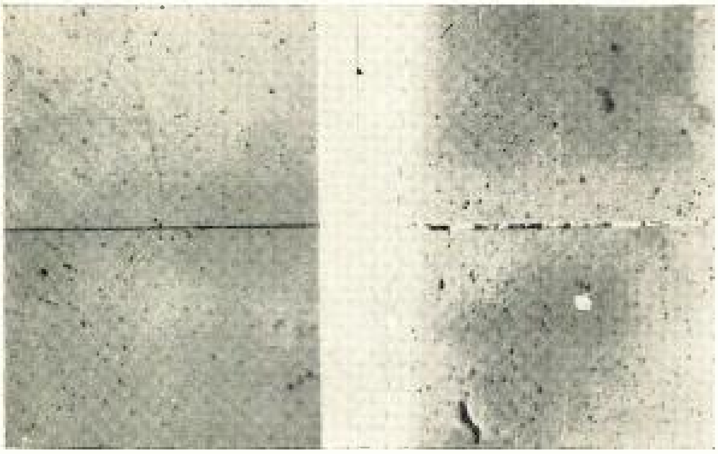
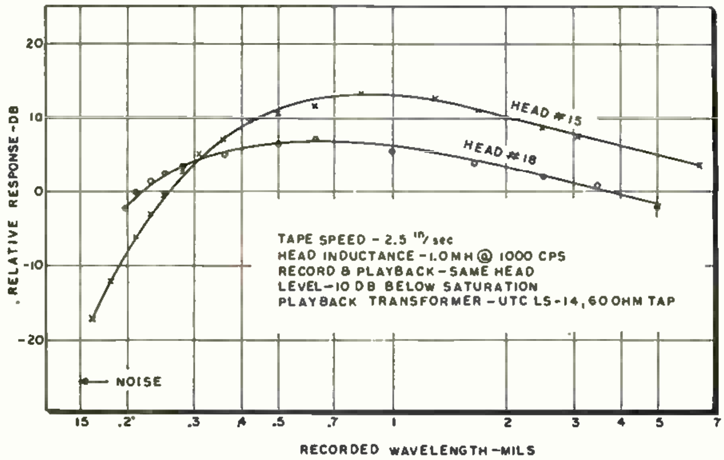


Fig. 4: Wavelength response of ferrite heads



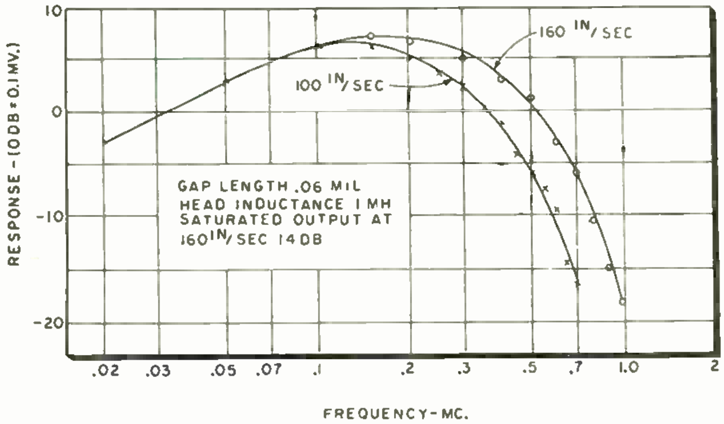



Fig. 5: Response curves for head No. 15 at 100 and 160 ips

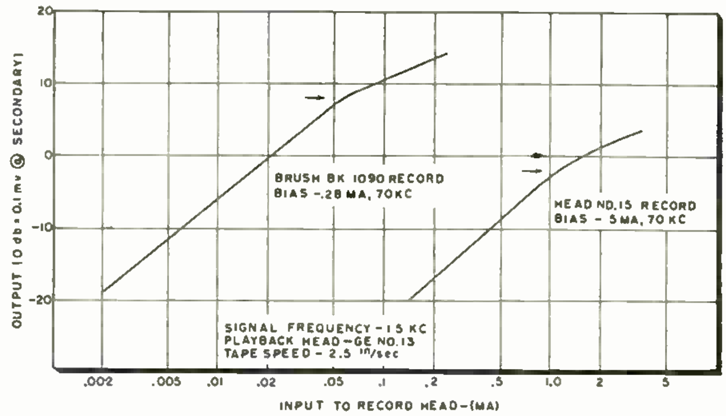



Fig. 6: Comparative curves for ferrite and Brush BK1090 heads

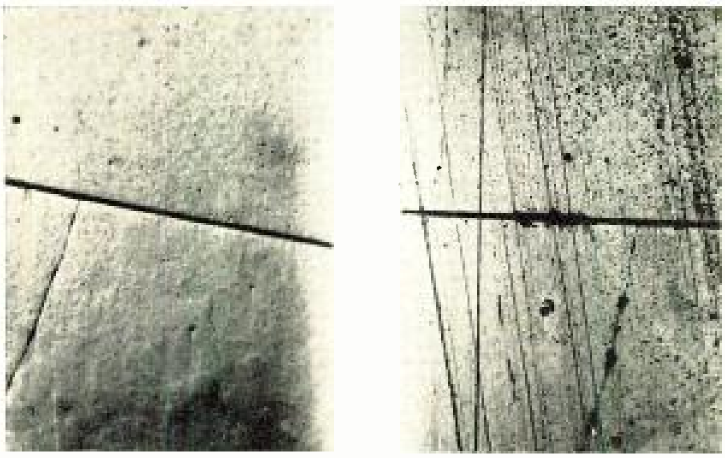


Fig. 7: Wear (l) after 35 hrs. at 100 ips, (r) after 83 hrs. at 100 ips

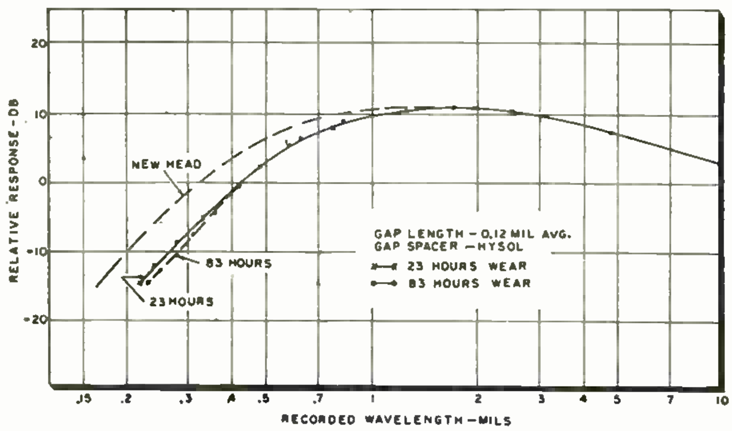



Fig. 8: Effect of wear on resolution of ferrite head at 100 ips

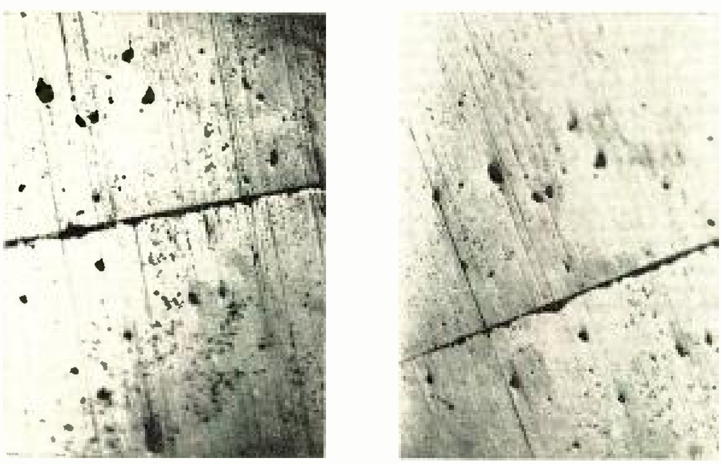


Fig. 9: Glazed head showed great improvement in wearing qualities

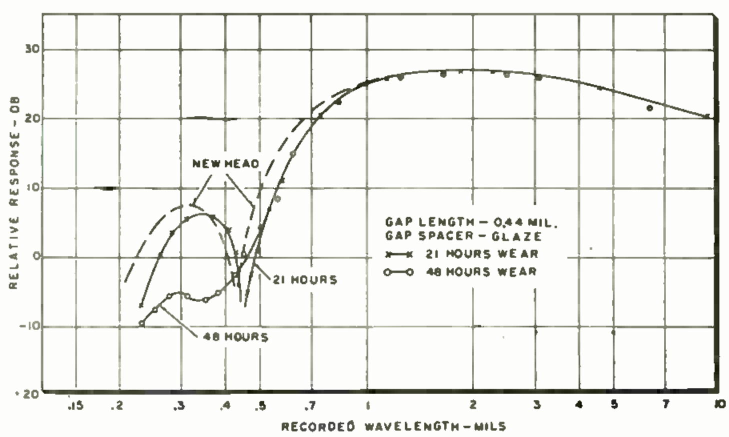



Fig. 10: Wavelength responses taken after 21 and 48 hrs. of wear

properties for use in heads. In terms of the original aims, this program was quite successful. Ferrites were produced with satisfactory permeabilities and Q to be used as playback heads up to 5 MC; Fig. 1 shows a graph of permeability and Q as a function of frequency. That these ferrites had the necessary physical properties to make sharp recording headsgaps is shown in Fig 9. It will be noted that the ferrite is free from large voids and blow holes and that the gap edges are quite straight and uniform. Additional evidence of the sharpness of the gap edges is shown in Fig. 2. The sharpness of the nulls is a characteristic of relatively sharp and parallel edges.

The head just described (Fig. 2) is not a high resolution head; it could be used out to 0.5 mil wavelength. Photomicrographs of two higher resolution heads are shown in Fig. 3. It will be noted that the gap edges appear straight and parallel and free from large irregularities. The sharpness of a gap edge is significant only when related to the recorded wavelength; from this point of view the edges are not sharp and straight but have irregularities which are comparable to the gap length. The minimum gap length for head #15 (Fig. 3) is around .06 mil and for head #17 is around .03 mil, therefore the irregularities, although relatively large, are quite small on an absolute scale. The wavelength response of these heads is shown in Fig. 4; the problem of gap alignment at very short wavelengths was dodged by recording and playing back on the same head. There were some differences in output between the heads but data on such factors as front and back gap reluctance and the effect of potting strains was not sufficient to attach specific significance to these output variations. It is significant that the curves do not show the sharp null of head #10. This is evidence that the gap edges are less sharp relative to the recorded wavelengths at which the null should occur. In Fig. 5 are shown frequency

(*Continued on page* 169)

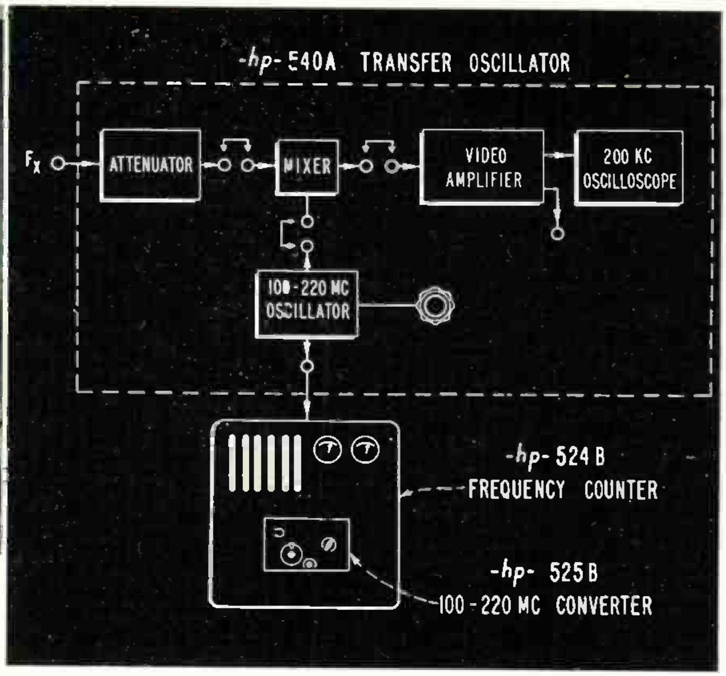



Fig. 1: Complete measuring system requires only moderate bench space

Fig. 2: (r) Block diagram of counter-transfer oscillator arrangement

# Designing a Precision

*Addition of transfer oscillator and frequency converter to high-speed frequency counter extends range to 12.4 KMC, and down to 0 CPS. Internal time base system holds accuracy within 1 part in $10^6$*

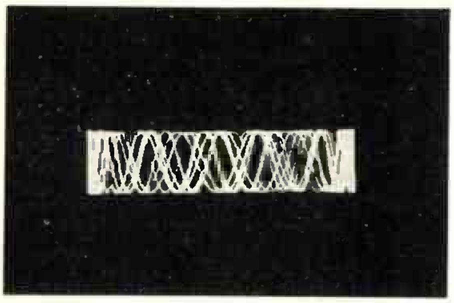


Fig. 3: Scope presentation as low difference frequency is approached. 60 CPS sweep on scope

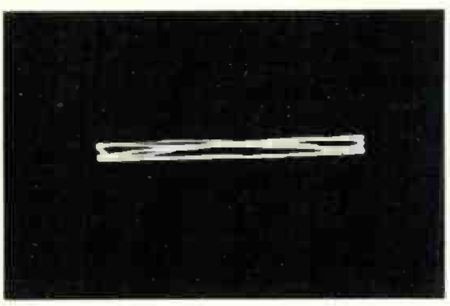
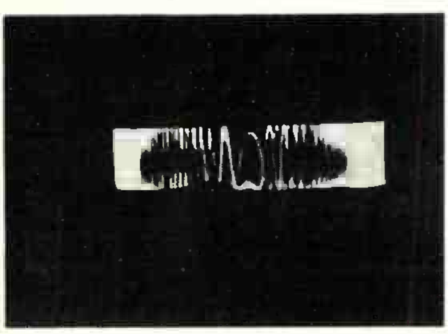


Fig. 4: Typical oscilloscope presentation at zero beat when measuring stable signal

Fig. 5: Typical scope presentation at zero beat when signal has incidental FM.



A COMPLETE integrated precision frequency - measuring system covering the range from 0 CPS to at least 12,400 MC has been formed by combining the high-speed frequency counter with simple auxiliary equipment. The accuracy of this system, since it is derived from a precision frequency standard, is equal to or better than that of other systems. The versatility of this system, however, is not approached by other systems. The system will, for example, measure the carrier frequency of pulse-modulated carriers or the limits of deviation of frequency-modulated carriers.

Fig. 2 is a block diagram of the components of the system. The basic component is the high-speed frequency counter which measures c-w frequencies up to 10 MC. The fact that the counter will make this measurement in 1 sec and that it can be operated by non-technical personnel is responsible for the popularity of the counter method and for the demand to extend the range of measurements it can make to higher frequencies. The counter will, for example, measure a frequency such as 9,809,271 CPS in 1 sec. Since it displays the measurement in illuminated numerals and since it makes the measurement automatically, it can be operated by anyone with the ability to read numbers.

*ALAN S. BAGLEY and DEXTER HARTKE, Hewlett-Packard Co., Palo Alto, Calif.*

In addition to measuring frequencies as high as 10 MC, the counter will also measure frequencies as low as approximately 0 CPS. Measurements of these low frequencies are made by reversing the usual method of measurement, i.e., by counting a standard frequency from the counter's time base system for the duration of 1 or 10 cycles of the unknown frequency.

The counter's accuracy is controlled by an internal time base system designed to operate from a 100 KC frequency standard. The internal time base is capable of an accuracy of 1 part in $10^8$. This gives the counter an overall accuracy of $\pm1$ part in $10^8$ $\pm1$ count (cycle) when operated from a suitable frequency standard. The frequency standard included in the counter is rated as

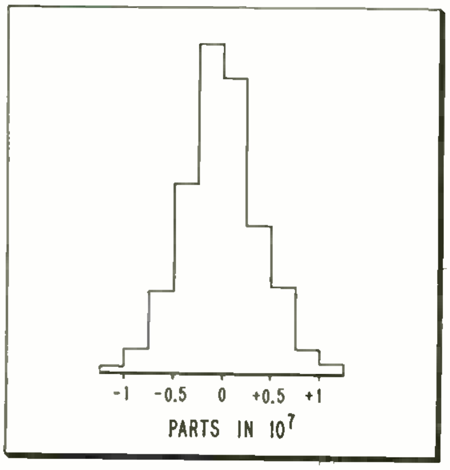



**Fig. 6: Distribution of error of comparison when a large number of measurements are taken**

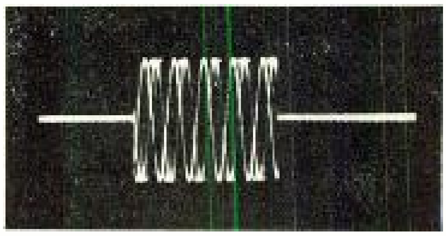


**Fig. 7: When measuring rectangular pulses**

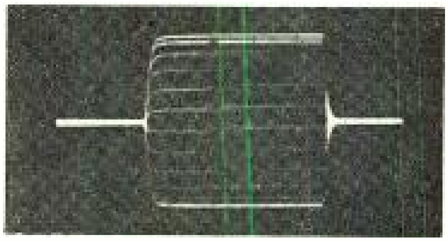


**Fig. 8: Difference frequency at low value**

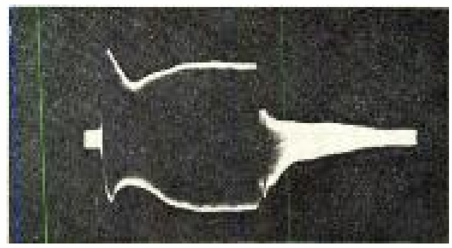


**Fig. 9: Pattern when checking pulsed carriers**

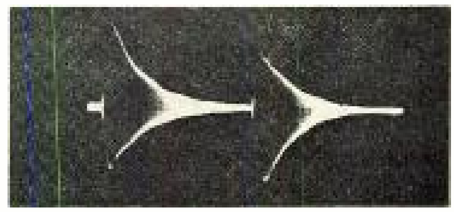


**Fig. 10: When using differentiation technique**

*By ALAN S. BAGLEY and DEXTER HARTKE*

# Frequency-Measuring System

having a short-time accuracy of ±1 part in $10^6$.

### Converter

The second component of the system is a frequency converter. This converter actually becomes an integral part of the counter, since it fits into a panel recess in the counter, is operated as part of the counter, and has the same accuracy as the counter. Two converters are available, one of which extends the counter's range to 100 MC and another from 100 MC to 220 MC.

The manner in which the converters operate can be described in terms of the 100-MC converter. This equipment multiplies a standard frequency from the counter's time base and makes it available as a mixing frequency in 10-MC steps in the range from 10 to 90 MC. These mixing frequencies have the same accuracy as the frequency standard from which the counter is operated. A desired mixing frequency is selected by a calibrated switch on the converter panel.

To measure a frequency in the 10-100 MC range, the operator connects the frequency to be measured to the converter. A calibrated wavemeter on the converter is then adjusted for an indication on the converter's electron-eye tube. When the wavemeter is tuned, the calibrations on the wavemeter control inform the operator of the proper mixing frequency to use. This mixing frequency is always the nearest multiple of 10 MC below the frequency to be measured.

When the mixing frequency switch has been set to the proper position, the converter mixes the frequency to be measured with the mixing frequency to produce a difference frequency which is never more than 10 MC. This difference frequency falls within the range of the counter and is measured and directly displayed by the counter. The frequency being measured is thus equal to the setting of the converter switch plus the reading on the counter. Adding these two frequencies is easy to do mentally, because the mixing frequency is always a simple value such as 10, 20, 30, etc., MC.

As mentioned earlier, the counter will make its measurements in 1 sec. But it is also arranged to make measurements in even shorter times such as 0.01 sec. In many applications, especially in the frequency range of the converters, these shorter gate times permit frequency drifts or the effect of tuning adjustments on external equipment to be observed immediately. For this reason it is often desirable to use the 0.01-sec. gate time when the counter is being used with the converter.

The 100-220 MC converter operates in much the same manner as the lower frequency converter. The higher frequency converter is of special interest, however, because it is used in extending the system to even higher frequencies.

The foregoing has been the existing system for measuring frequencies up to 220 MC. The requirements established for extending this system to the measurement of higher frequencies included provision for the measurement of pulsed and f-m frequencies as well as c-w frequencies, since these types of modulation are widely used at the higher frequencies. In addition, the system should be able to measure these frequencies at the millivolt level.

These requirements are met by the system's third component, a new transfer oscillator which extends the measuring range of the system to at least 12,400 MC. The transfer oscillator is really a combination of several circuits, including a stable oscillator which is adjustable over the range from 100 to 220 MC. The range of the oscillator thus coincides with the range of the higher frequency converter so that the frequency of the oscillator can be measured at all times to the full accuracy of the counter and converter.

When a high frequency is to be measured with the system, a harmonic of the transfer oscillator is compared with that frequency in a broadband crystal mixer contained in the transfer oscillator cabinet. The difference frequency between the frequency being measured and the oscillator harmonic is observed on a self-contained oscilloscope. When the transfer oscillator is tuned

*(Continued on page 134)*

# 27 Rules for
# Guided Missile

*The goal of "absolute reliability" demands new tice. Recommendations include strict attention construction, and adoption of the rule*

**By ROBERT LUSSER**

*Reliability Coordinator,*
*Redstone Arsenal,*
*Huntsville, Ala.*

SINCE the war, our military equipment, particularly electronic equipment, has increased enormously in complexity, sensitivity, volume and cost. The achievement of reliability and serviceability has, therefore, become the top problem of our armament program.

Since guided missiles are more complex and sensitive than any other weapon, they pose the most difficult reliability problem of all. The overall reliability of a missile or complex electronic system equals, not the average, but the product of the reliabilities of its *n* components.

$$P_{overall} = p_1 \cdot p_2 \cdot p_3 \cdots p_n$$

For example, if a missile contains 100 components, each having 99% reliability (which is a widely accepted standard of "quality"), the overall reliability would turn out to be only 36.5%. If a missile contains 1000 components having the same 99% reliability, the overall reliability would turn out to be only 0.02%.

The reliability formula indicates, furthermore, that, in order to achieve an overall reliability of 80% for a missile containing 4000 components (which is by no means unusual) one can tolerate, on the average, not more than one failure in 18,000.

As an aid to the designers of guided missiles and their components, the following twenty-seven rules, based on the latest experiences in the field of reliability, are offered.

**1** Reliability is not an "ability" but a *probability,* namely, that an item will operate successfully under service conditions. Failure to clearly recognize this mathematical implication may severely delay the development of a guided missile. Study, therefore, the basic concepts of statistics and probability.

**2** Study in particular the unique reliability problem of guided missiles in all its practical and theoretical aspects.

**3** Avoid Rube Goldberg designs. The effort to achieve reliability goes up with about the *square* of the number, *n*, of the components. A very complex design may, therefore, never become reliable and serviceable. Simplicity should be the art, vocation, and objective of every designer.

**4** Mistrust the validity of the time-honored concepts of quality and reliability. Many are obsolete as far as guided missiles and their components are concerned.

**5** Mistrust the concept of redundancy. In guided missiles, no human being is aboard to make the decision to switch over to the stand-by component.

**6** Mistrust the concept of "Production Environmental Testing." It teaches that missiles and their components can be "debugged" prior to flight by shaking, shocking, or pre-aging. Actually, bugs may not only be tested out but also tested in because some of the many sensitive components may become fatigued and fail later in flight, thus causing the whole missile to fail.

**7** Mistrust inspections and check-outs. Although they are indispensable, they are not, and cannot be, conducted under the environmental conditions of flight that are usually much more severe. Therefore, they do not nearly suffice to make missiles reliable.

**8** Mistrust flight testing as a means of improving reliability. Of course, we have to test missiles in flight in order to determine environmental conditions, and important flight parameters. Yet, since missiles are not recoverable, it is nearly hopeless to try to determine the "ultimate" cause of a missile failure.

**9** Mistrust any specification unless you have been able to determine whether or not it is really applicable to the missile and to the component you are going to design or to select.

**10** Try hard to get from those responsible for the systems design, the actual environmental conditions under which the component will have to work reliably. In many instances, you may encounter vagueness. Insist upon an answer. If your component should fail and cause the failure of a missile it is you who may have to take the blame rather than those who gave you the wrong information.

**11** If an environmental condition, any shock, has not yet been determined numerically, make a generous estimate and apply safety factors of ignorance that are the larger the less the environmental condition is known. The opposite would certainly ruin your missile.

**12** Once the condition has become well known, say through flight tests, you may reduce these factors, if desirable. The opposite principle, that of beefing up the strength of the components at a later stage, will most certainly ruin the missile type because the design must be frozen once production is ordered.

**13** Before designing or selecting a component type inquire what level of component reliability must be achieved for the particular type of missile. For reasons discussed earlier, the component reliability may have to be ten times or even a hundred times more reliable than the commercial product, depending on the complexity of your missile.

# Design Engineers

*and more rigid standards of engineering prac-*
*to specifications, a striving for simplicity in*
*that testing to failure is mandatory.*

**14** Never worry about design reliability of your component being too high. Rather, strive for "absolute" reliability, that is, make sure that not more than one unit in 10,000, or better, one in 100,000, will probably fail under service conditions. Only then may you be sure that your component will never "kill" an expensive missile.

**15** Consider every component type as a potential "killer" of a missile until you have absolute proof that it is highly reliable. Mistrust any claim of "high quality," and "maximum reliability" unless you have been able to convince yourself that the selected component type can stand up under the environmental service with unusually high safety factors.

**16** Safety factors of 1.5 or 2, although still specified in most specifications, should be disregarded because they are not nearly high enough to achieve the "absolute" level of component reliability required in guided missiles. If you can attain a safety factor of 10—and in most instances you can—you are contributing much more to the reliability of the missile than if you were satisfied with a safety factor of 1.5 or 2.

**17** Prove the existence of these high safety factors by testing all component types *to the point of failure*. This will help you determine the "modes" of failure, that is, the predominant weaknesses of your component. By feeding back such knowledge into design you may raise the reliability of your components considerably, sometimes by orders of magnitude.

**18** Do not believe that the test to failure method is "intolerably expensive." True it may cause additional effort and worry to you and to the test laboratories. Yet, in the long run failure testing will pay high dividends to you, your company, to the taxpayer and to the Armed Forces because it is virtually the only sure way to raise the reliability of your component up to the required "absolute" level and to make your missile reliable and serviceable.

**19** In planning a test to failure program for your component, black box or missile, anticipate all conceivable modes of failure, even if some may appear to be very remote. Even a remote weakness of your component may once in a while kill a missile that may be ten thousand times more expensive than your component.

**20** Do not be mislead by the widespread opinion that it is just the environment of shock and vibration that needs to be considered in a test to failure program. There may be hundreds of other design criteria that may be hazardous to the missile, such as maladjustments, misalignments, electrical and mechanical instabilities, structural overloads, frictions, insufficient power supplies, mechanical and electrical resonances, and many, many others. Whenever you have the slightest suspicion that one of these design criteria may become hazardous to your component, and your missile, you should insist that it be included in the test to failure program. Suspicion is the father of reliability; optimism and gullibility ruins it.

**21** Do not rely on the test to failure results of just one unit. A subsequent unit might be much weaker. Therefore, insist that the characteristic variability of the "strength" value of your component type be determined by testing a statistically significant number of units. This will be the only sure way to determine whether or not your component has really attained the required "absolute" level of reliability.

**22** After you have achieved the required "absolute" design reliability of your component, make sure that it is maintained in production and operation. Follow your component through all subsequent phases of production, assembly, inspection, transportation, storage and operation. You may detect new unexpected weaknesses.

**23** To this end, see to it that periodic tests to failure, on a sampling basis, are performed as long as your component is being produced.

**24** Insist that Statistical Quality Control be applied to your component. However, make sure that the proper yardsticks of reliability are applied. Remember, not more than 1 out of 10,000 units may be permitted to fail.

**25** Confer with the manufacturer of your component. The best component type may become a severe hazard to the missile if its design reliability cannot be maintained in production. This may easily happen if your design is inadequate to the needs of manufacture. For example, tight tolerances may badly impair the reliability of your component because they may make manufacture difficult. Remember, in guided missiles we are interested in "reliability," and not necessarily in "quality." These two properties are often unrelated and even opposed to each other.

**26** Should your component show a weakness do not be too quick to place the blame on the manufacturer. In many instances the failure might actually originate in a design oversight of your own.

**27** Keep in close contact with users. Your missile may have attained high intrinsic reliability, yet, it may be useless if this reliability cannot be maintained in service.

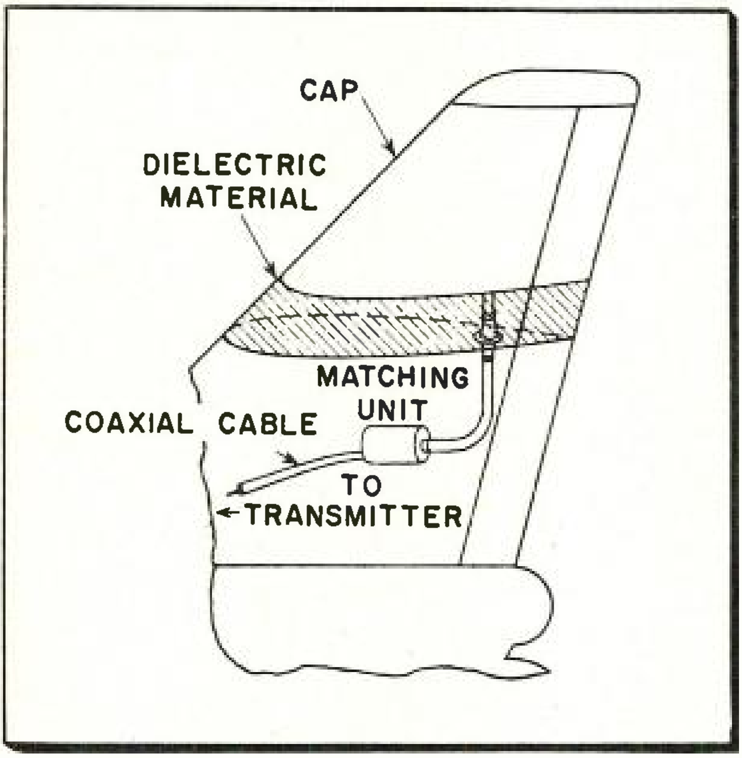



Fig. 1: Dielectric isolates tail cap section from fuselage

*An evaluation of the electrical and mechanical stability under service conditions of the polyester and epoxy laminates currently in use as isolating dielectrics for cap-type aircraft antennas*

# Structural Dielectrics In Cap-Type H-F Antennas

**By H. J. SANG and B. M. SIFFORD**

THE use of flush antennas is becoming standard on all new high-speed aircraft. The flush configurations which appear most suitable from the electrical standpoint for the 2-24 MC liaison communications band are the cap-type antennas made by electrically isolating a portion of the vertical stabilizer or the wing tip with a structural dielectric material. The study described in this paper has been concerned with an evaluation of the stability of the electrical and mechanical properties under service conditions of structural dielectric materials currently in use or considered for use in aircraft antennas of this type. These materials consist of various kinds of glass fiber-resin laminates.

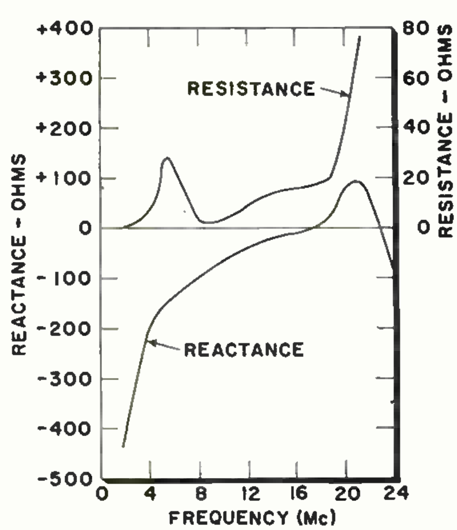
The electrical performance of a communications antenna system is determined, of course, by how efficiently it radiates power from the transmitter in the directions useful to communications. It is the purpose in this part of the discussion to consider how one aspect of the antenna design—the electrical properties of the dielectric gap material—affects the electrical performance of the cap-type h-f antenna system.

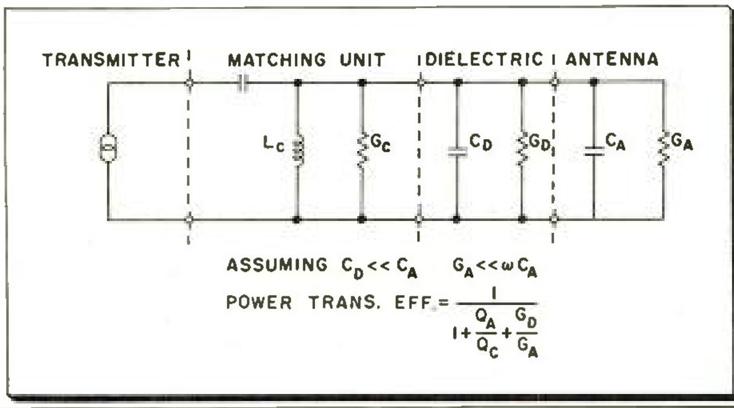
Fig. 1 shows a simplified sketch of a typical tail-cap antenna. The shaded area represents the dielectric skin of the isolating gap. The antenna is connected directly to an antenna matching unit which automatically transforms the impedance of the antenna to a constant 50 ohm level. The matching unit is connected through a coaxial cable to a remotely located transmitter.

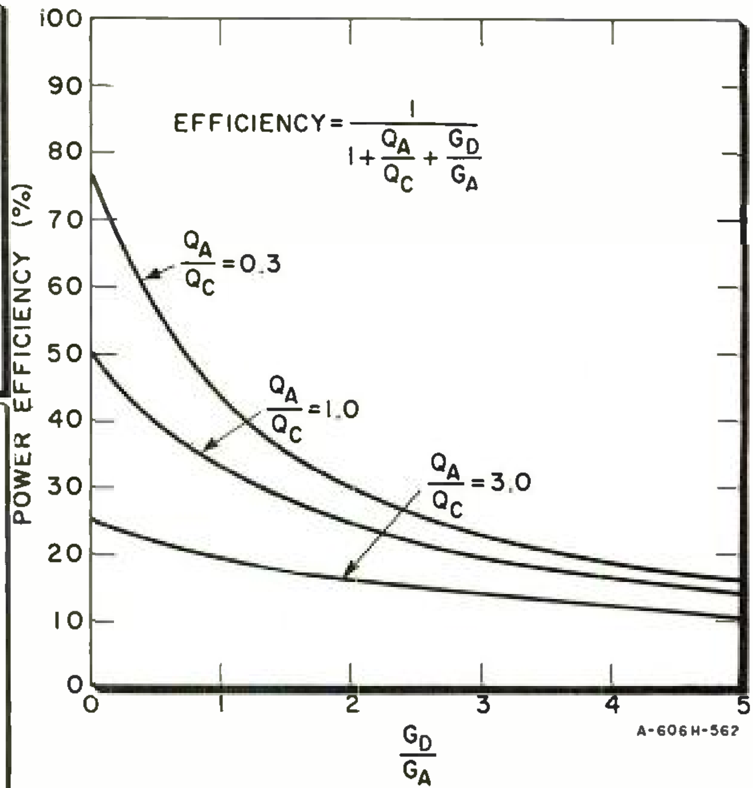
The principal power losses in the antenna system are the loss in the coaxial cable from the transmitter to the matching unit, the loss in the matching unit, the loss in the dielectric material of the isolated section, and the loss due to radiation from the antenna in directions not useful for communications. The loss in the coaxial cable is directly proportional to frequency and cable length and also varies with the VSWR on the cable. The losses in the elements of the matching unit depend primarily upon the Q of the load (i.e., the antenna) which it is required to match. The losses in the dielectric material at a particular frequency depends upon the dimensions of the antenna gap, the impedance of the antenna, and the electrical properties of the dielectric material. The radiation pattern efficiency of the antenna, which is defined as the fraction of the total radiated power which goes into sectors

H. J. SANG and B. M. SIFFORD, Stanford Research Institute, Menlo Park, Calif.

Fig. 2: Impedance characteristics of antenna





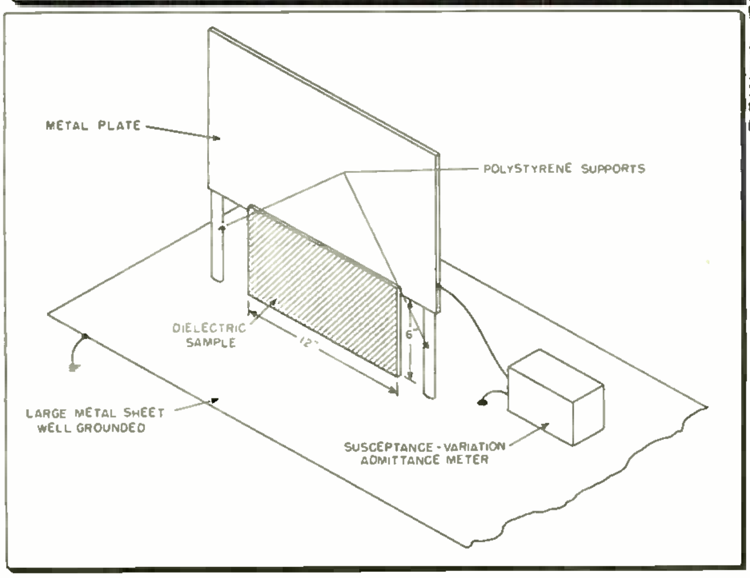




**Fig. 3: (above left) Equivalent circuit at low frequencies**

**Fig. 4: (above) Effect of dielectric loss on power transfer**

**Fig. 5: (left) Set-up for measuring losses of isolating dielectric**

useful for communications purposes, depends upon the size and configuration of the airframe and the location of the antenna.

The impedance characteristics of a typical tail-cap antenna are shown in Fig. 2. The behavior of the resistance component is determined primarily by resonances of the major airframe elements such as the wings and fuselage. A larger cap size generally raises the level of the resistance curve slightly while decreasing the reactance.

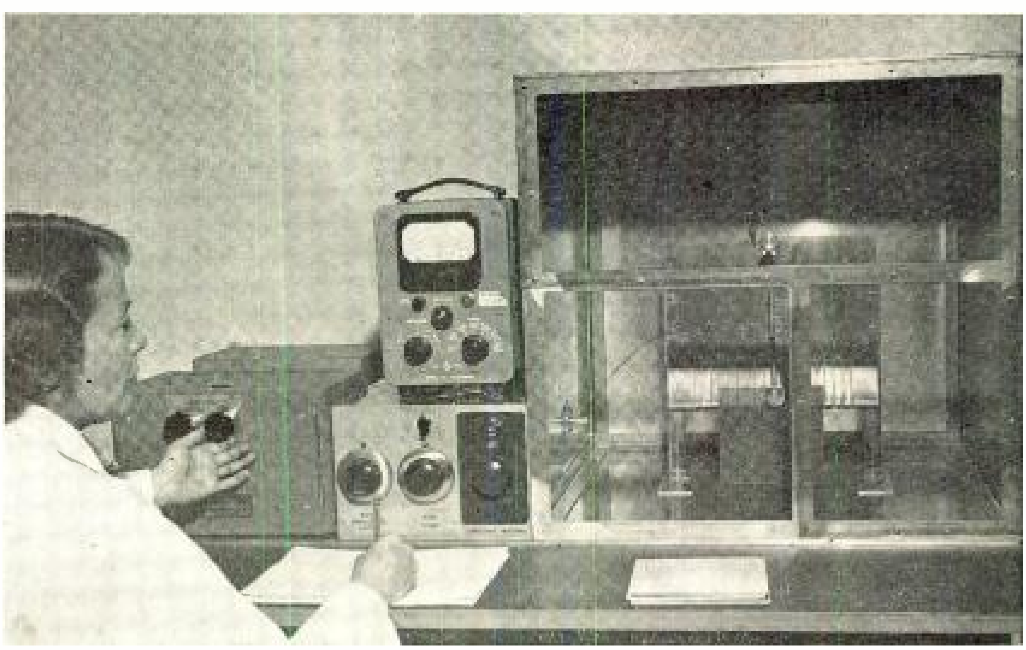
In the high frequency range—say above 6 MC—the antenna impedances are usually such that relatively high efficiency can be obtained from a matching unit with reasonably low loss elements. Also the equivalent antenna radiation conductance will usually be much larger than the equivalent loss conductance placed across the gap by even the most lossy dielectric materials. The performance above 6 MC, therefore, is governed primarily by the radiation pattern characteristics and coaxial cable losses.

For frequencies below 6 MC, the wavelength becomes larger than the largest aircraft, so that the radiation patterns of any cap-type antenna degenerate into the radiation pattern of a simple dipole. Although the orientation of the dipole pattern relative to the airframe will depend upon which airframe extremity is used as an antenna and, to some extent, on the airframe configuration, it is found that the radiation pattern efficiency is relatively independent of such changes in pattern orientation. The designer hence has little control over the antenna pattern in this frequency range, so the other design factors become paramount.

Furthermore, in most installations, the loss in the coaxial cable can be neglected if a low loss cable is used and a good match is provided by the coupler. In the 2 to 6 MC range, therefore, the antenna performance will be a function primarily of the dielectric loss and the matching unit loss. The measure of the antenna performance at these frequencies

(*Continued on page* 180)

**Fig. 6: Dielectric conductance measuring equipment and sample holder**



*Designed for amplifying the low level outputs of thermocouples and strain gauges, this extra-sensitive magamp employs two high gain push-pull stages, with negative voltage feedback*

**By F. GOURASH**

# Low Level Magnetic

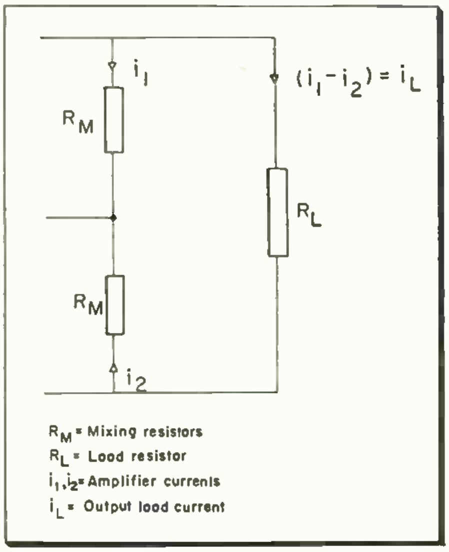



**Fig. 1: Resistive mixing circuit for magamp**

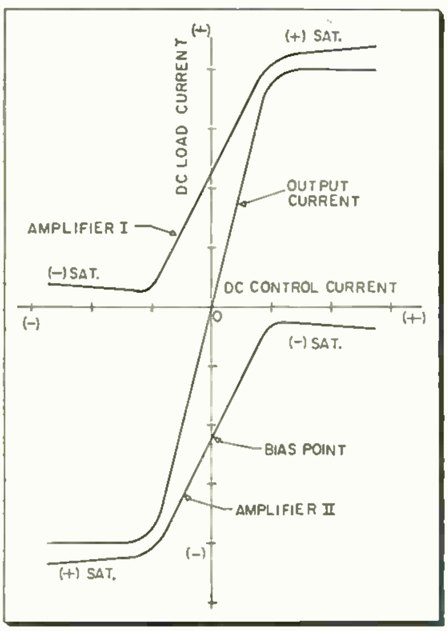
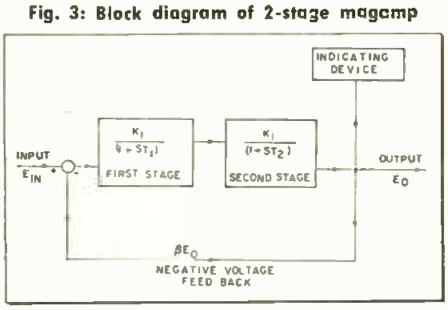



**Fig. 2. Transfer curves, push-pull operation**

**Fig. 3: Block diagram of 2-stage magamp**




INPUT signals for many control systems are obtained from thermocouples, strain gauges, and barrier-layer photocells. It is desired to use these signals to perform some useful function such as to actuate an alarm, provide information on an indicator, or control a processing system. Signals from these devices, however, are at very low power levels and cannot perform their intended functions directly. They must be amplified to higher power levels before they can be effectively utilized. The low-level amplifier provides the necessary power amplification. It must be extremely stable and sensitive in order to detect the low-level signals it receives. A short time constant is also desirable for the amplifier so that no appreciable time lag is introduced into the system. Low-level magnetic amplifiers have been built to meet these requirements; they exhibit zero drift levels of $10^{-9}$ watts with time constants of the order of seconds[1]. Although some laboratory models have zero drift levels of $10^{-12}$ watts[2], it is difficult to build practical models to have this drift level.

In this article we will describe the design and performance of a two-stage low-level magnetic amplifier that was successfully developed to meet the exacting requirements of a temperature indicating and alarm thermocouple application. The amplifier exhibits a zero drift level of $10^{-12}$ watts referred to the input for the specified conditions of voltage, frequency, and ambient temperature. The response characteristic is critically damped with a total response time of 0.10 secs. Conventional circuitry and existing components are used. An individual biasing arrangement and matched cores and rectifiers maintain a balanced amplifier. Consequently, zero drift is kept to a minimum. The detrimental effects of component instability are minimized by obtaining the overall power amplification with two high-gain stages in cascade. The application of negative voltage feedback around both stages insures a high degree of gain stability and provides the necessary linearity. The input impedance is raised to a level many times higher than the ohmic resistance of the input circuit which makes the amplifier essentially a voltage-sensitive device. The over-all characteristics and performance exhibited by the amplifier are favorable to its application in a wide variety of low-level systems.

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### *Design Analysis*

The design analysis is carried out for a particular thermocouple application to illustrate the design features of the amplifier. The design features, however, are not limited solely to the thermocouple application, but are applicable when the amplifier is used for other types of low-level systems.

An Iron-Constantan thermocouple is subjected to a hot junction temperature range of 330°C. and produces a linear output voltage change of 0.055 mv/°C. It has a lead resistance of 20 ohms. The amplifier must receive its input signal from the thermocouple and drive both an indicating instrument and the control circuits of relay amplifiers. The relay amplifiers provide the alarm signals at various preset temperatures. These functions are to be performed to an accuracy of 1%. A maximum response time of 1 sec. is permissible, but a faster response is desired. Ambient temperature varies over a range from 0°C. to +70°C. The supply voltage is 120 v., 800 cycles. Ten percent voltage and five percent frequency variations are specified.

An appraisal of these specifications dictates a high-gain sensitive

# Amplifier

amplifier with an extremely stable and linear output current vs. input voltage transfer characteristic. The response time is to be as short as possible. The difficulties experienced with the design of low-level magnetic amplifiers to meet similar specifications arise because the components are not sufficiently stable for the circuitry used to permit operation at the low input levels with a high degree of accuracy. The self-saturating, push-pull circuit is commonly used because it has a high gain characteristic. This circuit consists of two amplifiers that are biased for maximum gain and whose outputs are mixed in a common load (Fig. 1). A given dc input signal drives one amplifier toward positive saturation and the other amplifier toward negative saturation by the same amount. The output current is the difference between the two load currents (Fig. 2). At zero input signal the two load currents are equal for a well-balanced amplifier and the output current is zero. Instability of cores and rectifiers unbalances and produces an output current with zero input signal. The unbalanced amplifier also produces some gain drift.

