TELE-TECH

& Electronic Industries

IRE NATIONAL CONVENTION

NEW YORK CITY, MAR. 19-22, 1956

NATIONAL ELECTRONICS CONFERENCE

CHICAGO, OCT. 3-5, 1955 (OCT. 1-3, 1956)

WESCON 1956

LOS ANGELES, AUG. 21-25, 1956

Three Regional Conventions

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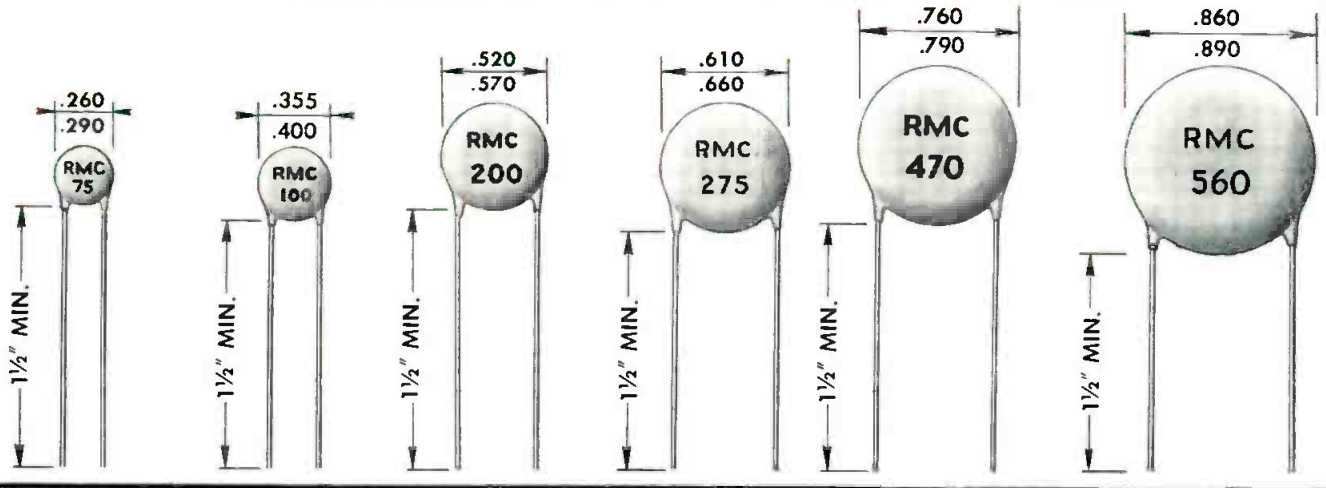
October • 1955

the PROVED replacement
for tubular ceramic and mica capacitors

RMC DISCAPS



TC	1/4 Dia.	5/16 Dia.	1/2 Dia.	5/8 Dia.	3/4 Dia.	7/8 Dia.
P-100	1- 3 MMF	4- 9 MMF	10- 20 MMF	—	—	—
NPO	2- 12	13- 27	28- 56	57- 62 MMF	63-100 MMF	101-150 MMF
N- 33	2- 12	13- 27	28- 56	57- 62	63-100	101-150
N- 75	2- 12	13 27	28- 56	57- 68	69-110	111-150
N- 150	2- 15	16- 30	31- 68	69- 75	76-140	141-150
N- 220	3- 15	16- 30	31- 75	76- 90	91-130	131-190
N- 330	3- 15	16- 30	31- 75	76-100	101-150	151-190
N- 470	3- 20	21- 40	41- 80	81-120	121-200	201-240
N- 750	5- 25	26- 56	57-150	151-180	181-300	301-350
N-1500	15- 50	51-100	101-200	201-250	251-330	331-560
N-2200	47- 75	76-150	151-200	201-275	276-470	471-560

Temperature coefficients up to N-5200 available on special order.