The self-saturating, push-pull circuit is used in the thermocouple amplifier to take advantage of the high gain characteristic, but the amplifier is designed to minimize the effects of component instability on over-all performance. The thermocouple amplifier consists of two stages with negative voltage feedback around both stages. This produces a two time delay system as shown in Fig. 3. The LaPlace transform for this system is as follows[3]:

$$G(s) = \frac{E_o(s)}{E_{in}(s)} = \frac{K_1K_2}{(1 + ST_1)(1 + ST_2) + \beta K_1K_2} \quad (1)$$

$K_1$, $T_1$, $K_2$, and $T_2$ are the voltage gains and time constants of the first and second stages, and $\beta$ is the feedback ratio. The static gain for this system reduces to:

$$G = \frac{E_o}{E_{in}} = \frac{K_1K_2}{1 + \beta K_1K_2} \quad (2)$$

By designing high gain into the two stages to permit a large feedback ratio, the product $\beta K_1K_2$ is also large and the over-all gain reduces to approximately $1/\beta$. Thus, over-all amplifier stability is dependent on the stability of the feedback circuit. With an essentially resistive load circuit, the stability problem is reduced to that of maintaining a stable feedback ratio.

The two stages are designed for both high power and high voltage gain. The first stage achieves its power amplification not by controlling a large amount of output

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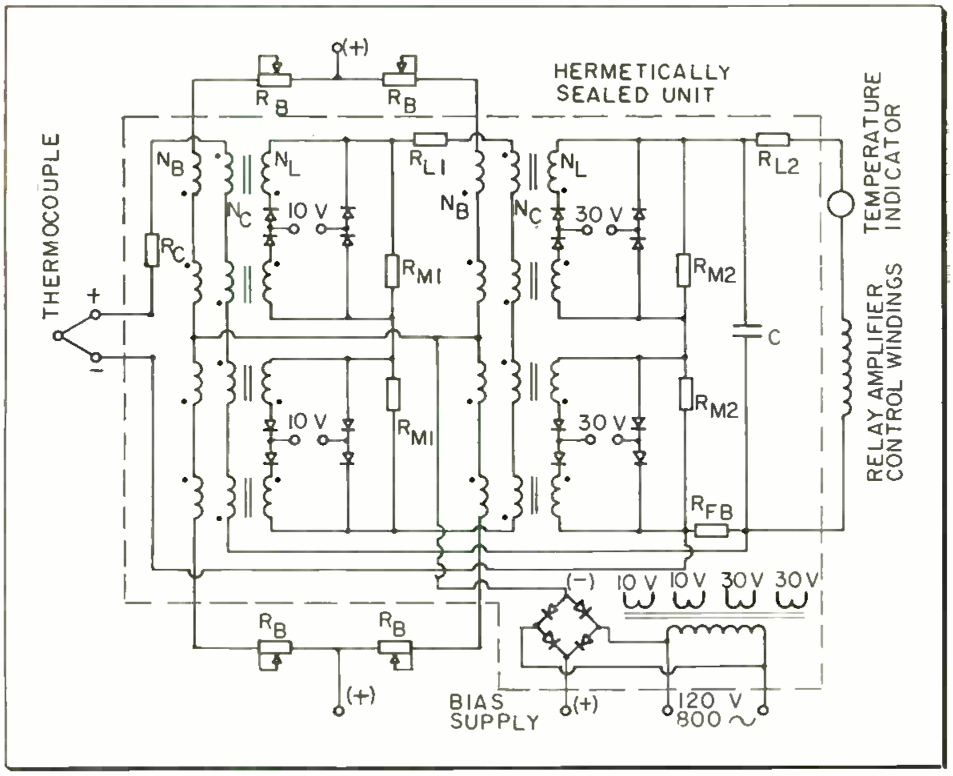



Fig. 4: Schematic circuit diagram of 2-stage low level magnetic amplifier

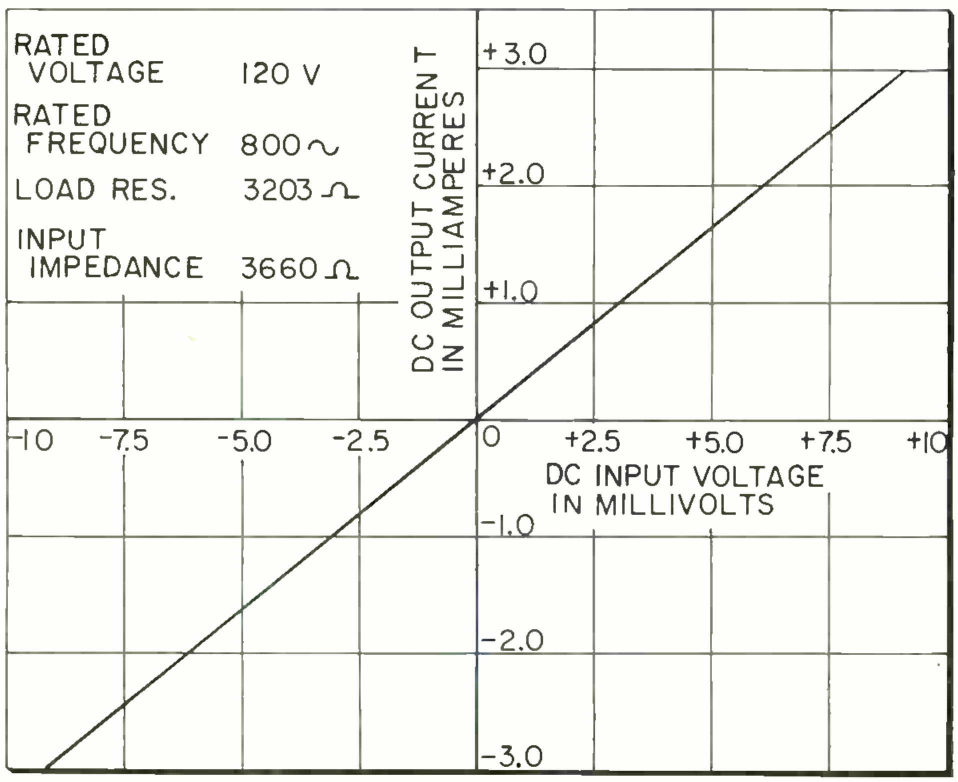



Fig. 5: Closed loop transfer curve, defines operation for rated conditions

# Stacked Ceramic Tubes

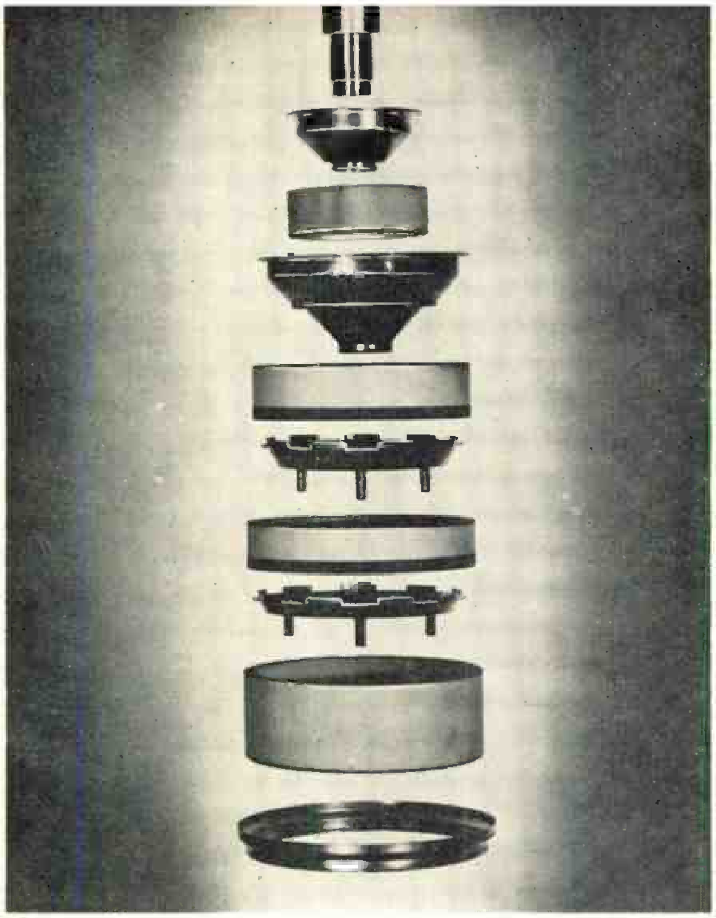


Fig. 1: Stem structure of 5 kw tube has four ceramic rings

THE term "Stacked Ceramic Tube" means a construction in which all of the tube parts, including envelope sections as well as electrode structures, are assembled by simple stacking operations. Both transmitting and receiving type tubes will be described. In the receiving type tubes, the stacking technique has been developed to the fullest extent.

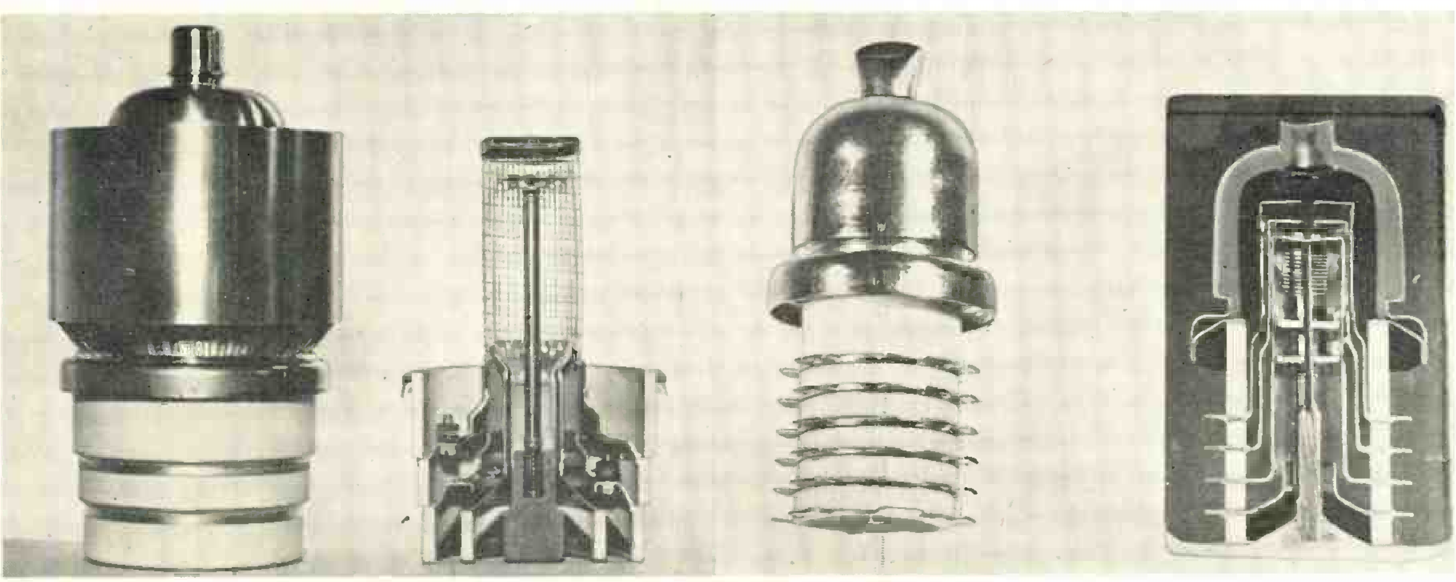
Fig. 2 shows side elevation and sectional views of a tetrode having an anode dissipation rating of 5 kw, which is representative of a larger tube in the transmitting tube category, identified as the 4X5000A. The right-hand view in the photograph is a cut-away section through the stem of the tube and clearly illustrates the envelope construction built up on ceramic and copper rings, the latter providing electrode supporting members. These envelope sections are all self-jigging, so that axial and vertical alignment is obtained automatically when the parts are stacked together, without requiring skilled operators. The entire envelope stem structure is brazed together in a single furnace operation.

Fig. 1 is an exploded view of the stem structure for the 5 kw tube, showing the four ceramic rings and several metal parts which make up the envelope. This photograph helps to visualize the stacking method of assembly. Conical formation of the metal rings, particularly at the base of the stem, insures adequate rigidity.

In all of the tubes here described, the ceramic employed is of the aluminum type. Metalizing is by the refractory metal powder sintering technique. Only high temperature brazing alloys such as copper-gold and the like are employed at the ceramic-to-metal seals. In standard production these seals normally pass rupture pull tests of the order of 5,000 psi. High temperature materials are used throughout to permit bakeout at elevated temperatures during tube manufacture, and to provide a tube which will operate in high ambient temperature environments.

*HAROLD E. SORG is Vice-President, Research at Eitel-McCullough, Inc. San Bruno, Calif.*

Fig. 2: Side and sectional views of 5 kw transmitting tetrode. Fig. 3: 150 watt tetrode. Ceramic and metal rings comprise side wall.



*New developments in the application of ceramic-metal assemblies to transmitting and receiving tube construction. Adaptability to modular circuitry cited.*

**By HAROLD E. SORG**

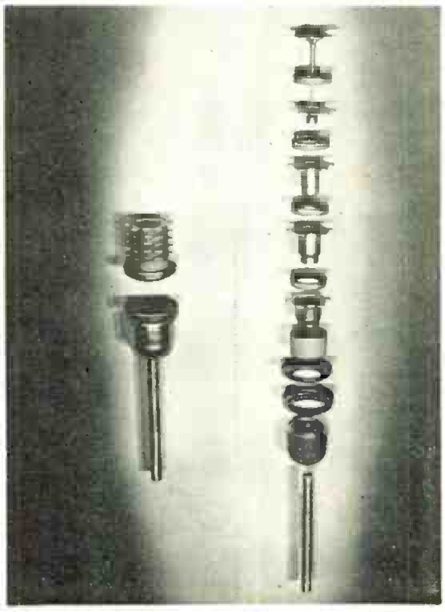


Fig. 4: Exploded view—150 watt tetrode

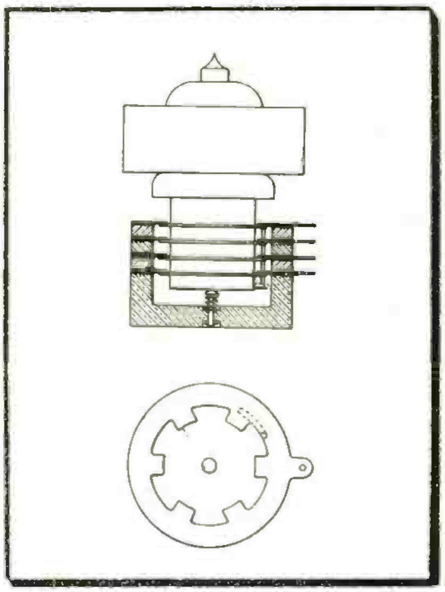


Fig. 5: Preferred socket contact arrangement

Fig. 3 is a photograph showing side and cross section views of a smaller 150-watt transmitting tube having characteristics comparable to the Eimac 4X150A glass tetrode. This illustrates advanced techniques in stacked construction wherein ceramic and metal rings are sandwiched together to build up the envelope side wall. The interposed metal rings function as electrode supports and also as terminal members, being radially extending segments of the metal side wall rings. This introduces a unique method for socketing the tube.

### *Stacked Relationship*

Fig. 4 shows exploded views of the above tube, the left-hand portion of the photograph showing the parts completely exploded and the right-hand illustrating the envelope subassemblies prior to mounting the electrodes and final sealing. These views illustrate the stacked relationship of the ceramic and metal rings making up the envelope and also show the tubular electrode supports which are formed as an integral part of the metal side wall rings.

Fig. 5 is a drawing illustrating the preferred socketing arrangement for the 150-watt tube. The socket has contact segments complementary to those on the tube so that the tube may be inserted into the socket and then turned to rotate the terminals into engagement under the socket contacts. A spring in the socket presses the tube upwardly against the socket contacts. The lower view in the drawing looks down on the socket and indicates the arrangement of the contacts.

Fig. 6 shows a small double triode in the receiving tube category similar in characteristics to the 6SN7

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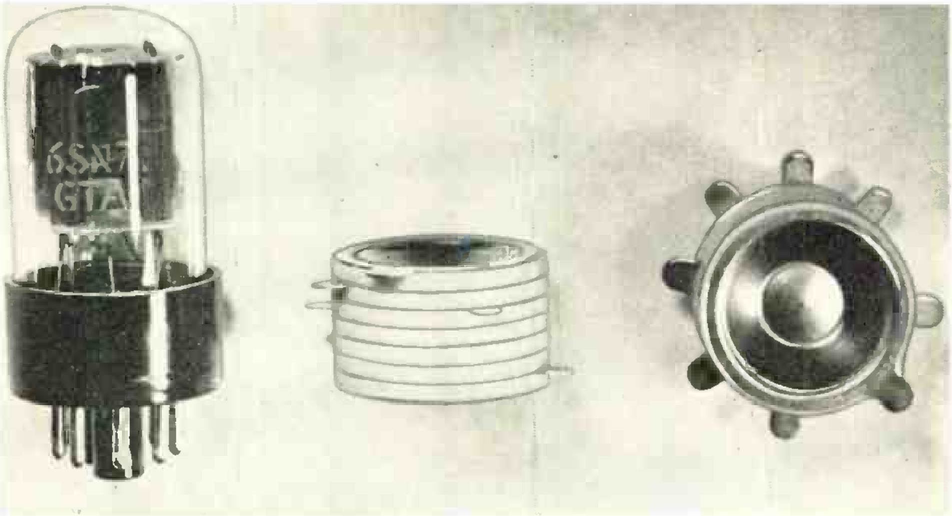


Fig. 6: Ceramic double triode (r) is counterpart of familiar glass 6SN7

Fig. 7: Sectional drawing illustrates positioning of tube elements

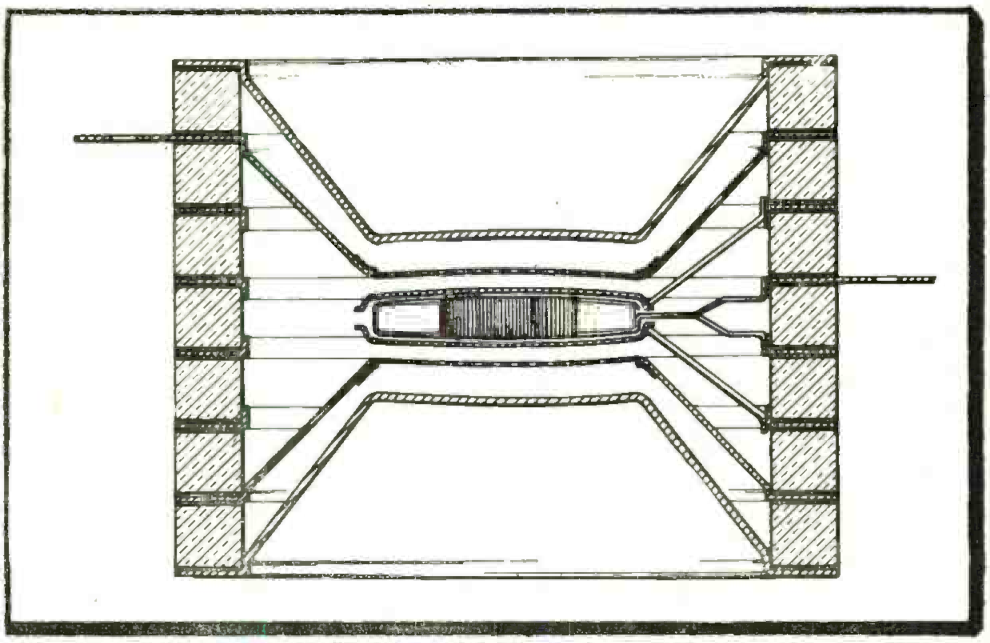


FIG. 1 Complete transmitter and power supply assembly is mounted on a single printed circuit card

# An Airborne Standby VHF

By KENNETH M. MILLER

*Compact, rugged, printed circuit unit works off aircraft's 24 v. storage battery*

K. M. MILLER

■ Many military aircraft employ both a 400 CPS power plant and a storage battery. In these aircraft the radio communication equipment is normally powered by the ac power generator. It is obvious, therefore, that the loss of ac power will create a hazardous situation for both the crew and the aircraft. To overcome this problem a project was established to design a VHF transmitter-receiver which would provide maximum reliability and which would assure radio communication during an emergency caused by an ac power failure or failure of the ac operated communication equipment.

The equipment about to be described uses no ac power. It is operated directly from the aircraft storage battery.

Several objectives were established at the onset of the project. Foremost were the following:

1. Reliability—The device must be as reliable as the state of the art will permit.

2. Physical compactness—If the end product is large and bulky, space and weight considerations might prevent its application in the already over burdened modern military aircraft.

3. Performance—It must accomplish the basic task of providing clear communication at distances equivalent to line of sight paths on an emergency frequency universally used today at both military and commercial airdromes.

### Power Supply

Once it was established that the unit was to be powered by the aircraft's 24 v. battery, two basic types of power supplies were considered: These are dynamotor and vibrator. In the interest of maximum reliability, compactness, and light weight, it was decided that a vibrator supply would be used. Recent developments have yielded relatively long potential life from vibrators operating at 400 CPS. This high vibrator frequency permits the use of a compact power transformer and the associated filter reactor and capacitors. The obvious bonus yielded by the use of these small components are reduced weight and size. Furthermore, these 400 CPS vibrators are hermetically sealed to nullify the detrimental effects of humidity and high altitude operation.

The total power requirements of this equipment are 1.75 amps when receiving and 3.0 amps for transmitting, using a 27.5 v. dc voltage source.

The power output from this power supply is 120 v. dc at 100 MA during the "receive" duty cycle and 220 v. dc at 125 MA during the "transmit" duty cycle. Conversion of the ac output of the transformer to dc is accomplished by means of a selenium rectifier designed for military applications. In order to permit the use of a single power transformer secondary winding, a full wave rectifier circuit is used during "receive" and a bridge circuit is used during

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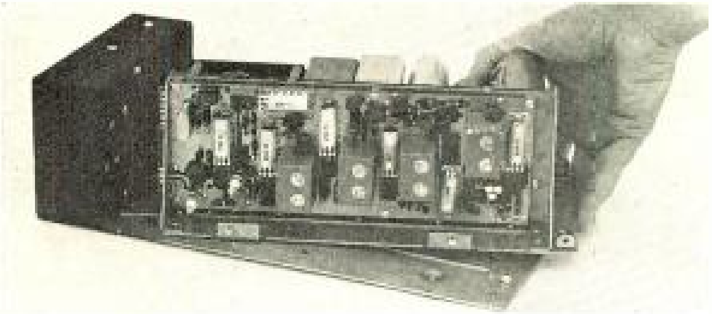

FIG. 2 Etched circuit cards are mounted "back-to-back"

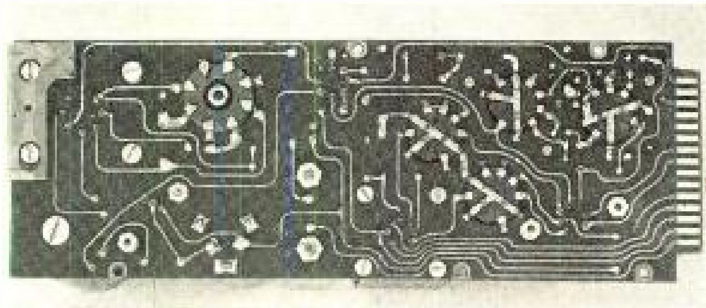

FIG. 4 Printed circuit boards have rhodium-plated contact tips

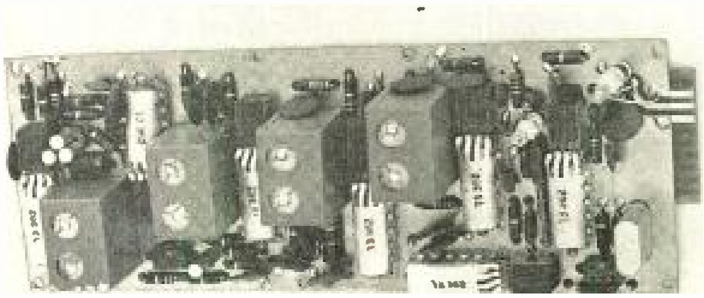

FIG. 3 Receiver assembly, too, is complete on single card

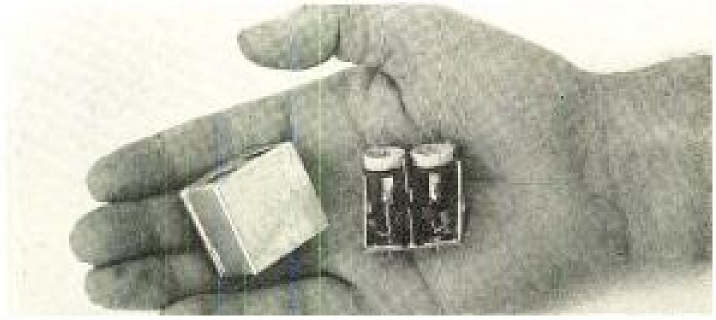

FIG. 5 Miniature i-f transformers employ toroids with Q of 140.

# Transmitter and Receiver

"transmit." The changeover of circuitry is accomplished by energizing relay K2. This is done automatically when the "press-to-talk" button on the microphone is depressed.

The overall dimensions are 11¾ long, 5½ wide and 3¾" high. Total weight is 6 lbs. This includes the transmitter, receiver, and vibrator power supply and mounting base. Components have been selected to provide reliable performance when subjected to the rigorous environmental conditions set forth in MIL-E-5400. Amongst these are the ever unpopular (to the equipment designer)

1. Operation at ambient temperatures between −55° and +55° C.
2. Operation at altitudes up to 60,000 ft.
3. Operation at relative humidity of 100% at +50° C.
4. Requirement for storage without permanent damage to temperatures of −65 to +85° C.
5. Requirement for moisture and fungus proofing.
6. Vibration of 0.06 in. double excursion over the frequency range of 10 to 55 cps, and
7. It must remain operative after submission to impacts of 15 G's acceleration in any direction.

To assist in achieving successful operation when exposed to the above conditions, many of the time proven, plus some fairly new techniques of ruggedization, were employed. The use of etched circuits contributes substantially to the excellent performance obtained under conditions of vibration. Fig. 4 shows the use of this technique. Several base materials for the etched circuit cards were considered. Influencing the final decision were the importance of such factors as 1—low radio frequency losses (some circuits operate at 121 MC), 2—low moisture absorption, 3—physical strength, 4—and to a minor degree, reasonable cost. The results of the investigation indicated that an epon glass would be the best choice for this application. The cards have 0.003-in. thick copper foil laminated to each side. The copper foil is gold flashed to provide good RF conduction plus the added benefit of ease in soldering. Each transmitter and receiver card is designed for dip soldering which provides economy in production as well as maximum reliability resulting from uniformity in the quality of the soldered connections and elimination of failures caused by wire breakage.

The copper foil on the component side of the card is etched away only at the points required for the components. The remainder of the foil serves as a ground plane. This permits the operation of both the receiver and transmitter without being assembled as a unit. This is of great assistance should servicing be required.

Note in Fig. 2 that two of these etched circuit cards are employed in a "back-to-back" configuration. The entire receiver is contained on the left card and the transmitter, including the modulator and the vibrator power supply, are on the right card. These are shown individually in Fig. 1 and Fig. 3. Attention to detail is exhibited by the use of rhodium plating on the "fingers," or contacts of the cards, which plug into the mating printed circuit connectors. The rhodium plating extends inward from the edge of the card for a distance of approximately ¼". It has been determined that ordinary printed cards with 0.003 in. thick copper will endure only approximately 25 insertions in the mating receptacle before copper is worn to the point of causing intermittent contact. The hard rhodium plating has produced cards showing negligible wear after 1000 insertions and withdrawals.

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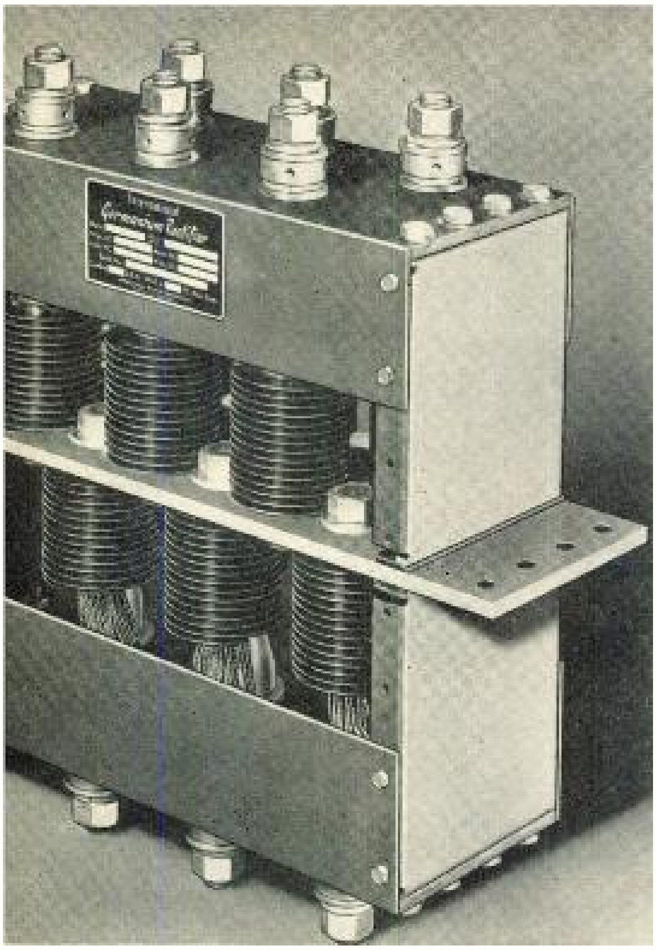

Fig. 1: Fan-cooled 60 kw germanium power rectifier

*Unique forward and reverse characteristics of these rectifiers provide power conversion efficiencies of more than 90%. Units show negligible aging effects*

# Germanium Power Rectifiers

**By JOSEPH T. CATALDO and NOEL ILE**

THE PHYSICAL and electrical advantages inherent in germanium diffused junction rectifiers account for their increasingly widespread use in industry. Within the indicated ranges of application, these relatively new germanium power rectifiers offer a number of superiorities over other types now available.

A maximum amount of forward current is an engineering objective. Theoretically, a perfect power rectifier would provide zero forward resistance and infinite reverse resistance. In practical operation, some power losses are inevitable in metallic rectifiers. Fortunately, the forward voltage drop in germanium power rectifiers is extremely low in comparison with other metallic rectifiers. Compared with silicon diffused units, the forward drop in germanium is only about 20%.

In common with other metallic rectifiers, germanium types show temperature-dependent forward and reverse characteristics. For example, the forward drop at −60°C. is roughly 20% higher than at 25°C. At 75°C., the forward drop is slightly under 10% below that shown at 25°C. Even at −60°C., germanium power rectifiers show forward voltage drops low enough to supply dc current with exceptional efficiency. The effects of temperatures on forward drop is given in Fig. 3. The effects of load current variations on forward voltage drop is shown in Fig. 4.

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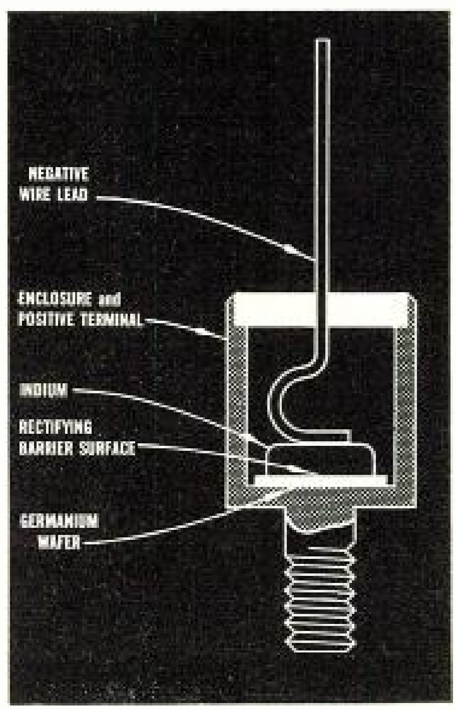
### Less Reverse Flow

The low reverse leakage of a germanium power rectifier decreases by a large factor as the ambient temperature is reduced. It is interesting to note in Figs. 5 and 6 how the already low leakage at 25°C. continues to decrease rather than swinging upward at some point below room temperature. It is also evident that the increase in forward losses as temperatures are lowered is at least partially compensated by concurrently decreasing reverse losses. Ratios of forward-to-reverse losses are also affected by the magnitude of the reverse voltage and by resistance of the rectifier.

The effects of voltages on reverse currents in typical 10-amp germanium power rectifiers are plotted in Fig. 5. These curves show one unit may have negligible leakage at 100 v. compared with another that has less leakage below 60 v. When reverse losses become an important fraction of the forward drop, or at higher ambient temperatures, voltage derating becomes necessary. Such derating protects the metallic junctions from damage and provides longer operating life. Even with such deratings, permissible voltages may be comparatively high at ambient temperatures up to 75°C.

Because of their unique forward and reverse characteristics, germanium power rectifiers provide ac to dc power conversion efficiencies of more than 90%. Their low forward voltage drop and high permissible cur-

Fig. 2: Germanium rectifier construction



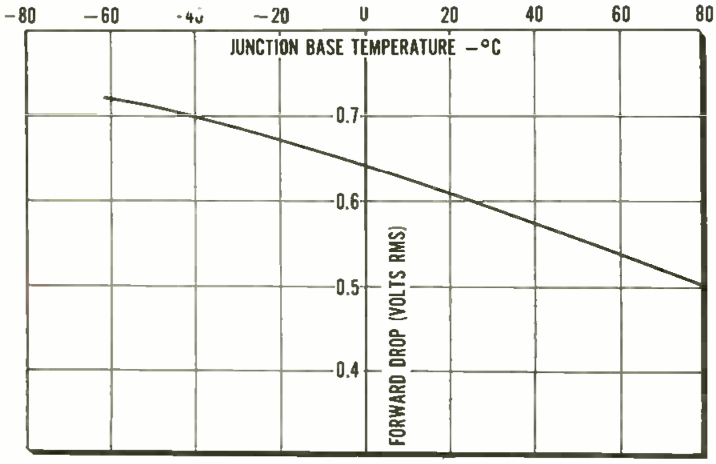



Fig. 3: Forward drops vary with temperature, but are very low

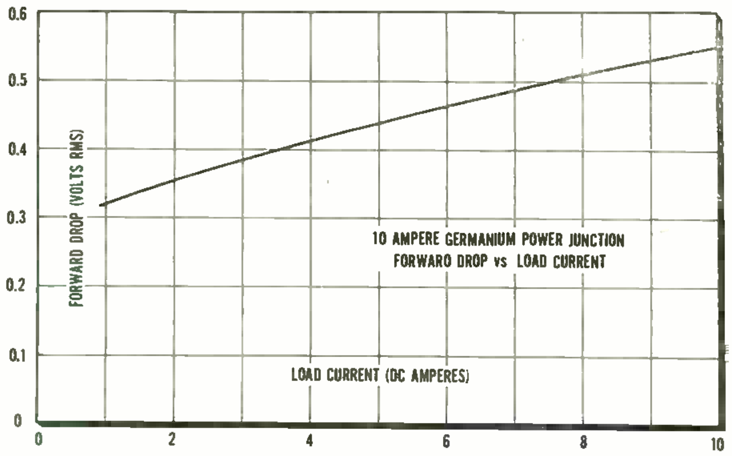



Fig. 4: Effects of load current variations on forward drop

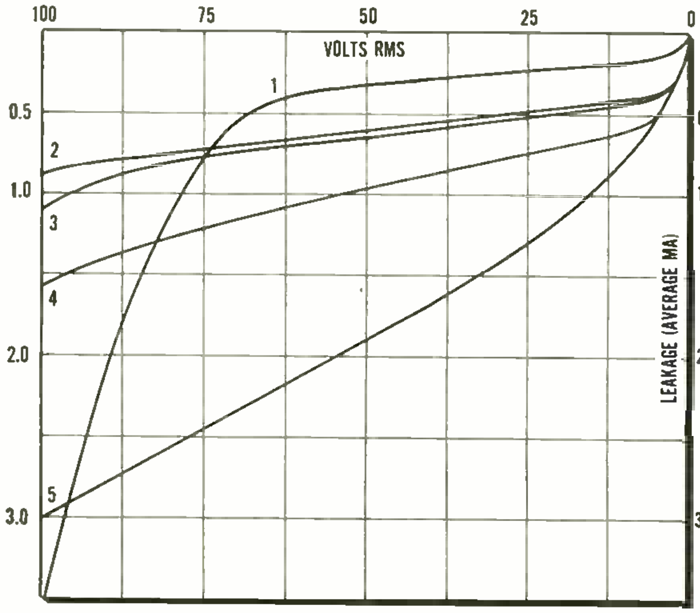



Fig. 5: (I) Effects of voltages on reverse currents in 10 a. rectifier

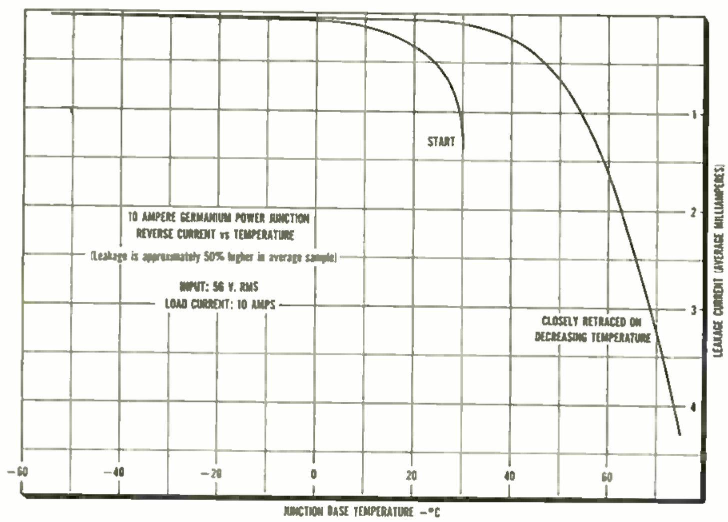



Fig. 6: Reverse leakage decreases as temperature is reduced

rent densities (about 75 amp/cm.[2] average readings in half-wave circuits) permit production of stack or other multiple rectifier assemblies that are light in weight and small dimensionally.

As a result of the high voltage rating per junction, the number of junctions needed in series to form a high voltage assembly is reduced. With fewer units required in series, the overall forward drop of a germanium rectifier assembly is exceptionally low. One result is improved voltage regulation, as shown in Fig. 7. The absence of any appreciable aging effect in germanium rectifiers assures high efficiency and excellent voltage regulation for a very long time. Field tests to date show no appreciable change in forward or reverse resistance after 1,250 working days.

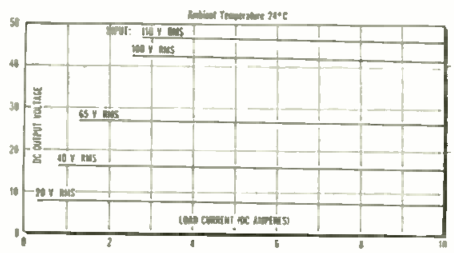
As with other semiconductors, germanium power junctions—whether used in series or in parallel—should be carefully matched for characteristics. Voltage derating permits reasonably equal heat dissipation in all sections of a rectifier assembly. The amount of derating needed depends upon how closely units are matched at temperatures likely to occur during normal operation.

Overheating, caused by current above the normal load limit or too high ambient temperatures, is a common cause of failure in germanium power rectifiers. Such failures can occur suddenly if units are not operated in accordance with manufacturers design recommendations. Operating experience shows that fan or liquid-cooling, plus necessary voltage derating in high ambient temperatures, delivers useful amounts of power at higher voltages than are safe for convection-cooled units. In case the cooling equipment fails, provision should be made for immediate removal of voltage to fan or liquid-cooled rectifiers.

"Forming" treatment such as required with other type rectifiers is not needed when putting germanium rectifiers into operation. Nor is there any "deforming" effect evident when germanium junctions are inoperative. This holds true regardless of the rating of a germanium power rectifier. The efficiency of this type rectifier depends more upon the precise processing of the germanium wafer and complete diffusing at the germanium-indium junction than on any forming action in service.

In a broad sense, germanium power rectifier production is an art as well as a science. Continuing research will undoubtedly reveal more precisely the factors governing such power rectifiers. This should make possible production of crystals approaching nearly ideal characteristics.

Fig. 7: Voltage regulation in half wave circuit with resistive load



PART ONE
OF TWO PARTS

# Improving

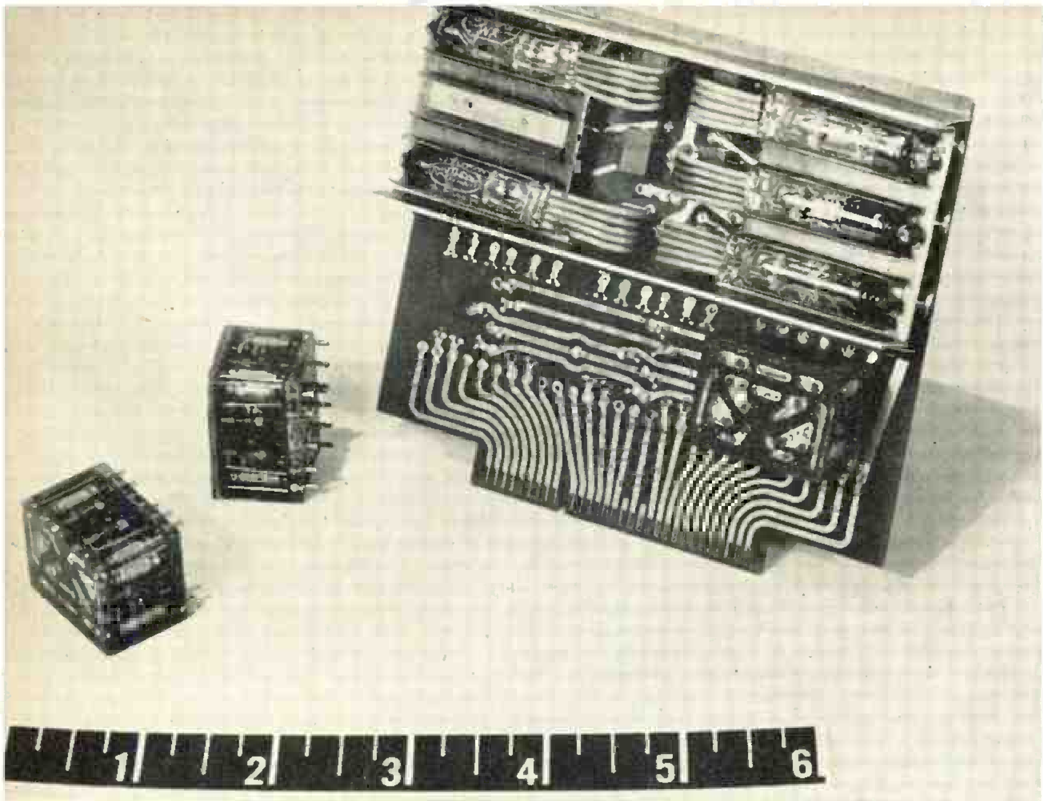


Fig. 1: Potting and printed wiring highlight the "reliability" program at Hughes Aircraft Co.

H. B. Brooks

■ The first step in reliable-izing a product is to view it with a completely logical and unbiased attitude. Although it is not impossible for the designer to approach this ideal viewpoint it is usually wise to appoint a separate group to evaluate reliability. This reliability group can guide the choice of parts and construction techniques effectively, and usually without excessive waste or duplication of design effort. Unfortunately, redesign of the basic system or circuitry does waste time and design effort, and for that reason the development engineers themselves should be taught the principles of system and circuit design for reliability as rapidly as they become known.

The choice of circuits, components and techniques is dominated by fads. Engineers are slow to adopt some innovations while others sweep the country and find wide acceptance even where they are unsuitable. The popularity of a new idea appears to depend on publicity, choice of a "catchy" name, and prestige of the sponsors. It should depend solely on a logical and objective evaluation of its suitability for the proposed application. And wherever possible, reports of failures during assembly and in the field should be analyzed by a separate group to determine whether the innovation actually worked out as expected.[38]

*HERBERT B. BROOKS, Test Equipment Engineering Dept., Hughes Aircraft Co., Tucson, Ariz.*

### *Construction*

In the narrow sense, "ruggedness" is the ability to withstand shock and vibration without failure (powered or "cold," as the application requires). Components must be mounted rigidly enough to endure the expected acceleration ("g") and to elevate their mechanical resonant frequencies.[18, 23]

Direct, point-to-point wiring with short leads can be made rugged. One manufacturer, in the competitive market since 1930, has used it widely, and a recommendation has been made that it should be accepted in military equipment.[5] Where mounted-part terminals alone do not have adequate strength to support interconnected parts by their leads, strong terminals should be added for this purpose. These should be chosen with great care to ensure adequate strength after assembly and the heat of soldering. They may be in the form of single standoff insulators, multiple tie points, or terminal boards. Resistors and capacitors which are designed for mounting by their wire leads, but which are too heavy for point-to-point mounting in the particular application, should be strapped down.

Terminal boards can impede convective cooling of components (especially when mounted horizontally), and heating of capacitors or germanium products by adjacent resistors causes many failures. Terminal board construction is more difficult to circuit-trace during maintenance than is point-to-point wiring. Vibrating a terminal board at its resonant frequency can damage the parts mounted on it. Cabling wires together can cause a deterioration of performance due to crosstalk, a defect that is not uniform even among various units of the same production run. But the engineer can minimize these difficulties with careful design; and terminal board mounting of components with cabled wiring is preferred in military equipment. Stranded wire is good for long leads because it can flex without fatigue, and in doing so it dissipates some of the vibratory energy by friction between strands. Strain on terminals should be relieved by providing slight excess length of stranded wire, or by crimping solid wire component leads.

Criticism for the appearance of components and wiring that deviate from the four points of the compass can be avoided by "potting," or encapsulating the assembly in an electrical insulating compound. This also increases flashover voltage and rigidity, and reduces moisture absorption. Its disadvantages are poor heat dissipation, higher stray capacitance, difficulty of repair, and possible chemical, mechanical or thermal damage to the components. Development of a moderately soft plastic foam (pliant and mechanically dis-

*A separate plant group responsible for "reliable-izing" techniques is seen as key to problem. Methods for boosting reliability are described.*

**By HERBERT B. BROOKS**

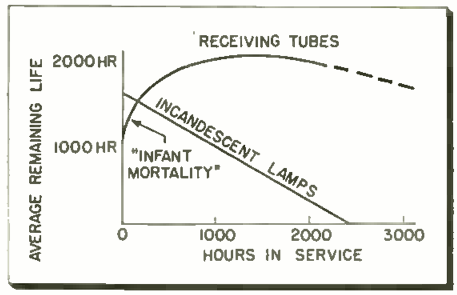



**Fig. 2: Despite progress made in "reliable-izing" program tube life is unpredictable**

# Electronic Reliability

sipative) should receive more attention for reduction of shock and vibration damage to electronic equipment. Soft copper braid could be used to conduct component heat out to the equipment "skin" without conducting in vibration.

### *Shock Mounting*

The high-frequency components of shock and vibration can be reduced by spring-mounting of the assembly to the frame. The greatest vibration encountered by mobile equipment is above 30 CPS, with a considerable component extending down to 3 CPS.[39] Shock-mounting is analagous to low-pass filtering; the response rises to a peak at the resonant frequency and drops above it. The resonant frequency should be chosen well below any anticipated strong vibration frequencies. If occasional strong vibration at resonance cannot be avoided, consideration should be given to damping[18, 21] the resonance.

"Soft-mounting" can do more harm than good if the mount is permitted to "bottom" under severe shock; impact generates undesired high frequencies, with a peak acceleration often exceeding that applied to the frame. Fig. 3 indicates the proper shock mount stiffness and range for various drop distances. The use of non-linear springs has been recommended to prevent impact.[21]

Shock testing can disclose the following types of faults:

1. Weak mechanical design or construction.[24] The output of the equipment is not necessarily monitored during the shock; damage is discovered by subsequent inspection or test. The applied shock is severe and somewhat destructive, and is recommended on a sampling basis.[35]

2. Intermittent connections due to manufacturing errors can be discovered at moderate, non-destructive shock amplitude by monitoring performance during shock. These can be loose connections normally held closed by wiring tension, or accidental short circuits normally held open. They jump suddenly into existence when the shock acceleration exceeds the holding tension. Shock testing is useful even for equipment not required to function during shock conditions, because unsecured connections can cause trouble after a few months of corrosion and loosening due to normal vibration.

3. Position or proximity effects (microphonics) producing a temporary change of characteristics during the shock. This effect is normally proportional to shock magnitude, but where it is due to loose "fit" it may approach an upper limit as the motion becomes limited mechanically. ("Tap"-testing is used to detect microphonism in tubes.[31])

### *Vibration Testing*

Sustained vibration affects equipment differently than does shock, because:

(1) With sine-wave excitation of the frame, resonant parts can vi-

(*Continued on page* 118)

**TABLE 1: Reliable and Rugged Tubes (Subminiatures not included)**

| Approx. Prototype | Reliable or Rugged Type* |
|---|---|
| 2C51 | 5670 |
| 2D21 | G.E. 5727, RCA 2D21W |
| 3B24 | 3B24W |
| 5R4GY | Ray. 5R4WGY |
| 5U4G | Syl. 5U4WG/5931 |
| 5Y3GT | G.E. 6087, Hytron 5Y3WGTA |
| 5Z4 | Bendix 6106 |
| 6AC7 | G.E. 6134, RCA 6AC7W |
| 6AG5 | 6186 |
| 6AK5 | 5654, 6AK5W, 6096 |
| 6AL5 | 5726, 6AL5W, 6097 |
| 6AQ5 | G.E. 6005, Bendix 6094 (9-pin) |
| 6AS6 | 5725, 6AS6W, 6187 |
| 6AS7 | RCA 6080 |
| 6AU6 | G.E. 6136 |
| 6BA6 | 5749 |
| 6BE6 | 5750 |
| 6BH6 | G.E. 6265 |
| 6C4 | 6C4W, 6135 |
| 6L6 | Syl. 6L6WGA/5932 |
| 6J5 | Ray. 6J5WGT |
| 6J6 | Ray. 6J6W, RCA 6101/6J6WA, 6099 |
| 6SA7 | Ray. 6SA7WGT |
| 6SJ7 | RCA 5693, Ray. 6SJ7WGT |
| 6SK7 | G.E. 6137, RCA 6SK7W |
| 6SL7GT | RCA 5691, Syl. 6SL7WGT |
| 6SN7GT | RCA 5692, 6SN7WGT |
| 6V6GT | Bendix 5992 |
| 6X4 | G.E. 6202, Ray. 6X4W, Bendix 5993 (9-Pin) |
| 6X5 | 6X5WGT, Bendix 5852 |
| 7F8 | Syl. 7F8W |
| 12AT7 | G.E. 6201 |
| 12AU7 | 5814, 6189 |
| 12AX7 | 5751 |
| 12AY7 | G.E. 6072 |
| 12J5GT | Ray. 12J5WGT |
| 28D7 | Syl. 28D7W |
| 807 | Syl. 807W/5933 |
| None | W.E. 421A Dual Power Triode |
| " | W.E. 422A F.W. Rect. |
| " | 5686 Beam Pentode (9-pin min) |
| " | RCA 5690 F.W. Rect. |
| " | Bendix 5993 F.W. Rect. |
| " | Ray. 6187 Mixer (9-pin min) |
| " | G.E. 6203 F.W. Rect. (9-pin min) |

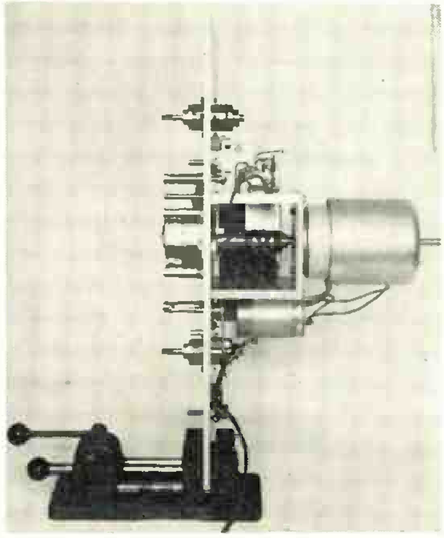


Fig. 1: (Left) Rotating head magnetic tape reader. Studs on front hold reels, guide tape past drum

Fig. 2: (above) Interior mechanism. Connections are made through slip rings and brushes

# Rotating Reading Heads

*Magnetic tape and wire used for external pulse storage in digital computer systems must be of exceptionally fine quality to ensure reliability of operation. This NBS-designed equipment provides a quick visual of holes, raised spots, or creases in the magnetic medium.*

A READING head that makes possible the close examination of a short section of magnetic tape or wire is now being used at the National Bureau of Standards to locate and investigate faults in magnetic recording media. Developed by J. R. Sorrells of the NBS data processing systems laboratory, this instrument (Fig. 1) makes use of a reading head mounted on a rapidly rotating drum so that the head is in contact with the tape for a part of each revolution. Since the tape is held stationary, the head reads exactly the same set of signals once each revolution, and the playback can be displayed continuously on an oscilloscope and observed as long as desired.

In addition to providing a means for closely examining the playback signals from a specific portion of the tape, the reader can be used to scan through and edit a complete tape. The observer can easily locate any defective signals along the entire length of the recorded tape. Interchangeable parts provide a means for examining several different sizes of magnetic tape or wire.

In the design and development of magnetic tape and wire equipment for external pulse storage in electronic digital computer systems, one of the primary considerations has been reliability of operation. An important factor in magnetic storage is the condition of the tape surface itself. Errors in operation can be caused by any of several types of tape faults such as "holes" and raised spots in the magnetic surface, or creases in the tape. Very often the loss of several pulses or the gain of a single pulse may be caused by a flaw that is too small to be visible to the unaided eye. Conventional means of tape reading are not suitable for locating errors, since in the usual tape transport mechanism the tape is moved continuously past a stationary head. In investigating tape for faults it is desirable to read a small specific portion of the tape over and over again at a rapid rate, and to display on an oscilloscope a steady, clear picture of the playback signals. The rotating head reading device developed at NBS provides such a repetitive method for examining tape. Once faults are located, they can be removed or else avoided in the future, thus increasing the reliability of the tape.

For convenience, the tape reader is mounted on a vertical panel (Fig. 2). Near the two upper corners are the shafts on which the tape reels are mounted. Although tape must be reeled manually on the NBS model, a motor drive or stepping mechanism could easily be attached. The idler shafts are friction loaded to maintain the proper tension on the tape for reading as the tape is reeled along.

### Rotating Drum

At the lower center of the panel is the rotating drum on which the reading head is mounted. The drum is 2⅞ in. in diameter and rotates at 10 rps; thus the equivalent tape speed is 90 ips. The drum is made in two

(Continued on page 144)

*Cut-Off Predictions Via Bandwidth Indexes, Improved Ladder Networks, and Suitable Wide Band Couplers, Aid Amplifier Design*

# Viewpoints on D-Amplifier Design

**Part Two**
**Of Three Parts**

***By DR. HARRY STOCKMAN***

OTHER variations of bandwidth indexes may be developed to suit particular needs. The proper way of determining the cutoff frequency appears to be that of formal circuit analysis, but this approach is far too difficult to be practical for extremely-wide-band amplifiers. It is of interest to consider as bandwidth index the cutoff frequency, determined from the integrated area of the absolute gain curve under the assumption of fixed gain. Before this approach is discussed, reference is made to the fact that the precise value of the conventional 3 db cutoff is not a reliable criterion of the amplifier's transient response. The advantage of the gain-curve-area method is that its particular cutoff frequency definition takes into account the transient response characteristic of the amplifier to a much greater extent than the 3 db cut-off frequency definition. The gain-curve-area method is therefore of considerable interest to us, although this method requires that at least one section of the amplifier be built in the laboratory, so that its amplitude response can be run off (which is generally a simple matter, using a signal generator and a vacuum-tube voltmeter).

In simplest possible presentation, the transient response of a wide-band amplifier is found by the application of a square wave, and the response to this square wave (its step function) may be described by the Fourier Integral. Observed at the output of the amplifier, this Fourier integral is modified by the amplitude response $A(\omega)$ and phase response $\phi(\omega)$ of the amplifier, and represents the response $v(t)$ in the time domain

$$v(t) = \frac{A(o)}{2}\psi + \frac{1}{\pi}\int_0^\infty \frac{A(\omega)\sin[\omega t - \Phi(\omega)]}{\omega}\,d\omega, \quad (4)$$

where $A(o)$ is the dc gain of the amplifier, and $\omega = 2\pi f$ the radian-frequency variable, which goes from zero (dc) to, theoretically, infinity. Thus, if a constant-voltage battery (representing the up-stroke step function) is attached to the input terminals, eq. (4) describes the delayed output transient voltage; the step function being degenerated into a sloping transient with undesirable overshoots. The slope of this transient has a definite value, often expressed via the rise time $t_r$; defined as the time required for the instantaneous amplitude to go from 10% to 90% of the peak value, the limits here being considered 0 to 100%. The slope is described mathematically by the time derivative of $v(t)$ in eq. (4), and may therefore be expressed by the ratio $A(o)/t_r$, or, if the rise time is inverted to a frequency $f_{eff}$, by the product $A(o)f_{eff}$. It is noted that we now have formulated a new bandwidth index, or gain-bandwidth product, and if the time derivation is carried out on the right side of eq. (4), this new bandwidth index becomes

$$f_o^{IV} = A(o)\,f_{eff} = K\int_0^\infty A(\omega)\,d\omega, \quad (5)$$

where K contains the various factors providing the proper proportionality constant. The above equation simply expresses the area under the absolute-gain curve, see Fig. 3, and since this area equals the rectangular area

(*Continued on page* 148)

**Fig. 3: Defining concept of gain-area-cutoff**

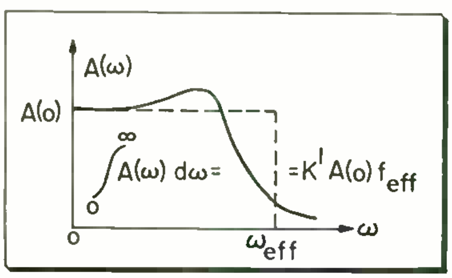
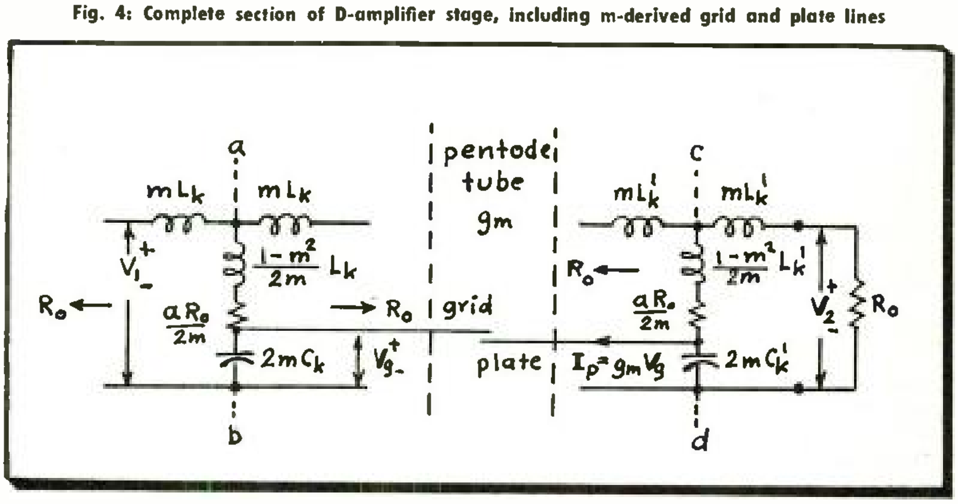



**Fig. 4: Complete section of D-amplifier stage, including m-derived grid and plate lines**

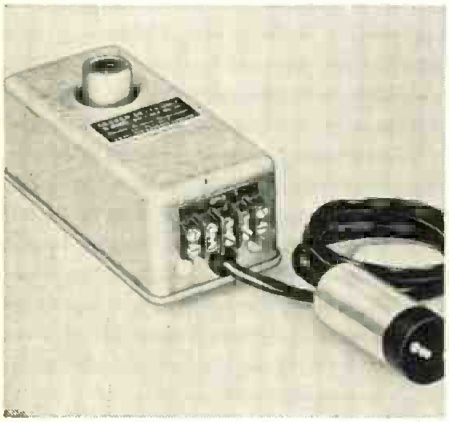



*Dr. Harry Stockman is senior physicist at Scientific Specialties Corp., (Subsidiary of Norden-Corp.), Boston, Mass.*

# New Avionic Equipment

## TRANSDUCER COMPONENT

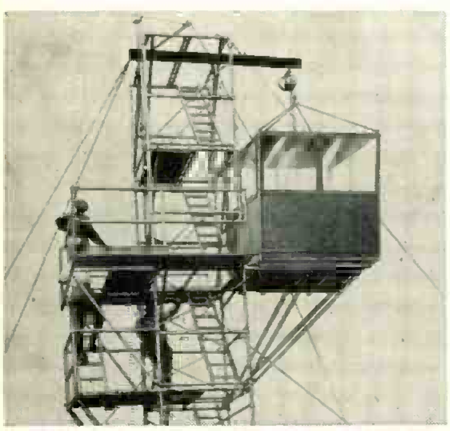
The "Delta Unit," a new multi-purpose transducer component built around the T-42 ionization transducer, provides a ready-to-use unit for analog conversion of capacitance changes to voltage



changes. Can be applied to the measurement of any physical phenomena that can be resolved into changes of capacitance, such as micrometric and macrometric displacement, angular motion, vibration, temperature, pressure, liquid level, humidity, dielectrica, continuous weighing, etc. Sensitivity is as high as 5 v./$\mu\mu$f $\Delta$C. Output is a phase sensitive dc. signal as high as +60 v. **Decker Aviation Corp., 1361 Frankford Ave., Philadelphit, Pa.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-26)

## CONTROL TOWERS

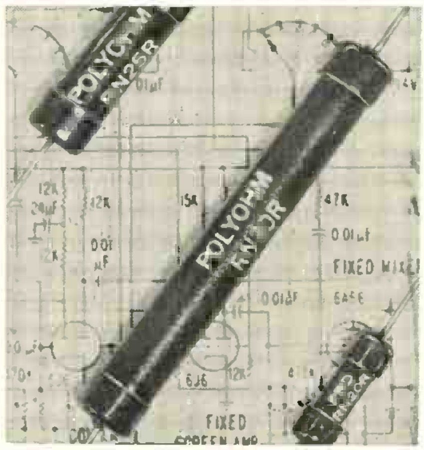
This line of portable aircraft control towers are transportable by truck, helicopter, or cargo plane. Each unit is a complete tower in itself, including interlocked two-position control of remotely located transmitters and paralleled monitoring of remotely located receivers, field lighting control facilities, and aerological instruments. Sectionalized supporting structures are



available in any height up to 250 feet and can be assembled without using cranes or external machinery. **Wickes Engineering and Construction Co., 12th St. and Ferry Ave., Camden 4, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-42)

## RESISTOR

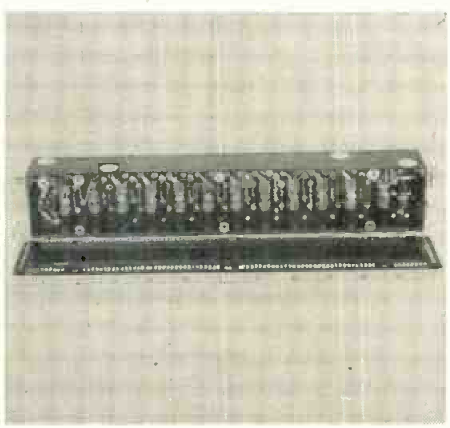
This new 1% resistor, called Polyohm, is ideal for use in aircraft, guided missiles, and other applications where high ambient temperatures rule out ordinary 1% resistors. Performance ex-




ceeds all MIL-R-10509A specifications and is capable of taking full power at ambient temperatures up to 120°C. Even under high humidity, it remains well within its 1% tolerance. Its temperature coefficient is only —150 ppm/°C, which is lower than both the R and X characteristics. **Polytechnic Research & Development Co., 202 Tillary St., B'klyn, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-31)

## I-F AMPLIFIER

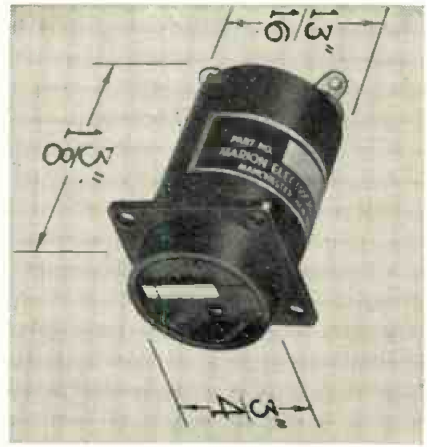
This series of subminiature I-F amplifiers used in airborne radar systems and broadband receivers is available in three models, M1154 at 30 mc, M1155 at 60 mc, and M1156 at 90 mc. Gains of over 100 db are obtained simultaneously with bandwidths over 12 mc at center frequencies of 30, 60, or 90 mc. Built to meet rigid military specifica-



tions, they contain tubes having a rated life of over 5,000 hours. Unique design provides complete shielding and absence of regeneration. **Maxson Instruments, 47-37 Austell Pl., L.I.C. 1, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-45)

## ANNUNCIATOR

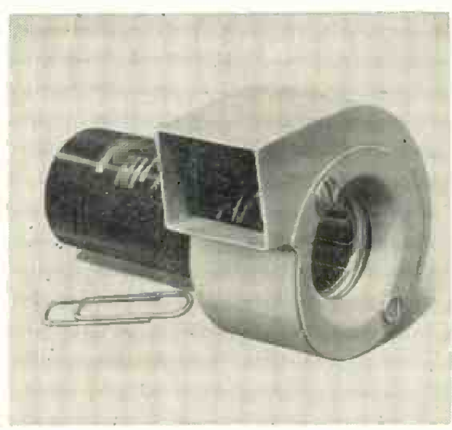
The new HCM ¾ Universal Annunciator, small in size, light weight and vibration resistant, is especially suited to aircraft use in such applications as indication of rudder control, roll, and



others. It is a 1.3 ounce, ¾" diameter D'Arsonval type indicator utilizing a coaxial mechanism. Uses have been found for it in servo and control systems as a flag alarm or miniature null indicator. It meets the vibration requirements of MIL-E-52 72A, Procedure I. **Marion Electrical Instrument Co., Manchester, N.H.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-43)

## BLOWER

This new subminiature centrifugal blower for cooling airborne electronic equipment is designed and tested for high altitude and high ambient operation and meets all applicable MIL specifications. The blower, available in either rotation and in single or double-ended models, features a rotatable metal blower housing. Air delivery of the single-ended blower is 13 CFM at 0"

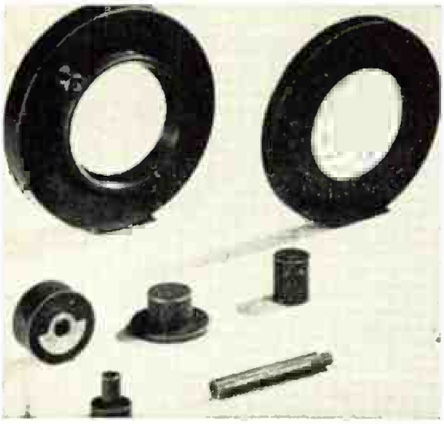


static pressure (20,000 RPM) and 7 CFM at 11,000 RPM. Utilizes a 1" diameter motor and is available in single or 3 phase for 400 cycle or variable frequency operation. **Eastern Air Devices, Dover, N.H.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-46)

# New Electronic Materials

## SHAPES AND PARTS

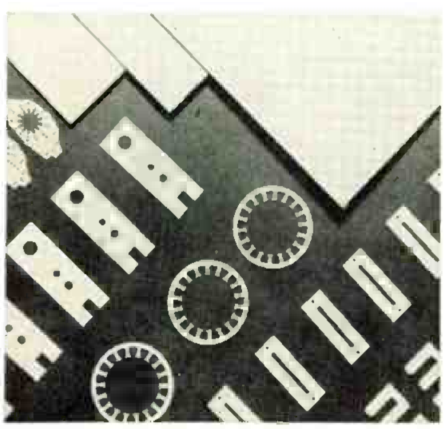
Electronic parts of intricate shapes and close tolerances can be accurately molded from "Flurothene" and have superior strength and dielectric properties over a temperature range to 710°F.



Temperatures from —320 to +390°F. have little effect on the properties. Makes fine insulators and parts for high frequency radio circuits. "Flurothene" can also be extruded coating, or cast into finished products by conventional processes with only slight adjustment to standard machinery. Bakelite Co., **Div., of Union Carbide and Carbon Corp., 260 Madison Ave., New York 16,** N. Y.—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-65)

## LAMINATES

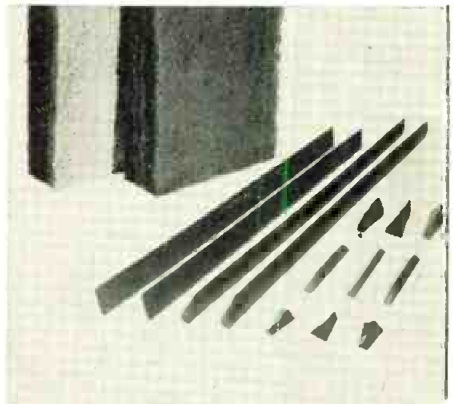
Three new grades of thermosetting laminated plastics utilizing a DAP diallyl-phthylate resin base, DAP-impregnated canvas (Grade C-104), "Orlon" (Grade 0-104), and woven glass cloth (G-104) are coded to filler material. Price wise, C-104 is the most economical. Grade 0-104 is outstanding in that after NEMA water immersion tests, power factor and dielectric constant show very little change. Grade



G-104 has the best electrical properties in the dry condition. "Orlon" DAP withstands continuous temperatures of 225°F., canvas 275°F. and glass fabric 325°F. **Synthane Corp., Oaks, Pa.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-68)

## MICROWAVE ABSORBERS

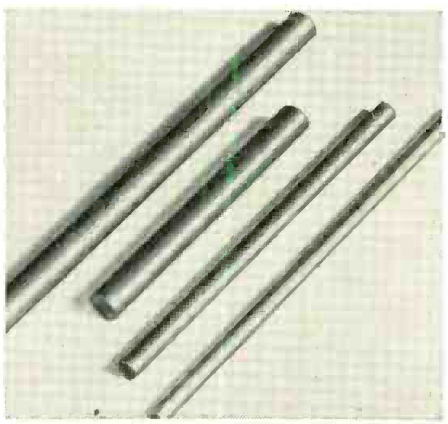
ECCOSORB CH is a flexible, rubberized fiber for use in microwave darkrooms. Having a maximum energy reflection of 2% at all angles of incidence, this absorber enables indoor antenna



measurements. The material is lightweight, easy to apply, and has a white surface. Three types—CH 460, CH 475, CH 490—are broadbanded within the following wavelength range, 0.5 cm.—12 cm., 0.5 cm.—30 cm., 0.5 cm.—60 cm. A second series, ECCOSORB HF, for waveguide terminations and loads, comes in standard rods, sheets, and specified molded shapes. Each series member has different bulk resistivity, Range, 50 to $10^{12}$ Ohm $cm^3$. **Emerson & Cuming, Inc., 869 Washington St.,** Canton, Mass.—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-66)

## FERRITE

The high Q ferrite, designated as "M" material, is now in production. The ferrite provides the answer to most antenna rod problems. The magnetic properties of the material are: Initial permeability at 1 MC/sec., 125.



Maximum permeability, 450. Saturated flux density, 3,300. Residual magnetism, 1,050. Curie Point, 350. Voltage resistivity, high. **National Moldite Co., 1410 Chestnut Ave., Hillside 5, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-69)

## WIRE

A new grade of molybdenum wire, especially developed for grids in power and receiving tubes, known as "Moly-G," has improved mechanical properties obtained by small, controlled


amounts of cobalt added to a high purity molybdenum base. Tensil strength is about 45 grams per mg/200 mm. The ratio of yield to tensil strength is a maximum of 85%. Elongation is about 17% in 2 inches. Improvements are minimized wire breakage on grid winding machines. **Fansteel Metallurgical Corp., 2200 Sheridan Rd., North Chicago, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-67)

## ANTENNA CORES

Standard size antenna cores, that are said to offer maximum economy and greater quality uniformity are made of "Ferramic Q" that provides complete stability in respect to age, shock, vibration, and temperature. The cores are available in five lengths of rods and plates. F-125, rod, diam. 0.250 in. ±0.015 in. F-214, rod, diam. 0.330 in. ±0.020 in. (Camber 0.011 per inch) F-429, width 0.725 in. ± 0.025; thickness

0.125 in. ± 0.030 in. Lengths, 7.520 in. ±7/32 in., 6.250 in. ± 3/16 in., 5.300 in., ±5/32 in., 4.625 in., ± 1/8 in., 4/100 in. ± 1/8 in. Complete information available at **General Ceramics Corp., Keasbey, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-70)

# New Western Test and

## RESET GENERATOR

Model 32 is a pulse generator of variable low frequency and low duty cycle which resets the computer and provides a synchronized trigger for repetitive solution presentation on an oscilloscope.

Frequency range 0.06 cps to 20 cps continuously variable. Outputs: To computer-Negative going pulse of about 20v. amplitude with 12,000 ohm internal impedance; To oscilloscope-positive fast pulse of 6v. amplitude to start oscilloscope sweep. **Donner Scientific Co. 2829 Seventh St., Berkeley 10, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-1)

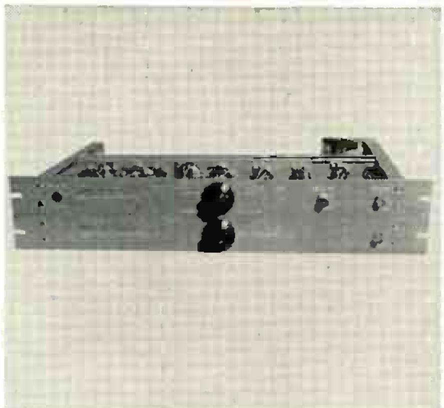
## OSCILLOSCOPES

All 1700 large screen oscilloscope models can be installed in this modern console type cabinet. The console oscilloscope, utilizing a 17" rectangular tube, is especially designed for production test setups where work can be placed in front of the operator. Enables detailed observation of data or complex

signals. Overall dimensions: height, 42⅞"; width, 23⁹⁄₁₆"; depth, 37". **Electromec, Inc., Console Oscilloscope Dep't., 3200 No. San Fernando Blvd., Burbank, Calif.** — TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-2)

## MARKER GENERATOR

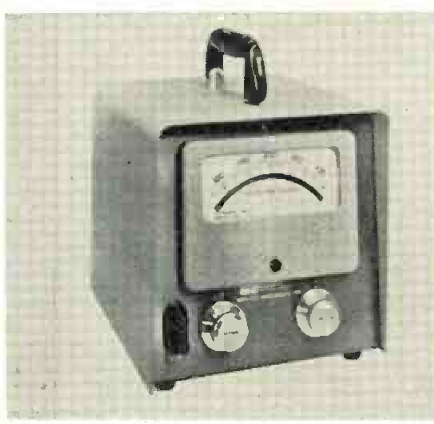
The Model B4-100 Marker Generator and the B4-200 Oscillator measure delay line lengths, rise times, and time intervals from a few millimicrosec. to tens of μsec. The B4-100 provides marker



signals of 0.1 μsec. and 1 μsec. in either polarity. Accuracy is .01%. The B4-200 consists of a free-running blocking oscillator phase locked to the 1 μsec. marker pulses. Together with a B-2A Pulse Generator, can measure delay line lengths to ± 2 millimicrosec. **Rutherford Electronics Co. 3707 So. Robertson Blvd., Culver City, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-3)

## FREQUENCY METERS

The Arga Models 401 and 601 Expanded Scale Frequency Meters are designed for fast, accurate monitoring of frequency. Particularly, where a permanent record of frequency is required. Input voltage harmonics of 5% and input voltage changes of ± 10% will not cause errors in frequency indication greater than ± ½ cycle for Model 401 or ¼ cycle for Model 601. 401 base fre-



quency 400 cycles, span ± 25 cycles; 601 base frequency 60 cycles, span ± 5 cycles. Price $305.00. **Shasta Div., Beckman Instruments, Inc. P.O. Box 296, Station A, Richmond, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-4)

## DIGITAL OHMMETER

Essentially a self-balancing bridge with the unknown resistance one arm of the bridge. Balance is achieved by automatically adjusting a digital rheostat with stepping switches. Model DO40 dis-

plays 4 digits accurate to 0.05% ± 1 digit from 0.1 ohm to 1 megohm in 4 ranges. Range is indicated by a lighted, automatically located decimal point and by the symbol Ω or kΩ in the extreme right window. Average read time approx. 1 sec. **Electro Instruments, Inc. Box S Old San Diego Station, San Diego, 10, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-5)

## METER AND COUNTER

Model WE-110 frequency meter and counter uses glow-transfer tubes and simplified circuitry to obtain a sensitivity of 50mv. rms, and has an accuracy of 0.1% nominal, ± one count. Designed for use with magnetic speed pickups, turbine flow meters, and vibration pickups, to measure rpm, flow, and

vibration frequencies. Response, 10 cps to 50 kc; max. indicated count, 10,000 units. Power 40w., 105-130v. 60 cps. Size 6"x6"x11", price $295.00. **Westport Electric, 149 Lomita St., El Segundo, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-6)

# Measuring Equipment

## DEKABRIDGE

The Model 210 "Dekabridge" has two "Dekadials" that provide uniline readouts to four places over the resistance range 0-12 megohms. The rheostat arm has a total resistance of 12,000 ohms.

Resistance ranges are 1,000/1, 100/1, 10/1, 1/1, 1/10, 1/100, and 1/1000 making incremental steps of 0.001 ohms each available on the lowest resistance range. Limit of measurement error on all ranges is 0.1%. Included in the structure is a key for connecting battery and galvanometer in the wheatstone bridge circuit. **Electro-Measurements, Inc., 4312 S.E. Stark St., Portland 15, Ore.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-7)

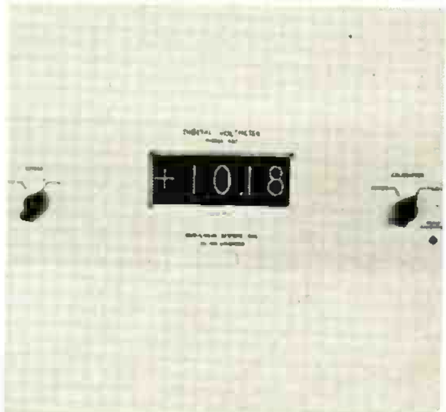
## GALVANOMETERS

The first five "High-Performance" series galvanometers break the "frequency barrier" and enable accurate recording of dynamic signals up to 200 CPS without amplifiers. New units are

electrically interchangeable with CEC's 7-300 units, but feature extended frequency response. It is said that no circuit revisions are required to use these instruments in existing test arrangements. Types are available for direct connection to commonly used 120, 180, and 350 ohm strain gages. **Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-9)

## DIGITAL VOLTMETER

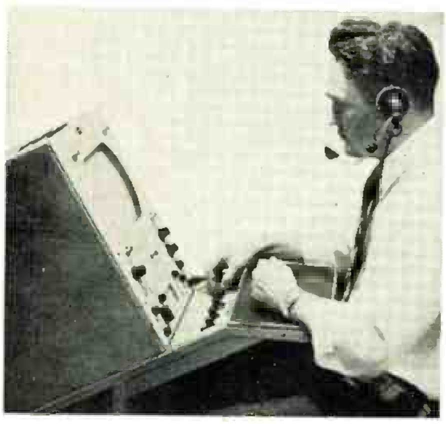
The Model 450 digital voltmeter provides rapid digital readout for analog computers. Operates as a self-balancing digital potentiometer with oil-immersed stepping switches. Life tested for 20



million readings. Range, ±00.01 to ±99.99 v. dc. Accurate to ±10 mv. Resolution, 00.01 v. Operation rate, 1 reading/sec. Input impedance, 1,000 megohms. Required external reference, ±100 v. dc. Model 450, for bench use, is 12½ x 8¼ x 14½ in. in size. Model 450L, for rack mounting is 5¼ x 19 x 14½ in. Power source 115v., 60 c. **Non-Linear Systems, Inc., Del Mar Airport, Del Mar, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-12)

## VIDEO MONITOR

The Model ARM-13A video monitor provides complete monitoring facilities for broadcast station camera chains. The unit has an "A" scope and an illuminated calibrated scale that enables direct measurement of the composite video signal height. A switch enables two lines or two fields of video information to be viewed on the "A" scope. Separate



high voltage power supplies are used for the 10-in kinescope and the 3-in. "A" scope. The kinescope is a flat-faced, tinted, aluminized CRT. **Kay Lab, 5725 Kearney Villa Rd., San Diego 12, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-8)

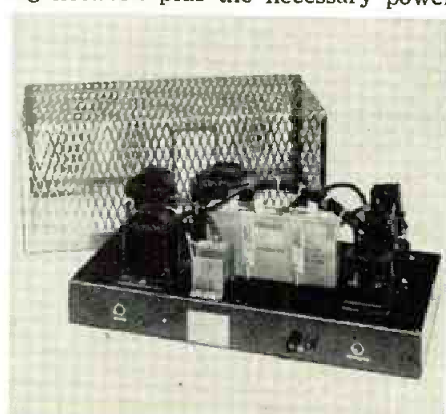
## MARKER-PULSER

A combined marker generator and pulse generator locks all outputs together and provides jitter-free synchronization of output pulses, scope-marker pulses, and scope-synchronizing pulses. Output and scope synchronizing pulses vary as to each other and to scope markers. Output pulse width, 0.1 to 10 µsecs. Amplitude, 0 to 100 v. Rise and

fall time, 0.03 µsec. Delay, 0 to 1 µsec. (coarse), 0 to 0.1 µsec. (fine, calibrated). Synchronizing pulse width, 3 µsecs. Amplitude, 5v. **Brubaker Electronics, 9151 Exposition Dr., Los Angeles 34, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-10)

## PULSE GENERATOR

Pulse repetition occurs only once during a line frequency cycle of the Model MP-85 pulse generator due to its refined circuitry. Circuit stages are cascaded giving frequency step-up ratio between the line frequency and discharge frequency of 1:800 to 1:1250. Eliminates all vacuum tubes; replaces the hydrogen thyratron, its pulse forming network plus the necessary power

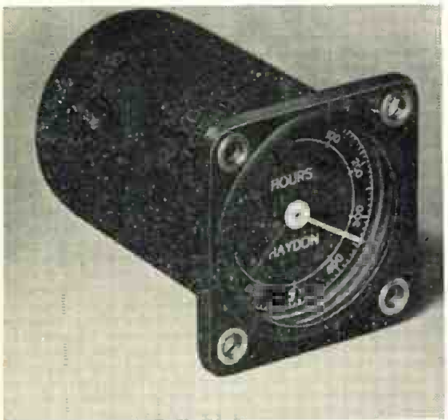


supply of the conventional magnetron trigger circuit. Output power (X-band), 45 kw. Average output power (X-band), 36 ÷ 40 w. **Magnetic Research Corp., 200-202 Center St., El Segundo, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-11)

# New Electronic Test &

## ELAPSED TIME METER

Model 7008 running time meter indicates hours of operation up to 10,000 hours on a dial-type face. Weighing less than 6 ounces, it has a power drain of approximately two watts. Hermetically




sealed to conform to military specification MIL-I-7793 (AER), it is said to meet military shock (25 g) and vibration requirements. Available in a 60 cycle version for avionic equipment and engine suppliers and is installed in many 400 cycle powered equipment. Diameter 1½" by 2¾" long, offered in either front or back panel mounting. **Haydon Mfg. Co., Inc., Torrington, Conn.**—TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-44)

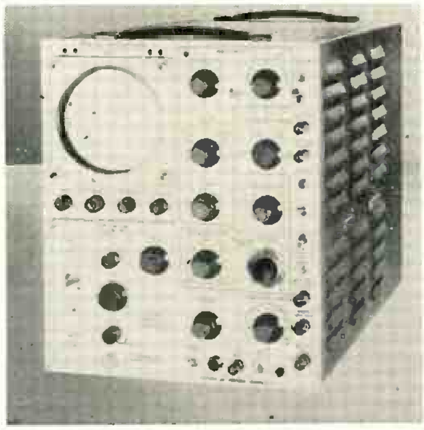
## VISUAL MONITOR

The Model 20 dynamic visual monitor combines 24 moving-spot, light-beam galvanometers in one package and enables simultaneous display of 24 separate electrical signals on a single ground glass screen. Use of low period galvanometers and a long-path optical system enables the presentation of signals up to 120 CPS with only 0.24 ma. required for full-scale deflection. Spot intensity is sufficient to permit photographing

photo panel displays or high incident light viewing. Operates from 22-28 v. ac/dc at 1.5 amps. Size 8½ x 8½ x 6 in. **Century Geophysical Corp., 1333 N. Utica, Tulsa, Okla.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-77)

## OSCILLOSCOPE

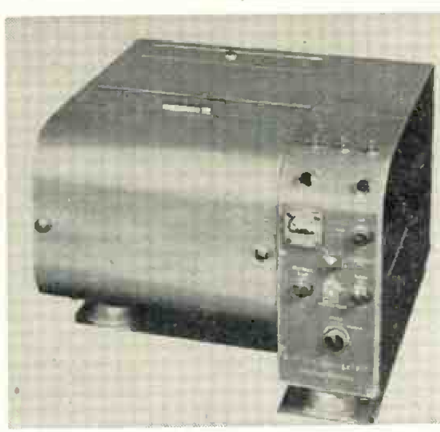
The Type 545 dc. to 30 MC oscilloscope, in combination with the Type 53K/54K plug-in preamplifier, has vertical-amplifier risetime of 12 mμ/sec and passband of dc to 30 MC at cali-



brated sensitivities of 0.05 v./cm. to 20 v./cm. with 20 μμf input capacitance direct, 7.5 μμf with a 10x probe. The new CRT provides 4 cm. by 10 cm. linear display. Calibrated sweep range is 0.1 μsec/cm. to 5 sec./cm. with accurate 5x magnifier. Has amplitude-level selection, automatic triggering, 20 MC sync. Wide sweep-delay range, 1 μsec to 0.1 sec calibration. Range accuracy within 2%. **Tektronic, Inc., P.O. Box 831, Portland 7, Ore.** (Ask for 8-40)

## OSCILLOGRAPH

The PM-20 is a new unit for static or dynamic testing of all types of industrial or aircraft equipment. Up to 71 individual variables can be recorded on one oscillogram when combined with suitable transducers and amplifiers. A wide choice of galvanometers, up to 6000 cps, provides flexibility of measurement. Exclusive features include: two separate galvanometers mounts; a drive



system not using change gears to obtain the record-speed range of 4-500 fpm; automatic shutter that closes as the 100 ft. record holder is released. **G. E. Co., Schenectady 5, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-47)

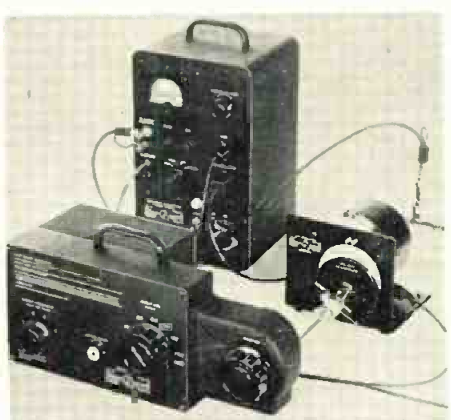
## PANEL METER

Model 131 ruggedized panel meters feature a positive watertight sealing arrangement accomplished by an internal locknut between the meter mounting flange and the case barrel.

A miniaturized D'Arsonval movement is used to provide maximum accuracy and stability. High flux density Alnico #5 magnets are another feature of this instrument. Available in a variety of scales, ranges, and specifications. Model 131 meters meet Signal Corps specifications Mil-M-10304. **DeJUR-Amsco Corp., 45-01 Northern Blvd., L.I.C. 1, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-52)

## SWEEP DRIVE

The Type 1750 sweep drive replaces point-to-point frequency analyses by using a mechanical hand that turns an oscillator dial back and forth. It is adjustable over a speed range from ½ to 5 cps. The sweep is independently adjustable from 30 to 300°. Flexible couplings attach knobs or shafts. The drive also provides a sweeping voltage, proportional to shaft angle, that applies



to the CRO horizontal deflection plates. The Type 1263-A amplitude-regulating power supply provides cathode and plate power for oscillators and adjusts plate voltage. **General Radio Company, 275 Massachusetts Ave., Cambridge 39, Mass.** (Ask for 8-75)

# Measuring Equipment

## COLOR BAR GENERATOR

A new combined color bar dot generator, the ChromaDot, features vertical sync and requires one connection to the RF antenna or video amplifier. Provides color bars and dots at video and speci-

fied RF frequencies. Pattern produces 10 color bars with progressive 30° phase shifts from the color pulsed signal. Receivers using I, Q, B-Y and R-Y Matrix systems can be adjusted from this signal. Video output—0.6v. P to P. into 75 ohms, 10v. P. to P. into 5K ohms. RF output—0.2v. into 75 or 300 ohms. **Kay Electric Co., Pine Brook, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-51)

## SPECTRUM ANALYZER

This unit is designed to cover a frequency range of from 10 megacycles to 16,000 megacycles without the use of auxiliary heads or equipment. Designed specifically with Klystrons completely eliminated and modern pencil triodes used instead for better stability. All band frequencies are directly read on an illuminated dial accurate to ±1%. Analyzer has been used in close prox-

imity to a 5 megawatt radar transmitter without spurious responses and without sacrificing sensitivity. 25 in. high, 19 in. wide, approx. wt. 140 lbs. **Lavoie Laboratories, Inc., Morganville, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-54)

## WATTMETER

The 641N calorimetric type r-f wattmeter measures power from 0-300 w. with the precision of a primary standard. It can be used to check the accuracy of other types of r-f wattmeters

and determine the actual output of an r-f power source when its approximate magnitude is known. The unit has an accuracy of better than ±2% of full scale—using the calibration curve supplied—over the frequency range of 0-3,000 MC. For more accurate measurements, the meter can be calibrated by the user at dc or 60 cps. Required power, 3 w., 105-125 v, 60 cps. MC. **Jones Electronics Co., Inc., Bristol, Conn.** (Ask for 8-49)

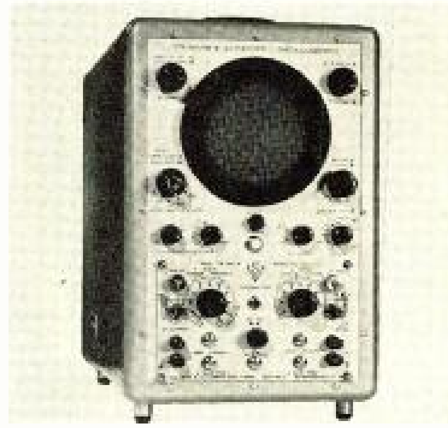
## VTVM

The Volt-Ohmatic Automatic VTVM eliminates the need for manually selecting the appropriate voltage or resistance before using the meter. Has automatic AC, DC, Ohms, Range and (DC) polarity selection. During Automatic Range Selection, the meter movement is disconnected from the circuit to prevent overloading. One probe is used for

all meter functions. Ranges may be changed manually if so desired. Multiplier switch in probe extends AC and DC ranges to 1500 volts. **Bergen Laboratories, Fair Lawn, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-53)

## DC OSCILLOSCOPES

The series VS-900B sensitive dc. oscilloscopes have exceptionally low dc. drifts due to chopper-stabilization of their vertical amplifiers. Guaranteed drifts are less than 1 mv. after warmup



of 2 minutes. DC sensitivity is 700 μv/cm. Available in three models: VS-930 B, (700 μv/cm. only) has symmetrical push-pull input on its most sensitive range. VS-940B, has symmetrical push-pull input on all ranges to facilitate elimination of common interference signals such as hum at high or low signal levels. VS-960B, has a built in "hushed transistor pre-amplifier" to increase ac. sensitivity. **Volkers & Schaffer Mfg., Corp.,** Schenectady, N.Y. (Ask for 8-50)

## MICROWAVE POWER METER

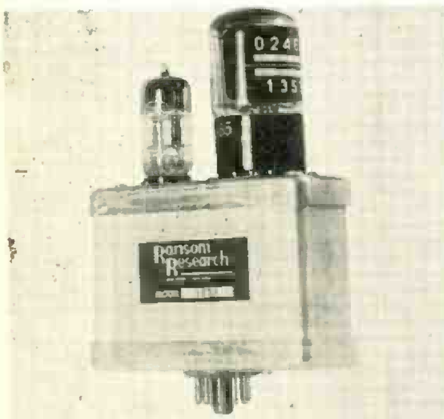
The new Model 430C provides automatic power readings from 1/10th to 10 mw direct in decibels or milliwatts and eliminated computations and adjustments during measurements. Pulsed or CW power may be measured on either waveguide or coaxial systems. This instrument can be used with a wide variety of bolometer mounts having either positive or negative temperature coeffi-

cients. Operation may be at 100 or 200 ohms and power is read direct in milliwatts from 0.02 to 10 mw or in dbm from −20 to +10dbm. Accuracy ±5%. **Hewlett-Packard Co., 275 Page Mill Rd., Palo Alto, Calif.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-71)

# New Western

## DECADE COUNTERS

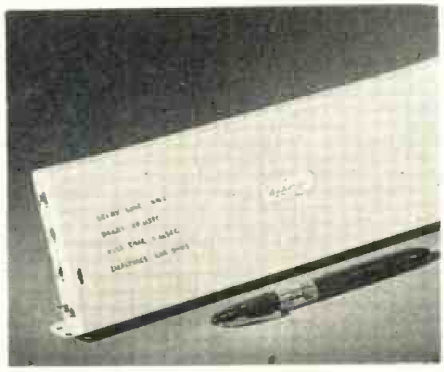
Employs the new direct-reading EIT decade-scaler tube and weighs only 6 to 8 oz. complete. Available in four types; 20kc, 40kc, 100kc, (offered with or without an input-shaper circuit) and




an output stage scaler at 10 cps, which can be used to feed a mechanical counter. Octal plug construction for quick installation and removal. Dimensions of all models 1⅝ x 2¾ x 3³⁄₁₆, excluding tubes. **Ransom Research, P. O. Box 382, San Pedro, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-17)

## DELAY LINE

The XN-1 lumped-parameter 20 usec delay line has a rise time of 1.0 usec. Impedance is 600 ohms. The unit is hermetically sealed in epoxy resin, and operates through the temperature



range from —70°C to 135°C. Size, including terminal lugs, 10¼ x 3⁵⁄₁₆ x ¹⁵⁄₁₆ in. Complete data available at **The Gudeman Company of California, Inc., 2661 South Myrtle Ave., Monrovia, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-13)

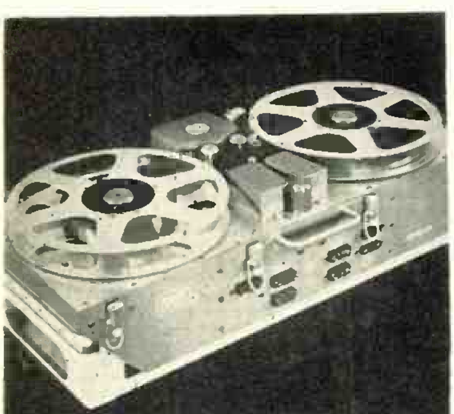
## VACUUM RELAYS

Available in 2PDT (Type RM2) and 4PDT (Type RM4) models for switching antennas, pulse networks, and many DC circuits. 24 v DC actuating coils built into flanged bases. Vacuum en-

closed contacts rated at 12 kv. peak; current carrying capacity 10 amps. rms, continuous. Contact resistance only 0.005 ohms. Can withstand 18 kv peak test between contact terminals. Operating time, less than 30 millisec. 4½" long and 4" in diameter. **Jennings Radio Mfg. Corp., P. O. Box 1278, San Jose, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-16)

## AIRBORNE RECORDERS

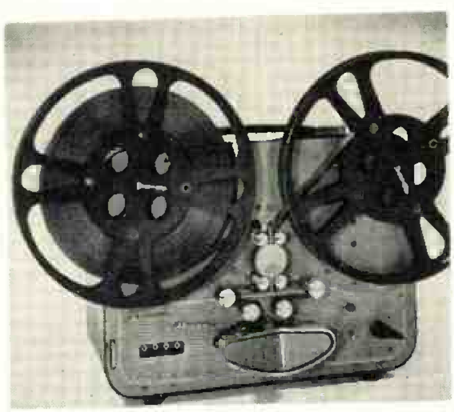
The series 800 flight-test data magnetic tape recorders are available in units designed to record two channels of information on ¼ in. tape to models intended to record 28 tracks on 2 in. tape. Plug-in amplifiers enable recording pulse-width modulation data, high accuracy transient information by means of wide-deviation frequency modulation, or wide band direct data,



including mixed RDB/FM subcarriers. The typical Model 807 records 7 information tracks on ½ in. tape. Consists of five cable-connected units. **Ampex Corp., 934 Charter St., Redwood City, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-18)

## FILM EQUIPMENT

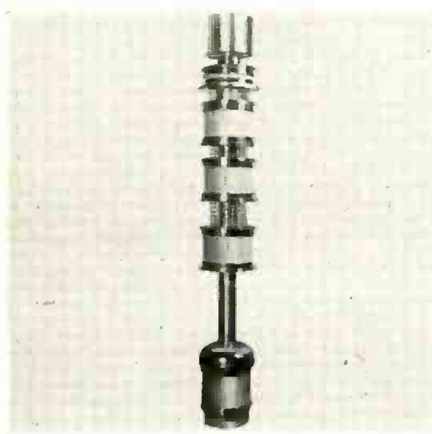
The Model S6 system of professional magnetic film equipment is operated from ac. sources or 24 v. batteries. The studio production unit consists of three 10¾ x 14½ x 6 in. cases. One contains a two-channel microphone preamplifier mixer with an announce microphone and buzzer system. A second contains the recording amplifier, playback amplifier, and power supply.