SPECIFICATIONS

POWER FACTOR: Over 10 MMF less than .1% at 1 megacycle. Under 10 MMF less than .2% at 1 megacycle.
WORKING VOLTAGE: 1000 V.D.C.
TEST VOLTAGE (FLASH): 1750 V.D.C.
CODING: Capacity, tolerance and TC stamped on disc
INSULATION: Durez phenolic-vacuum waxed
INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms
AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms
LEADS: No. 22 tinned copper (.026 dia.)
TOLERANCES: ±5% ±10% ±20%

These capacitors conform to the RTMA specification for Class 1 ceramic condensers

The capacity of these condensers will not change under voltage

Leading manufacturers of electrical and electronic products have proved by their continued use that Type C DISCAPS replace tubular ceramic and mica capacitors at lower cost.

Type C DISCAPS are available for varied applications in a wide range of capacities and temperature coefficients. These capacitors feature smaller size, lower self inductance, and greater dielectric strength. Rated at 1000 working volts, Type C DISCAPS assure trouble-free performance and cost no more than ordinary 600 volt capacitors. Specify Type C DISCAPS for your product, their many mechanical and electrical advantages combine with a lower initial price permitting substantial production cost reductions. These capacitors are available for use with printed wire circuits.

DISCAP CERAMIC CAPACITORS

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Two RMC Plants Devoted Exclusively to Ceramic Capacitors

TELE-TECH
& Electronic Industries

October, 1955

FRONT COVER: Three Regional Conventions—As a result of the editorial "On Conventions and Shows" appearing in the August issue of Tele-Tech & Electronic Industries p. 69, a great many letters have been received from readers recommending the the onnual National Electronics Conference is the logical engineering function for the midwest. This yeor the 11th annual Conference takes ploce at the Hotel Sherman in Chicago, Oct. 3-5. The symbol of this occasion, (together with those for the Eastern and Western regions), has the predominant position on the cover. Program details ore on p. 76 in this issue.

TELE-TECH & ELECTRONIC INDUSTRIES, October 1955, Vol. 14, No. 10. Published monthly by Caldwell-Clements, Inc. Publishers also of MART and TECHNICIAN. Publication Office, Emmett St., Bristol, Conn. Editorial, advertising and executive offices, 480 Lexington Avenue, New York 17. Telephone PLaza 9-7880. M. Clements, President; M. H. Newton, Assistant to President; John J. Borghi, Vice President and Treasurer; M. B. Clements, Secretary. Acceptance under section 34.64 Postal Laws and Regulations authorized at Bristol, Conn., June 9, 1954. Additional acceptance at New York, N. Y. 75¢ a copy. Subscription Rates: United States and U. S. Possessions: 1 year $5.00; 2 years $8.00; 3 years $10.00. Canada: 1 year $7.00; 2 years $11.00; 3 years $14.00. All other countries: 1 year $10.00; 2 years $16.00. Please give title, position and company connections when subscribing.

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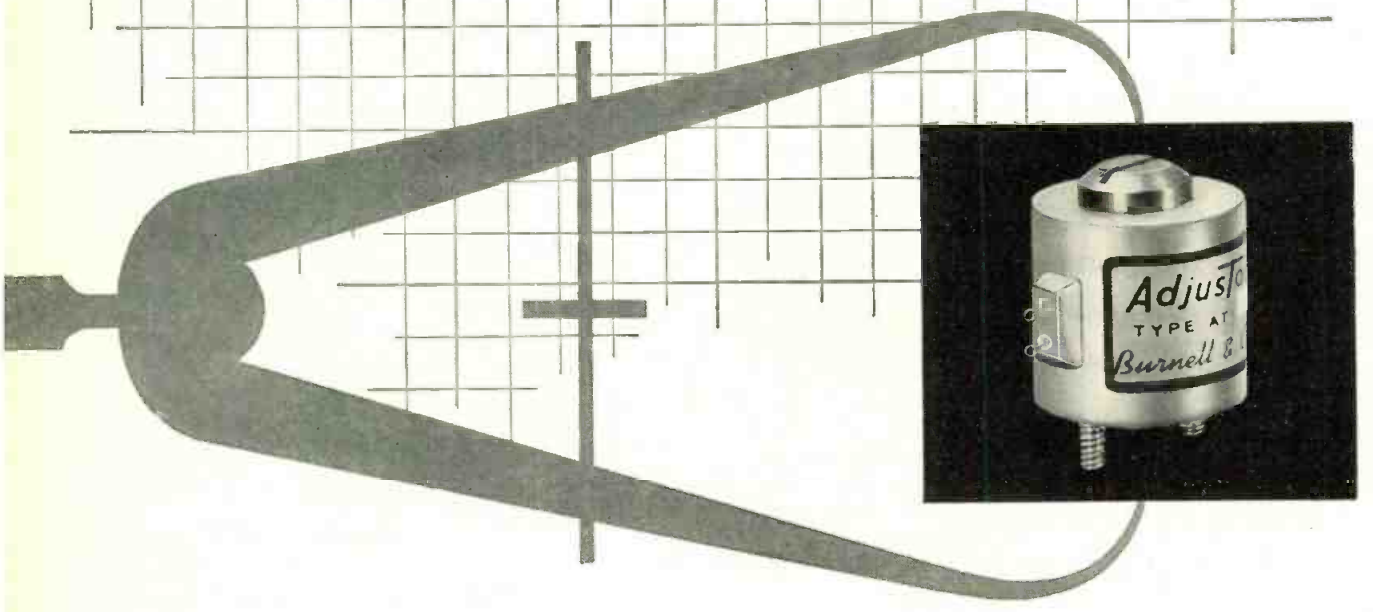