A third contains the film transport or sprocket. One S6 system is contained in a single case. Available for 16 or 17½ mm film. **Stancil-Hoffman Corp., 921 N. Highland Ave., Hollywood 38, Calif.** TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-24)

## KLYSTRON

The 3K3000LQ UHF amplifier klystron provides CW operation at 760-980 MC and delivers two KW power output with a power gain of 1000 times and 40% efficiency. Containing a long-life oxide cathode, this forced-air-cooled tube is of rugged ceramic and metal construction. The resonant cavities are external to the vacuum system, which

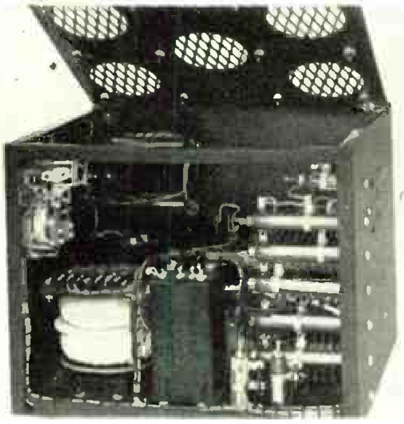


is free of RF circuitry, enabling wide-range tuning, easily adjustable input and output coupling, simple installation and maintenance. Priced at $2360.00. **Eitel-McCullough, Inc., San Bruno, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-15)

# Electronic Equipment

## VOLTAGE REGULATORS

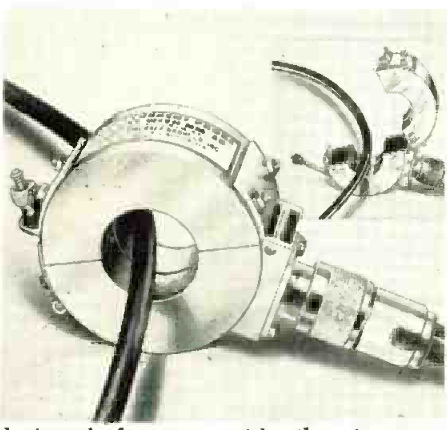
A typical unit of a line of magnetic amplifier voltage regulators built to customer requirements has the following specifications: AC input, 120 v. single phase, 400 cycle. V. A. rating,



50; DC output, 15-150 v. at 0.05-0.500 amps. to fields of exciter. Voltage adjustment ±10%. Regulation accuracy, ±1%. Dimensions, 13 x 11 x 10 in. Weight, approx. 35 lbs. Connections, terminal strip. Has adjustable overvoltage cutout relay to shut off motor should excessive alternator voltage develop. **Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.**—TELE TECH & ELECTRONIC INDUSTRIES. (Ask for 8-22)

## CURRENT PROBE

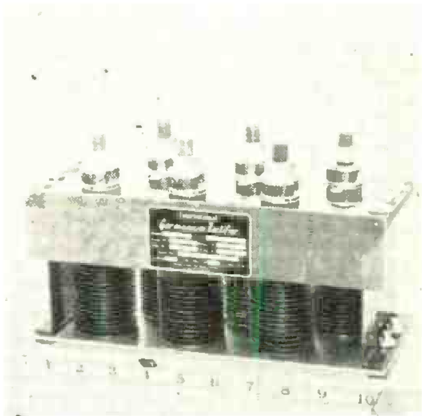
Model 91129-1, a new RF current transformer of the inserted primary type, has a nominal output impedance of 50 ohms. The probe consists of two semi-circular, hinged, insulated windings on a hypersil core. By opening the probe, the conductors may be placed in its center and when closed, a locking arrangement holds it. The unit can be used from 20 cps to 25 MC. Especially



designed for use with the Stoddart NM-10A and NM-20B Radio Interference Field Intensity Measuring Equipment. **Stoddart Aircraft Radio Co., 6644 Santa Monica Blvd., Hollywood, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-14)

## GERMANIUM POWER RECTIFIERS

Three styles of diffused junction germanium power rectifiers—natural and forced convection, and liquid-cooled are recommended for ac to dc power conversion where high power



output, efficiency, non-aging and small size are required. By careful selection of junction characteristics and circuit design, and connecting junctions and assemblies in series or parallel, germanium junction rectifiers can be supplied for voltage ranges from 10 v. to 100 kv. and from 10 amps, to 100,000 amps. **International Rectifier Corp., El Segundo, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.—(Ask for 8-20)

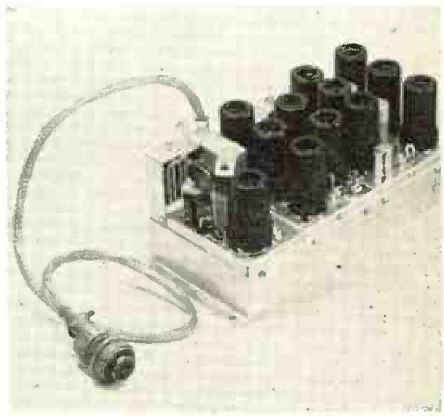
## TV CAMERA PEDESTAL

The "PD-7" is adapted to the small studio, or can be used as an auxiliary mount in larger studios. Weighs only 140 lbs. and will pass through a 30-in. door. Maneuvers by two types of steering: "parallel," whereby the three wheels are locked in parallel to turn in any direction together; "tricycle," whereby steering is done with the rear wheel, while the front wheels are

locked in parallel. Raises or lowers from 34 to 55 inches by the column handwheel. **Houston Fearless Div., Color Corp., of America, 11805 W. Olympic Blvd., Los Angeles 64, Calif.** —TELE-TECH & ELECTRONIC INDUSTRIES.—(Ask for 8-21)

## TELEMETERING TRANSMITTER

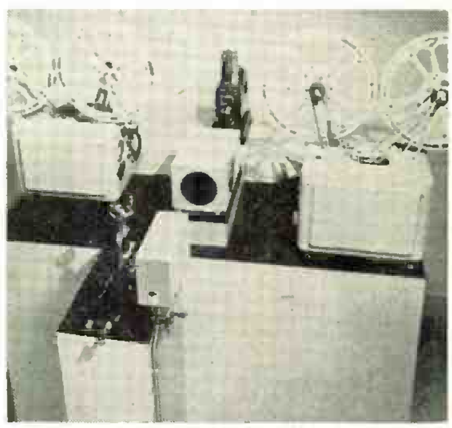
The XT-1 telemetering transmitter, designed for higher powered data transmission in guided missile and aircraft telemetering systems accepts modulating signals between 900 and 100,000



cycles. Provides 8 w. power output, 215 to 235 MC frequency range; direct crystal control with a better than 0.03% precision. Output impedance 50 ohms. Frequency modulation, 150 kc deviation. Frequency response, flat within ±1 db. Harmonic distortion less than 1%. Video input impedance, 50,000 ohms. Weighs 60 oz. **West Coast Electronics Co., 5873 West Jefferson Blvd., Los Angeles 16, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-19)

## FILM AND SLIDE SYSTEM

The new Vidicon Film and Slide System provides two film projectors, a slide projector and an optical multiplexer. It contains a high sensitivity vidicon camera of extremely low noise level and extended dynamic range. The system also contains a camera control unit with dynamic focusing, aperture corrections, and keyed black level clamps. The projectors have 120-cycle

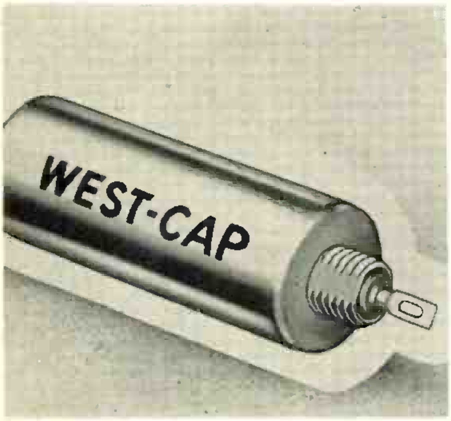


shutters with long application time, providing flicker free reproduction. High sound level output of 7mv. across 150 ohms is provided. **Kay Lab, 5725 Kearney Villa Rd., San Diego 12, Calif.** —TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-34)

# New Electronic Products

## CAPACITOR

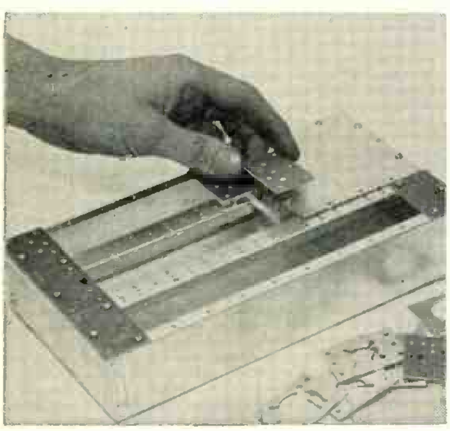
The new and improved West-Cap vertical mounting type capacitor is designed for circuits with critical requirements in high vibration and low weight limits. It is a metal-cased, hermetically




sealed with glass to metal type terminals, paper dielectric, temperature range from —55°C to ±125°C and conforms to military specification Mil-C-25A. Available up to 1000vdc in capacity ratings from .001 mfd to 6 mfd with either axial wire leads or spade type terminals. Designated as type A, AA, AAA. **San Fernando Electric Mfg. Co., 1509 First St., San Fernando, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-37)

## CHASSIS UNITS

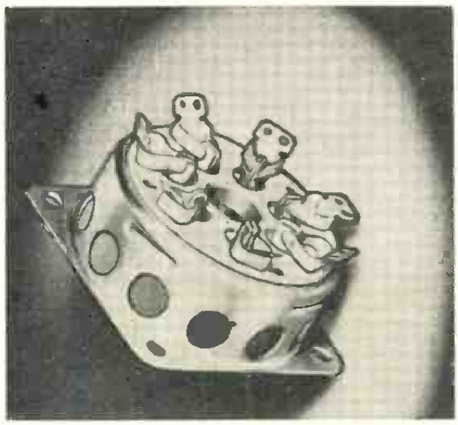
This is a new type of expandable chassis designed for laboratory breadboard use. Almost any size and shape of chassis may be assembled by using the various parts offered in the patented SeeZak line. Included are such items as side and end rails, tops and bottoms, rail extenders, pre-punched prototype panels, and rail feet. Unique angles can be worked out to meet requirements



during wiring. Punching, drilling, and insertion of hardware may be done in the flat as breadboard work progresses **U M & F Manufacturing Corp., 10929 Vanowen St., N. Hollywood, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-33)

## TUBE SOCKET

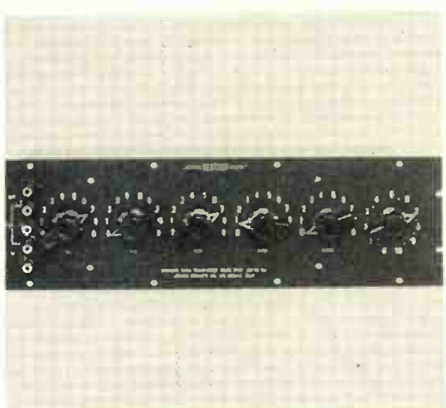
This is a new 7 pin steatite insulated tube socket designed for popular new VHF septar based tubes such as the RCA 5894, 6524, and the Amperex 5894, 6252. It requires ⅓" less chassis mounting



space than previously available types and has an integral ventilated shield base which submounts the tube for optimum input and output shielding. The socket will permit more compact equipment design in mobile, aircraft, and other types of transmitting equipment. **E. F. Johnson Co., Waseca, Minn.** —TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-32)

## STANDARD RATIO TRANSFORMERS

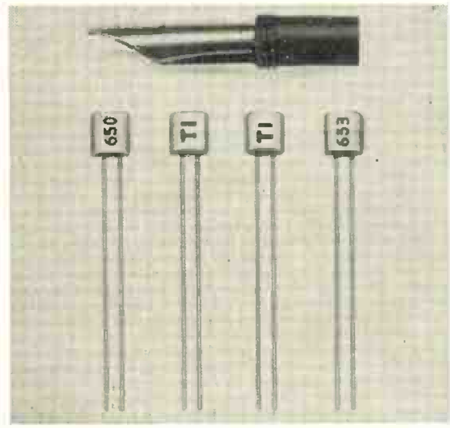
The PT Series consists of nine rack mounted and case models of precision ac voltage dividers with accuracies to 0.005% and resolution to 0.00001%. Models are available to cover frequencies from 30 to 3,000CPS—to 10,000 CPS at reduced accuracy. Four new ruggedized versions of standard ratio transformers have heavy silver rotary switches for use where severe continu-



ous service is required. Used for core material investigation, ac meter calibration, checking resolvers, servos, etc. **Gertsch Products, Inc., 11846 Mississippi Ave., Los Angeles 25, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-41)

## SILICON DIODES

Four new silicon diodes Types 650, 651, 652, and 653 feature extremely small breakdown voltage temperature coefficients from —55°C to +150°C. The units maintain accurate reference in-




definitely regardless of variation in moisture, altitude, or other environmental conditions. They have a reverse breakdown voltage (measured at 5 ma) from 3.7 to 8.0 volts. Total power 150 mw at 25°C and 40 mw at ambient temperature of 150°C. Max. average rectified forward current from 90-125 ma at 25°C. **Texas Instruments Inc., 6000 Lemmon Ave., Dallas, Tex.**—TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-30)

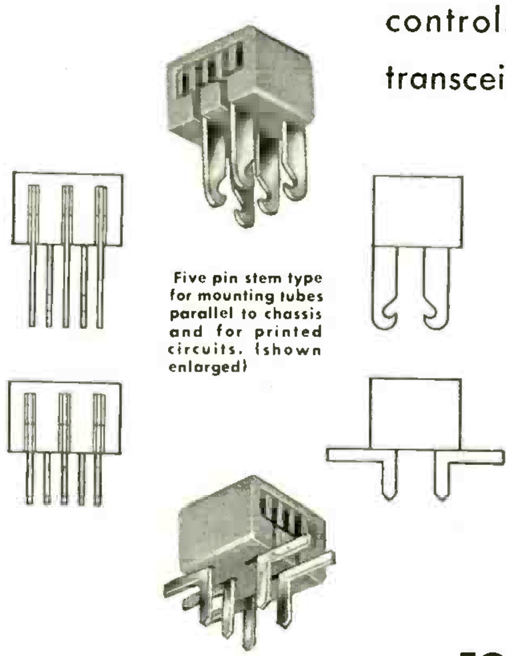
## CAMERA AND PEDESTAL

Mounted on the camera head are a field lens and a highly efficient color filtering system, consisting of two full- silvered mirrors, two dichroic mirrors, and individual color filters for each channel. Adjacent to each camera tube is a four-tube preamplifier with a cascode connected input stage followed by a feedback output amplifier. The camera pedestal contains the sweep chassis and the

junction panel for interconnecting cables. Both camera and pedestal are part of the GPL Three-Vidicon Color Film Chain, Model PA-520. **General Precision Lab., Inc., Pleasantville, N.Y.** —TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-56)

# CINCH ☆ STANDARD SOCKETS

The CINCH Sub-miniature socket insures positive electrical contact, holds tubes securely in place, permits easy maintenance and replacement, yields maximum insulation resistance and minimum high frequency loss. And provides manufacturers of electrical controls, transmitters, receivers, transceivers, airborne equipment, etc., and hearing aids . . . a labor saving chassis installation which serves terminal board functions while permitting designers to obtain maximum space afforded by the standard flat base tubes.



Five pin stem type for mounting tubes parallel to chassis and for printed circuits. (shown enlarged)

☆ **SUB-MINIATURE SOCKET FOR "SAVINGS" AND CONVENIENCE IN**

# PRINTED CIRCUITS AND ☆ AUTOMATICALLY MADE SOCKETS FOR AUTOMATION

CINCH is producing exactingly made components for the exacting requirements of mechanical assembly, automatically made with precision metal and insulation components, insuring the uniformity and quality mandatory for use in AUTOMATION in the end users equipment.

CINCH will design new, or re-design, parts within the category of their manufacture to fit your particular plans, and will also assist in the introduction in the assembly of CINCH's specially designed component in your radio and TV equipment.

**CONSULT CINCH**

## CINCH MANUFACTURING CORPORATION

1026 South Homan Ave., Chicago 24, Illinois

Subsidiary of United-Carr Fastener Corporation, Cambridge, Mass.

☆ CINCH components fully perform the service for which they were designed, so that judged by demand and usage, "CINCH is the Standard".

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For product information, use inquiry card on last page.

**MORE TV SPACE**—Reallocation of the spectrum for television, primarily, with the possibility of providing three more VHF television channels in the 88-108 megacycle FM broadcasting band is now under study by two highly qualified radio-tv engineering groups working with the Senate Interstate and Foreign Commerce Committee and the FCC. Recommendations from the two groups—an ad hoc engineering committee named by Chairman Magnuson of the Senate body and the Joint Television Advisory Committee which has been aiding the FCC—are slated to be completed this fall. JTAC has asked the Commission to institute with its coordinated assistance a long-range study of frequency utilization so as to obtain the optimum use of channels, including spectrum requirements of the armed services and the other government agencies such as the Civil Aeronautics Administration.

**ARRAY OF EXPERTS**—The makeup of the two groups which were designated to formulate the recommendations for the survey of spectrum reallocation program constituted virtually the top-level stratum of radio-tv engineering and frequency authorities. The ad hoc group, headed by MIT professor Edward Bowles and consultant to Raytheon president Adams, comprises such leading engineers as Dr. Allen B. DuMont, Philco research director Donald Fink, IRE secretary Haraden Pratt, Westinghouse engineering vice president Ralph Harmon and CBS engineering vice president William Lodge. The JTAC body handling the study are RCA frequency bureau chief Philip Siling, Bell Labs' Dr. Ralph Bown, and I. J. Carr of GE with Lloyd Berkner of Associated Industries as chairman.

**ECONOMIC PROTESTS**—That the Section 309 (c) of the Communications Act which requires the FCC to hold hearings on economic protests to new radio-tv grants and to stay new authorizations pending the determination of the protests should be greatly delimited or repealed was advocated by two leading FCC members in hearings before the Senate and House committees. There are 70 cases of radio and tv stations now held up for decision because of the legislation and this work consumes 28% of the Commissioners' time in meetings and the staff in one month spent 2404 man hours costing around $49,000 on these protests. FCC Chairman George C. McConnaughey urged the FCC have discretion on accepting such protests, while Commissioner John C. Doerfer advocated outright repeal of the section. Whether Congress in its final legislative lap acts on solution of this situation was not predictable at TELE-TECH's deadline.

**TV DE-INTERMIXTURE**—Determination of future of uhf television in competition with vhf video operations in question which FCC faces this fall after its August recess. Issue of de-intermixture was brought to the forefront in two-day oral argument before the entire FCC on five cities, four with no vhf station on the air and the fifth with a single vhf station operating. The decision on this proceeding can have an important bearing on contention of uhf interests that in 23 areas among 100 top markets existing uhf stations should be "protected" from competition from vhf operations. The controversial situation has precipitated the thought of a 90-day "freeze" on the new uhf station grants until the policies are delineated.

**MOBILE RADIO GROUPS**—Two types of organizations to work with the FCC Commissioners and staff on problems and policies affecting the mobile radio services have been recently proposed. One was for the formation of an interservice safety-special mobile users association which would present a united front on the maintenance of private industrial frequency allocations and operations and also have a voice in the selection by the Commission of department heads dealing with the safety-special radio services. The other was the establishment of a Radio Technical Commission for Land Mobile Services, patterned like the radio technical commissions for aeronautics and marine services. The latter was presented by Motorola communications-electronics Vice President Daniel Noble, a leading authority in the mobile radio field.

**PAY-SEE TV**—After the first influx of large support for pay-see television in letters to the FCC and to leading newspapers, the views of the vocal public on this issue have become reversed and now the preponderance is in opposition to this plan of operating video public service. The majority of the public—three-fourths in the largest city, New York—opposed the payment idea for TV programs, while the remaining fourth favoring the method generally had qualifications as to amount of fee and types of programs specially desired. This current trend is felt to lighten the pressure on the FCC for approving this method of television in a speedy carte blanche authorization.


*National Press Building*
*Washington, D. C.*

*ROLAND C. DAVIES*
*Washington Editor*

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*Telecast stable, 600 line color pictures of unmatched quality with the outstanding 3-Vidicon Color Film Chain recently developed by GPL. Typical GPL performance superiority has been achieved in this equipment with a highly advanced color filter system, precise registration, precision-engineered GPL components, and factory-adjusted optical and mechanical alignment. Compactness of the chain permits easy installation into your present monochrome film layout.*

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**General Precision Laboratory Incorporated**

PLEASANTVILLE, NEW YORK

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For product information, use inquiry card on last page.

# CUES for BROADCASTERS

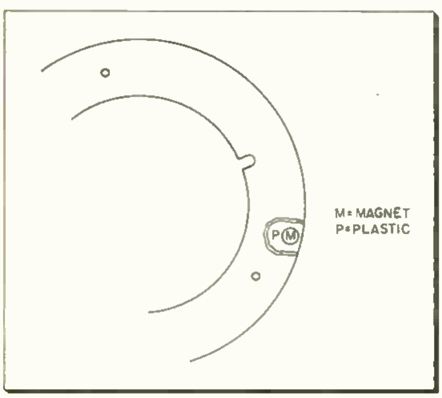
***Practical ways of improving station operation and efficiency***

## Magnetic Tape Threader

*JOSEPH F. LANG*
*WJR, Detroit, Mich.*

ONE of the most time consuming operations in using a tape recorder is the act of threading the tape on the take-up reel. It takes only a few seconds but multiplied by a hundred or so times, it can add many unproductive minutes to the recording day. However, the time element is considered small compared to the ease with which the tape is spooled on the reel, and the frustration spared the engineer by the method described below. This method words satisfactorily if one condition is observed. You must use at least a thirty second lead-in on the recording, which I might add is standard practice at our station.

A standard NAB hub was reworked, and where the tape is normally threaded, a circular plastic insert was added. In this plastic insert was put (press fit) a small bar magnet (taken from a kitchen blackboard which has little magnets to hold notes).




**Magnet imbedded in reel holds tape in place**

By positioning the bar magnet so that the tape will come in contact with it, it was found that the tape could be held in place on the hub with enough force to enable the operator to wind a few turns on the take-up reel.

Next, tests were run to determine the effect of the magnet on each succeeding turn of the tape. It was found that the magnet caused a thump on each turn, decaying with each turn until at the 25 second point the thump disappeared.

In this way, the problem of threading tape on a take-up reel was solved without resorting to adhesives, special leaders, or the old method of making a loop of the tape.

## Remote Recording Aids

*JACK THORNTON*
*733 Georgia Ave., Bend, Ore.*

MANY radio stations have occasion to make tape recordings at summer camps, emergency areas, parades, or other locations away from regular power lines. When taking power from portable generators or "home light plants" it is sometimes found that recordings are not the proper speed for normal studio playback. Often there is no frequency meter on the generator. A simple check can be made before recording, and with many recorders a quick adjustment made even if the generator cannot be corrected.

Before leaving the studio or transmitter, record a one-minute time-check calling off the start of the check and then the last ten seconds of the minute second-by-second. At the remote location—after determining that the available current is a.c. —play back the time-check. Any playback *over* 60 seconds indicates a slow-running generator. (The number of seconds over 60 showing the number of cycles-per-second the generator is slow.) Playbacks *under* 60 seconds similarly indicate a fast-running generator. Thus the speed error can be corrected by speeding or slowing the generator until the time-check is accurate.

If generator adjustment is not possible, tape machines having exposed drive capstans can be adjusted in many cases. If the time-check playback is under 60 seconds go ahead and make the recording, erasing the original time-check and recording a new one before the program. Back in the studio the tape will playback slow. Bring it up to a speed where the time-check compares by wrapping tight layers of adhesive tape around the tape drive wheel. (Capstan)

However, if the time-check at the recording location plays back under 60 seconds, bring the tape up to speed before recording by wrapping the adhesive tape around the capstan. Remove the adhesive tape for normal studio playback.

While only emergency measures, these methods can save a program that might otherwise have been lost.

## *Rapid Replacement of Tubes*

*KEN MAXWELL*
*Ch. Eng. KLTI, Longview, Texas*

MANY commercial consoles, limiter amplifiers and other complicated pieces of equipment have a front panel selector which meters the voltage across the cathode resistor. In case of failure of the piece of equipment while it is in operation, the meter selector can quickly indicate if any tube has an open filament or other trouble causing a great vibration from its usual plate current. The next step is to try to locate the manufacturer's manual about the console, amplifier or limiter and find the proper page which tells which tube is indicated by position 9, for example. In order to save this loss of time in identifying the tube indicated by the selector switch the numbers on the selector switch were typed on a piece of paper and "scotch" taped beside the tube socket they represented. It now takes only a few seconds to locate the defective tube. This idea originated in a piece of equipment which was wired differently from the chart in the instruction manual. It seemed so useful that it was repeated with all other equipment in the station.

---

### $$$ FOR YOUR IDEAS

*Readers are invited to contribute their own suggestions which should be short and include photographs or rough sketches. Typewritten, double-spaced text is requested. Our usual rates will be paid for material used.*

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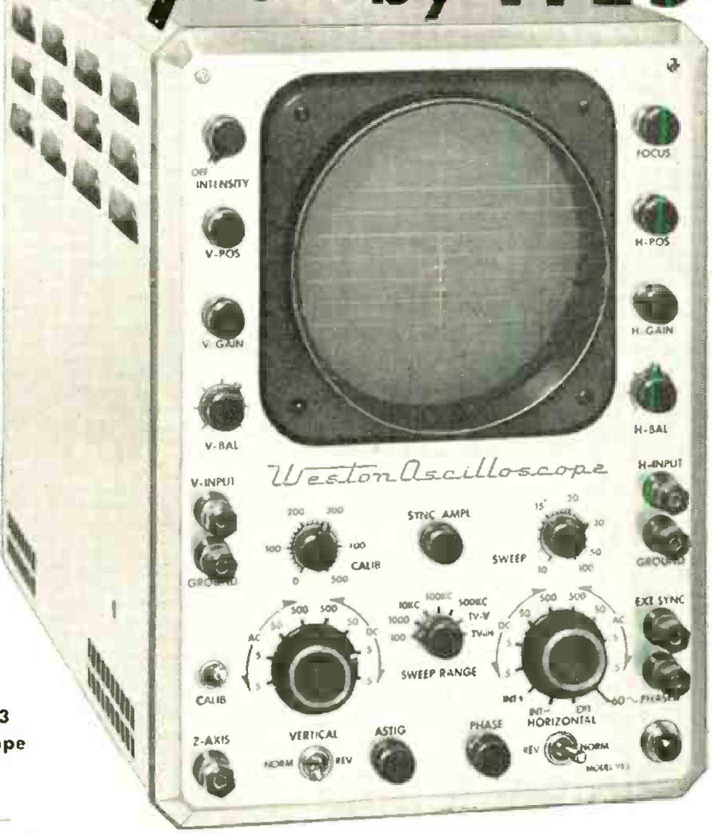
# NOW...the All-purpose 'Scope by WESTON




Weston
Model 983
Oscilloscope

Model 983 is a high gain, wideband Oscilloscope designed to accurately reproduce waveforms comprising a wide band of frequencies. High sensitivity of 15 millivolts per inch RMS makes this "scope ideal for—SETTING RESONANT TRAPS... SIGNAL TRACING IN LOW LEVEL STAGES... AS A GENERAL NULL INDICATOR... for PHASE CHARACTERISTIC MEASUREMENT IN INDUSTRIAL APPLICATIONS... and for SWEEP FREQUENCY VISUAL ANALYSIS.

The 'scope contains identical vertical and horizontal push-pull amplifiers with a choice of AC or DC coupling without affecting either sensitivity or band width. Both amplifiers have compensated step attenuators and cathode follower input. *It has excellent square wave reproduction with overshoot of only 2 to 5%, with a rise time of 0.1 microsecond. The 'scope response is essentially flat throughout the specified range of 4.5 mc and is usable to 6 mc.*

The unit has provisions for internal calibration, internal phased sine wave, and Z-axis intensity modulation. Reversal of polarity of both horizontal and vertical signals is easily accomplished by means of toggle switching. *Tube replacements are non critical, and etched circuitry facilitates quick and rapid maintenance.*

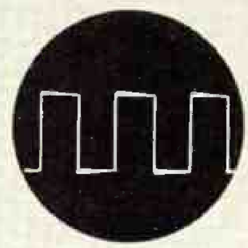
The Model 983 Oscilloscope is now available through local distributors. For complete literature write WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.

**WESTON** *Instruments*

### WAVEFORM ANALYSIS

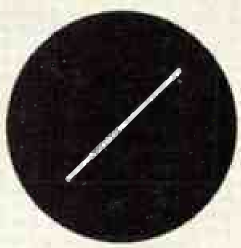
Response curves accurately displayed. Ideal for use with Weston intensity marker display. A fast, retrace sweep circuit with cathode follower output prevents pattern distortion.

### SQUARE WAVE RESPONSE



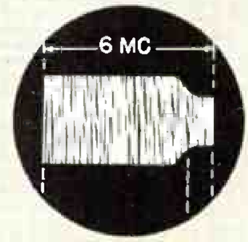
Overshoot is only 2 to 5%. Rise Time is 0.1 Microsecond. Square wave depicted 250 kc.

### PHASE MEASUREMENTS



Phase shift between horizontal-vertical amplifiers, 0-500 kc-0°, to 1 mc within 2°; by internal adjustment with gain controls at max 0° phase shift possible on any specific frequency to 6 mc.

### RESPONSE CHARACTERISTIC




Note flatness throughout specified range; to 3.6 mc down 1.5 db, at 4.5 mc down 3 db, at 6 mc down 6 db.


For product information, use inquiry card on last page.

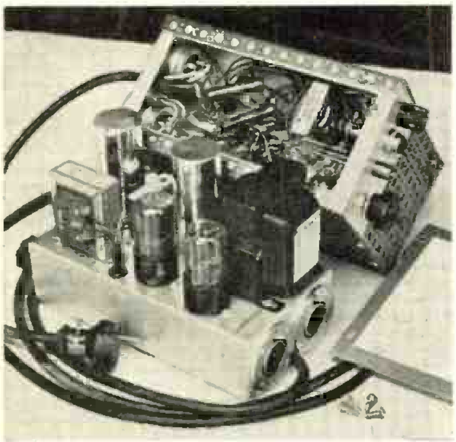


Fig. 1: External program line amplifiers

## Improving

# Communications in TV

*External program line amplifiers provide effective liaison between television broadcast station personnel*


**By WILLIAM H. COLE**
*Technical Operations Staff*
*National Broadcasting Co.*
*Hollywood, Calif.*


WE use RCA TS-30A field switching equipment in both our local station and network mobile units. This gear provides good communications under normal conditions. However, there are occasions when more than the normal complement of personnel are required to produce and engineer a program. Hence, program line or "PL" circuits become overloaded, resulting in loss of volume. Inherent cross-talk, when both program and engineering circuits are in use, contributes to confusion of directions. Then, too, there are times when the nature of the program is such that much greater communications levels are required to over-ride a loud orchestra or cheering crowd. And, in many cases, a third and fourth circuit, for lighting and audio crews, must be provided.

Through the use of external PL amplifiers (see Fig. 1) to be described, we now reserve the built-in facilities of our field switchers for the Technical Director, his camera and video men. This allows us to maintain the highest communication level possible with our unmodified switchers, eliminates cross-talk and relieves our cameramen of the program PL's that would be normally plugged into their cameras. An adaptor, to be described later, may be used in conjunction with one of the amplifiers to further reinforce the director's voice under adverse conditions.

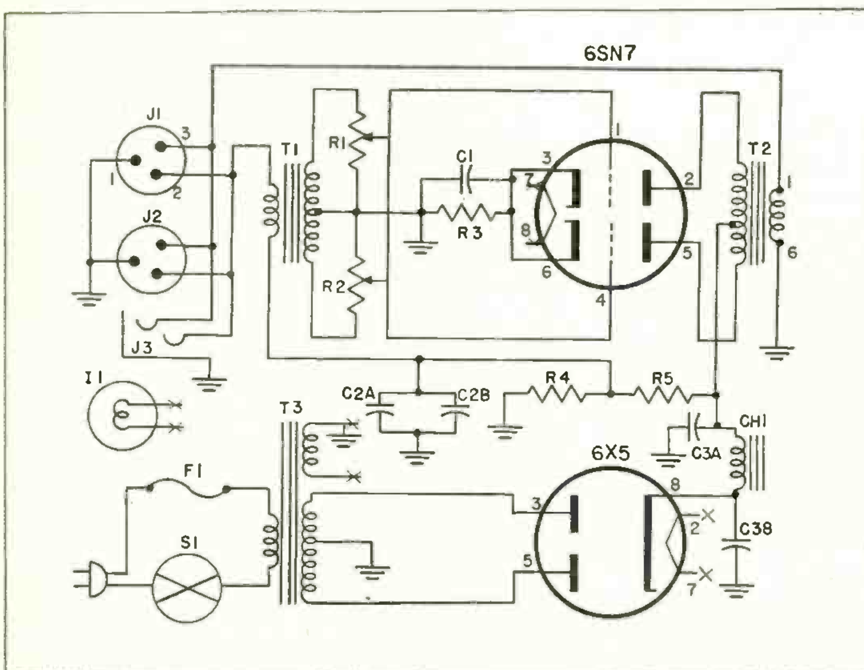
Each PL amplifier provides adequate gain for up to twelve Western Electric type 52BW headsets. The amplifier is a push-pull stage, using inexpensive, readily available parts. Using the standard components listed, the amplifier, measuring 4 x 5-½ x 8 in. and weighing 6 lbs., is quite portable. As shown in Fig. 2, "battery" for the carbon microphones is furnished through a divider in the plate supply.

We use three-circuit Cannon fittings for our field audio cables (mike extensions, etc.), so this type connector was the logical choice for the amplifier. The only requirement is that there be three circuits interconnecting amplifier and headsets. This allows us the use of our regular microphone extensions for this purpose, and thousand-foot lengths have been used with negligible loss and no trace of inductive feedback, even though input and output leads are enclosed within a common shield. Of course, adaptors are used to join the headset's Tip, Ring and Sleeve plug with the Cannon connector.

The photo of two of the amplifiers (Fig. 1) gives an idea of part placement and shows the bottom plate with circuit diagram and parts list cemented to the inner face. We usually run one microphone extension from each amplifier to the

(*Continued on page* 124)

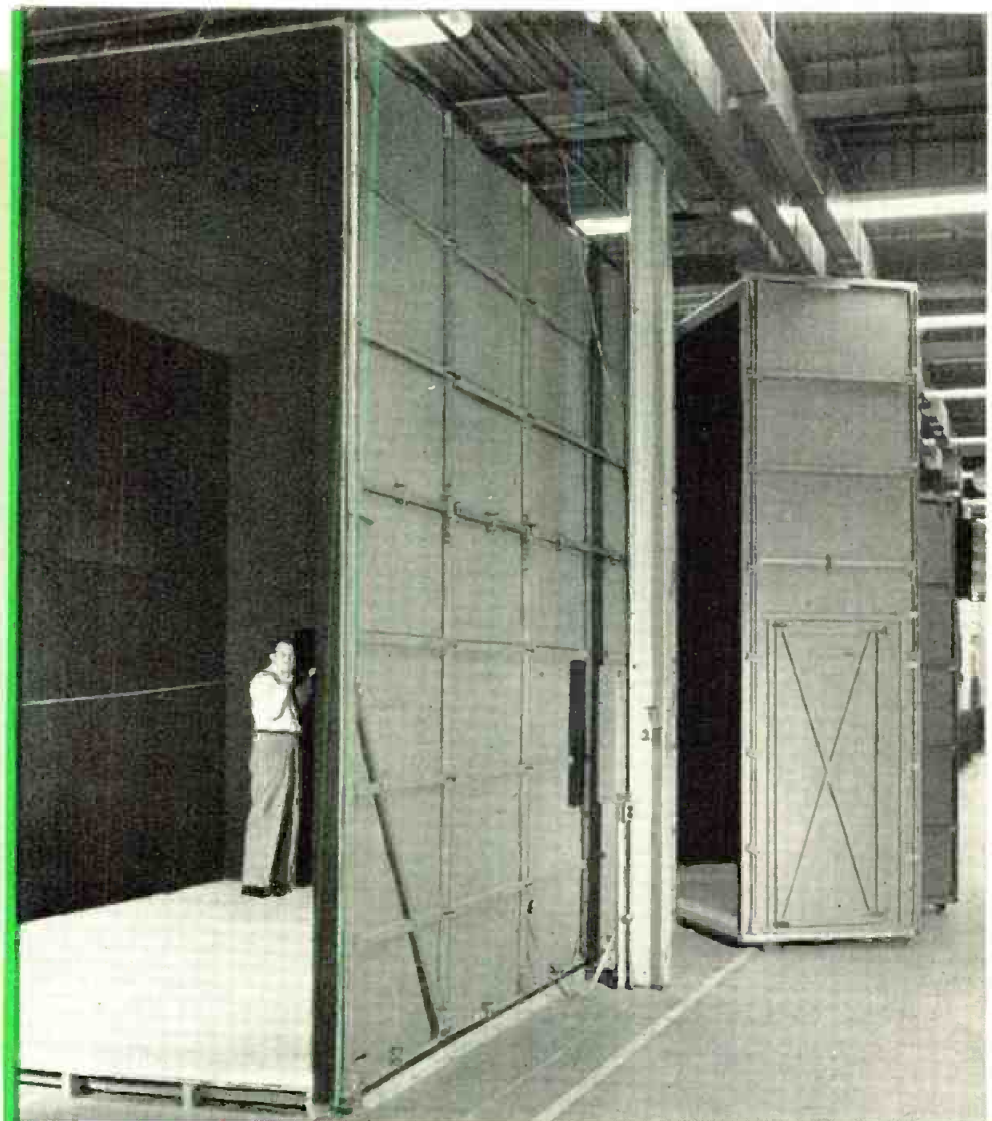
Fig. 2: Circuit diagram and parts list for push-pull external program line amplifier. Unit provides gain for up to 12 headsets




| | | |
|---|---|---|
| J1 | 3 CKT FLUSH RECEPT. | CANNON P3-13 |
| J2 | " " " | " " |
| J3 | TRS JACK | W. E. 238A |
| R1 | 500K VOL. CONTR. | IRC PQ 13-133 |
| R2 | " " " | IRC M13-133 |
| R3 | 1K, 1/2 W | OHMITE 10% |
| R4 | 5K, 10 W | TRU-OHM WIRE |
| R5 | 10K, 10W | " " |
| C1 | 10 µF, 25V | CORNELL DUBILIER BR102A |
| C2A | 40 µF, 450V } | " " UPT4445 |
| C2B | " " | |
| C3A | " " } | " " " " |
| C3B | " " | |
| T1 | MIKE TO PP GRIDS | STANCOR A4742 |
| T2 | PP PLATES TO VC | " A3856 |
| T3 | 230V, 50MA PWR | " PC8418 |
| CH1 | 7HY, 50MA | " C1707 |
| S1 | DPST N.O. SWITCH | IRC 76-2 |
| F1 | 1 AMP FUSE | LITTEL FUSE 342003 (HOLDER) |
| I1 | 6V PILOT | DIALCO B108-431 (ASSEMBLY) |

## to simulate free space for microwave antenna testing

## Westinghouse uses the new



# McMillan "free space" room

At Westinghouse Electric Corporation's Air Arm Division in Baltimore, the problem was to produce a large room which would simulate free space conditions for microwave testing to be done in conjunction with environmental testing. The McMillan "free space" unit illustrated above was especially designed in association with Westinghouse to fit this particular need.

McMillan supplied a "modular unit" consisting of the individual structural-steel channels, or ribs, together with the microwave absorber panels. It was a simple job for Westinghouse workmen to form the construction and mount the panels.

In this installation, McMillan Hair Mat, type H-4 was used on the wall and ceiling panels for its light weight, while the floor panels utilized McMillan Plastic Foam Block, type B which can be walked on without affecting its electrical performance. All absorbing materials were backed with copper shielding to prevent R.F. disturbance from outside. Panels were approximately 4' x 8'. The complete front section (right hand section of illustration above) which includes the door, was mounted on roller casters to allow large equipment to be moved in and out.

McMillan can produce any size room on this "modular" principle, with whatever type microwave absorber may be required — for either indoor or outdoor use. Send for catalog.

McMillan INDUSTRIAL CORPORATION
27 BROWNVILLE AVENUE
IPSWICH, MASSACHUSETTS


For product information, use inquiry card on last page.

## Electronic Reliability

*(Continued from page 99)*

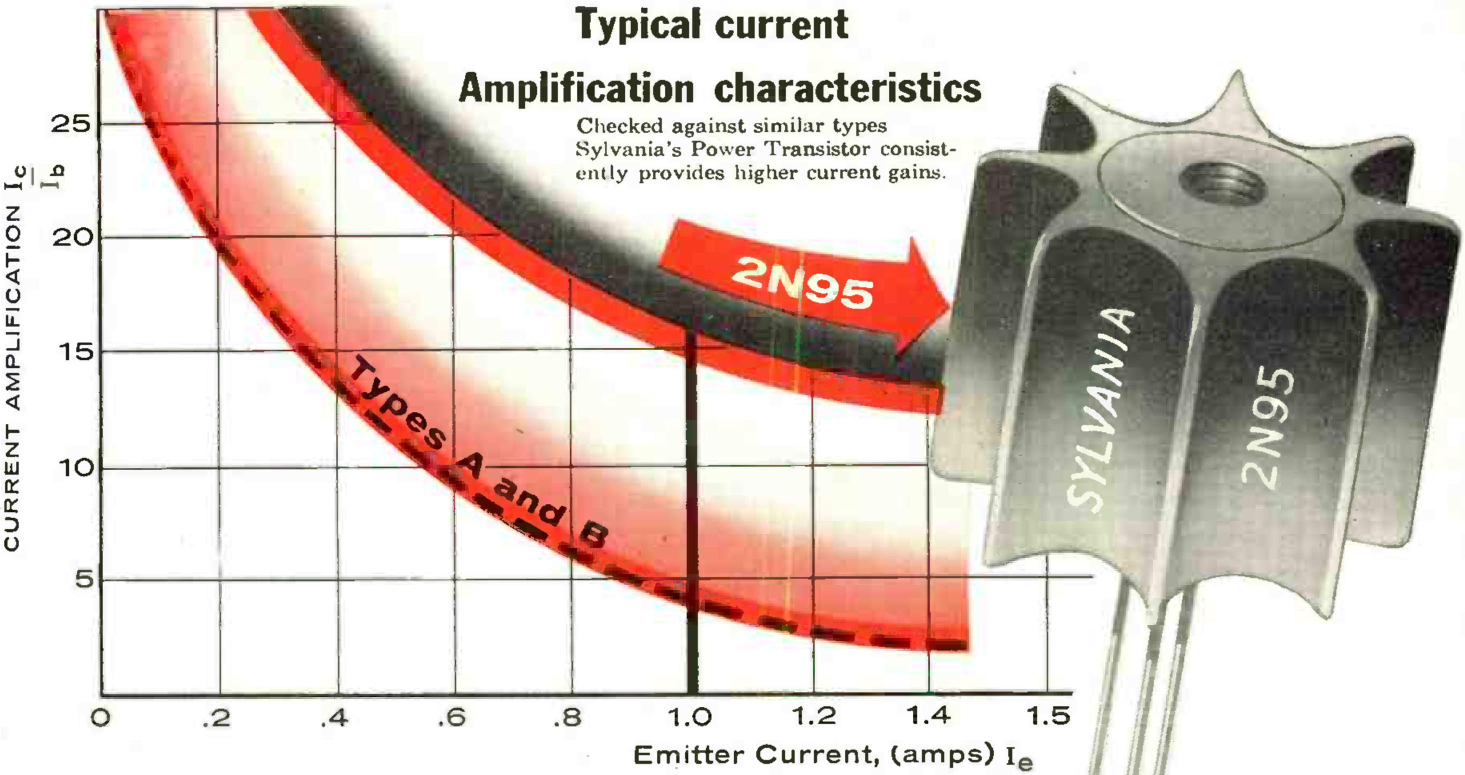
(1) With sine-wave excitation of the frame, resonant parts can vibrate at much larger amplitude than the frame. Since electronic equipment (including tubes) consists of large numbers of parts in a hierarchy of assemblies, it is quite possible for a mode of resonance in a small part to coincide with a mode of resonance in the assembly upon which it is mounted, thus experiencing near the mutual resonant frequency a vibration amplitude several hundred times as great as that applied to the frame.

(2) Vibratory energy can be dissipated in a gas or liquid without harm to the equipment, but that portion that is dissipated in solid materials should be suspected as destructive until proven otherwise, since it normally implies superelastic strain, abrasion, sawing, loosening of fasteners, etc. This damage occurs on every cycle during vibration but only once per shock.

For these reasons, sinusoidal vibration is applied at very much lower peak acceleration than the shock endurance capability of the same equipment. Hence vibration is less sensitive for detection of ultimate strength, intermittents and microphonics than is a higher-amplitude shock, except at resonant frequencies. Vibrating to destruction on a sampling basis can be valuable,[31, 35] although correlation with service life is difficult to establish because the vibration encountered in actual service is seldom sinusoidal or even well-known.[39] Swept-frequency vibration at very low amplitude can be useful as a production test; an abnormal spectrum of resonances may indicate inadequate clinching of essential fasteners or partial structural failure.

### *Vacuum Tubes*

The reliability and environmental testing of electronic components is presently receiving much attention and effort by the military services and their contractors. Vacuum tubes should, and do, receive a large share of this attention. The development of long-life tubes is necessarily slow because prove-in of new techniques by life-testing takes so long. ("Ruggedized" tubes may or may not have extended life in quiet service. Preliminary reports indicate that they usually do, but this opinion is not unanimous.) Incandescent lamp failure frequency in-




Shown more than twice the actual size

## Sylvania NPN Power Transistor 2N95 Exhibits

# 3½ times more gain

Operated at 1.0 amp emitter-current, the Sylvania 2N95 Transistor typically provides a current gain of 17 . . . 3½ times that of comparable types A and B. Even at 1.5 amp emitter current the 2N95 typically exhibits a high gain of 13 . . . in fact, as the curve shows, the Sylvania 2N95 provides the highest gain over the widest range of operating current conditions.

In addition, Sylvania's 2N95 combines all the important features you want in a power transistor, whatever your application. If, for example, yours is a switching application, the 2N95 offers high gain at high currents.

Designed for low thermal resistance, the Sylvania 2N95 Transistor provides dissipation up to 2½ watts without an external heat sink and up to 4 or more watts with a suitable heat sink. This insures stable operation in high ambient temperatures.

### You compare

Check the Sylvania 2N95 against similar Transistor types yourself—for current gain as well as all of these important power Transistor features.

| Does the Sylvania 2N95 offer— | answer |
|---|---|
| 1. lower cost | yes √ |
| 2. low input impedance | yes √ |
| 3. low thermal resistance | yes √ |
| 4. high current switching | yes √ |
| 5. high current gain | yes √ |
| 6. mounting for air cool or heat sink | yes √ |
| 7. hermetic seal | yes √ |

A smaller version for heat sink mounting, the Sylvania 2N102 is also available with the above features.

*"another reason why it pays to specify Sylvania"*

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☐ High frequency Types 2N94 and 2N94A
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For product information, use inquiry card on last page.

## Electronic Reliability

(*Continued from page* 118)

creases with the operating time of the lamp; therefore, lamp life has a fairly well-defined distribution,[24] and dependability can be increased by regular replacement. By contrast, vacuum tube failure (at least in receiving tubes) is still virtually unpredictable and not subject to improvement by preventive maintenance.[33, 38] (See Fig. 2.) Tube failure frequency is usually highest in new tubes ("infant mortality"), whereas many 2.5 v. receiving tubes are still operating after 20 yrs.

It is suspected that some incipient tube failures are foreshadowed by decreasing transconductance[27] (perhaps especially when tested at subnormal heater voltage), but the practical importance of this potential maintenance aid is not yet proven. To be certain of beneficial results, it appears necessary to use transconductance tube testers with accurately reproducible indications, and to keep a continuous record of $G_m$ for each individual tube.[1] This history can be kept on a sticker adhered to octal size tubes. This is more difficult with miniature tubes, where the advisability of periodic checking is further doubtful because of the frequency of undetected failure by glass breakage during insertion into the socket.[2]

In general, tube life can be prolonged by operating well under the manufacturer's maximum ratings (voltage, current, dissipation, etc.). Cathode failure can be caused by gas released by overheating of almost any part of the tube. But in some circuits, notably broad-band amplifiers, the sacrifice of transconductance at reduced current cannot be tolerated.

Operation of ordinary tubes for long periods of time with zero cathode current can produce cathode "sleeping sickness," an interface formation in the oxide coating, causing reduced transconductance and/or a video peaking effect with a time-constant of a μsec or so. This effect can probably be reduced by operation at lower heater voltage, where the peak current requirement permits.[32] Tube manufacturers have learned how to avoid interface formation in "premium" tubes, and we can hope that this new knowledge will eventually be applied to all tube types.

A third major cause of cathode failure is due to excessive cathode current.[9] It is believed that the oxide coating is simply overheated by the space current passing through it.

# PRESTO PROUDLY PRESENTS


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**WORLD'S LARGEST MANUFACTURER OF PRECISION RECORDING EQUIPMENT AND DISCS**

# "Reps" & Distributors Serving the

## REPRESENTATIVES

This section lists those representatives on the West Coast operating as independent "reps" who handle two or more lines. They do not include factory staff salesmen. "Reps" are listed alphabetically under states and cities. Asterisks (*) indicate membership in "The Representatives" of Electronic Product Manufacturers, Inc. Telephone numbers are given to speed contacts.

### CALIFORNIA

LOS ANGELES AREA
- *Appleton Co Harry 136 San Fernando CA 1-2171
- Barron-Jures 817 S Hoover St DU 3-5248
- *Barstow & Doran 1406 S Grand Ave RI 6191
- Baughman Co E J 1914 N Cogswell (El Monte) FO 0-7586
- *Becker Co Herb 1140 Crenshaw Blvd WE 1-1257
- Berman Co J 1141 LaCienega St BR 2-9138
- Buchman Co W B 923 E 3 St MA 6-2325
- Cohn S H 1769 S Holt Ave TE 0-4398
- *Cochrane Co Irv M 408 S Alvarado DU 5-1715
- Craig Ralph P 715 N Harper Ave WE 0468
- Davidson & Assoc Joe PO Box 108 (South Gate) NE 6-2245
- *Davis Sales Co George 5259 E Beverly Blvd UN 3-3594
- Denkle B 3257 W 6 St
- *Ealy Co M D 633 S La Brea WE 5-0771
- Eastman Pacific Co 2320 E 8 St TR 6317
- *Edwards & Co Jackson 6047 Hollywood Blvd NO 5-1141
- Electronics Unlimited 4934 Venice Blvd Los Angeles 19 Calif WY 3828
- *Emmet F A 2837 W Pico Blvd RE 1-8211
- *Feldman Co Henry 1244 S Grand PR 8803
- Fox Associates 5401 Santa Monica Blvd HO 3-7194
- Hardie Co R M 901 S Manhattan Pl RE 4-2752
- *Harmon Co W S 121 N Robertson Blvd (Beverly Hills) BR 2-3321
- Hast Nate 301 S Reeves Dr (Beverly Hills) CR 5-2652
- *Hastings Sales Co 4942 Vineland Ave (N Hollywood)
- *Hill Sales Co J T 800 W 11 St RI 7-5384
- *Hitt Co W C 1169 S Broadway PR 2105
- King Co W C 1355 Westwood Blvd GR 8-8679
- *Kittleson Co 416 N LaBrea WE 8-2455
- *Knight Co W Bert 10373 W Pico Blvd BR 2-5647
- *Koessler Sales 6907 Melrose Ave YO 6271
- Lacey Bob 436 S Beachwood Dr (Burbank) TH 8-9421
- La Moree G D 1325 San Julian RI 6378
- Larshan Inc 1409 Wilshire Blvd (Santa Monica) TE 0-8489
- *Lasure Co Harry A 9041 W Pico Blvd BR 2-7805
- *Loukota Co Douglas 1052 W 6 St MA 6-4505
- Lynch & Son C R 3307 Glendale Blvd NO 3-8236
- Lynn & Brooks 3055 Wilshire Blvd DU 2-2255
- Mann Assoc Martin 8346 Beverly Blvd WE 3-8528
- *Marsh Co J W 4216 W Jefferson RE 2-0145
- *Marshall Co G S 40 S Los Robles (Pasadena) SY 5-2022
- *Marshank Sales 672 S Lafayette Pk DU 7-8235
- Maynard Sales Co 6214 W Manchester OR 8-3150
- *Miller Co Gerald B 1550 N Highland (Hollywood) HO 2-1195
- Mitchell Co C H 256 S LaPeer Dr Beverly Hills BR 2-0183
- *Neely Enterprises 7422 Melrose Ave WE 3-9201
- *Olander & Co Roland 7225 Beverly Blvd WY 0028
- Osborne R E 1044 S Park View DU 8-1039
- *Owens Co Lee H 2331 W Washington RE 0230
- Perlmuth-Colman & Assoc 2419 S Grand Ave RI 7-4321
- *Power Ralph L 767 Castelar St MU 5277
- Renz Roy E 1406 S Grand Ave RI 7-3893
- Rios Ed 1250 Wilshire Blvd MA 6-8912
- *Rissi Al J 2724 S Peck Rd (Monrovia) DO 6-2135
- *Roberts & Assoc E V 5068 W Washington WE 8-2541
- *Rupp Co V T 2230 W 11 St DU 3-4197
- *Saul & Assoc Howard M 5015 San Vincente Blvd. WE 8-3591
- *Seigel Co Samuel 1133 S LaCienega Blvd BR 2-4183
- Shephard Marty 7559 Melrose Ave WE 8-2996
- Sievers Edward S 1662 Hillhurst Ave NO 2-1105
- Smedley A B Box 67-C (Pasadena) SY 8-1174
- Snitzer T Louis 5777 W Pico Blvd WE 1-5566
- Starr Edwin E 4101 Rhodes Ave (N Hollywood) ST 7-5879
- *Stolaroff Co M A 466 W Slauson Ave AX 3-6219
- *Stone Assoc Carl A 1102 S Western Ave R 2-8103
- *Stone Sales Co R L 9548 W Pico Blvd BR 2-4916
- *Strassner Co Conrad R 1865 N Western Ave HO 7-7086
- Tivy George S 1148 S Grand Ave RI 7-7553
- *Tebergen Assoc 2232 W 11 St DU 9-3173
- Uecke E H 4938 Neola Pl CL 7-9611
- Van Groos Co 14515 Dickens St (Sherman Oaks) St 7-7882
- Vermilye Co Charles 3440 Wilshire Blvd DU 2-5695
- *Wallace & Wallace 1206 Maple Ave RI 7-0401
- *Weber Co Wedge 1217 Venice Blvd DU 7-2111
- *Western Electronic Enterprises 3348 W Compton Blvd (Gardena) OR 8-4817
- *Wiley Paul F 1632 Silverlake Blvd NO 3-8028
- *Wood Co A M Box 150 (Elmonte) CU 3-1201
- Wright Eng'g 180 E Calif St (Pasadena) RY 1-8488

SACRAMENTO
- *Neely Enterprises 309 Oschner Blvd GI 3-7461

SAN FRANCISCO AREA
- Ault C E 625 Laurel Ave (Menlo Park) DA 5-4983
- *Barstow & Doran 248 9 St UN 3-2079
- *Belchamber P A 1401 Middle Harbor Rd (Oakland) GL 1-4460
- *Berman Co E L 780 Natoma St UN 3-0317
- Brainard W V 721 Clementina St UN 1-2569
- Buchman Co W B 444 Brannan St YU 2-4312
- Detsch & Co 341 10 St MA 1-2788
- Eichorn & Melchior 500 Minn. St UN 1-8309
- Frazar & Hansen Ltd 301 Clay St EX 2-5112
- *French S P 721 Garland Dr (Palo Alto) DA 3-D597
- Harriss Sales Co L H 383 Brannan St YU 6-1084
- Held Herman E 147 10 St UN 3-4250
- *Hermane Co James P 1234 Folsom St MA 1-4166
- Hitt Co W C 1355 Market St KL 2-2311
- *Hodges Elmer C 1264 Folsom St UN 1-2367
- *Howard G M 782 Bryant DO 2-6320
- Jewett Samuel O 13537 Addison St (Sherman Oaks) ST 9-6027
- Kittleson Co 2166 Market St HE 1-5304
- *Lewis Assoc Dean 219 9 St UN 3-1414
- *Logan Assoc 725 Greenwich GA 1-0076
- *Logan Sales Co 530 Gough St HE 1-5127
- Marshall Harry E 104 Olive St OR 3-2173
- *Meyer & Ross 113 10 St HE 1-0480
- *Moulthrop & Hunter 165 11 St HE 1-2624
- Moxon Sales G E 422 LaJolla Ave (San Mateo) FI 5-2866
- *Neely Enterprises 2830 Geary Blvd WA 1-2361
- *Nickerson & Redat 381 Brannan St YU 2-2982
- *Nott & Co L A 1061 Howard St HE 1-4738
- *Purdy Co W J 312 7 St UN 3-4321
- *Ross Co David H 534 El Camino Real (San Carlos) LY 3-8224
- Scales Co James M 1355 Market St KL 2-2311
- *Sinai Arnold A 65 9 St UN 1-6259
- *Tompkins & Co W W 941 Newell Rd (Palo Alto) DA 3-3270
- West Coast Electronics 1013 S Claremont (San Mateo) DI 3-4700

### OREGON

PORTLAND
- *Burcham Co Don H PO Box 4098 BR 3830
- Eckersley James W 3150 SW Hamilton St AT 0308
- Hawthorne Electronics 700 SE Hawthorne Blvd FI 9375
- *Legg Co Richard 2118 SE Division St EM 8918
- *Minthorne Co L L 7521 NE Glisan St KE 0010
- *Weber Co Dale 234 Sherlock Bldg AT 5403

### WASHINGTON

SEATTLE
- Backer Co Jas J 2321 2 Ave MA 8811
- Carlson Co Fred W 2307 5 Ave EL 6630
- *Haight Co Fred H 3212 Eastlake EA 1818
- Howell Sales 1250 1 St S EL 4214
- Jensen Co Vernor O 2616 2 Ave MU 2929
- *Lee Co Dave M 2517 2 Ave MA 5512
- Levinson Co Harry 1117 2 Ave MA 5317
- *Marsh Agencies 2601 I Ave MA 8761
- *Merritt Co Ron 120 W Thomas GA 6644
- Meredith Co Ron 2410 Beacon Ave FR 8040
- Norris Co George D 3010 1 Ave EL 6662
- *Northwestern Agencies 4130 1 Ave S EL 8882
- *Parsons & Co C B 3028 1 Ave MU 3933
- *Porter Co Bert C 4310 Roosevelt Way ME 6828
- *Stroum Co S N 1612 Broadway FR 7515
- *Wedel Co Frank 3215 Western Ave GA 0222
- *Widdekind Co M K 216 1st Ave N EL 6981

## DISTRIBUTORS

These are the names and addresses of organizations handling the distribution of radio-TV-electronic parts and equipment on the West Coast. Listings are alphabetical under states and cities. Asterisk (*) indicates membership in National Electronic Distributors Association (NEDA). Telephone numbers are given to speed contacts.

### CALIFORNIA

ALHAMBRA
- *Coast Electronic Supply 527 W Main AT 9-4361

BAKERSFIELD
- Arbuckle J C 500 E 19 St 5-5816 Hdqrs Fresno
- Gough Industries 3125 Jewett St
- Valley Radio Supply 716 Baker St FA 7-8831

BERKELEY
- Pacific Radio Supply 1940 Ashby Ave TH 3-8900

BURBANK
- Dean's Electronics 1500 W Burbank Ch VI 9-2277
- Pacific Radio Exch 4101 W Burbank Hdqrs Hollywood
- Valley Electronic Supply 1302 N Magnolia Blvd

CATHEDRAL CITY
- Wholesale Electronic Specialists 573 Broadway PA 8-3302

CHICO
- Kemp Co E M 851 Main St FI 2-8703
- Radio Television Products 738 Cherry FI 2-8140

COMPTON
- Electronic Parts Distrs 1508 E Compton Blvd NE 1-7227

CULVER CITY
- Stewart & Stevens 8525 Steller Dr TE 0-6511

EL CENTRO
- Ainza-Huffman Distrs 1125 W Main 2307

EL MONTE
- Kimball-Stark 713 S Tyler FO 0-2594

EUREKA
- Commercial Radio & Elec 317 W 7 St HI 2-4179
- Redwood Electronics 313 W 7 St HI 2-1301

FRESNO
- Arbuckle J C 2349 Kern 4-6555
- Billings Wholesale Radio 260 Fulton St
- DeJarnatt Whsle B J 223 Fulton 2-2153
- Dooley Harry 725 L St 2-4108
- Fresno TV Supply 1449 Broadway 6-9666
- General Elec Supply 1234 O St 4-4746
- Graybar Electric 101 Van Ness Ave FR 2-4175
- Hoffman Sales 1740 Van Ness 6-8321
- Kierulff & Co 725 L St Hdqrs Los Angeles
- Kinney & Faust 1740 Van Ness 6-8321
- Meyberg Co L J 2930 Butler Hdqrs San Francisco
- Ports Mfg Co 3265 Belmont 3-6728
- Schiefer Sound 2121 Blackstone 7-7234
- Westinghouse Elec 2608 Calif 4-5091

FULLERTON
- United Radio & Electr 122 S Pamona St LA 5-3424

GARDENA
- Video Suppliers 14526 Crenshaw DA 9-4053

GLENDALE
- Hagerty Radio 6826 San Fernando Rd TH 8-2453
- *Weatherford Co R V 6921 San Fernando RO 9-2281

HOLLYWOOD
- Hollywood Radio 5606 Hollywood HO 4-8321
- Pacific Radio Exch 1407 Cahuenga HW 2-1393
- Western States Elec 1509 N Western Ave HO 5-7185
- Yale Radio Elec 6616 Sunset Blvd GL 4169

HUNTINGTON
- Martin Dist Co 2475 E Florence Ave

INGLEWOOD
- Acorn Radio 599 La Brea OR 8-5344
- Cook Electronics 210 E Hardy St OR 8-7644
- Inglewood Electronics 836 S LaBrea OR 4-2366

LONG BEACH
- Cal-Tenna Electronic 363 South St LB 20-7954
- Dean Co F S 969 American 6-5281
- General Electric Supply 840 W 12 St 3-5311
- Gough Industries 838W12 Hdqrs Los Angeles
- Graybar Electric 800 W 16 St LO 70-2911
- Kierulff & Co 1760 Pacific Ave 6-8268
- Ley Co Elwyn W 5550 Dairy Ave 20-5444
- Lynde Electronics 1526 E 4 St 7-4807
- Radio & TV Equip 2227 Pacific Hdqrs Santa Ana
- *Scott Radio Supply 266 Alamitos 7-8629
- Waller Inc H T 645 W 15 St 35-4844
- Westinghouse Elec Supply 901 W 12 St

LOS ANGELES
- Allied Radio Supply 7319 S Normandie Ave PL 2-3134
- American Electronic 567 S Fairfax Ave YO 5181
- Basford Co H R 3320 Leonis Blvd LU 1-6258
- Bell Radio Supply 1311 W Florence Ave PL 2-7191
- Calif Electronic Supply 11801 W Pico Blvd BR 2-2126

# West Coast Electronic Industries

Ceazan J N Co 3535 S Broadway AD 1-9133
Central Scientific Co 6446 Telegraph Rd RA 3-6141
Dunkle Radio Parts 2506 W 8 St
•Federated Purchasers 11275 W Olympia Blvd BR 2-0831
Figart's Radio 6320 Comm Sloat Dr YO 6218
General Elec Supply 700 Turner St MA 5-7141
Gerstman Dist 414 S. Western DU 8-2238
G.L. Electronics 905 S Vermont DU 7-5104
Gough Industries 560 S Mission Rd MA 6-2474
Graybar Electric 210 Anderson AN 3-7282
Henderson Co 628 N Alvarado DU 2-8301
Henry Radio Shop 11240 W Olympic Blvd GR 7-6701
Hollywood Electronics 7460 Melrose Ave WE 3-8208
Kerwin Co JJ 1525 S Flower St PR 5323
Kierulff Electronics 820 W Olympic RI 7-0271
K & L Radio Parts Co 1406 Venice Blvd RI 9-0553
Los Angeles Radio 10217 Venice TE 0-5862
Martin Dist Co 2475 E Florence LO 5-7111
Meyberg Co Leo J 2027 S Figueroa St RI 7-4451
Minthorne Music 2920 W Pico Blvd RE 4-2177
National TV Supply 4032 S Figueroa AD 3-8058
Olympic Elec 7636 Santa Monica Blvd HO 4-9144
Pacific Radio Exch 1407 Cahuenga Blvd HU 2-1393
Pacific Television 4032 S Figueroa AD 3-8058
•Panel Bros 2605 E 4 St AN 2-5151
Quality Dist 2545 S Yates Ave RA 3-7121
Radio Doc 721 S Main St VA 3104
•Radio Equip Dist 1340 S Olive St PR 9151
Radio Parts Sales 5220 S Vermont TW 9178
•Radio Prod Sales 1501 S Hill PR 7471
Radio Spec 1956 S Figueroa PR 7271
Radio TV Sup 341 W 18 St RI 9131
Ravenscraft Co 2320 S Hill PR 1317
Shelley Radio 2008 Westwood GR 7-6741
United Radio & Elec 1924 S Grand RI 7-0441
•Univ Radio Sup 1729 S Los Angeles PR 5241
Victor Distr Co 2027 S Figueroa RI 7-4457
Westinghouse Elec Sup 905 E 2 MA 9-4161
Wholesale Radio & TV Sup 4305 S Figueroa St AD 3-8171

MALIBU
Teleoa 1 Azurelee Dr GL 6-2611
Yale Radio Electric 6616 Sunset Blvd GL 4169

MARYSVILLE
•Dunlap Whsle Radio 826 5 St Hqrs Stockton

MAYWOOD
Kierulff 6058 Walker Ave LO 5-5461

MODESTO
Dunlap Whsle Radio 1216 K St Hdqrs Stockton
Pacific Teletronic & Radio Sup 417 7 St 3-7751

MONTEREY
Wholesale Electronics 229 Alvarado St 2-7642

NORTH HOLLYWOOD
Ilycor Sales 11423 Vanowen St
N Hollywood Radio 4212 Lankershim Blvd St 7-3063

OAKLAND
Basford Co H R 2101 Bush St GL 1-0314
Brill Co W D 198 10 St TE 2-6100
Cass Altschuler Co 6038 Telegraph Ave OL 3-7557
Electric Supply 140 11 St
•Elmar Electronics 140 11 St HI 4-7011
General Electric Supply 5400 Hollis St OL 3-4433
Graybar Elec 1911 Union St GL 1-5451
•Millers Radio & TV 336 E 8 St TW 3-3848
Raycraft Co 568 3 St TW 3-9698
Wenger Co E C 1450 Harrison GL 1-1020
Westinghouse Elec 711 E 8 TE 4-9900

PALO ALTO
Associated Radio Distr 459 California Ave DA 3-3173
Zack Radio Supply 525 High St DA 5-5678

PASADENA
Dow Radio 1759 E Colorado SY 3-1196
Electronic Supply 2615 E Foothill SY 5-8902
Empire Electronic Dis 37 E Union St RY 1-7671

POMONA
Anderson-Maggs 1095 E Third LY 9-9669

REDWOOD CITY
Electronic Supply 1740 Broadway EM 8-4093
Television-Radio Supply 415 Lathrop St Hdqrs San Francisco

RICHMOND
Millers Radio & TV Supply 319 37 St BE 5-4424

RIVERSIDE
Electronic Supply 2486 3 St OV 3-8110
Massey's Radio Supply 2992 8 St

SACRAMENTO
Broili-Parks 2225 19 St GI 2-2983
•Dunlap Whsle 1628 "S" St GI 2-1031 Hdqrs Stockton
General Elec Supply 1131 "S" St GI 3-9001
Graybar Electric 1900 14 St GI 2-8976
•Kemp Co E M 1115 R St GI 3-4668
Meyberg Co Leo J 1730 8 St GI 2-5837
Radio Television Prod 2012 19 St GI 2-7691
•Sacramento Electronics 1219 "S" St HU 1-4821
Westinghouse Elec 1730 14 St GI 3-6525

SALINAS
Peninsula TV & Radio 42 W Gabilan 2-6503

SAN BERNARDINO
Arrowhead Radio & Television 418 Base Line 2-5181
Featherstone Radio & TV 1010 E St 81-1306
General Elec Supply 485 S "I" St 5135
Gough Industries PO Box 222 Hdqrs Los Angeles
Graybar Electric 655 S "H" St SA 9-1051
HIFI Supply 418 Baseline 2-5581
•Inland Electronic Supply 843 Colton Ave 6-5571
Kierulff & Co 1123 W Base Line Hdqrs Los Angeles

SAN DIEGO
Ceazan Co J N 1945 E Harbor Dr BE 9-1301
Electric Supplies Dist 435 2 Ave
Electronic Equip Dist 1228 2 Ave BE 2-3155
General Elec Supply 450 2 Ave BE 9-0271
Gough Industries 3255 5 Ave WO 0659
Graybar Electric 720 State St BE 3-1361
Kierulff & Co 2426 4th Ave
Radio Parts Co 2060 India BE 9-9361
Shanks & Wright 2045 Kettner BE 9-0176
Silvergate Radio Supply 2361 India FR 9-6125
Western Radio & TV 1415 India St BE 9-0361

SAN FRANCISCO
•Assoc Radio Distr 1929 Market St HE 1-0212
Basford Co H R 235 15 St MA 1-8545
•Brown Co C C 61 9 St MA 1-7000
Century Distr 1111 Front St YU 2-1480
•Eber Electronics 160 10 St MA 1-4332
Edwards Co Frank 382 6 St MA 1-9700
Ets-Hokin & Galvan 551 Mission St EX 2-0432
General Electric Supply 1201 Bryant St UN 3-4000
Graybar Electric 1750 Alameda St MA 1-5131
Kaemper & Barrett 1850 Miss UN 3-3080
•Meyberg Co L J 33 Gough St MA 1-3400
Offenbach & Remus 1564 Market St KL 2-2100
•Pacific Whlsle 1850 Mission St UN 1-4843
Radio Parts Supply 281 9 St MA 1-0552
•San Francisco Radio 1284 Market UN 3-6000
•Smith & Crawford 789 Stevenson St UN 3-2045
Tel-Radio Supply 408 Market EX 2-2898
•Television Radio Supply 326 Market St EX 2-2898
Tilton Industries 1850 Mission St UN 1-4843
Westinghouse Elec 201 Potrero UN 1-5051
•Wholesale Radio 140 9 St HE 1-3680
•Zack Radio Supply 1424 Market MA 1-1424

SAN JOSE
Peninsula TV & Radio 881 S 1 St CY 4-8781
•Quement Inc Frank 161 W San Fernando St CY 4-0464
San Jose TV Supply 986 The Alameda CY 4-7900
Schad Electronic Supply 256 W San Fernando CY 7-5858
Westinghouse Electric 292 Stockton Ave CY 5-3707

SAN LEANDRO
Millers Radio & TV Supply 1600 150 Ave BR 6-3214
Styles & Engleman 2255 Bancroft Ave LO 9-9433

SAN MATEO
Associated Radio Distributors 1701 Gum St FI 5-3575

SAN RAFAEL
Abbott Co E B 345 Francisco GL 3-1130

SANTA ANA
Graybar Electric 301 French St KI 3-8309
Hurley Electronics 1434 S Main KI 3-9237
Radio & TV 207 Oak KI 2-6741

SANTA BARBARA
Channel Radio Supply 523 Anacapa WO 2-3429
Gough Industries 404 State St Hdqrs Los Angeles

SANTA CLARA
Central Scientific Co 1040 Martin Ave AX 6-6650

SANTA MARIA
Dealers Wholesale Supply 310 W Main WA 5-7213

SANTA MONICA
Santa Monica Radio 117 Santa Monica EX 3-8231

SANTA ROSA
Santa Rosa Electro 1066 Santa Rosa Ave 7708

SOUTH GATE
Mac's Radio Supply 8320 Long Beach KI 4111

STOCKTON
DeJarnatt Whsle B J 515 N Hunter Hdqrs Fresno
•Dunlap Whsle Radio 27 N Grant HO 6-7907
General Electric Supply 24 N Aurora St HO 5-7231
Kemp Co E M 50 N Wilson Way HO 5-5976
Sacramento Elect Supply 710 E Main St HO 5-2691
•Stockton Electronics 710 E Main St HO 5-2691

VALLEJO
Associated Radio Distr 1927 Solano Ave VA 3-4531
Walker Co R Lyman 1401 Hiway 40 VA 3-5675

VAN NUYS
Tags Radio & TV Supply 14530 Calvert St ST 5-3123

VENTURA
Dealer's Whsle 265 S Laurel MI 3-6147

VERNON
Westinghouse Elec Supply 4601 S Boy L St KI 0141

WALNUT CREEK
Millers Radio 2497 Mt Diablo Blvd YE 4-8404

WEST LOS ANGELES
California Electronics 11801 W Pico BR 2-2126

## OREGON

EUGENE
•Carlson Hatton & Hay 96 E 10
Eoff Electric 556 N Charnelton St 5-4349
Gilbert Bros 424 Charnelton St hdqrs Portland
Graybar Electric 2180 6 Ave W EU 4-2224
•United Radio Supply 712 W 6 Ave 5-8547

KLAMATH FALLS
R F Supply 2367 S 6 St 6572

MEDFORD
General Electric Supply 121 W 4 St 3-2423
United Radio Supply 301 S Front 3-4003
•Walker Co V G 205 W Jackson 2-4558
Westinghouse Elec Supply Co 1233 Court St

PENDLETON
Harolds Radio Supply 320 SW Court Ave 1956

PORTLAND
Appliance Whole 600 N W 14 AT 6584
•Central Distrs 1131 NW Couch AT 0146
Connelly Co F B 905 NW 12th Ave CA 1755
Eoff Electric 509 NW 10 St CA 9411
General Electric Supply 300 NW 14 Ave BR 0651
Gilbert Bros 826 SW 2 Ave BR 5641
Graybar Electric Park & Flanders BR 6641
Home Makers Supply 824 S W 18 St CA 9385
H & R Radio Supply 5210 NE Sacramento TR 0057
Instrument Lab 1728 SW Harbor Dr CA 6863
Johnson Co Lou 1506 NW Irving
Marshall Wells 1420 NW Lovejoy BR 6421
North Pacific Supply 2025 NW Overton AT-9576
Northwest Radio Supply 110 SE 8 Ave FI-9787
Pacific Stationery 414 SW 2 CA 4221
•Portland Radio 1234 W Stark St AT 8647
Saelens Radio 1605 NW Everett AT 6395
•Stubbs Electric 33 NW Park Ave BR 5404
Television & Radio 720 SE Alder EA 1104
•Tracey & Co NW 10 & Glisan Sts BE 6263
•United Radio Supply 22 NW 9 Ave BE 6323
Westinghouse Elec 815 NW 12 Ave CA 9851

SALEM
Eoff Electric Co 156 N Front St 3-9251
Gilbert Bros 355 N High St Hdqrs Portland
Johnson Co Lou 1051 S Commercial 3-5955

## WASHINGTON

BELLINGHAM
Waitkus Supply 110 Grand Ave 274

BREMERTON
•C & G Radio Supply 1301 Pacific Ave 7-5515

ELLENSBURG
Geiger Radio W A 1101 Columbia 2-7701

EVERETT
•Pringle Radio Whole 2514 Colby Ave

KENNEWICK
Wible Radio Supply Inc 13 S Dayton Ave 3591

SEATTLE
Associated Industries 1752 Rainier St MI 4400
Central Electronic 2023 7th Ave
Coast Radio 110 University St MA 9133
Connelly Co F B 1015 Republican St SE 4155
Electronic Supply 5601 Calif Ave
Fidelity Electric 960 Republican St SE 5100
Garretson Radio Supply 2416 2 Ave MU 4380
General Elect Supply 1212 1 Ave S SE 6400
•General Radio 100 Wall St
Graybar Elec King & Occidental MU 0123
Instrument Lab 934 Elliott W AL 4940
Marshall-Wells 1258 1 SE 7447
Pacific Electronic Sales 1209 1st Ave MU 5877
•Radio Products Sales 1214 1st Ave MA 1035
Radio TV & Appl 500 Westlake Ave N MA 0787
Ratelco Inc 820 Minor N SE 7770
•Seattle Radio Supply 2117 2 Ave SE 2345
Stusser Electric 2246 1st Ave S SE 5285
•Western Electronic 717 Dexter Ave SE 3200
Westinghouse Elec 1051 1 Ave S EL 7001
Westlake Electronic 511 Westlake N MA 6601
Zerega Distr 515 Westlake N MU 2525
•Zobrist Co H E 2121 Westlake MU 2121

SPOKANE
Columbia Electric S 123 Wall St RI 3131
Connelly Co F B S 124 Wall St RI 6174
Frank's Radio Supply 161 S Adams St MA 8108
General Electric Supply E 1805 Trent Ave KE 0431
Graybar Electric 1033 W Gardner Ave EM 6611
Johnson Co E M W 615 1 Ave RI 5432
•Northwest Electr N 102 Monroe MA 9289
Prudential Distr 318 W Trent Ave MA 6002
Spokane Radio Supply 301 W 2 Ave RI 8441
Standard Sales 1219 W 1 Ave RI 7196
Taylor Distributing E 206 Augusta EM 3301
Westinghouse Elec N 1023 Monroe EM 3371

TACOMA
•C & G Radio Supply 2502 Jefferson Ave BR 3181
General Electric Supply 2316 A St BR 8454
Graybar Electric 2112 A St Ma 0164
Stewart Co A T 711 Broadway BR 3174
Westinghouse Elec 1930 Pacific BR 8417
•Wible Radio Supply 2360 S Fawcett St BR 8395

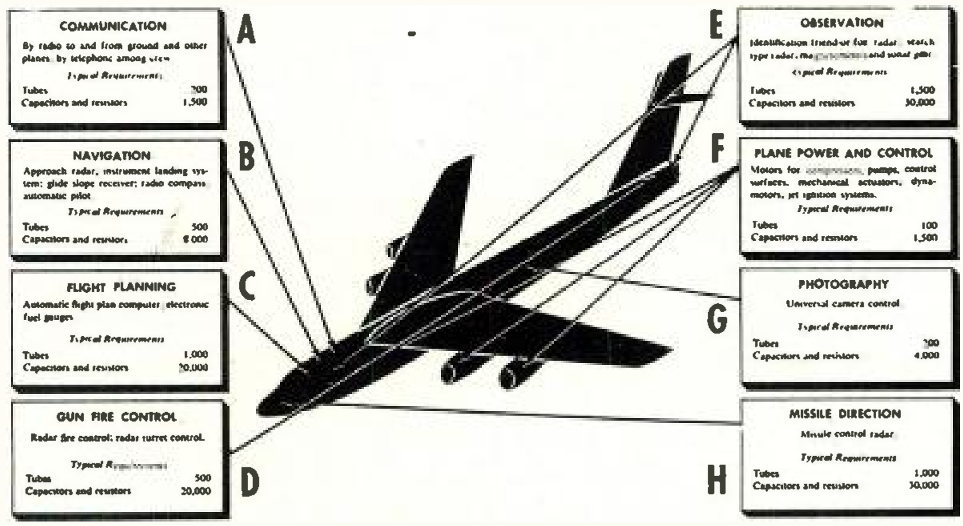
VANCOUVER
Saelens Radio 310 W 8 St 4-2671

WALLA WALLA
Kar Radio & Electric 12 & Pine Sts 4572

WENATCHEE
Mid-State Radio 611½ N Wenatchee Ave 510
Pringle Radio 417 King St

YAKIMA
Lay & Nord 112 S 2 St 3-5591
Westinghouse Elec 210 W B YA 3-4701
Yakima Wholesale Radio 506 S 1st 4670

## Aircraft Electronic Equipment



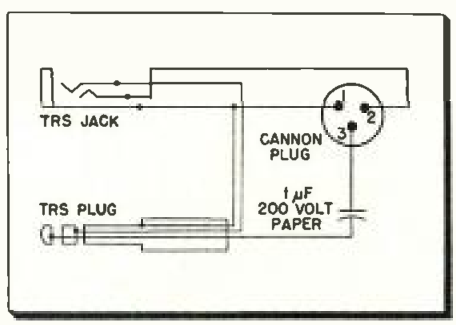

The above illustration was originally shown on page 3 of the June 1955 issue of Tele-Tech. Accompanying data should have mentioned the fact that this material was originally compiled by staff members of the Sprague Electric Co., North Adams, Mass. Eight categories of electronic equipment are shown against the outline of a generalized airplane. Component requirements vary with the class of aircraft. For example 600 tubes and 9000 capacitors and resistors for a fighter become 5000 tubes and 115,000 capacitors and resistors for a heavy bomber. Interference suppression filters range from 250 to 500

## Communication in TV

(*Continued from page* 116)

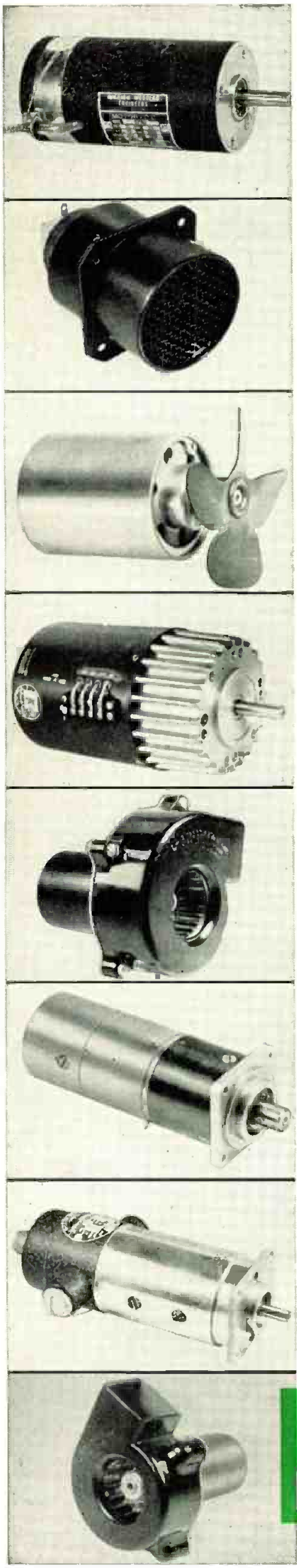
"stage," then, through "multi-boxes," distribute the circuits from that point.

The adaptor (Fig. 3) shows the Cannon plug which plugs into the amplifier, the TRS plug which plugs




into the switcher jack normally used for the technical director's headset and the TRS jack into which his headset is plugged for reinforcing his voice on the camera PL circuits. Used in this position, his voice is also boosted on the engineering PL line to master control. In using the amplifier and adaptor to adapt it to the two-wire circuits, the voice on the microphone of the headset plugged into the adaptor is the only voice reinforced. The regular dc communications power remains on to furnish battery to all other headsets in the circuit. The amplifier-adaptor combination may also be used at any of the camera positions to amplify the cameraman's voice if necessary.

Our PL amplifiers have been in use in the field for two years without a single failure or tube replacement, and their use is gradually being adopted by the studio.



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More than 50 basic motor designs, including axial and centrifugal blower designs, ranging from .001 to 2 HP, from 50 to 1,000 cycles, any voltage range, to fill virtually any specification. Please detail your requirements. Our engineers will make recommendations promptly. Write Executive Offices, Western Gear (Electro Products Division) P.O. Box 182 Lynwood, California.

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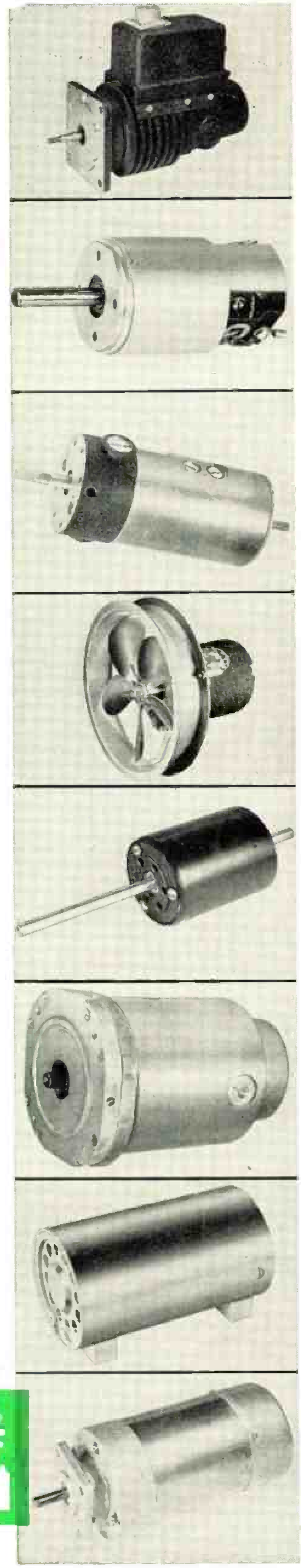




For product information, use inquiry card on last page.

# News of MANUFACTURERS' REPS

## REPS WANTED

Industrial and jobber sales on both film and composition resistors to cover southeast territory for midwestern manufacturer. Includes Georgia, Alabama, North and South Carolina and Tennessee. (R-8-1)

National Sales organization seeking representation in Minnesota, North Dakota, South Dakota and Western Wisconsin for line of crystal high fidelity phonograph cartridges. (R-8-2)

Reps wanted for precision line of electronic laboratory and television test equipment. Territories: Upper New York State; New England area; Chicago; Western States not including California, Oregon, Washington, Idaho and Montana. (R-8-3)

Electro-mechanical servo components line available for representation in Canada, all of midwest including Cleveland, Detroit, Chicago, St. Louis, Indianapolis, Dayton, all of Texas. (R-8-4)

Representation for a line of precision uhf and microwave test equipment available in the Pittsburgh area as well as in the states of Washington and Oregon, also Canada. (Ask for R-8-5)

Ohio, Texas, Florida, New England, Washington and Canada are territories offered by manufacturers of precision test equipment. (Ask for R-8-6)

---

**Neely Enterprises**, electronic manufacturers' representatives, have announced the appointment of General Manager **Robert L. Boniface** to the office of Vice President. The announcement was made by President **Norman B. Neely**, coincident with the transfer of the company's Los Angeles offices to the newly-constructed headquarters in North Hollywood, California. This building program was projected and completed under the supervision of Mr. Boniface.

"Bob" Boniface is a well-known figure in the electronics industry. His thorough knowledge of the electronic industry has been gained through fourteen years of practical, first-hand experience in sales and business administration with Neely enterprises.

**Leonard P. Blakely** and **Martin Silver** announce the formation of a new sales and engineering organization known as **L&M Associates**, located at 253 Boulevard, Hasbrouck Heights, New Jersey. The companies represented by the organization include **Adler Communications Laboratories**, New Rochelle, N. Y.; **McColpin-Christie Corp., Los Angeles**, Calif.; New **London Instrument Co.**, New London, Conn.; **Radio Frequency Laboratories, Inc.**, Boonton, N. J., and **Tel-Instrument Co.**, Carlstadt, N. J.

**Fairchild Recording Co.**, Whitestone, N.Y. announced the following new representatives: **William Engelbretson Co.** of St. Paul, Minn., covering Minnesota, North and South Dakota, Nebraska, Iowa and part of Wisconsin. **Ray Johnston** of Seattle, Wash. covering the Northwestern States, British Columbia and Alaska. **Loren F. Green & Associates** of Chicago, Ill. covering Illinois and part of Wisconsin and Indiana. **H. Roy Gray Ltd.** of Toronto, Canada covering all of Canada except British Columbia for Fairchild high fidelity items.

**Joseph Murphy** has been appointed manufacturers representative for the **Cambridge Thermionic Corp.** line of electronic components. He will represent C.T.C. in Indiana and Kentucky.

**The M. A. Stolaroff Co.**, 4622 West Slauson Ave., Los Angeles 43, Calif., was recently appointed as sales representative to handle the line of electronic components manufactured by the **Birtcher Corp., of Los Angeles.** Mr. Stolaroff will cover Southern Calif., Southern Nevada and Arizona.

**Joe Davidson and Associates**, South Gate, Calif., has been appointed as technical service representative for the **Norden-Ketay Corp.**, manufacturer of electronic and electro-mechanical components and instruments. The Davidson organization will render sales, engineering and technical services for all products produced by the **Precision Components Division** and sold in Calif., Arizona, Nevada and New Mexico.

**ElectroData Corp.**, digital computer manufacturer of Pasadena, Calif. has named the Ottawa firm of **Data Processing Associates Ltd.** as its sales and service representative in Canada.

**I. R. Stern** will handle the **Masco** line in Southern Calif., Arizona, and part of Nevada.

**Marshank Sales Co.**, celebrating their 35th year as sales representatives, announce their move to spacious new quarters at 7422 Melrose Ave., Los Angeles, Calif. **Karl F. Tidrow**, formerly Vice-Pres. of **Dow Radio, Inc.**, in Pasadena has been added to their inside industrial sales staff.

**James W. Eckersley**, 3510 S.W. Hamilton St., Portland, Oregon has been appointed sales representative in the Northwest, covering Wash., Idaho and Oregon, for **Alliance Mfg. Co.**, makers of radio-controlled garage door operators and the Alliance Tenna-Rotor. **G. J. Rodgers of Rodgers Associates**, 198 Old Farm Rd., Springfield, Mass., has been appointed as their sales rep in the New England area.

# New!

# ONE Watt


## Raytheon KTR-1000A TV Microwave Link

### A new addition to the proven KTR series†

The ultimate in simplicity and portability. Only 4 compact units per system.

- Uses stable, dependable one watt Klystron
- Reliable, low cost, powerful operation
- Frequency range—6875-7125 mc
- For STL, Remote, Intercity, Network interconnection
- Monochrome or Compatible Color with Audio Channel

Model KTR-1000E available soon for common carrier band.

† In use by leading TV stations throughout the U.S.A.—names on request.

**RAYTHEON MANUFACTURING COMPANY**

Equipment Marketing Division, Waltham 54, Mass.

RAYTHEON

*Excellence in Electronics*

# Delay Lines

(*Continued from page* 80)

readily analyzed. Pulse delay may be easily measured to within ±5%. Depending on the quality and stability of the test equipment, this accuracy may be extended to ±2%.

### *Sinusoidal Testing*

Fig. 6 illustrates a sinusoidal-test setup. A calibrated signal-generator is fed through a matching network to the input of a properly terminated delay line. A lissajou pattern is used to compare the phase relation between the input and output.

To compensate for phase shift introduced by the measuring oscillograph, a phase-equalizing network is normally required. This may be a delay line and may be adjusted to obtain zero-closure when the switch is thrown to the input position.

When the switch is returned to the output, the lissajou pattern will give an indication of phase shift introduced by the delay line. A measurement of the lowest frequency which effects an identical closure of the pattern yields the time delay for 360° of phase shift. Effectively, time delay equals the period of this frequency.

As frequency is increased, successive identical closures will be obtained. The periods of these closure-frequencies will correspond to submultiples of time delay. Phase linearity can then be determined, but the number of points that can be taken is limited by delay line response and over-all time delay.

Accuracy of phase-shift measurements is largely dependent upon the accuracy to which the frequency may be determined. Other factors also contribute to error; special precautions are required to insure:

1. Freedom from coupling between measured points.
2. Freedom from harmonic distortion.
3. Adequate resolution of the lissajou-closure reading.

A similar test setup employs high-frequency voltmeters at input and output in place of the oscillograph. Bandwidth is obtained by plotting the ratio of output to input voltage as frequency is varied.

Presented at the 1955 I.R.E. National Convention.

**References**

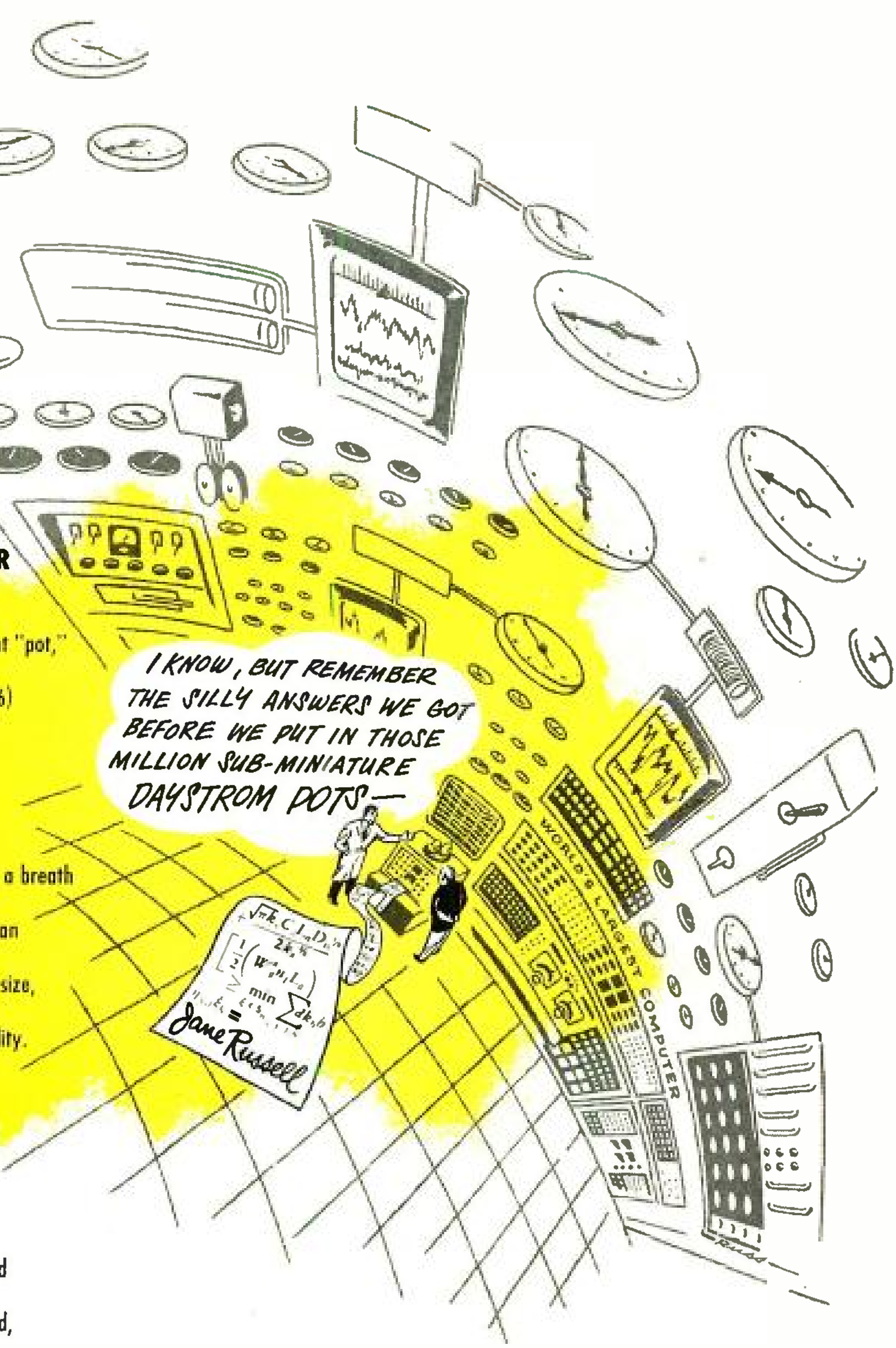
1. E. W. Kimbark, *Electrical Transmission of Power and Signals*," Wiley, 1949.
2. M. B. Kline, "Techniques in Pulse Measurements." *The Oscillographer*, Vol. 14, Nos. 2, 3.

## DAYSTROM POTENTIOMETER

If you are having trouble finding the right "pot," consider TINY TRIM Model 300-00 (TT3/16) or TINY TEN Model 341-00 (T-101/2).

Tiny Trim, a precision-built, wire-wound trimming potentiometer, weighs less than a breath of fresh air—is so small that 20 of them can be mounted in one cubic inch. Despite its size, it offers unexcelled resolution and reliability.

Tiny Ten, a precision-built, wire-wound, ten-turn potentiometer, offers full scale performance in a package ½ inch in diameter by 1 inch long. It is unexcelled for uses where size and weight are limited, but which require high performance.

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Write for complete information. Openings exist for highly qualified engineers.

# WEST COAST NEWS BRIEFS

**Allen B. Du Mont Labs., Inc.** is constructing a new West Coast electronics center in Los Angeles to handle the increased West Coast activity of the company. The new building will be located at 11800 West Olympic Blvd., and will contain approximately 30,000 sq. feet of floor area.

**California State Polytechnic** college's engineering department reached a milestone recently when **Herbert L. Leach** of South Gate received the one thousandth engineering degree to be given out since 1941.

**Dr. E. L. Michaels,** supervisor of the Advance Development Group of the **Packard-Bell Co.,** said recently that the public can expect a color television set by this fall that will be practical both as to cost and quality. Dr. Michaels bases his statements on the advances which have been made in overcoming the technical problems which have stood in the way of color TV.

**Dr. Lee A. DuBridge,** president of the **California Institute of Technology,** Pasadena, Calif., announced recently the four winners of **Howard Hughes Fellowships** in Science and Engineering, established for the training of outstanding research engineers and physicists. The awards went to: **Robert W. Hallwarth,** 24; **Arthur F. Messiter, Jr.,** 25; **Richard I. Tanaka,** 26, and **Norman J. Zabusky,** 26.

**Electronic Specialty Co.** of Los Angeles, Calif. has established a new Miniature Components Division to design and manufacture special capacitors and radio noise filters.

**Hoffman Electronics Corp.'s,** 3761 S. Hill St., Los Angeles, Calif., 1955 catalog was the only black and white winner in the fifth annual Lithographic Awards Competition in the catalog division. It placed third directly behind full-color catalogs on the Chrysler Imperial and the '55 Chevrolet.

**International Resistance Co.,** Phila., Pa., has purchased **EMEC, Inc.** of Seattle, Wash., manufacturers of magnetic clutches for electronic and electrical applications.

**Lenkurt Electric Co.,** San Carlos, Calif., has announced five new 24-channel frequency allocations are now available in Lenkurt 45BX channelizing equipment for radio and microwave communications systems. The new allocations permit up to 120 voice and signaling channels to be transmitted and received over a single wideband radio system. They are in the frequency range from 12 to 528 kc.

**Newark Electric Co.** of Chicago, Ill., has purchased **Acorn Radio and Electronics,** 4736 West Century Blvd., Inglewood, Calif. It will be operated as a wholly owned subsidiary under the name of **Newark Electric Company of California.**

**Packard-Bell Co.** has won the **Research Institute of America's** Key Member Award for Merit for its work in the field of employee relations.

**Philco Corp's** Government and Industrial Division has announced the removal of its West Coast and Pacific Northwest regional sales office to a new location at Suite 417, 1355 Market St., San Francisco, Calif.

**The Ramo-Wooldridge Corp.** of Los Angeles was recently involved in a $20,000,000 financial arrangement with its electronics and guided missile affiliate, **Thompson Products, Inc.** This was made available to them by Thompson Products to finance the continued rapid expansion of the firm, now employing nearly 1000.

**R-C Scientific Instrument Co., Inc.,** 307 Culver Blvd., Playa Del Rey, Calif. recently perfected a rapid, accurate, non-destructive method of testing evacuated or pressurized sealed containers.

**Resdel Engineering Corp.,** Los Angeles, Calif., recently moved into new quarters ten times its original plant capacity. **Henry K. Abajian,** president, announced that added emphasis on the production division necessitated the move to a 21,000 sq. ft. brick building at 330 S. Fair Oaks Ave., Pasadena, Calif.

**Servomechanisms, Inc.** recently moved their executive offices. The Eastern division is now located at Post and Stewart Avenues, Westbury, N. Y. and the Western division at 12500 Aviation Blvd., Hawthorne, Calif.

**Stanford Research Institute** has completed a preliminary design and cost study for a highly versatile test nuclear reactor it hopes to establish in Calif. Construction and operation on an industry-cooperative basis is contemplated.

**Sylvania Electric Products, Inc.** officials stated recently that the nation's use of electricity will double in the next 10 years, much of it due to increased electric power demands in the West, and that the West Coast would be in the forefront of atomic energy as an electric power source.

**The Gudeman Co.** of Calif. has moved their branch at 9200 Exposition Blvd., Los Angeles to new and larger quarters at 2661 S. Myrtle Ave., Monrovia, Calif., in line with the company's expansion program. The enlarged plant will be immediately adjoining the Dilectron division of the company.

**The Kaynar Company, Kaylock Division,** 820 E. 16th St., Los Angeles, Calif., is offering without charge to those who write in for it, a new drafting template, covering the full line of Kaylock miniature all metal, self-locking nuts.

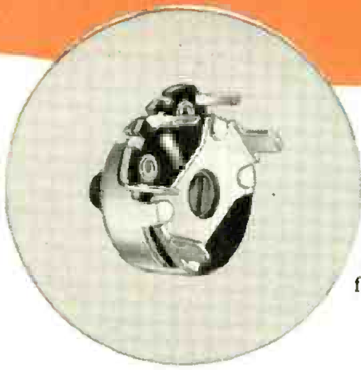
**The Northern California Audio Shows, Inc.** is holding their 3rd annual High Fidelity Audio Show at the Sheraton-Palace Hotel from Sept. 30 to Oct. 2. The exhibitors will be custom high fidelity component manufacturers, factory reps, hi-fi distributors, hi-fi shops, and record manufacturers. The general public is invited.

**Tomlinson I. Moseley,** president of **Dalmo Victor Co.,** San Carlos, a wholly-owned subsidiary of Textron American, Inc., recently announced plans for a new $1,200,000 building to bring under one roof all of the electronic firm's present facilities. The 180,000 sq. ft. plant will be constructed on 10 acres of company-owned land on Harbor Blvd. and Industrial Way, Belmont.

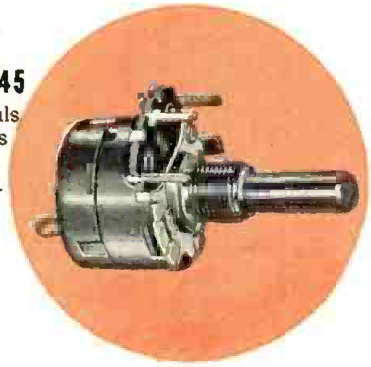
**Zero Mfg. Co.** of Burbank, Calif., manufacturers of deep drawn metal instrument cases, has ordered two new hydraulic presses, built to Zero's special design and specifications, from **Hydraulic Press and Engineering Co.** of Los Angeles, to keep pace with their current orders.

# FOR YOUR AUTOMATION PROGRAM

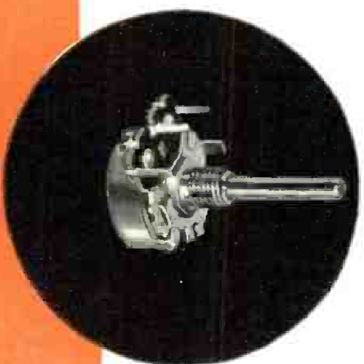
## VARIABLE RESISTORS FOR PRINTED CIRCUITS



**Type UPM-45**
For TV preset control applications. Control mounts directly on printed circuit panel with no shaft extension through panel. Recessed screwdriver slot in front of control and 3/8″ knurled shaft extension out back of control for finger adjustment. Terminals extend perpendicularly 7/32″ from control's mounting surface.

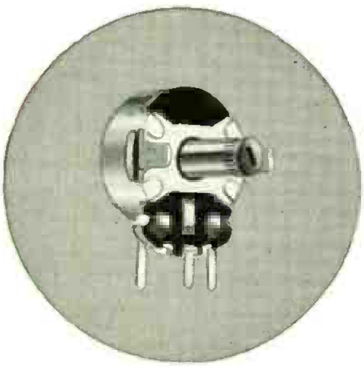


**Type GC-U45**
Threaded bushing mounting. Terminals extend perpendicularly 7/32″ from control's mounting surface. Available with or without associated switches.

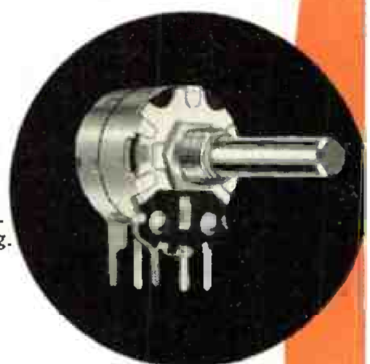


**Type U70 (Miniaturized)**
Threaded bushing mounting. Terminals extend perpendicularly 5/32″ from control's mounting surface.


**Type YGC-B45**
Self-supporting snap-in bracket mounted control. Shaft center spaced 29/32″ above printed circuit panel. Terminals extend 1-1/32″ from control center.

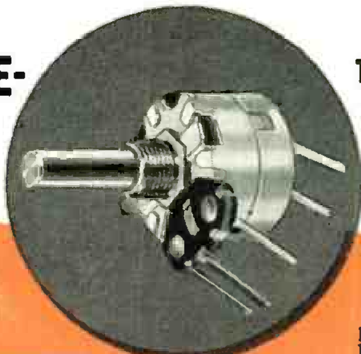


**Type XP-45**
For TV preset control applications. Control mounts on chassis or supporting bracket by twisting two ears. Available in numerous shaft lengths and types.



**Type XGC-45**
For applications using a mounting chassis to support printed circuit panel. Threaded bushing mounting.

## VARIABLE RESISTORS FOR SOLDERLESS "WIRE-WRAP" CONNECTIONS



**Type WGC-45**
Designed for solderless wire-wrapped connections with the use of present wire-wrapping tools. Available with or without switch and in single or dual construction.

The controls illustrated are typical constructions. CTS' years of engineering and technical experience makes available many other types for your automation needs.

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Burton browne advertising

# Transistor Amplifier

(*Continued from page* 75)

voltage gain. Strong shunting of the input by $R_s$, however, may cause the power gain to drop faster than the first power of the voltage gain. Nevertheless, the input resistance may be so much greater when $R_E$ is employed that many applications may become feasible that would not be practical with very low input impedances. Furthermore, the introduction of $R_E$ immediately banishes the problem of the input current being an exponential function of the input voltage. The input voltage is now applied across the series combination of the emitter-base diode and $R_E$ rather than directly across the input diode, thus the degenerative and resistive effects of $R_E$ cause the transistor currents to be practically perfect linear functions of the input voltage. Were $R_E$ not employed, it would be necessary to drive the input with a current (high impedance source) for undistorted signal transfer. While voltage feedback has been used around several stages (operational amplifier style), for local, stage-by-stage degeneration, current feedback ($R_E$) has been used exclusively. Voltage feedback lowers the input impedance, and voltage feedback does not simplify the equations in a natural obvious manner as does current feedback.[8]

In order to compare, crudely, the predictability of the performance of different amplifiers, operating points, and transistor types, it might be of value to compare the added emitter resistance to the denominator of the voltage gain expression, Eq. 2, and the external input shunt to the input impedance of the transistor. Thus the following design factors are suggested:

$$D_G \equiv \frac{r_e + r_b(1-\alpha) + (r_e + r_b)\dfrac{R_L}{r_e}}{R_E}, \quad (8)$$

and

$$D_Z \equiv \frac{R_s}{R_I} \cong \frac{R_s(1-\alpha)}{R_E}. \quad (9)$$

Where $D_G$ is defined as the voltage gain design factor and $D_Z$ is defined as the input impedance design factor. Obviously, from a predictability standpoint, the design factors should be made as small as is economical. The small-signal parameters in Eq. 8 and 9 are intended to be the nominal or average values for the particular transistor type employed at the anticipated normal operating point and temperature.

(*Continued on page* 165)

# *For the First Time...*

## High Frequency Circuits Can Be

# COMPLETELY TRANSISTORIZED


New small-size Philco SB Transistors are hermetically sealed and have universal applications for RF and Audio.

Today, Philco's new SB Transistor opens up a completely new field of commercial, industrial and military applications for the electronics design engineer. With vastly superior performance assured to 50mc and above, many basic circuits can now be *completely transistorized.* Video bandpass amplifiers, wide band low-pass amplifiers, high frequency oscillators and high speed switching are only a few of the innumerable circuits which the design engineer can produce quickly, easily, efficiently with the revolutionary new SB Transistor.

### UP TO 10 TIMES BATTERY LIFE

The Philco Surface Barrier Transistor operates efficiently with power consumption of less than *one* milliwatt! This extremely low power drain results in up to *ten* times the battery life obtainable with junction transistors, vastly reducing operating costs. Hermetically sealed, the SB Transistor has greater inherent characteristics of stability, longer life and higher efficiency than any other type of transistor.

### HIGHEST UNIFORMITY YET ATTAINED

Due to Philco's unique design and precision production methods, the SB Transistor reaches a degree of uniformity and unvarying quality never before achieved with transistors. This remarkable quality permits design engineers to specify the Philco SB Transistor with full assurance of superior performance.

**Now being produced in quantity this new Philco SB Transistor is available for your current projects and immediate shipment can be made to you.**

***For complete technical information on the PHILCO SB Transistor write Dept. TT***

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**GOVERNMENT AND INDUSTRIAL DIVISION • PHILADELPHIA 44, PENNSYLVANIA**

In Canada: Philco Corporation of Canada Limited, Don Mills, Ontario

## Frequency Measuring

(*Continued from page* 85)

so that one of its harmonics is equal to the frequency being measured, the difference frequency will be zero. The frequency being measured will then be equal to the frequency of the transfer oscillator times the number of the harmonic causing the beat. Since the approximate value of a frequency to be measured is usually known, the proper harmonic number will also usually be known. In any case the harmonic number can be found by a simple system described later.

### *Typical Zero Beats*

When the transfer oscillator is being tuned for a zero beat with the frequency to be measured, the first presentation obtained on the oscilloscope will be similar to Fig. 3. If the signal is stable, it will be possible to reduce the difference frequency to an actual zero beat as in Fig. 4.

It will be realized that typical high frequency signals generally have sufficient instability that an ideal zero beat will not be possible. In these cases a typical zero beat will be like that in Fig. 5, depending on the amount of instability or incidental frequency modulation contained in the signal. These patterns are those of typical zero beats as plotted by a 60-cycle sweep on the oscilloscope. A 60-cycle sweep is useful for the internal oscilloscope, because the instability and incidental frequency modulation are often related to the 60-cycle power line frequency.

The limits of deviation of frequency modulation can also be measured by adjusting the zero beat to occur at the limits of the f-m excursion. To make measurements of the excursion, it is convenient if the oscilloscope sweep can be phased with the excursion of the signal. The transfer oscillator oscilloscope is therefore provided with a phasing control as well as with a terminal for using an external sweep signal.

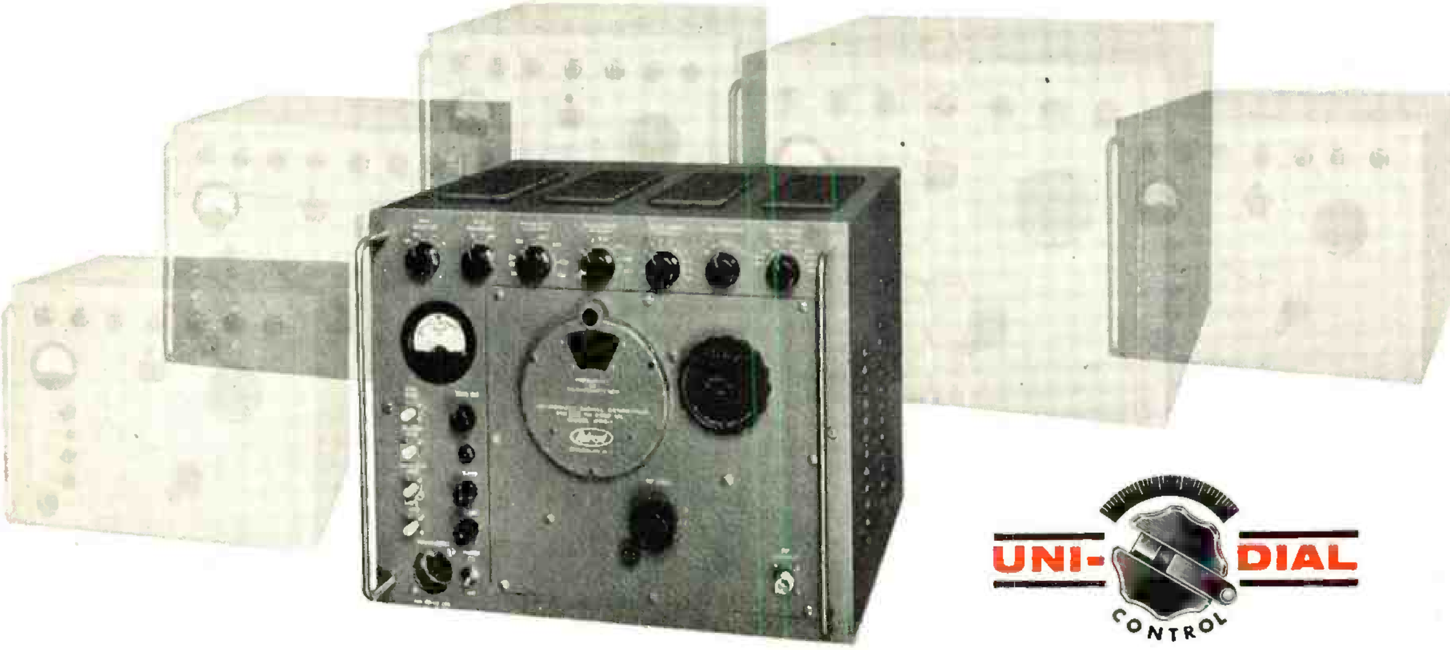
### *Accuracy*

As mentioned earlier, the accuracy of the system is comparable to the accuracy of other precision systems. In analyzing the system error, it will be found that this error can be divided into two parts. First is the error in ascertaining the frequency of the harmonic causing the beat. The error in this frequency determination will be the same, percentage-wise, as the error with which the fundamental of the transfer

(*Continued on page* 136)

# MICROWAVE SIGNAL GENERATORS

**950 to 11,500 mc**



UNI-DIAL CONTROL

## JUST ONE POLARAD MICROWAVE SIGNAL GENERATOR CAN MAKE ALL THESE MEASUREMENTS

- Receiver sensitivity
- Noise figure
- Signal to noise ratio
- Image rejection
- Beacon sensitivity
- Bandwidth
- Standing wave ratio
- Antenna gain and pattern
- Conversion gain or loss
- Attenuation
- Filter characteristics
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| Model # | Frequency Range |
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| MSG-1 | 950 - 2400 mc |
| MSG-2 | 2150 - 4600 mc |
| MSG-3 | 4450 - 8000 mc |
| MSG-4 | 6950 - 10,800 mc |
| MSG-4A | 6950 - 11,500 mc |

**Frequency accuracy:** ±1%

**Power output:**
MSG-1 & 2: 1 mw
MSG-3, 4 & 4A: 0.2 mw

**Attenuator range:** 120 db

**Attenuator Accuracy:** ± 2 db

**Output impedance:** 50 ohms nominal

**Internal pulse modulation:**
Pulse width: 0.5 to 10 microseconds
Delay: 3 to 300 microseconds
Rate: 40 to 4000 pps
Synchronization: internal or external, sine wave or pulse

**Internal FM:**
Type: Linear sawtooth
Rate: 40 to 4000 cps
Synchronization: Internal or external, sine wave or pulse
Frequency deviation:
MSG-1 & 2: ±2.5 mcs
MSG-3, 4 & 4A: ±6 mcs

**Internal square wave modulation:**
40 to 4000 pps

**External pulse modulation:**
Polarity: Positive or negative
Rate: 40 to 4000 pps
Pulse width: 0.5 to 2500 microseconds
Pulse separation (for multiple pulses): 1 to 2500 microseconds

**Output synchronizing pulses:**
Polarity: Positive, delayed & undelayed
Rate: 40 to 4000 pps
Voltage: Greater than 25 volts
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## Frequency Measuring

(*Continued from page* 134)

oscillator is known. This error amounts to ±1 part in $10^8$ using a suitable external standard or ±1 part in $10^6$ using the internal standard.

The second error is the error in comparing the transfer oscillator harmonic with the frequency being measured. This error is more difficult to specify precisely but is in the order of ±1 part in $10^7$. It involves to some extent the skill of the operator in adjusting the transfer oscillator for a zero beat. It also involves the short-time stability of the transfer oscillator and, of course, the stability of the signal. Fig. 6 shows the distribution of the error of comparison made in a large number of measurements on a very stable signal by five operators. To obtain only the error of comparison, a setup was used such that this error was the only error in the system.

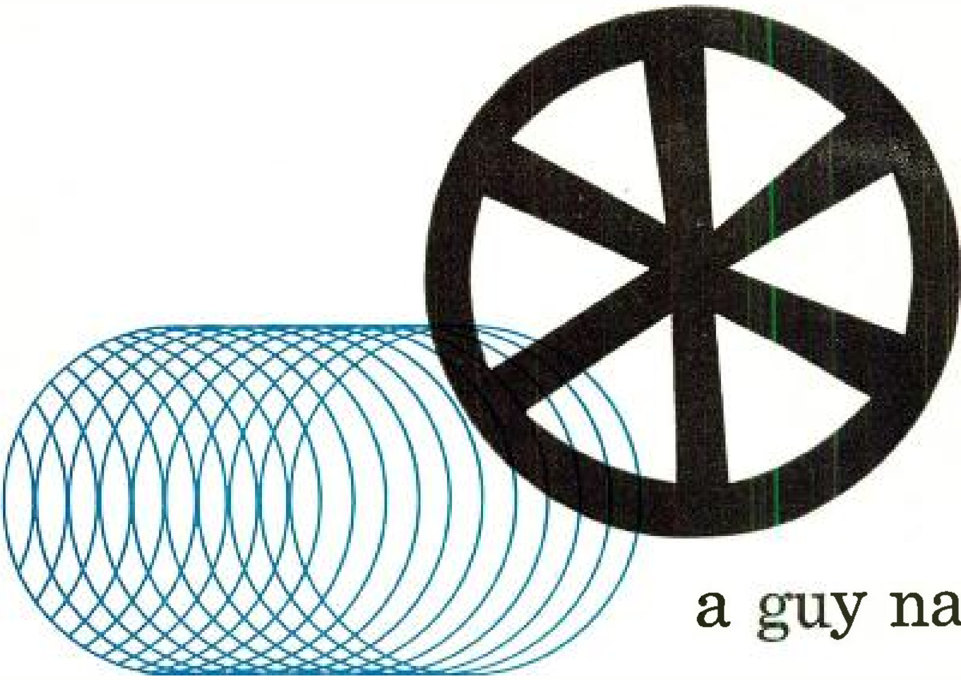
### *Modulation*

One of the advantages of the system in high frequency use is that it does not require that the signal being measured be at all times above a certain minimum amplitude. Momentary absence of the signal such as is obtained with 100% amplitude modulation or momentary excursion into the noise level does not prevent the measurement from being made.

A case of 100% amplitude modulation which is of special interest at higher frequencies is the case of pulse modulation. When r-f pulses are being measured, the difference frequency will be presented on the oscilloscope for the duration of the pulse but will not be presented during the off-time when there is no pulse. This situation makes it more convenient to use an oscilloscope with a linear rather than sinewave sweep, since the scope can be sync'd from the r-f pulse envelope.

When the carrier frequency of an r-f pulse is mixed with a harmonic of the transfer oscillator, oscilloscope presentations similar to those in Fig. 7 will be obtained when the difference frequency is low. When the difference frequency is reduced to its lowest value, the scope traces within the pulse envelope will be a family of curves all having the same shape as in Fig. 8. If the stability of the signal permits, the scope traces at an actual zero beat with a rectangular pulse will be a family of straight lines which have no slope. In practice, however, signals of such stability are not often encountered.

(*Continued on page* 138)



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## Frequency Measuring

(*Continued from page* 136)

In fact, it is rather typical that some frequency shift or incidental f-m of the signal source will occur during the pulse. This will be indicated by a waviness in the lines that comprise the family of curves. Such waviness can be used to obtain a qualitative indication of the amount of f-m occurring during the pulse.

### *Sawtooth Presentation*

While it is entirely practical to measure the frequency of pulsed carriers in the manner just described, there is a modification of the method that has been found to make the measurement faster with rectangular pulses. This modification consists merely of differentiating the difference frequency signal. Such differentiation will cause the pulse envelope viewed on the oscilloscope to appear as in Fig. 9. When the transfer oscillator has been adjusted for the lowest obtainable beat frequency and when the shortest time constant suitable for the pulse width has been selected, the pulse envelope will fully converge at the end of the pulse as shown in Fig. 10. The optimum time constant for differentiation thus becomes equal to about one-fourth the pulse width.

To facilitate differentiation, the lower cutoff frequency of the video amplifier in the transfer oscillator has been made adjustable over a wide range by a control brought out to the front panel.

The accuracy with which a pulsed r-f frequency can be measured using either the rectangular or sawtooth presentation is in the order of one one-hundredth of a cycle per pulse width. For example, the carrier frequency of a 2 μsec pulse can be measured to an accuracy of approximately 5 KC. For a carrier frequency of 5,000 MC this would amount to an error of only 1 ppm. Pulse width affects the accuracy of measurement for the reason that it affects the length of time that a sample of the difference frequency can be observed.

### *Extracting Information*

When making frequency measurements, it often becomes desirable to have available the short- and long-time information contained in the signal being measured. It may, for example, be valuable to record the slow drift occurring in the signal. It may be even more valuable to extract the incidental frequency modulation from the signal.

(*Continued on page* 140)

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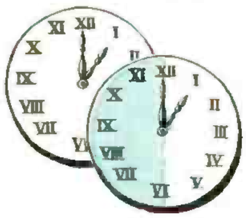

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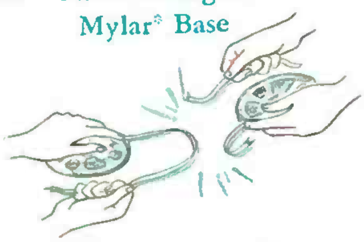

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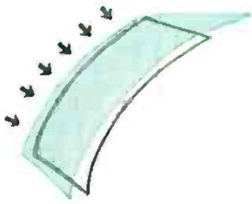

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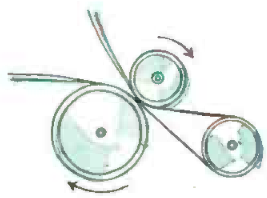

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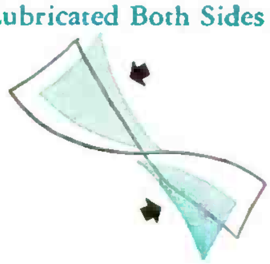

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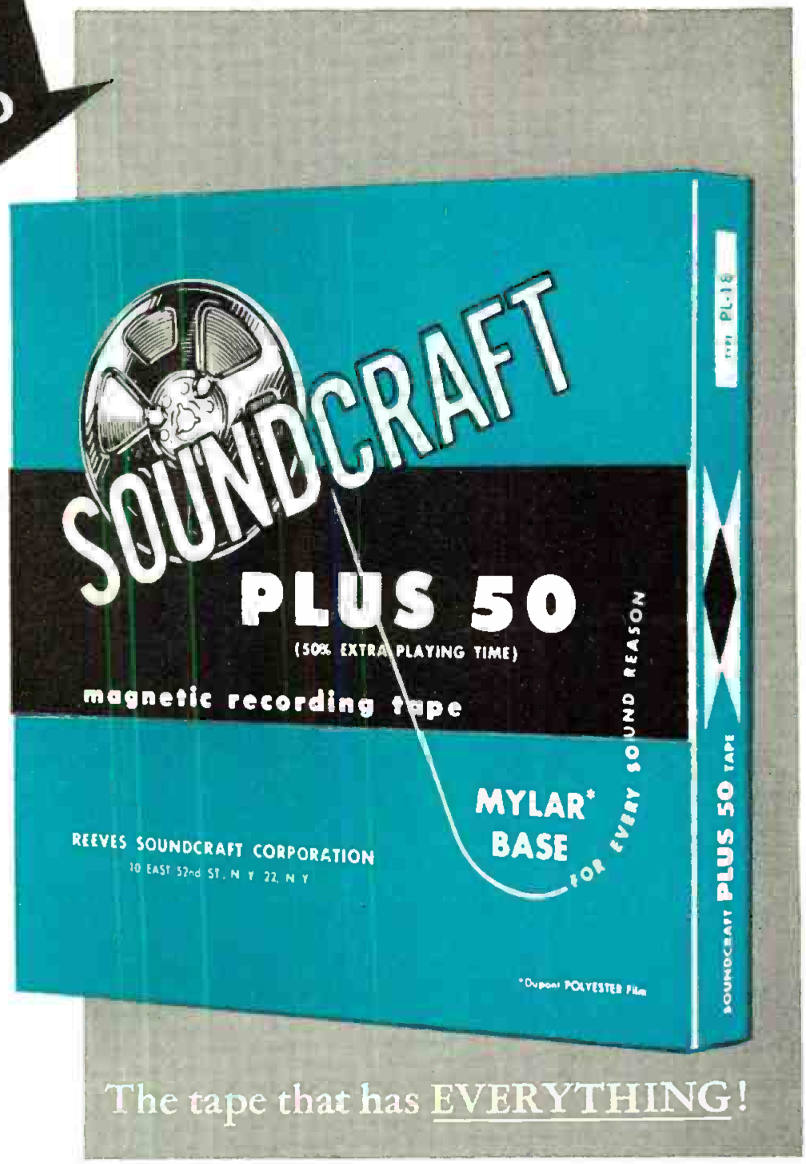


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## Frequency Measuring

(*Continued from page* 138)

Since both of these types of information are translated to the difference frequency produced in the transfer oscillator, they become available at carrier frequencies which are convenient to deal with. By suitably offsetting the transfer oscillator frequency, a difference frequency in the range from a few cycles to a few kilocycles is obtained which can be applied to a wide range frequency-to-current discriminator. The output of this discriminator can then be passed to a d-c recorder for permanent record purposes.

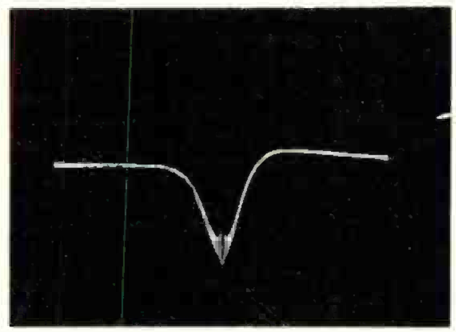

Fig. 11: Pattern when measuring wavemeter tuning. Transfer osc. birdie is at bottom of notch

Short-time information can be recovered by much the same arrangement. In this case a discriminator giving an output voltage proportional to instantaneous frequency must be used. Such discriminators are commercially available and, when used in this arrangement, will recover the short-time instability and frequency modulation originally introduced into the signal. By analyzing the recovered information with an audio-frequency harmonic wave analyzer, the relative magnitudes of the various modulation components can be compared. Such an arrangement has been used to analyze the modulation introduced into a portable high-frequency transmitter when subjected to mechanical vibration.

### *Other Applications*

A precision frequency-measuring system having the wide range and simplicity of the frequency counter-transfer oscillator system finds many uses in addition to straightforward measurements of frequency. By using the system to monitor a stable, tunable signal source, for example, the source becomes a generator of very accurately known frequencies.

The system is further valuable in measuring the frequency character-

(*Continued on page* 142)

## Frequency Measuring

(*Continued from page 140*)

istics of devices which themselves are not frequency generators. An example of this is checking the calibration of cavity type microwave wavemeters. If a reaction type wavemeter is fed from a swept-frequency source, it will cause a "notch" in the power level received at the output end of the wavemeter. If that output power is then applied to the transfer oscillator, a harmonic of the local oscillator can be adjusted to the center frequency of the wavemeter notch. By this means not only the accuracy of the wavemeter calibration but also the effect of temperature and mechanical tolerances can be checked. A typical presentation observed on an oscilloscope with the set-up is shown in Fig. 11.

### *Harmonic Numbers*

The harmonic that causes a given zero beat can be determined readily as demonstrated by the following example. If a frequency of 5,000 MC were being measured, a zero beat could be obtained with a harmonic of 200 MC. Assuming for the moment that the harmonic number were not known, the transfer oscillator would be tuned to the next lower frequency that caused a zero beat. This would occur at an oscillator frequency of 192.307 MC. At this frequency the harmonic number causing the beat is one greater than that causing the beat at 200 MC. It is thus possible to set up the expression

$$h_1 f_1 = (h_1 + 1)\ f_2$$

where $h_1$ is the harmonic at the higher frequency $f_1$, and $f_2$ is the lower frequency. This expression thus reduces to

$$h_1 = \frac{f_2}{f_1 - f_2}$$

or in this example

$$h_1 = 25.$$

The harmonic number can be cross-checked by making a measurement with the next lower harmonic which would occur for a fundamental frequency of 208.333 MC.

The minimum voltage level on which it is possible to make measurements with the transfer oscillator naturally increases with the frequency to be measured. In all cases, however, measurements can be made with commonly available levels. At 200 MC, measurements can typically be made with signal levels of approximately 200 µv. At 12,400 MC, the necessary signal level is approximately 100 mv.

## Reading Head

(*Continued from page* 100)

sections (Fig. 3). The reading head is mounted on one section and has a groove or track machined around the periphery in which the tape or wire rides. This section is easily removed, and other similar sections may be substituted for different sizes of tape or wire.

The section of the drum nearest the panel is fastened to the drive shaft and is not ordinarily removed. This section is cup-shaped with the open side toward the panel. A photoelectric cell is mounted on the panel, inside the cup-shaped section, close to the periphery of the drum. A small aperture in the drum wall makes it possible to focus an externally mounted lamp on the photocell when the drum is in the proper position.

Each time the hole in the drum wall passes the light source, the light strikes the photocell and causes a small output pulse from the cell. The pulse is applied to a cathode follower which in turn triggers the oscilloscope sweep. The aperture in the drum wall is so located that the trigger pulse occurs just before the reading head makes contact with the tape, so that the oscilloscope sweep always begins slightly before the first pulse is sensed by the head. It is this timing system that provides a steady picture of the repeated playback signals on the oscilloscope screen.

### *Slip Ring Assembly*

Since the reading head is mounted on a revolving drum, electrical connections must be made through slip rings and brushes. A specialized slip ring assembly using commercial brushes was designed and constructed for this purpose. The three rings are made of electrodeposited silver on a premachined bakelite cylinder; the silver is further machined for good contact surfaces. The cylinder is mounted between the drum and the driving motor, and a two-wire shielded cable runs from the slip rings through the shaft to the reading head.

On the front of the panel are four grooved studs that guide the tape as it enters and leaves the reels and the rotating drum. Rubber shoes pressing firmly against the studs prevent the tape from creeping while being scanned. Interchangeable studs are provided for different sizes of tape and wire.

Trials of the equipment in the laboratory prove its usefulness in locating tape flaws and in reading re-

(*Continued on page* 147)

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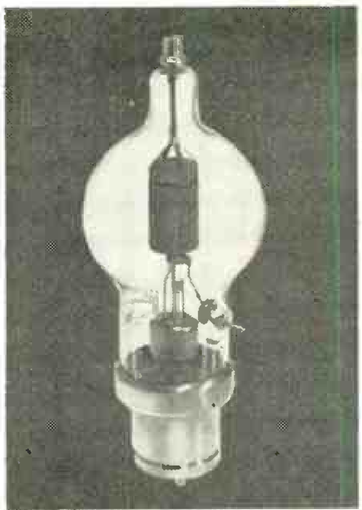

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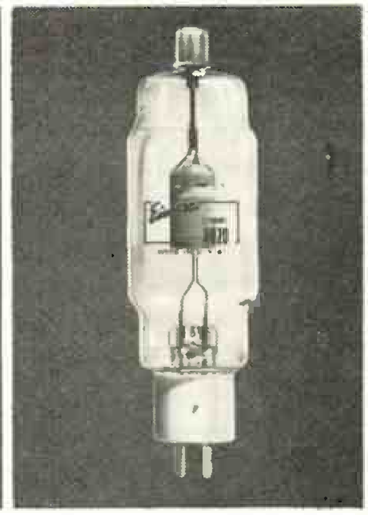

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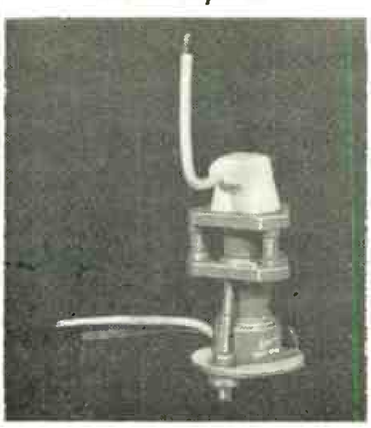
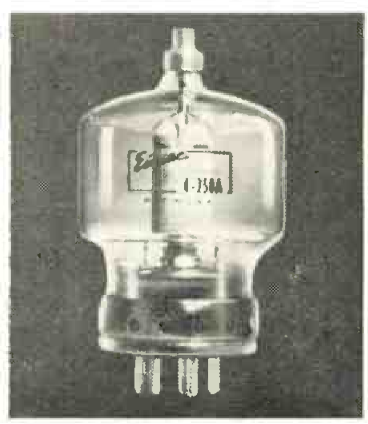


5kw Tetrode

250w Tetrode



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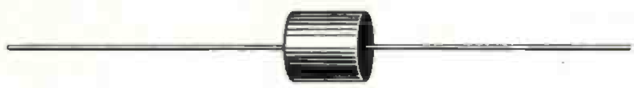

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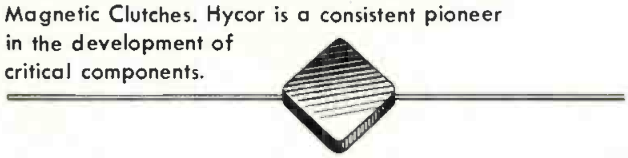

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# Reading Head

*(Continued from page 144)*

corded pulses. The playback signal on the oscilloscope screen shifts such a small amount that photographs taken with an exposure time of 15 sec. reveal no evidence of blurring. Moreover, there is no noticeable noise from the slip ring and brush assembly.

By expanding the oscilloscope sweep, it is possible to read a computer word simply by recognizing the value of each recorded digital pulse. The rotating head has been used in this way to compare information on a magnetic wire with the paper tape from which it was recorded. This method is used to determine whether the transcribing equipment is causing trouble or the wire is at fault.

Fig. 3: Reading heads, for tape (l), wire (r)

### *Direct Transcription*

In addition to being an effective and useful means of investigating magnetic recording phenomena, the rotating-head type of reader could also be used as a means for transcribing information directly from the keyboard to the magnetic tape. It would be most convenient to use a multichannel tape together with some provision for advancing it in short, precise steps. Each time a key on the keyboard is pressed, the corresponding character in coded form is set up in an electronic register. Then at a specific point of the rotating drum revolution, the contents are recorded on the tape in parallel form. On the next revolution of the drum, the character just recorded is compared with the character stored in the register. If the two agree, the tape advances a small distance, and the next key can be depressed to begin the next record-read-check cycle. If the two characters do not agree, the tape advance mechanism is locked out, an error indicator flashes, and the operator can either try to record again or find where the difficulty is. In this way, an operator could transcribe his problem directly from his manuscript to a magnetic tape, which then could be read directly into the computer.

## D-Amplifier

*(Continued from page 101)*

A(o)$w_{eff}$, the cutoff frequency $f_{eff} = w_{eff}/2\pi$ is determined by simple graphical integration (counting squar—es)[8]. ($K^1$ in Fig. 3 is identical with 1/K in eq. (5).

While the exact determination of $f_{eff}$ may be laborious, and is not always possible due to integration difficulties, the use of $f_{eff}$ in the laboratory is quite simple. Its value as a design factor stems from the fact that it is based on the transient slope, via the Fourier integral; in the general case determined by both absolute gain and phase characteristic of the amplifier. Full use of the bandwidth index $f_o^{IV}$ can only be made, however, if sufficient theoretical work is carried out as a backbone for the experimental work, and $f_o^{IV}$ is here included merely as a tool for relative comparison of different amplifier designs.

### *Modern Ladder Networks*

Again excepting transmission-line tubes from the discussion, we note that the ladder structure has progressed from simple constant-k sections to capacitively shunted m-derived sections, and other types of lattice sections, yielding a straightened-out differential time-delay characteristic and, for best pulse reproduction, a transmission characteristic following through the 3 db point the normal probability curve, known as the Gaussian curve. As the number of circuit elements per section have been increased, the possibilities for juggling values have also been increased, and thus the systematic network synthesis approach has become more appreciated in spite of its drawback of formidable computation work.[12]

It is well-known that the tube input grid conductance, increasing with the square of the frequency, may be utilized to turn an otherwise rising gain or transmission characteristic into a flat or properly falling curve; at least within a limited frequency interval. Improved results are possible, however, with Controlled Dissipation from artificially inserted resistors, and a first attempt might here be to insert small resistors in the grid and plate leads of each tube. With or without such added dissipative elements, a lattice network, or its corresponding bridge circuit, provides the best possible starting point, since it is basically an all-pass network. In our aim for better pulse amplifier performance, we must be prepared to give up some gain-bandwidth product. Thus, while both d-c gain and cutoff frequency may be reduced, a better amplifier for millimicrosecond pulses of small rise and decay times results. The principle of dissipation control has been described by Flood and Tillman[14], and practical design data contributed by Bassett and Kelly.[15] We will here discuss the Bassett-Kelly Network, Fig. 4, which has the dissipation element $aR_o/2m$ located in the shunt arm of a simple m-derived section, with $m > 1$. (Note that $L_k$ in Fig. 4 is expressed as $L_k/2$ in American standards; $2C_k$ as $C_k$.) For $a = 0$ the image impedance is resistive in the pass band, but for $a > 0$ we must match to complex image impedances. Accordingly we find ourselves forced to use lossy terminating sections, in which m has a different value, $m < 1$. (For example, inside the ladder networks $m = 1.3$, in the terminating sections $m = 0.6$.)

To give an idea of how D-amplifier sections such as the one shown in Fig. 4 may be treated analytically, we will demonstrate the principle by choosing the simplest case; $m = 1$ and $a = 0$, i.e. the constant-k section.[12] Cutting the grid line section along the line a-b, and doubling the shunt-impedance values, we provide a PI-terminated L-section, which can be treated as a potentiometer[16] so that the grid voltage directly obtains as (using American standards)

$$\mathbf{V}_g = \frac{V_1}{\sqrt{1-\eta^2}} \angle -\tan^{-1}\frac{\eta}{\sqrt{1-\eta^2}} \cdot \qquad (6)$$

Here $\eta$ is the frequency variable $\omega/\omega_c$, and $\omega_c$ the filter cutoff frequency (not the appreciably lower amplifier cutoff frequency). Proceeding to the section in the plate line, we apply the method of Ginzton, Hewlett, Jasberg and Noe,[3] and fold the circuit around the line c-d, obtaining $\mathbf{V}_2 = -R_o\,\mathbf{I}_p/2$ of the same phase angle as has $\mathbf{V}_g$. Since $\mathbf{I}_p = g_m\,\mathbf{V}_g$, the complex amplification of one amplifier section becomes

$$A(\eta) = -\frac{g_m R_o}{2\sqrt{1-\eta^2}} \angle -2\tan^{-1}\frac{\eta}{\sqrt{1-\eta^2}} \cdot \qquad (7)$$

The absolute value of this represents the transmission characteristic. The phase function (absorbing the — sign in front of $A(\eta)$ as $+\pi$) provides the plot of the phase characteristic. Its $\eta$— derivative yields the differential time delay curve,

(*Continued on page 175*)

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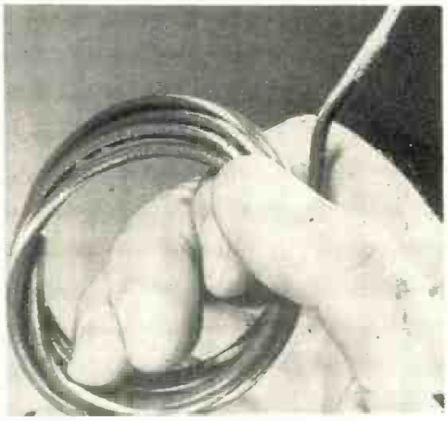

of one RG62/U. Their characteristic impedance is 98 ohms. Cellular polyethylene dielectric construction contributes to a velocity of propagation of 80%. A thin wall of nylon under the braid permits soldering both center conductor and braid. Temperature rating is −65° to +120°. Samples and specifications available at **Microdot, 1826 Fremont Ave., South Pasadena, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-23)

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milliseconds. Sealed beryllium-copper contact springs hold adjustment indefinitely. Shock rating is over 50 G's. Vibration resistance is 10-55 CPS at 0.12 in. max. excursion, and 55-500 CPS at 20 G's acceleration. Standard coil resistance, approx. 600 ohms for 28 v. dc. operation; 4,800 ohms available. The CR2791G210, a current sensitive model, 1,12 in. high, has 9,600 ohms, 3.2 ma. pickup current. **General Electric Co., Schenectady, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-26)

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This is a new refinement of the XT capacitor, featuring a method of integral mounting that withstands heavy shock and vibration. The capacitor has a threaded neck which fits through a keyed slot in the chassis. Also is supplied with a lock washer and hex nut to hold the unit securely in place. The


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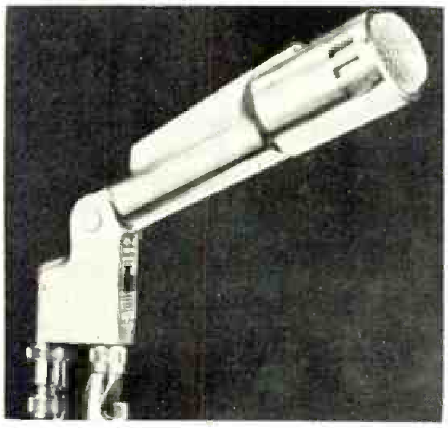
# Industries

## DYNAMIC MICROPHONE

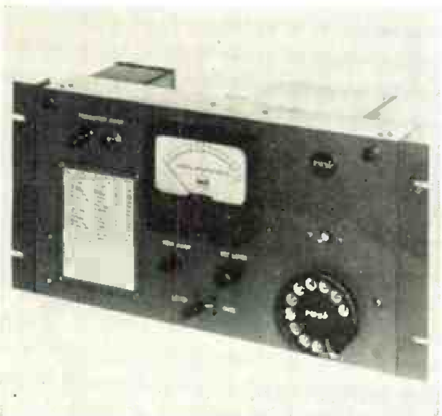
The Model 664 variable D cardioid dynamic microphone, for public address, recording, communications, etc., provides uniform cardioid polar pattern at all frequencies and response at



all frequencies from 60 to 13,000 CPS. Output level, 55 db, 150 ohm and high impedance. Impedance changed by moving one connection in connector. Shielded from dust and magnetic particles. Swivel enables aiming for most effective pickup. MC4M connector with 18 ft. cable. Size, 1⅞ in. diam., 7³⁄₁₆ in. long. **Electro-Voice, Inc., Buchanan, Mich.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 8-27)

## REMOTE CONTROL UNIT

Models 108-OD and 108-1D have been designed for use in directional and multi-transmitter installations where up to 24 control and metering functions are required. Complete in every respect, they are custom engineered to each station's specifications. Features include drop down panel construction,



no tubes, and the finest components. Consulting service and complete interconnecting diagrams are offered to assure proper installation. **Rust Industrial Co., Manchester, N. H.**—TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-28)

# Engineering Management In a Growing Laboratory

*Differences between small and large R and D organizations, problems encountered by the small lab as it grows.*

By R. E. SAMUELSON

R. E. Samuelson

■ Whenever a new Research and Development laboratory is first conceived, its founders hope for recognition and prosperity. If this comes to pass, the laboratory will certainly grow. If it continues to grow, it will some day get to be a big R and D laboratory; and at this point one has visions of a complex organizational structure, a highly systematized method of operation and vast rows of people at drawing boards, desks or laboratory benches.

At this point arise two questions: First, what sort of avoidable growing pains were involved in reaching the large laboratory status? Second, must the small organization undergo a complete metamorphosis through growth and lose its many desirable characteristics? The answers may be found in the case history of the Motorola Research Laboratory in Phoenix, founded early in 1949, with a small number of engineers and supporting people.

From a small beginning the laboratory has grown to a total population of around 800 people, of which about 175 are professional-grade engineers and scientists. It was decided at an early date to maintain the desirable features of a small organization throughout its growth and accordingly, the structure has been kept simple. The red tape has been held to a minimum.

As the size of the organization begins to grow, there is also the need for more predetermined procedures. In the large organization the problems of stock standardization, factory practices, and quality control make mandatory a well thought-out and detailed part numbering system.

### Structure

As the laboratory grows and it becomes necessary to departmentalize, there arises the necessity for a choice of what kinds of departments to create and how to split up and delegate responsibility. In the Motorola laboratory the organizational structure has purposely been kept simple. The director of the laboratory reports directly to the top management of the company in Chicago and the five departmental heads report directly to the director. The chief engineer, the heads of production, accounting, purchasing, and personnel also report to the director. The R and D activity is separated into project groups, each under a project leader chosen from the top engineers of the laboratory. The project leaders report directly to the chief engineer. To each project leader are assigned the requisite number of scientists, electrical and mechanical engineers, lab assistants, and design draftsmen, who work together in an assigned area throughout the job.

### Procedures

One of the most difficult, yet important management functions, is the foreseeing of necessary formalized procedures and selection and setting up of adequate ones. The number of miscellaneous special procedures should be kept to a minimum and reliance made on good judgment as much as possible. However, when a given problem becomes repetitive, its solution is best handled by a standard procedure. Most important, such procedures should be set up with a view towards their workability in case the organization should grow to many times its size. When a development is completed in the Phoenix laboratory and is ready to go into mass production in one of the Chicago plants, the transition takes place with a very minimum of confusion since all drawings, bills of material, and other engineering specifications are written in the same language and the same form.

When a person accustomed to working as part of a small organization does work with a large organization he is often amazed at the amount of interoffice memoranda, reports, and seemingly endless conferences, all of which he naturally labels as red tape, without stopping to think that two categories are represented here. Actually, one is red tape, but a good part of the items involved in it are communications made necessary by the requirement that members of a large team must know what the other members are doing and plan to do.

As the complexity of the communication problem is reduced, the important items become easier to recognize. It is then possible to sort out the purely red tape items and eliminate them by strong management action.

In conclusion, let it be said that the problems of a growing laboratory, organizational complexity, standardization of procedures, and internal communications, can be minimized through vigorous and forward-looking management action.


*R. E. SAMUELSON is Chief Engineer of the Phoenix Research Laboratory, Motorola Inc.*

## Magnetic Amplifier

*(Continued from page 91)*

power, but rather by requiring a minimum amount of input power for full control of its output. The window area of the cores in the first stage is essentially filled with control winding copper. A large number of turns is wound in the control windings to increase amplifier sensitivity and to keep the current and power required from the thermocouple to low values. The open-loop input circuit resistance is matched to the resistance of the thermocouple for a maximum transfer of power. Because of this matched condition of the input circuit, the wire size and number of turns in the control windings are determined by the resistance of the thermocouple.

The first stage output circuit is operated at a relatively low supply

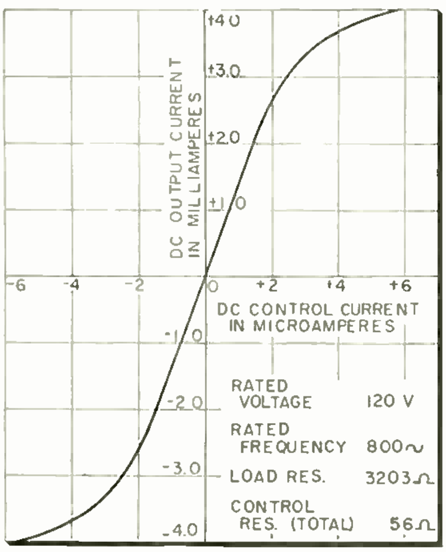


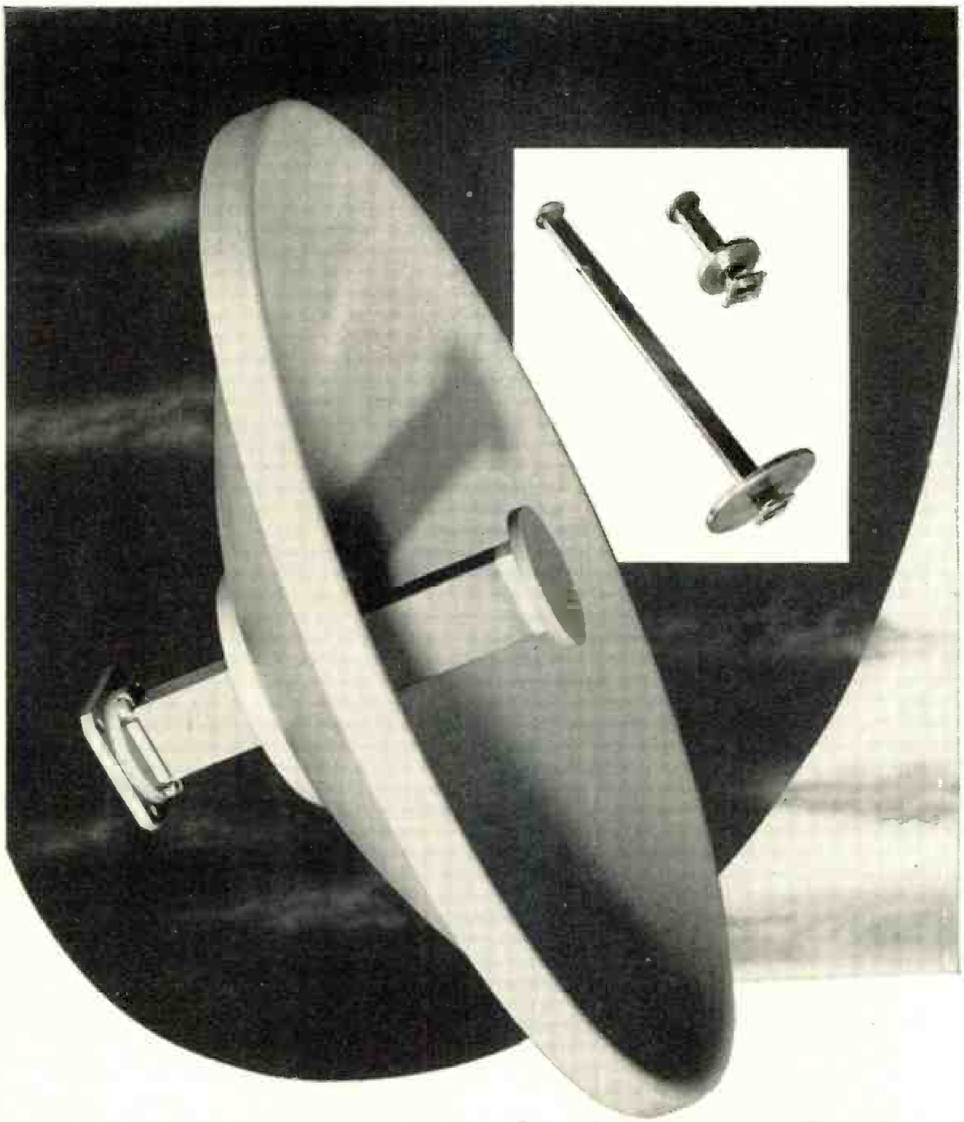

**Fig. 6: Open-loop characteristic curve**

voltage, and the load winding contains only enough turns of a small wire size to support this voltage.

The detrimental effects of rectifier leakage currents are minimized because the operating voltage is well below the inverse voltage rating of the rectifiers. Any leakage current that might occur flows through a relatively few load turns, and no appreciable leakage mmf is produced in the core to effect a change in gain. The power output from the first stage is made low because it is only necessary to provide sufficient power to drive the second stage over its full output range and force its response. The second stage, however, is operated at a higher voltage because it supplies the output power to the load circuit.

The negative feedback voltage is

*(Continued on page 154)*





## Magnetic Amplifier

(*Continued from page* 153)

obtained from the load circuit of the second stage which is essentially resistive. The basic gain of the two stages combined is sufficiently high to permit the application of a large amount of negative voltage feedback around both stages without decreasing the over-all amplifier sensitivity below that of the thermocouple requirements. The negative feedback voltage produces the following desirable results: over-all amplifier stability is increased; amplifier linearity matches the linear thermocouple characteristic; over-all response time is reduced; and the input impedance is increased to a value which is many times higher than the ohmic resistance of the input circuit. A high input impedance is desirable for a thermocouple amplifier because it makes the amplifier essentially a voltage-sensitive device whose gain is independent of the changes in thermocouple resistance. It also limits the current drain from the thermocouple to a low value and minimizes the voltage drop in the leads. As a result, a larger signal voltage is obtained at the amplifier input.

### Zero Drift

High gain and negative voltage feedback are effective in maintaining a stable over-all gain characteristic, but the problem of zero stability is that of maintaining a well-balanced amplifier for all conditions of operation. Both high gain and high input impedance are effective in the sense that a given drift in the output current is reflected as a small amount of input power to restore the output current to zero. The amount of output drift, however, is determined by the degree of unbalance in the amplifier. The precautions taken to insure low zero drift were to carefully select and match both core and rectifier characteristics. The cores are made of a temperature stable core material and are matched for gain and bias characteristics with a dynamic core tester[4]. Each pair of cores is individually biased to offset any mismatch that might exist (Fig. 4.) Rectifiers with stable characteristics and negligible leakage are used. They are matched so that any changes that occur produce equal changes in the load currents of the individual amplifiers which cancel in the common load. Thus, a balanced amplifier is maintained. The resistors used in the circuit are wire wound and are derated to insure a high degree of stability.

### *Amplifier Response*

The LaPlace transform for the system is given by eq. 1. By letting $T_1 = rT_2$, $\delta$, the damping coefficient is:

$$\delta = \frac{1 + r}{2\sqrt{r(1 + \beta K_1 K_2)}}$$

and $\omega_o$, the undamped natural frequency is:

$$\omega_o = \frac{1}{T_2}\sqrt{\frac{1 + \beta K_1 K_2}{r}}$$

the output response to a step input voltage $K_3$ is:

$$E_o(s) = \frac{K_1 K_2 K_3}{rT_2^2} \times \frac{1}{s(s^2 + 2\delta\omega_o s + \omega_o^2)} \quad (3)$$

This is a second order equation, and the type of response depends on the amount of damping in the system. Critical damping for a high-gain system with a large feedback ratio is obtained with a ratio, r, of approximately 200. Most thermocouple applications, however, do not require a critically damped response because thermocouple time constants are of the order of seconds and are not likely to produce step changes of voltage. An amplifier with an under-damped response whose total response time is faster than the thermocouple will faithfully follow the slowly varying signals from the thermocouple.

### *Amplifier Design*

The schematic circuit diagram for the low-level amplifier is shown in Fig. 4. The circuit is a balanced self-saturating, push-pull, full-wave bridge circuit. Cores for both stages are of Supermalloy core material and have the same iron cross section area. The first-stage cores, however, have a larger mean diameter than the second-stage cores to accommodate the control windings necessary for the desired sensitivity. The ratio of control winding copper to load winding copper is 6.10:1 for the first stage and 0.46:1 for the second stage. The second stage operates at a higher input signal level and does not require as high a ratio. Because it supplies the output power to the load circuit, the load winding is designed for this operation and occupies most of the available winding area of the core.

High-quality selenium rectifiers

(*Continued on page* 156)



 For product information, use inquiry card on last page. 

## Magnetic Amplifier

(*Continued from page* 155)

are used for both stages. One cell per leg permits operation with negligible rectifier leakage effects in the first stage, but because of the higher operating voltage, two cells per leg are used in the second stage. A full-wave selenium bridge rectifier connected to the supply voltage supplies the dc bias voltages. A step-down transformer supplies the low operating voltages for both the first and second stages.

Resistive mixing is used in the amplifier and the mixing resistors are $RM_1$ and $RM_2$, respectively. The resistors are selected to produce maximum amplifier stability. The first-stage load resistor $RL_1$, a large resistance, is connected directly in series with the control circuit of the second stage. The power output from the first stage drives the second stage and forces a fast response. The negative feedback voltage is developed across a 3-ohm resistor in the output circuit and is connected in series with the thermocouple voltage at the input circuit. Total resistance in the output circuit is 3203 ohms. The load consists of an indicating meter and the control circuits of the relay amplifiers. Automatic cold junction compensation and temperature biasing circuits may be added to the thermocouple amplifier without affecting its operation. The compensating voltages are applied across the control circuit resistor $R_c$. A reference device is needed to provide a reference temperature when these circuits are used.

### Performance

A numerical tabulation of amplifier characteristics is presented in Table I. The characteristics are derived for a particular thermocouple application and do not represent limiting conditions for the amplifier.

The amplifier exhibits an extremely linear relationship between output current and input voltage as shown by the characteristic transfer curve on Fig. 5. This curve defines the amplifier's operation for rated conditions and was obtained from the open-loop characteristic curve (Fig. 6) by the application of negative voltage feedback around both stages of the amplifier. The feedback ratio, $\beta$, is $0.938 \times 10^{-3}$, and the measured open-loop voltage gain $K_1K_2$ is 71,000. The product $\beta K_1K_2$ is 66.6, and the closed loop voltage gain $1/\beta$ is 1065 (Eq. 2). The actual measured closed-loop voltage gain is 1045 which is very nearly equal to the computed gain.

Varying conditions of voltage, frequency, and ambient temperature tend to change the amplifier's characteristic curve, and the magnitude of the changes is indicative of the amplifier's stability Quantities that infer stability are sensitivity, linearity, zero drift, and accuracy.

Sensitivity—is the average slope of the characteristic curve. The slope of the curve represents a

**TABLE 1**

**Thermocouple Amplifier Operating Characteristics**

| | |
|---|---|
| Current Gain | 1240 |
| Voltage Gain | 1045 |
| Power Gain | $1.30 \times 10^6$ |
| Input Control Power | $22.2 \times 10^{-9}$ watts |
| Input Impedance | 3660 ohms |
| Output Power | $28.8 \times 10^{-3}$ watts |
| Load Resistance | 3203 ohms |
| Zero Drift (Referred to Input) | $2.6 \times 10^{-12}$ watts |
| Linearity | 1.67% |
| Accuracy | 0.70% |
| Response Time (Step Input) | 0.10 secs. |
| Open-Loop Voltage Gain | 71,000 |
| Open-Loop Power Gain | $8.7 \times 10^7$ |

change in the output current of 0·328 ma. for a change of 1 mv. of the signal voltage. A maximum variation of —1.75% of the nominal value was observed for the varying conditions specified.

Linearity—is the amount of deviation of the control curve from a straight line. The maximum deviation in output current is 1.67% of the rated current of 3.0 ma.

Zero drift—is a measure of the lateral shift of the curve and is evaluated in terms of input control power. It is computed from the input voltage necessary to restore the output current to zero and the input impedance. The zero drift level at room temperature for specified voltage and frequency variations is $0{\cdot}33 \times 10^{-13}$ watts referred to the input. Total zero drift for all conditions is $2.6 \times 10^{-12}$ watts referred to the input.

Accuracy—describes the change in the input voltage to maintain a constant output current. The accuracy over a limited ambient temperature range (+30°C to +70°C) is 0·17% of the total input signal voltage. Over-all accuracy for all conditions specified is 0.70%.

The amplifier delivers 28.8 milliwatts of output power to the load circuit. Input power from the thermocouple necessary to control the output is $22.2 \times 10^{-9}$ watts, and the over-all closed-loop power gain is $1.3 \times 10^6$. The total open-loop power

(*Continued on page 159*)

# one suggestion from an Electronic Chief

*. . . and ten little indians buy the electronic products he specifies*

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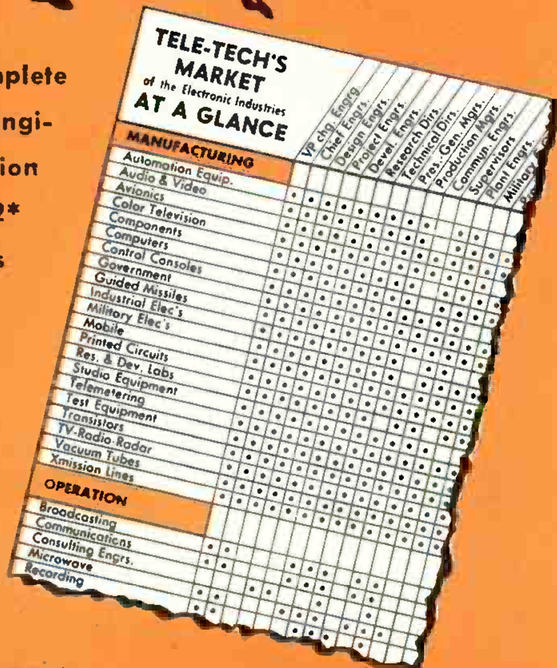


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# Magnetic Amplifier

(*Continued from page* 157)

gain is 8.78 x $10^7$; individual power gains are 11,800 for the first stage and 7,480 for the second stage. The approximate time constants are 1.50 sec. and 8 millisecs, respectively, for the first and second stages. A time constant ratio (r) of approximately 268 produces unity damping factor when the $\beta K_1K_2$ product is 66.6 (Eq. 3). The ratio for the thermocouple amplifier is 187 which produces an under-damped response; however, critical damping is obtained by connecting a 6.0 μf condenser across the output circuit as shown in Fig. 4. The response is critically damped with a total response time of 0.10 secs.

### *Physical Description*

The amplifier is packaged as a single hermetically sealed unit, and contains the components within the dotted lines of Fig. 4. An epoxy resin protects the components mechanically and increases the intercomponent insulation. The unit resists corrosive atmospheres and will withstand the shock and vibration requirements specified for most military applications. The over-all dimensions of the packaged unit are 3½ x 4 x 4 in. and the weight is 3 lbs.

Connections are made to a terminal header located at the bottom of the unit. The header also contains test terminals that facilitate balancing and calibrating the amplifier. Four mounting studs permit the unit to be flush mounted to a chassis or panel.

### *Additional Applications*

The amplifier was developed for a thermocouple application that uses an Iron-Constantan thermocouple. The amplifier provides temperature indication and alarm signals over a temperature range of 330° C for this thermocouple, but other types of thermocouples may also be used. If a platinum-rhodium thermocouple

(*Continued on page* 160)

## *Sylvania Installs "Shadowless-Lighting"*

Special "shadowless-lighting" fixtures and techniques designed to reduce plant production costs at the assembly line have been developed and installed at Sylvania's new giant-sized TV manufacturing plant recently completed at Batavia, N. Y. it was announced by T. G. Hearn of Sylvania Electric Products Inc.

## Magnetic Amplifier

(*Continued from page* 159)

is used, the amplifier provides temperature indication and control over a temperature range of 1700°C.

In addition to thermocouple applications, the amplifier is well suited for many other low-level applications. In the field of spectrophotometry the amplifier may be used to maintain the output of a light source at a constant intensity. An intensity of 0.8 ft.-candle will control the amplifier's output over its full range when a selenium type barrier-layer cell is used in the input circuit. The intensity of a light source can be regulated to within 0.7% of this range or 0.006 ft.-candle. The amplifier is particularly well suited for static strain measurements; however, the inherent time lag places a limitation on the frequency response for dynamic strain measurements. The amplifier can also be used in servo systems where the time constant is not objectionable. In general, the amplifier may be applied to any low-level application where a high degree of stability, sensitivity, and accuracy with a relatively fast response is required.

(This paper was presented at the 10th National Electronics Conference, 1954.)

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2. L. W. Buechler, "Low Input-Power Level Magnetic Amplifier", *Proc. N.E.C.*, Vol. 7, pp. 254-259; 1951.
3. H. Chestnut and R. W. Mayer, "*Servomechanisms and Regulating System Design*," Vol. 1, 3rd printing, John Wiley & Sons, Inc., New York, New York, p. 207; 1952.
4. R. W. Roberts, "*Magnetic Characteristics Pertinent to the Operation of Cores in Self-Saturating Magnetic Amplifiers*," Conference paper presented at the Winter General Meeting of the AIEE, New York, New York; 1954.

## *Single Head Automatic Assembly Machine*

The Minnesota Engineering Company, Minneapolis, Minn., has disclosed the development of a single head, multi-purpose, automatic assembly machine for electronic production. It is marketed under the trade name, "Minn-A-Matic."

The base for this type of assembly is the printed wire board. Boards ranging in size from 1" by 1" to 12" by 17", and up to ¼" in thickness may be accommodated. Boards are run vertically rather than horizontally through the machine. Boards may be inserted in two ways.

# Transceiver

(*Continued from page* 95)

The simplified mechanical arrangement shown in Fig. 2 permits the entire transmitter-receiver to be inserted or removed from its aircraft mounting base for service or normal maintenance in approximately 10 to 15 secs. It is only necessary to unsnap the two fasteners. It is not necessary to disconnect any electrical plugs. All electrical connections including the antenna are made through the two printed circuit connectors shown in Fig. 2 at the left.

The unit is designed to operate without a shockmount. However, longer life from the tubes may be expected if a vibration isolator is employed.

Particular attention was paid to the problem of removing the heat from the 5702 WA subminiature tubes. These tubes are mounted with special right angle subminiature printed circuit tube sockets, permitting the tubes to lay close to the copper etched circuit card. Aside from the obvious advantage of reducing the thickness of the package, this allowed the use of special heat radiating and conducting tube shields. These can be seen in Fig. 3. The etched card serves the function of a heat sink.

### *Electrical Characteristics*

The receiver is shown in Figs. 2 and 3. Basically the receiver is a single channel crystal controlled superheterodyne operating at a frequency of 121.5 MC. A type 5702 WA (VT1) is provided as a radio frequency amplifier. The impedance of the tuned circuit connecting to this amplifier is 50 ohms. The crystal controlled local oscillator is also a type 5702 WA (VT2). The control grid and screen grid are used to provide a 3rd overtone oscillator operating at 33.05 MC. The frequency accuracy of the CR51 crystal employed is ±.01%. This establishes the calibra-

**Fig. 6: Complete assembly of transmitter, receiver and power supply in metal housing**

(*Continued on page* 162)

## Transceiver

*(Continued from page 160)*

tion accuracy of the receiver.

This frequency is doubled to 66.10 MC in the plate circuit of this tube. Second harmonic injection is introduced into the control grid of the 5702 WA (VT2) mixer tube. High side injection is used resulting in an image frequency of 142.90 MC. This frequency is very seldom occupied and is used only by relatively low powered transmitters. If low side injection had been used, the image frequency would be 100.10 MC. This is near the center of the FM broadcast band. The RF image rejection ratio of the receiver is better than 55 db. The RF circuits can be tuned to any frequency between 118 and 130 MC.

The output of the mixer VT2 feeds the 10.7 MC intermediate frequency amplifier. This amplifier has 3 stages of amplification employing type 5702 WA tubes. These are VT4, VT5, and VT6. Four double tuned IF transformers are used to provide interstage coupling. Stage gains are approximately 30 db.

To obtain an efficient IF transformer in a relatively small package, the design shown in Fig. 5 was developed. Toroids were used to obtain a "Q" of 140 in a very small metal housing. The actual Q of the IF assembly was reduced with resistive loading to provide greater stability. Without the resistive loading, the IF amplifier had a bandpass characteristic of 20 KC at 6 db and 110 KC at 60 db. The sum of all the maximum frequency errors that could exist in the overall system (ground transmitter and airborne receiver) dictated widening the pass band.

**Fig. 7: Transmitter and power supply sections**

The selectivity provided by the final design is 55 KC at 6 db and 250 KC at 60 db, giving a shape factor of 4.54. AVC voltage is obtained from a type 1N217 silicon diode, CR4. An AVC delay voltage of approximately 9 v. is used to provide a relatively flat AVC characteristic. AVC control voltage is applied to the RF amplifier VT1 and to the first two IF amplifiers VT4 and VT5. The AVC characteristic shows only a 3 db rise in audio output when the input voltage at the antenna is varied from 10 to 100,000 microvolts.

The second detector is a type 1N217 silicon diode, CR1. To minimize interference from electrical devices such as electric motors, ignition noise, etc. two type 1N217 silicon diodes, CR2 and CR3, are employed in a very effective series/shunt automatic noise limiter circuit. The audio output from the ANL is amplified by a 5702 WA (VT7). Note that only one type of vacuum tube has been used in the entire receiver up to this point.

Two of the 5686 tubes, VT103 and VT104, shown on the transmitter card in Fig. 1, serve the dual function of modulator tubes for the transmitter and audio power output tubes for the receiver. During the receive cycle these tubes are operated at 125 volts plate voltage. The plate of the audio amplifier VT7 is transformer coupled to the grids of power amplifier tubes, VT103 and VT104, through the dual purpose transformer, T102. This transformer also couples the microphone to the modulator tubes during the transmit duty cycle.

The maximum audio power output from the receiver is 1.0 w. at an impedance of 600 ohms. The audio frequency response of the receiver is —3 db at 400 and 3500 cps. The overall sensitivity of the receiver is such that a 1 μf input signal at the antenna terminal will provide 50 milliwatts of audio output at a signal-to-noise ratio of approximately 12 db.

### *Transmitter*

The transmitter uses four identical tubes. The 5686 oscillator, VT102, uses a CR51 crystal in a third overtone circuit oscillating at 30.375 MC. Frequency tolerance is ±0.005%. The plate circuit of this tube is tuned to twice the oscillator frequency and drives the grid of the 5686, VT101. This tube operates as a Class "C" frequency doubler and power amplifier. The plate circuit is tuned to 121.5 MC. This power amplifier has an output of approximately 2 w. at an impedance of 50 ohms. The RF circuits can be tuned to any single channel in the frequency spectrum between 118 and 130 MC.

The RF power amplifier VT101 is high level plate and screen amplitude modulated with the two 5686 tubes, VT103 and VT104. These are the same tubes which are used as

(*Continued on page 164*)





For product information, use inquiry card on last page.

# Transceiver

(*Continued from page* 163)

the audio power amplifier for the receiver. The audio frequency response of the transmitter is —3 db at 350 CPS and 3500 CPS with 1000 CPS used as a reference. A carbon microphone input is provided.

Fig. 7 illustrates the transmitter mounted on its base. The complete assembly is shown in Figure 6.

It is believed that the transmitter-receiver described represents a practical present day approach to the problem of providing reliable emergency or stand-by communications in the VHF region for military and commercial aircraft. The components selected are available for immediate procurement in production quantities. It provides better reliability than larger multi-channel equipments inasmuch as it is not affected by failure of ac power sources. It was designed to be produced for a need that exists today.

## *Portable Light Control For Movie Studios*

Lighting and light effects are to television what tones and sound effects are to radio. The viewing public not only insists on seeing a good picture but also on enjoying properly lighted action and background to really feel the presentation. It is not enough just to see some black and white moving objects on the screen.

"Some installations of light control for television studios have run up into the six figure area to offer effective lighting for studio presentations," says Dan Murphy, President of the Otto K. Oleson Electric Co., of Los Angeles, "but we recently completed a studio installation that gives excellent light control in the low cost brackets."

The installation was in the Hollywood studios of The American Broadcasting Company where three portable Luxtrol light control units give a great degree of flexibility. The cost of $3,500 per unit is a fraction of the amount spent in many less elaborate stations. Each of the three Luxtrol package units is a dimmer board containing eight 6,000 watt dimmers and sixteen load pockets with alternate switching of either of the load pockets.

Moreover, each unit can be rolled on casters to any stage in the studio where show is to be produced.

## Transistor Amplifier

*(Continued from page 132)*

If the preceding simplified voltage gain and input impedance expressions are to be valid and the design factors are to be useful, then care must be taken to bias the transistors at the desired operating point and to prevent the biases from varying with temperature. If the transistors are not biased at the intended point and if the biases change with temperature, it may become impossible to satisfy the assumptions that lead to the simple predictable equations. Moreover, if the biasing is not predictable and stable, the operation of large signal stages will be in doubt (clipping levels and distortion) and the power supply requirements will be unknown and variable.[9]

A representative sampling of biasing circuits are shown in Fig. 3. The self-biasing circuit (a) sets its own bias along the loci of points where emitter and collector currents are equal. The circuit offers neither predictability nor stability (with temperature). The base-injection circuit (b) is too dependent upon (1-α) and, while better than the self-biasing circuit, it is still essentially unpredictable and unstable. The balance of the circuits can achieve any desired degree of bias perfection.

If it is assumed that α is near unity and that the base-emitter voltage drop is negligible then the biases for the last four circuits are determined as follows:

(c) $I_E \cong \frac{E_{EE}}{R_{EE}}$ for $R_{EE} >> (1-\alpha) R_{BB}$,

and $V_c \cong E_{CC} - R_{co} I_E$.

(d) $I_E \cong \frac{E_{EE}}{R_o}$ for $R_{EE} >> (1-\alpha) R_{BB}$,

and $V_c \cong E_{CC} - R_{CC} I_E$.

(e) A bleeder current, large compared with the base current sets a voltage level at the base. This voltage level divided by $R_{EE}$ determines $I_E$. $V_c$ is $E_{cc}$ less the $R_{cc}$ drop.

(d) A bleeder current, large compared with the base current sets a voltage level at the base. This voltage level divided by $R_{EE}$ determines $I_E$. $V_c$ is $E_{cc}$ less the $R_{cc}$ drop caused by $I_E$ plus the bleeder current.

The assumptions and approximations involved in the biasing techniques for the last four circuits are of but secondary consequence in strongly biased circuits. If weaker biasing is employed, nominal allow-

## Transistor Amplifier

(*Continued from page* 165)

ances can be made for the $R_{BB}$ drops and the emitter-base drops. For example, if the $R_{BB}$ drop is assumed as $(1-\alpha)\ I_E R_{BB}$ and if the $R_{BB}$ and input diode drops are subtracted from $E_{EE}$ in circuit (c), excellent predictability results. The input diode drops are reasonably uniform from one sample to another and are relatively

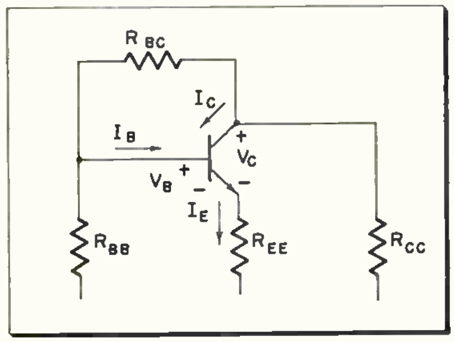


**Fig. 4: Circuit of Transformer Coupling**

invariant over a wide range of operating points. In germanium transistors the diode drops can normally be neglected. In silicon units, the drops may be of some consequence, but in either case, the consistency of the drops and familiarity with the transistor type allows for simple design since the effects are but secondary. Similar considerations apply to the circuits of (d), (e), and (f). The dc voltage feedback circuit (f) offers a slight advantage over the preceding three circuits in temperature stability but does not appear to be worth the additional complexity of design.[8] If two voltage supplies are permissible, the emitter-injection circuit (c) offers good economy of parts and power consumption along with high predictability, high stability, and simple design.[8] This circuit represents transformer-coupling as well as a RC-coupling. $R_{BB}$ would be the dc resistance of the secondary winding of the input transformer and $R_{cc}$ would be the primary of the output. The base-bleeder circuit (e) appears about optimum for a single-supply system, the addition of one resistor and the bleeder power loss being the price paid for single-supply operation. In all of the RC-coupled cases shown, $R_{BB}$ plays the additional role of an input impedance shunt, $R_s$. Also $R_{cc}$ creates part of the ac load resistance and may contribute to $R_s$ for a following stage.

So that the temperature stability of the biases may be evaluated for a particular circuit and so that one circuit may be compared with another, some type of stability factors are required. R. F. Shea[10,11] has introduced a stability factor,

$$S \equiv \frac{\partial I_c}{\partial I_{co}},$$

obtained by network analysis after assuming that "α" is constant and that the emitter-base voltage drop is negligible. For the purpose at hand, the spirit of Shea's attack will be preserved, but the details will be modified and the technique will be expanded.

A reasonably general bias circuit is shown in Fig. 4. The various resistances shown are abbreviations for actual, more detailed circuits (see Fig. 3). They are defined as follows:

$R_{BB}$ ≡ the net equivalent dc resistance from the base to all fixed potential points.

$R_{EE}$ ≡ the net equivalent dc resistance from the emitter to all fixed potential points.

$R_{cc}$ ≡ the net equivalent dc resistance from the collector to all fixed potential points.

$R_{BC}$ ≡ the net equivalent dc resistance from the base to the collector.

Using the circuit of Fig. 4, and assuming that "α" and "$V_B$" are constant and that $I_c = I_{co} + \alpha I_E$, one can solve for the three transistor currents and for the collector voltage. Having obtained the current and voltage expressions, they can be differentiated with respect to $I_{co}$, thus obtaining a set of stability factors.[9] Since the biasing method adopted previously involved the emitter current and the collector voltage, their stability factors will be considered.

$$S_E \equiv \frac{\partial I_E}{\partial I_{co}} = \frac{1}{D}, \text{ and} \qquad (10)$$

$$S_V \equiv \frac{\partial V_c}{\partial I_{co}} = \frac{-R_{cc}}{D}\left(1+\frac{R_{EE}}{R_{CC}}+\frac{R_{EE}}{R_{BB}}\right), \qquad (11)$$

where $$D = (1-\alpha) + \frac{R_{EE}}{R_{BB}}\left(1+\frac{R_{cc}}{R_{BC}}\right) + \frac{R_{EE}+R_{cc}}{R_{BC}},$$

$S_E$ ≡ emitter current stability factor, and

$S_V$ ≡ collector voltage stability factor.

That the stability factors obtained from the abbreviated circuit of Fig. 4 are valid for the more detailed circuits of Fig. 3 can be readily appreciated via the "principle of superposition" where $I_{co}$ is considered as a current source within the transistor and all the external voltage sources are suppressed for obtaining the stability factors.

Knowledge of the stability factors

# Transistor Amplifier

(*Continued from page* 167)

allows for an evaluation of the external biasing circuits, but they are insufficient for the determination of the temperature stability of the biases in a given case. One problem arises due to the fact that the near exponential dependence of $I_{co}$ upon temperature is not the same for all transistors, e.g., in one unit, $I_{co}$ will double every 10° C, while in another it may double every 15° C. Knowledge of the logarithmic slope of $I_{co}$ vs. temperature thus should be given some consideration by the designer, but its effects will not be formalized here. Another consideration, however, of obvious importance is how large is $I_{co}$ at, say room temperature with respect to the operating level. To appreciate the bias stability of a given circuit, one must know not only the rate at which a bias changes with $I_{co}$, but how important is $I_{co}$ in the first place. Thus level factors and stability products will be introduced to allow for a more complete quantitative evaluation of bias stability with temperature.[9]

$$L_I \equiv \frac{I_{co}}{I_E} \times 100\% \equiv \text{current level factor,}$$

$$L_V \equiv \frac{I_{co}}{V_c} \times 100\% \equiv \text{voltage level factor,}$$

$S_{PI} \equiv S_E L_I \equiv$ current stability product, and

$S_{PV} \equiv S_V L_V \equiv$ voltage stability product.

It should be noted that the stability factors and products are ideally zero. As they approach the ideal, however, power supply requirements become greater and small signal gain may be impaired. Only experience can establish the practical levels of the various factors introduced.

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# Ferrite Heads

(*Continued from page* 83)

response curves for head #15 taken at 100 and 160 ips tape speeds. It will be noted that the improvements in frequency response due to the increase in speed is not as great as one would expect. There was evidence that an air film between the head and tape was produced at 160 ips. A spacing loss of .02 mils will account for the decreased resolution.

These ferrite heads have a resolution which is at least as good as any of the metallic heads which have been made available for comparison at this time. A discernible output was noted at .125 mil wavelength. In terms of the equalization required, these heads would be useful to at least .2 mil recorded wavelength. The relatively low output would put a severe requirement on the associated amplifiers.

It has been demonstrated that ferrite heads with good short wavelength resolution can be fabricated. However, they are not, at this stage of development, a satisfactory general purpose head at these resolutions. As a record head they have the following shortcomings: relatively low saturation flux density, low Curie temperature, and erosion of the gap edges. Playback heads suffer from erosion at the gap edges.

The Curie temperature for these particular ferrites was fairly low, around 65°C. The use of these heads as record heads in an ambient temperature of 25°C is marginal; the rise due to combined bias and record current may cause the total temperature to exceed the Curie temperature. They would obviously not satisfy military specifications. This limitation does not appear to be fundamental. A further material development should raise the Curie temperature some, although perhaps at the sacrifice of some of the other properties.

The low saturation flux density is not a serious handicap in conventional playback heads, or in wide gap record heads. In record heads which have gaps as small as those described above, saturation becomes a serious problem. Since the recording process in a gap type head depends upon leakage flux, and since the relative amount of leakage flux with a very fine gap is very small, it follows that the flux density in the core, and especially the gap edges must be high. It has been found that with these ferrites and gap lengths saturation does occur. In Fig. 6 are

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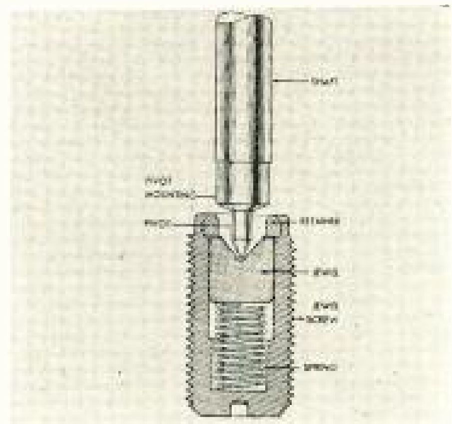

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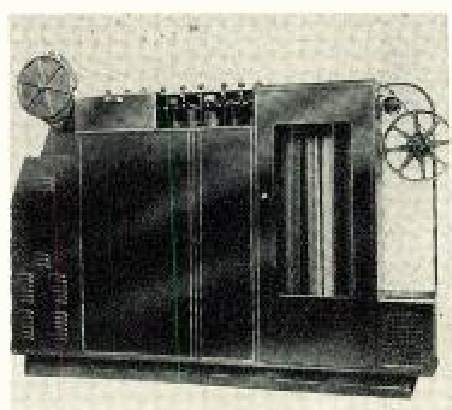

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# Ferrite Heads

(*Continued from page* 169)

shown input-output curves for a ferrite head and a Brush BK1090 head. For comparison, the same head was used for playback in each case. It will be noted that the first break in slope occurs at 8 db. output for the Brush head but at —1 db. for the ferrite head. It is not obvious from the data that the Brush head is saturating but certainly the ferrite head is saturating well below tape saturation. This difficulty may be reduced by using materials with higher saturation flux density or by increasing the record gap length. Ferrites as a class tend to have a low saturation flux density so that it appears wider gaps are necessary in ferrite record heads to avoid saturation. It should be emphasized that the use of a wider gap does not mean that a decrease in the sharpness of the gap edge is allowable. The use of a wide gap record head would require special attention to the gap edges in order to retain resolution and to reduce record gap anomalies in the frequency response curve.

### *Wearing Qualities*

Originally thought of as wear resistant heads because of their hardness, ferrite heads, at present, have wearing qualities which are poor. Wear shows up as an erosion of the tape contact surface. In many instances this erosion may appear all over the surface, but in most cases it is concentrated at the gap edges, the worst location as far as head performance is concerned. Some wear tests were performed on these ferrite heads by running them at a tape speed of 100 ips and then measuring the wavelength response at low tape speeds. A μ-metal head was run at the same time for control purposes.

A ferrite head (Head #5) with a Hysol gap spacer was wear tested for a total of 83 hrs., corresponding to 2,400,000 ft. of tape. The tape used was 3-M type 111 acetate backed tape, and the normal force between head and tape was around 75 grams. No pressure pads were used. In Fig. 7 are shown photomicrographs of the gap edges after 35 and 83 hrs. of wear. The original gap was similar to that of head #15 but somewhat more irregular. The gap after 35 hrs. of wear shows a definite wearing pattern. There are long scratches which do not appear to be serious except as a possible site for further erosion. After the scratches, erosion appears; actual erosion can be con-

## Ferrite Heads

(*Continued from page* 171)

sidered in two categories, surface erosion and gap edge erosion. Surface erosion may occur anywhere on a surface where conditions are favorable, and in itself is not detrimental to head performance. The type of erosion which is very serious in ferrite heads occurs at the gap edges. In the 35 hr. photomicrograph, the directional qualities of the gap edge erosion are quite marked. The trailing gap edge, which is directed against the direction of tape travel, is badly eroded while the leading edge, which the tape slides off of, shows very little evidence of erosion. Intuitively this situation seems reasonable. After 83 hrs. of wear the trailing edge is much more badly eroded, and some erosion is starting to occur at the leading edge; the surface erosion has also increased appreciably. In Fig. 8 are shown wavelength response data showing the deterioration in performance as a playback head as the result of wear. It can be seen that the bulk of the deterioration in performance has occurred in less than 23 hrs. of wear. The deterioration then progresses slowly and there is evidence that a usefully long life could be realized at 0.5 mil wavelength if the direction of tape travel was not reversed. If the tape direction is reversed, the uneroded gap edge will erode rapidly so that no portion of the gap would be sharp or well defined. Evidence based on some experience with ferrite heads designed for 1.0 mil useful resolution indicates that, when both gap edges deteriorate, the shortest useful wavelength will be around 1.0 mil.

### *Wearing Properties*

Wear data obtained on both sintered ferrites and single crystals without fabricated gaps indicate that the intrinsic wearing properties are appreciably better than those experienced with fabricated heads. For that reason methods of making the gap area physically more like an ungapped ferrite have been devised. One thought is that when the gap is very short the tape surface cannot get down into the gap region and erode the trailing edge; if the joint were perfect this certainly appears reasonable. It appears unlikely, at this time, that a head with usefully high output will have a short enough gap to successfully resist wear. For this reason it appears that something must be done in the gap or within the material in order to decrease this gap edge erosion.

A technique which holds some promise, is to fill in the gap with a glaze material which is nonmagnetic, bonds well to the gap faces, and is hard. Such a glazed head (Head #10) was fabricated and subjected to wear tests at 100 ips. A photomicrograph of this head is shown in Fig. 9. Most of the gap was clean and straight when new. After 48 hrs. of wear (1,450,000 ft. of tape) the head has a large amount of surface erosion and the gap edges have eroded somewhat. The directional wear qualities are not very obvious on this head. It can be seen that this head has not eroded as much in 48 hrs. as the previous head had in 35 hrs. In Fig. 10 are shown wavelength responses taken after 21 and 48 hrs. of wear. After 21 hrs. the gap edges were relatively sharp giving a well defined null but there was apparently a loss in resolution. After 48 hrs. the gap edges were irregular enough to almost completely suppress the second peak, although the resolution at wavelengths longer than 0.5 mil was substantially unchanged. Comparison of the wear on heads #5 and #10 indicated that the glazing technique has apparently increased the resistance to wear.

In conclusion it can be stated that ferrite heads can be constructed which have resolutions, when new, comparable to metallic heads, and that they compare favorably in performance with metallic heads constructed from thin lamination for high frequency use. They are, however, deficient in wearing qualities.

*(This paper was presented at the 1955 I.R.E. Convention.)*

## Power Transistor Survey

In the article "Survey of Power Transistors Currently Available," by Rufus P. Turner, Registered Electrical Engineer in the state of California, which appeared in June TELE-TECH, the footnotes to Table 2 were inadvertently omitted in printing and are as follows:

(A) Emitter stabilizing resistor must be bypassed to ground with at least 2000 μfd (6 v) to prevent reduction of power gain.
(B) Input resistance will be higher if emitter stabilization resistor is not heavily bypassed.
(C) Stabilization of dc operating points necessary to prevent collector current runaway.
(D) Non-inductive.
(E) Per collector.
(F) With typical heat sink: 1/16 in. aluminum chassis 6 x 6 x 2 in.
(G) Safe operation up to 70° C ambient.
(H) Common-base circuit only. These data placed in common-emitter section of table for convenience only.

## D-Amplifier

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$$t_{dd}(\eta) = \frac{d}{d\eta}[\phi(\eta)] = \frac{2}{\sqrt{1-\eta^2}}. \quad (8)$$

By this simple analysis, then, we are able to plot all the important steady-state characteristics to a first approximation. Dodging the synthesis approach, we would juggle the values around to obtain characteristics, improved in desirable directions. Curves obtained from laboratory measurements may be directly compared with the calculated ones.

In a similar but more involved analysis of the dissipative section, we obtain curves of the general nature shown by Fig. 5. These curves are not final; they only indicate the shape of the steady-state characteristics for arbitrary selected m and a values. Actually, the time-delay curve may be maintained almost flat to 85%, or so, of the prototype, non-dissipative section cutoff frequency. For sine-wave, steady-state applications, the indicated Gaussian response curve may be replaced by a nearly straight curve with abrupt cutoff.

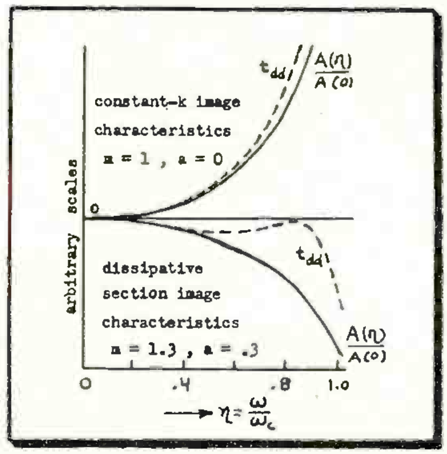


Fig. 5: Steady-state curves obtained by analysis of the section network of Fig. 4

Viewpoints on transient calculations are given in the following, but since such calculations are quite elaborate, except for the simplest types of networks, the design engineer is inclined to avoid them and instead fall back upon practical experience, aiming at steady-state characteristics, which are known to yield good pulse response, i.e. short rise and decay times, reasonable freedom from overshoots, etc.

### Use Of Laplace Transform

Laplace transform (and the associated Fourier transform already discussed) plays such an important role in D-amplifier design, including coupling devices, that a further discussion is motivated. Restricting ourselves to linear conditions, we find that transforms and associated poles-and-zeros techniques provide powerful tools, particularly if at least certain concepts of a synthesis approach are included.[12] This is true even if we concentrate on just one section of a stage, such as the one shown in Fig. 4, to extend our findings at a later time to the entire stage. The simplest but generally not sufficient approach in such an extension is logical reasoning, supported by empirical data.

We proceed to apply Kirchhoff's voltage and current sum laws to the ladder networks, being prepared for the necessity to extend our treatment to include determinants and matrices. Our aim is to formulate the Transfer Function for the D-amplifier section, expressing it via the s-variable. One and the same initial formula then yields the following information, (a) via the complex radian frequency $s = \sigma + j\omega$ the poles and zeros configuration in the complex plane, (b) similarly the transient conditions, after proper application of the Inverse Laplace Transform, (c) finally, the steady state condition for $s = j\omega$.

Since ladder networks have already been discussed, we will tie this subject matter to the following one by selecting a stage-coupling device for our discussion; a typical cathode follower coupler, used between stages in a limited upper frequency, cascaded D-amplifier. The cathode follower circuit and its equivalent is assumed known. Starting from conventional circuit theory, we may use the constant-current source, ccs, equivalent circuit for the cathode follower (more appropriately referred to as "voltage follower"), and write down the following integro-differential equation, generalizing to the extent of considering the cathode lead inductance expressed as a shunt inductance $1/\Gamma$ ($\Gamma$ : reciprocal inductance in the unit yrneh)

$$C\frac{dv}{dt} + Gv + \Gamma\int v\,dt + i(t) = O, \quad (9)$$

where $i(t)$ contains the driving force current waveform, and $v(t) = v$ symbolizes voltages appearing in the circuit. Actually, each term in above generalization may represent several terms of similar form. Via one or more substantiating relations, all variables except the output voltage may be determined; the output voltage being the only unknown in the equation system. By means of its Particular Integral (for steady state)



## D-Amplifier

(*Continued from page* 175)

and Complimentary Function (for transients), the above equation gives the complete answer to the problem. Instead of using the "classical" solution, we here read off each term in Laplace notation, obtaining a simpler, algebraic equation in the s-domain. For the moment ignoring the initial conditions, and assuming step-function excitation, we write the s-version of Eq. 9 in the general form

$$sCv(s) + Gv(s) + \Gamma \frac{v}{s} + \frac{I}{s} + \dots = 0, \quad (10)$$

After some computation work, the transfer function f(s) is obtained as the output-to-input voltage waveform ratio, here given for a simplified, inductance-free circuit,

$$f(s) = \frac{C_{gk}}{C_{kgk}} \cdot \frac{1}{s + g/C_{kgk}} + \frac{g_m}{g} \cdot \frac{g/C_{kgk}}{s(s + g/C_{kgk})}, \quad (11)$$

where $C_{gk}$ is the cathode follower grid-cathode capacitance, $C_k$ its cathode capacitance, $C_{kgk} = C_k + C_{gk}$, $g_m$ the transconductance, and $g = g_m + 1/r_p + 1/R_k$, where $R_k$ is the resulting cathode resistance. To obtain the transient in the time domain we apply the Inverse Laplace Transform,

$$f(t) = \frac{1}{2\pi j} \int_{c-j\omega}^{c+j\omega} f(s)\, e^{st}\, ds. \quad (12)$$

By proper use of transform tables, we may get around the step-by-step application of Eq. 12 so that cumbersome integration in the complex plane will be avoided. In our example, the answer takes the simple form

$$f(t) = K_1 - (K_1 - K_2)\, e^{-at}, \quad (13)$$

where $K_1 = g_m/g$, $K_2 = C_{gk}/C_{kgk}$, and $a = g/C_{kgk}$. Eq. 13 involves the unpermissible assumption of a non-energized initial system, and considering the fact that the method described may be expanded and applied to much more intricate circuits, the final f(t) may be much more elaborate than indicated. Plotting Eq. 13, we obtain the time response, yielding information about response time delay, rise time and decay time, overshoots and undershoots, etc.

Considering the steady-state case, we interpret s in Eq. 10 as $s = j\omega$, *for High Speed • Low Cost Piercing of*

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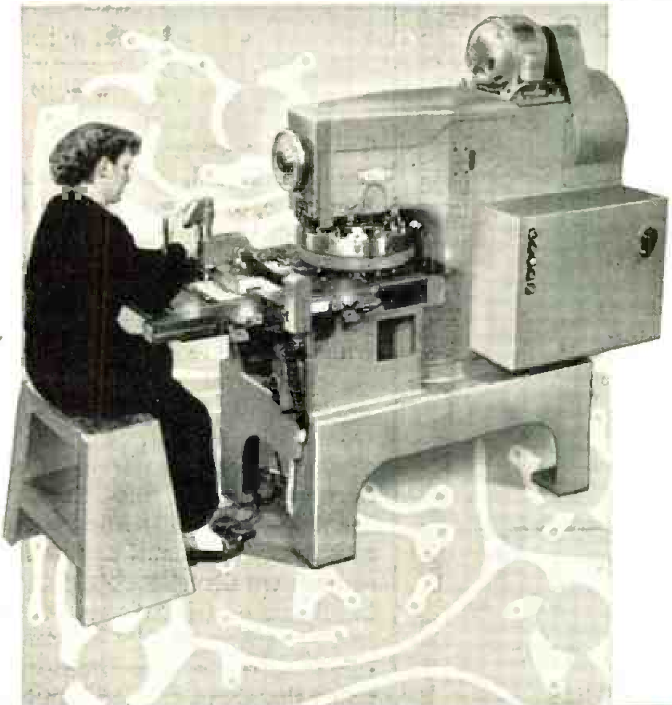

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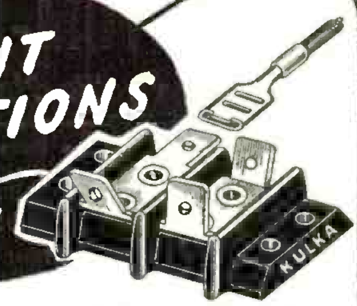


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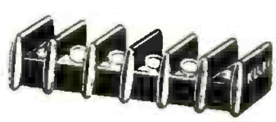

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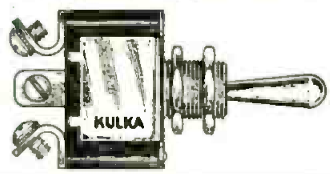


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## D-Amplifier

(*Continued from page 176*)

obtaining the complex amplification

$$A(\omega) = A(\omega)\ \text{exp.}\ j\phi(\omega) = \frac{1}{j\omega}\cdot\frac{ak_1 + j\omega k_2}{a + j\omega}. \quad (14)$$

This is the same result as we would have obtained, using initially the Symbolic, or jω-method, well-known to all electronics engineers. Plotting A (ω) and φ (ω), and the differential time delay $d\phi(\omega)/d\omega$, we obtain the three vital curves, which describe the general steady-state performance of any coupling device, or D-amplifier section, treated in the same fashion. The same curves may be plotted from measurements in the laboratory. By reshuffling eq. (14) into its Thevenin or Norton fixed emf or fixed current source, we directly obtain the output immittance (impedance or admittance), since this immittance is the same as the source immittance. By using the given applied input voltage, knowing the impressed current, we can determine also the input immittance. By the straight-forward technique indicated, we have then, starting from Eq. 10, analyzed a typical circuit both for steady state and transient behavior, and by designating different numerical values to the R:s, C:s, and Γ:s, we may plot many families of curves, ready for checking in the laboratory. When this one or similar techniques are applied to complete D-amplifier sections, such as the one shown in Fig. 4, the computation labor will be found to be quite exhausting.

In professional engineering approaches we refrain altogether from entering the solution via the time domain, using instead the method the writer prefers to call the Generalized Laplace Transform Method. Here all equivalent circuit notations, to the extent possible, are introduced directly in the circuit diagram as s-domain notations, including all initial conditions, added to the driving function, bringing it into the more generally useful "excitation function." This technique enables us to use the time-saving Potentiometer Method.[16]

Time and space do not allow us to go into a discussion of the powerful poles and zeros visualization, uses of potential analogue methods, and the general technique of applying synthesis methods. If these fields are entered into, the reader will find that the described approach fits well with the concepts to be used.

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## Structural Dielectrics

(*Continued from page* 89)

will be called the power transfer efficiency, defined as the ratio of total power radiated by the antenna to the power delivered by the transmitter.

An equivalent circuit of the antenna system in the low frequency range is shown in Fig. 3. The power transfer efficiency for most typical systems can be estimated by the relation shown by using some assumptions concerning relative values of certain components. The main assumption is that changes in the dielectric constant of the insulating material will not change the antenna

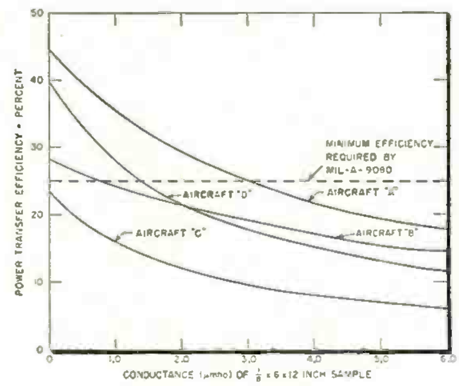


Fig. 7: Power transfer efficiencies

capacitance appreciably. Measurements have shown that the removal of the insulating band has a relatively small effect on the antenna capacitance indicating that most of the field lines associated with the capacitance are external to the dielectric and are hence not disturbed by changes in the properties of this material. It is for this reason that variations in capacity of the dielectric material were not measured in these tests.

The term $Q_c$ is the Q of the coil in the matching unit which resonates with the antenna capacitance. This factor accounts for losses in the antenna matching unit which are assumed to be all in the inductive matching element.

The power transfer efficiency is shown in Fig. 4 as a function of the ratio of dielectric loss to antenna conductance for a few values of a constant $Q_a$ to $Q_c$ ratio. Of interest to note here, is that the power transfer efficiency decreases at various rates depending on the antenna impedance and matching unit losses as the dielectric loss is increased. Also, if the efficiency is required to exceed a certain minimum value, then the maximum dielectric loss permitted will be less for higher ratios of $Q_a/Q_c$. The effect of dielectric loss on the antenna performance hence cannot be calculated on the basis of the properties of the material alone. The decrease in radiated power caused by the presence of a dielectric material with given loss characteristics in the antenna gap will be strongly dependent upon the antenna impedance, the matching unit efficiency, as well as the geometry of the gap region. As a result of these factors, the requirements of the electrical quality of insulating materials for antennas of this type vary widely from one antenna system to another.

An estimate of the total equivalent

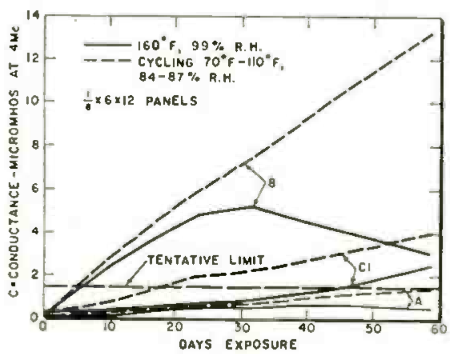


Fig. 8: Deterioration with temperature

shunt conductance which appears across the terminals of the antenna due to dielectric loss can be made from loss data measured on a small panel of the material and a knowledge of the gap width, total gap periphery, and thickness of the dielectric material of the particular aircraft antenna.

MIL-A-9080, the specifications for the design of these antennas, recommends that the loss of the samples be measured over the frequency range 2-6 MC using a test jig that places the material in a field similar to that which it encounters in service. However, MIL-P-8013, the material specification for these types of plastics, requires that the electrical characteristics be determined at 1 MC using a 2 in. diameter sample and sample holder. Loss measurements made by the standard disc method were not considered valid, however, because in this test the electric field is impressed normal to the plane of the laminations where the field in cap antennas is impressed essentially parallel with the laminations. Tests made with the standard sample holder on 1/8 x 1/8 x 2 in. samples of various materials oriented with the field first parallel and then perpendicular to the laminations showed far greater loss in the parallel direction, especially after environmental exposure. However, the inaccuracies inherent in dielectric measurements of such small samples limit the usefulness of this test.

For this study a sample holder

## Structural Dielectrics

(*Continued from page* 181)

was designed according to MIL-A-9080, simulating the field in a typical installation as shown in Fig. 5. The sample size was 12 x 6 x ⅛ in. By using the image-plane technique, it was possible to use samples having only half the width of the antenna gaps of interest and also to employ an unbalanced measuring system.

To calculate the total equivalent shunt conductance across the antenna terminals from conductance values measured with the samples, the conductance of the sample is multiplied by the ratio of the peripheral length of the gap to the sample length.

The sample conductance was determined by measurements of the conductance of a resonant circuit with and without the sample in the circuit, using the susceptance variation method. A Q raising circuit using an active negative resistance element was used to increase the range and accuracy of measurements. By the use of negative feedback in this circuit, stable Q's of the order of 100,000 were achieved with commercial power supplies. A special vernier capacitor of coaxial type was designed to give a linear capacitance change of 0.05 μμf per turn of the control shaft. Fig. 6 shows the measuring equipment and sample holder. Equipment components and layout were designed for simplicity and reliability of operation so that measurements could be made by non-technical personnel at specified times during the environmental tests. Measurements were made a 2, 4 and 6 MC.

### *Power Transfer*

The power transfer efficiency for four typical tail-cap antennas as a function of the loss of 12 x 6 x ⅛ in. sample are shown in Fig. 7. The frequency with the least favorable antenna impedance is shown for each aircraft. A constant coupler Q of 100 was assumed. Aircraft A and D are large aircraft with large isolated section antennas. However, differences in gap dimensions make the performance of aircraft A less dependent of dielectric loss and therefore able to tolerate a larger increase before the antenna performance falls to an unacceptable value. Aircraft B is a small aircraft but with a relatively large dielectric gap width. Although the efficiency is initially low, it is less affected by increase in dielectric loss because of

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## Structural Dielectrics

(*Continued from page* 182)

the greater gap width and smaller dielectric area. MIL-A-9080, the specification for the performance of liaison antennas, requires the efficiency to be at least 25% in the frequency range of 2 to 6 MC. For these antennas the maximum allowable conductance of the dielectric sample would be 3.0 μmhos for aircraft A, 1.4 μmhos for aircraft D, but only .75 μmhos for aircraft B. The antenna design of aircraft C is such that even with zero loss in the dielectric the performance of the antenna would not meet the minimum requirement. Since the initial conductance of all materials examined in this program is of the order of 0.1 μmho for this size sample, the allowable increase due to environmental conditions varies from effectively zero times for aircraft C to thirty times for aircraft A. These values will be compared with the characteristics of actual materials tested in a later part of this paper.

These results again emphasize that the dielectric loss will affect the performance uniquely for each type antenna. The maximum allowable dielectric loss can be estimated when the antenna impedance and gap configuration are known. This will allow a limit to be set on the permissible increase of dielectric loss due to environmental exposure.

### *Quality Control*

The electrical requirements for structural dielectric materials having been defined, the next phase of the study was concerned with two questions:

(1) Is the performance of available materials adequate under service conditions?

(2) Are the present specifications and quality controls adequate for insuring production of consistently good material?

Structural dielectrics currently in use consist of laminates made of glass fabric and resin. No other materials will do this particular job, although other types of reinforcement such as refined asbestos may be developed for this use. The laminates are usually cured at low pressure, around 15 psi, for economy in tooling.

The principal resins in use are the polyesters. Some epoxys are employed although their initial electrical properties are not quite as good as those of the polyesters and they are more difficult to handle in production.

The antenna specification MIL-A-9080 states that the laminates are governed by a material specification MIL-P-8013, which in turn cites other controlling specifications for resins, fabric and finish (or coupling agent). Lastly, the manufacturer's process specification, when approved by the Air Force, becomes a part of this quality control system.

The material specification sets forth requirements for dielectric constant and loss tangent at 1 MC, tested with the electrical field impressed normal to the laminations. Material is tested as received and after immersion in distilled water at room temperature for 24 hrs., in which condition slightly reduced values of limiting electrical properties are listed. The antenna specification calls for a similar immersion test, but for 72 hrs.

Environmental conditions for testing deterioration of mechanical properties consists of two hours in boiling water or thirty days in water at room temperature.

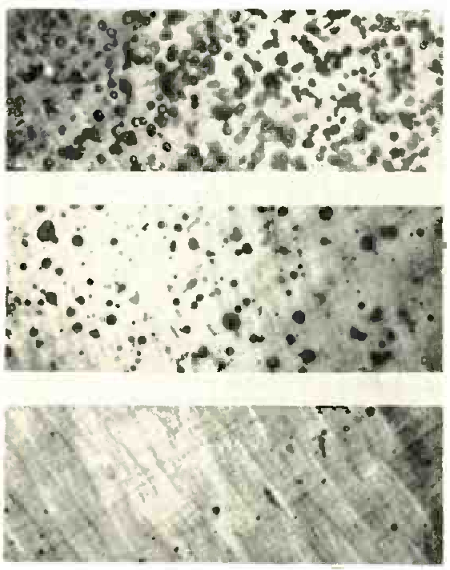

Fig. 9: Voids in one bath of laminate. Voids had no effect on deterioration

To investigate these requirements, samples of laminates representing production material were obtained from three major aircraft manufacturers. Several samples of each material were exposed to various environmental conditions as follows:

(1) Air at 160°F., 20% R.H.
(2) Air at 160°F., 99% R.H.
(3) Concentrated ozone
(4) Simulated solar radiation at 70,000 ft. altitude
(5) Alternate freezing and thawing
(6) Military specifications conditions
(7) Natural aging in standard atmosphere

Exposure periods extended up to sixteen weeks. Properties measured









For product information, use inquiry card on last page.

## Structural Dielectrics

(*Continued from page* 185)

before, during, and after exposure were conductance at 4 MC, weight, flexural strength and stiffness, and flexural fatigue strength. Conductance at 2 and 6 MC was measured before and after exposure only.

The environmental conditions were not intended to simulate actual service conditions but rather to exaggerate them, to find cut under which environments deterioration occurred.

In judging the performance of the materials, the limits for flexural strength and stiffness were taken from the military specification. A tentative conductance limit was set up by calculating the average of values which would result in a system efficiency of 25% for the four aircraft investigated. This value was 1.47 µmhos at 4 MC for the standard test panel 1/8 x 6 x 12 in., tested with a width of 12 in. and a gap of 6 in. No basis for judging fatigue resistance exists in the specifications so the test values were simply compared among themselves.

### *Test Results*

Twelve laminates were tested consisting of eight polyester, two epoxy and two polyester-TAC materials. No significant deterioration occurred in the hot dry air, the ozone, the solar radiation or the natural aging conditions.

In the hot humid air condition, eleven of the twelve materials showed serious electrical or mechanical deterioration, or both. All these materials were acceptable under the electrical requirements of the specifications and all except one under the mechanical requirements. There was no apparent correlation between electrical and mechanical deterioration.

In alternate freezing and thawing, reductions up to 10% occurred in flexural strength, the epoxy laminates being the least affected. No electrical deterioration was observed in this condition.

Insignificant changes were produced by edge sealing or by coating with an Air Force approved rain erosion resistant compound. In some cases deterioration was accelerated by stressing the samples.

Having found the combination of heat and humidity to be the chief deteriorating factor, and believing the 160°F. and 99% R.H. condition to be exaggerated with respect to service conditions, a realistic environment was set up in a chamber consisting of temperature cycling between 70°F. and 110°F. at about 85% R.H. This was named the Rangoon condition since it approximates the climate of that region in the spring of the year.

It was found that electrical deterioration was more severe in the Rangoon condition than in the original test at higher temperature and humidity. This comparison is shown in Fig. 8 for representative materials A and B, which are polyester laminates, and Cl which is an epoxy laminate. The tentative limit shown in the figure was defined earlier. Two representative materials reached the tentative limit of conductance after about ten and fourteen days respectively in the Rangoon condition. The order of merit of the materials was the same in both types of environment. The mechanical deterioration was less severe than in the 160°F. condition, but the worst polyester lost 23% of its strength in sixty days, while the void free epoxy lost 15%, which is more than is allowed by the military specifications for epoxy resins.

### *Processing*

Because wide quality variations were found in nominally identical samples and because chemically similar samples also varied drastically in resistance to deterioration, a program was started to investigate the raw materials and processing factors responsible for this performance. Laminates reproducing those which gave unsatisfactory performance were made at Stanford Research Institute and tested under various environments of heat and humidity. This program, which is still going on, has shown conclusively that slight variations in the quality of raw materials or in the processing can cause very large changes in resistance to deterioration.

As a result of these evaluations, it is concluded that within the limits of present specifications and quality control procedures, materials are likely to be produced which are electrically not suitable for cap-type antennas and which may be subject to serious mechanical deterioration. Factors not yet understood and certainly not controlled by present standards, are the determining influences in the quality of the final product.

Experiments made at Stanford Research Institute indicate that the most important of these factors are the cleaning of the glass fabric, the compatability of the coupling agent

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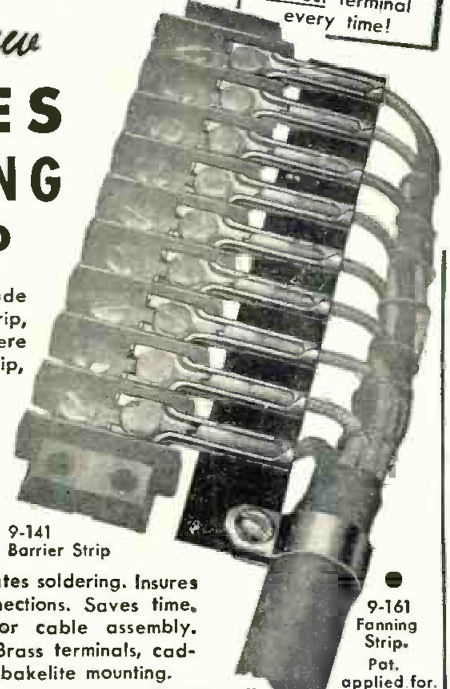


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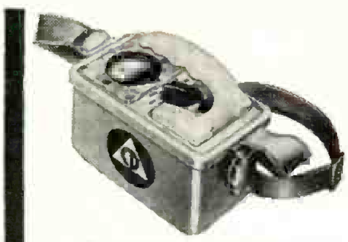

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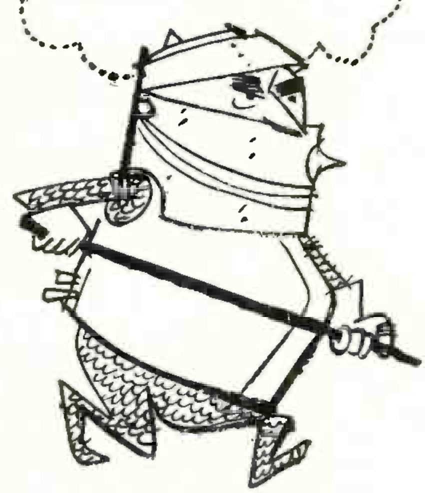

# STRIKE BACK!

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## Structural Dielectrics

(*Continued from page* 187)

and the physical conditions during its application, and the type of catalyst used with the resin. By modifying one or more of the foregoing factors, satisfactory materials have been produced with the same glass fabrics and resins used by participating fabricators at no increase in cost or complexity.

To insure proper control of the quality of structural dielectrics, it was concluded that:

(1) A dielectric properties test similar to that in the antenna specification should be added to the material specification together with revised property limit requirements.

(2) A new accelerated service test is needed to predict deterioration in hot, humid climates.

(3) The design property limits for materials should be based on the condition immediately after the simulated service tests. Listing of initial properties should be discontinued.

(4) Until the factors governing quality are better understood, fabricators should institute a sampling system whereby material from actual parts is continuously being tested for mechanical and electrical deterioration.

The current military specifications require void free construction; that is, relatively little entrapped gas. Fig. 9 shows the range of distribution of voids in one batch of a polyester laminate. The tests indicated that the relative number of voids had no effect on the rate of deterioration. It has been generally believed that electrical deterioration is proportional to water absorbed, that weight gain equals water absorption, and that voids increase the water absorption. The test data did not support any of these beliefs. Studies of free water content of the laminates were made by chemical analysis and it was shown that after severe exposure to heat and humidity the free water added was less than the original content, and that only a fractional and variable part of the weight gain was due to free water. The lack of correlation between weight gain and electrical deterioration is shown by contrasting the performance of the two materials in the following table. The resin was

## Structural Dielectrics

(*Continued from page 189*)

an epoxy. The two materials were made by different fabricators but were nominally identical as to ingredients and processing.

| | | |
|---|---|---|
| Initial conductance (1) | 0.07 | 0.07 |
| Conductance after exposure (2) | 2.28 | 0.10 |
| Weight gain after exposure, % | 0.39 | 0.39 |

(1) Micromhos at 4 MC. 1/8 x 6 x 5 in. sample
(2) 200 hrs. in water at 140° F.

The general conclusion from this study is that much more work is needed to insure consistent good performance from glass fiber laminates. Service environments neglected in this program should be investigated. A great deal of chemical and physical experimentation is needed to trace the factors that cause some materials to deteriorate. Resistance to degradation should be investigated in all appropriate frequency ranges. Quality inspection procedures need to be developed. The results of this work should be incorporated in the standards and specifications for raw materials so that the fabricator can depend on the products that he purchases, and can get more effective control in his processing.





NEW PRODUCT

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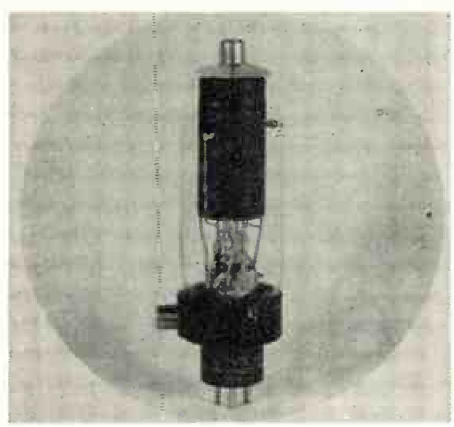
NL-5560, a new thyraton, is expected to be of considerable interest to maintenance engineers and users of electronic control equipment. Mercury-vapor filled for longer life, it uses an indirectly heated cathode, shield grid. The ratings on this tube are: Heater volts, 5 v; heater current, 4.5 amps; peak



inverse and forward volts 1000; average anode current, 2.5 amps; peak anode current, 15 amps; anode averaging time, 15 sec; and cathode heating time, 5 minutes. **National Electronics, Inc., Geneva, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 8-48)

## Stacked Tubes

(*Continued from page 93*)

which is placed alongside for comparison. Side and top views of the new ceramic tube appear in the photograph, indicating that the ceramic tube has the shape of a simple flat cylinder. Terminal lugs project

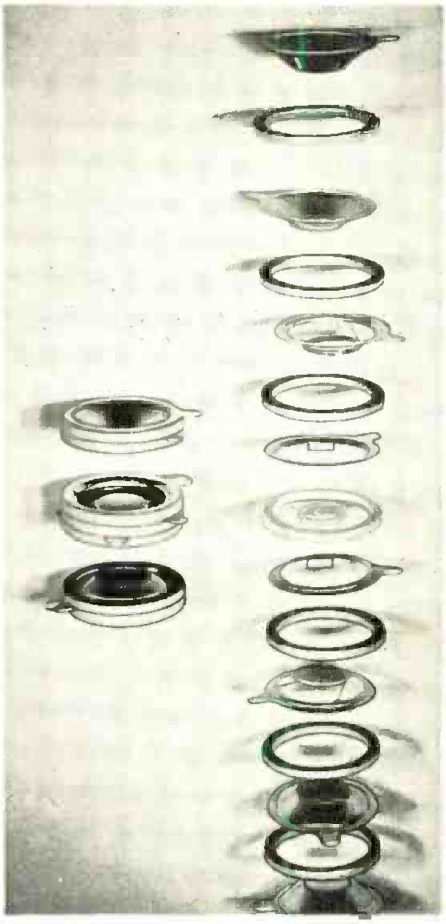


**Fig. 8: Stacked assembly of double triode**

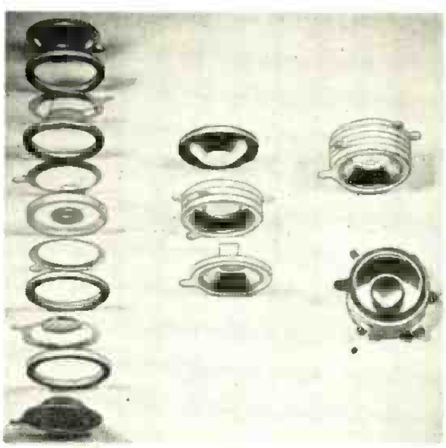


**Fig. 9: Ceramic-metal assembly of double diode**

radially so that the tube may be soldered or wired directly into a circuit as would a condenser or resistor. While the ceramic tube is quite small, having a diameter of only ⅞ in., nevertheless, it has a

## Stacked Tubes

(*Continued from page* 191)

cathode area larger than that of the 6SN7.

Fig. 7 is an enlarged sectional drawing of the tube illustrating the stacked structure comprising ceramic and metal rings sandwiched and brazed together. The tube is essentially of planar electrode construction, the disk-like cathode and grid electrodes being supported from the metal side wall rings. Copper end walls on the envelope provide the anodes. Conical formation of the electrode supports insures maximum rigidity, and nested parts provide a compact structure.

Fig. 8 shows exploded views of the double triode, the left-hand view in the photograph showing parts completely exploded and the right-hand illustrating the subassemblies prior to making final seals. Each end section is a grid-anode assembly unit, and the center section is a cathode-heater assembly. The components comprising each subassembly being later joined to make up the final tube. The tube is processed and evacuated while the subassemblies are separated in a vacuum chamber, after which the envelope sections are brought together and brazed before removal from the vacuum.

From inspection of the individual

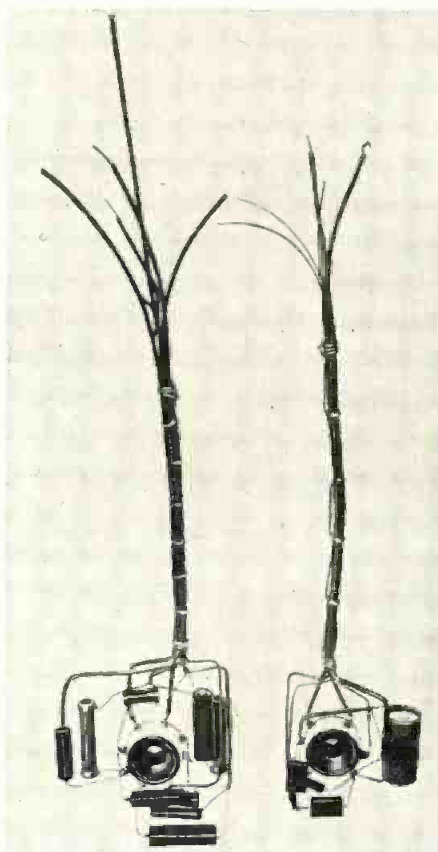


Fig. 10: Stacked tubes soldered in circuits

components making up the tube, it is seen that maximum utilization is made of the stacking technique. Electrode structures, as well as the envelope parts, nest together as the stack is built up. Since the individual components may be precisely formed and are self-jigging vertically and axially, it is seen that skilled personnel are not required and that the tubes are ideally suited for assembly by automation. Such automatic machinery is now being designed.

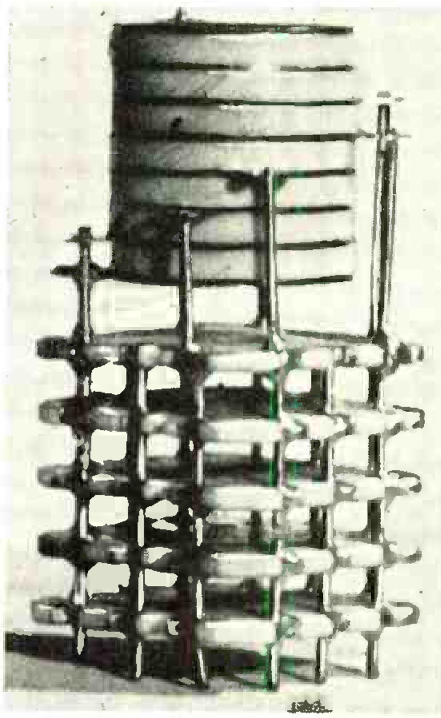


Fig. 11: Double triode on circuit module

Fig. 9 shows how the tube parts fit together to form a double diode. The only difference here is that the two grids and two ceramic rings have been omitted. This approach to the tube making problem, utilizing tube parts which become common to a variety of tube types, is one of the important advantages of the stacked structure.

Fig. 10 illustrates the double triode and double diode tubes soldered into typical circuits. The double diode at the left in the photograph has one section operating as a rectifier and the other section functioning as a limiter diode. The double triode at the right is operating as a two-stage low frequency amplifier such as used in servo-mechanisms.

Fig. 11 shows the double triode mounted on a module, the latter being a circuit assembly unit produced by automation programs such as Tinkertoy. These stacked ceramic tubes are ideally suited for combination with such circuit module units.

*(Presented at the National Conference on Aeronautical Electronics, May, 1955.)*

## INDUSTRY NEWS

**Richard Hodgson** was elected vice president of Fairchild Camera & Instrument Corp., it was announced by **Sherman M. Fairchild**, Chairman of the Board.

H. J. Buehler

R. Hodgson

**Herbert J. Buehler** was recently named as General Manager of Rutherford Electronics Co., Culver City, Calif. This newly created post was established to meet the increasing growth of the company's activities.

**Leon T. Eliel** has been elected to the Board of Directors of Fairchild Camera and Instrument Corp. Mr. Eliel is President of Fairchild Aerial Surveys, Inc., a subsidiary of Fairchild Camera.

**Jack L. Hobby**, of Weston, Mass., has been named manager of publicity and institutional advertising for Raytheon Mfg. Co., Waltham, Mass. Mr. Hobby came to Raytheon more than four years ago as Staff Ass't for Public Relations.

**Jerry S. Frank** has been appointed by the Telautograph Corp. to direct the company's recently expanded sales, service, and advertising program. The general sales and service offices have been moved to Los Angeles.

**James L. Caddigan** has been appointed to the newly created post of director of "Electronicam" marketing for Allen B. DuMont Laboratories, Inc. His new duties will be performed at the company's main office, 750 Bloomfield Ave., Clifton, N.J.

**Harrison Johnston**, recently elected as an officer of Ampex Corp., has since been made director of Ampex International, newly formed division of Ampex. Mr. Johnston joined Ampex as sales manager in 1951.

**J. Trevor Downer** has been appointed West Coast Sales Manager by Chatam Electronics, a division of Gera Corp., Livingston, N.J.

### New Transistor Plant

Ground was broken recently for Motorola's new one and one-half million dollar transistor manufacturing facility in Phoenix, Arizona.

# TELE-TECH ADVERTISERS — AUGUST, 1955



While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

# PERSONAL

Dr. **P. S. Christaldi** has been appointed to head the new Technical Products Division of **Allen B. Du Mont Labs, Inc.**, Dr. Christaldi has been associated with Du Mont since 1938.

P. S. Christaldi

W. Hotine

**Bill Hotine**, a relay and electronic engineer from Bayville, L. I., has been employed to manage research and development on new products for **Assembly Products** of Calif., a new subsidiary of Assembly Products, Inc., Chesterland, Ohio, manufacturers of contact meter-relays. Prior to this position, Mr. Hotine has for several years done product design on instruments and controls for automation in industry.

**Dr. Harris M. Sullivan** has been named manager of the **Electronics Laboratory** at G.E. Co.'s Electronics Park in Syracuse, N. Y. Previously, he was vice-president of **Central Scientific Co.**, Chicago, in charge of research and engineering.

**R. J. Krause** has been appointed to the newly-created post of Chief Administrative Engineer at Pacific Division, **Bendix Aviation Corp.**, No. Hollywood, Calif.

**Gerald C. Schutz** has been appointed Director of Electronics of the **Gruen Watch Co. Mr. Edward H. Weitzen** president of the company, announced the appointment. Mr. Schutz was formerly associated with the **Gibbs Manufacturing** and **Research Corp.** as Director of Electronics.

**Edwin H. Chapin** has been appointed as Director of Quality Control, **Triad Transformer Corp.**, Venice, Calif. Mr. Chapin was formerly Superintendent, Transformer Div., **Sangamo Electric Co.**, Marion, Ill., and Ass't Chief Engineer, **Radio Condenser Co.**, Watseka, Ill.

**John B. Cicchetti** and **Thomas A. Fulshaw** have become members of the technical staff of the **Microwave Laboratory, Hughes Research** and **Development**, Culver City, Calif. Dr. Cicchetti was formerly associated with the **Microwave Research Institute**.

**Hoddy Nakamura** and **Britton T. Vincent, Jr.** have joined the technical staff of the Systems Division, **Hughes Research** and **Development**, Culver City, Calif. Mr. Nakamura was formerly associated with **Douglas Aircraft Co.**

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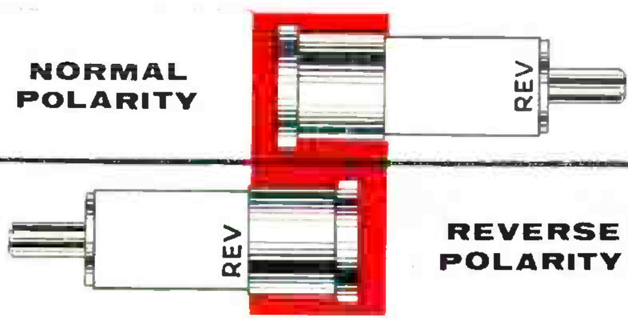
Polarity is indicated by the letters REV located at one end of the diode. To change the polarity, just switch the position of the end cap.

With the end cap attached to the contact pin at the unmarked end of the cartridge, the diode will be of normal polarity. With the end cap attached to the end marked REV, the diode will be of reverse polarity. The complete assembly, with either polarity, is electrically the same as its equivalent type of regular silicon diodes.

The Bomac 1N415 and 1N416 series will meet all conditions of JAN 1A specifications.

1N415 - 1N416 SERIES

NORMAL POLARITY

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## UNIQUE PACKAGE PROTECTION


For complete protection during shipment and storage Bomac has designed a reusable RF Protective Package* which conforms with MIL-E1B specification. Diodes stored in this package are completely protected no matter how many times they are handled after the original seal is broken.

*PAT. APPLIED FOR

| Band | Type | Equivalent Type | Frequency (Mc) | Max. Conversion Loss (db) | Noise Ratio (Times) | Max. (VSWR) | IF Imped. (OHMS) | Burnout (erg) |
|---|---|---|---|---|---|---|---|---|
| X | 1N415B | 1N23B | 9375 | 6.5 | 2.7 | — | — | 1.0 |
| | | 1N23BR | 9375 | 6.5 | 2.7 | — | — | 1.0 |
| X | 1N415C | 1N23C | 9375 | 6.0 | 2.0 | 1.50 | 325-475 | 1.0 |
| | | 1N23CR | 9375 | 6.0 | 2.0 | 1.50 | 325-475 | 1.0 |
| X | 1N415D | 1N23D | 9375 | 5.0 | 1.7 | 1.30 | 350-450 | 1.0 |
| | | 1N23DR | 9375 | 5.0 | 1.7 | 1.30 | 350-450 | 1.0 |
| S | 1N416B | 1N21B | 3060 | 6.5 | 2.0 | — | — | 2.0 |
| | | 1N21BR | 3060 | 6.5 | 2.0 | — | — | 2.0 |
| S | 1N416C | 1N21C | 3060 | 5.5 | 1.5 | — | — | 2.0 |
| | | 1N21CR | 3060 | 5.5 | 1.5 | — | — | 2.0 |

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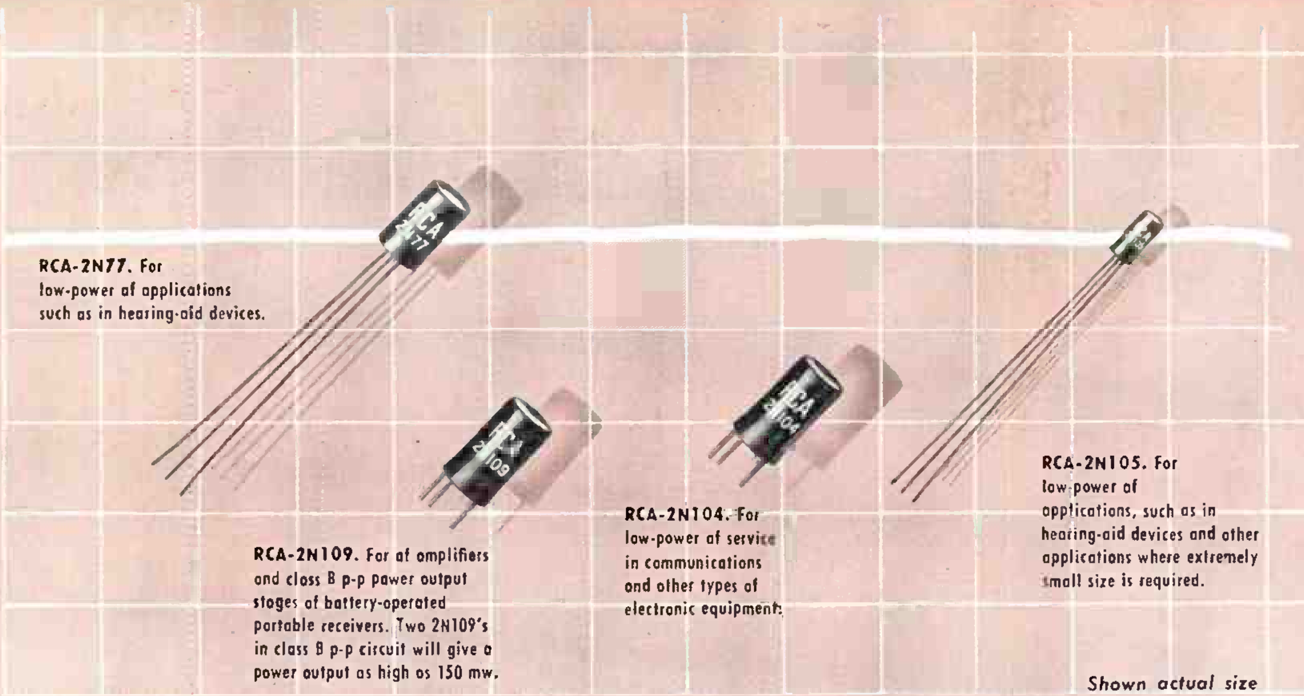


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For applications where extreme stability is paramount . . . for circuits where very low collector cutoff current is essential . . . for services that require exceptional uniformity of characteristics . . . RCA-developed transistors provide consistent high-quality and dependable performance. *Closely-controlled processing and manufacturing techniques assure high-level performance initially and THROUGHOUT LIFE!*

Here again is specific technical evidence of RCA's continuous effort to provide advanced-quality products. For a quick rundown on the ratings and characteristics of the four transistors pictured here, see the chart. For complete technical data, call your RCA Field Representative—or write RCA, Commercial Engineering, Harrison, New Jersey.

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The RCA-2N77, -2N104, -2N105, and -2N109 are hermetically sealed, germanium p-n-p alloy-junction types—and each carries the RCA one-year warranty!

| | RCA-2N77 | RCA-2N104 | RCA-2N105 | RCA-2N109 |
|---|---|---|---|---|
| MAX. RATINGS (Absolute Values): | | | | |
| Collector Volts | −25 | −30 | −25 | −20 |
| Collector Ma. | −15 | −50 | −15 | −50 |
| Collector Dissip. (mw) | 35 | up to 150* | 35 | 50 |
| Operating Temperature (°C) | 50 | 70 | 50 | 50 |
| TYPICAL OPERATION:† | | | | |
| Collector Volts | −4 | −6 | −4 | −4.5 |
| Collector Ma. | −0.7 | −1 | −0.7 | −13 |
| Alpha (Collector-to-base connection) | 55 | 44 | 55 | 70†† |
| Power Gain (db) | 41 | 41 | 42 | 30** |
| Power Output (mw) approx. | — | — | — | 75** |
| Source Imped. (ohms) | 2450 | 1400 | 2300 | 375 per base connection |
| Load Imped. (ohms) | 20,000 | 20,000 | 20,000 | 100 per collector |
| Noise Factor (db) | 6.5 av. | 12 max. | 4.5 av. | — |
| Cutoff Freq. (kc) | 700 | 700 | 750 | — |
| Figure of Merit for High Frequency Performance (Mc) | 1.7 | 1.6 | 2.6 | — |

* Depends on temperature and circuit parameters  †† Large-Signal
† In common-emitter circuit at 25°C, ambient temp.
** For 2 transistors in class B of circuit, and maximum distortion of 10 percent

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