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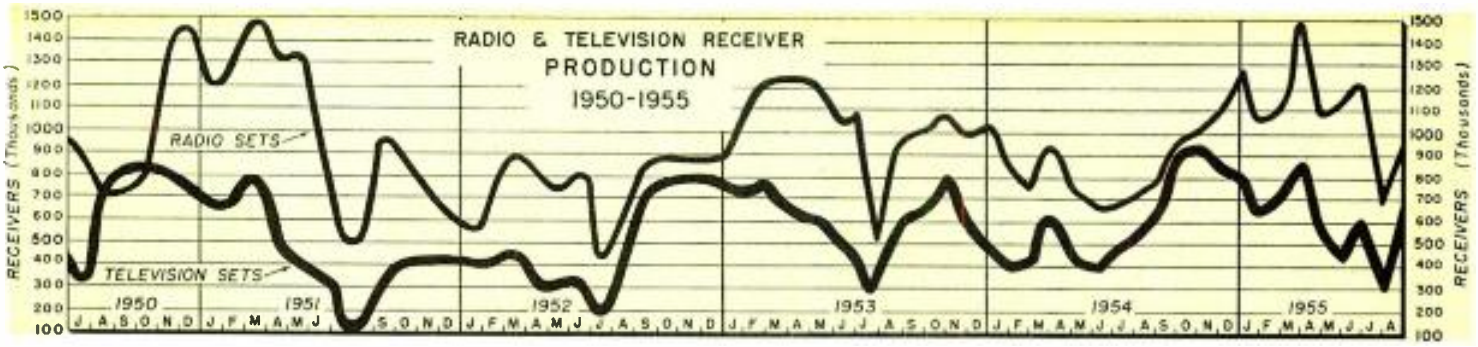


Indicative of the growing interest in electronic industries statistics, the editorial and statistical departments of RETMA, 777 Fourteenth St., NW, Washington 5 DC, have just released their first "Fact Book." The 26-page volume summarizes production and sales figures for television sets, radio sets, receiving and picture tubes, military equipment and related electronic activities over the last decade or more. Excerpts of interest are shown below:

Value of Goods Produced ($ Millions)

Year 1/	Total	Home-type radio and television receivers, and related products	All other electronic equipment except tubes and components	Electron tubes	Electronic components other than tubes
1954	$5800	$1417	$2464	$619	$1300
1953	6300	1593	2503	734	1470
1952	5400	1340	2330	604	1126
1951	3400	1296	843	473	788
1950	3300	1687	473	443	697
1947	1750	810	469	122	349
1939	340	186	40	39	75
1937	350	182	54	43	71
1935	240	135	31	32	42
1933	135	73	14	27	21
1931	220	125	30	29	36
1929	465	2/275	8	82	100
1927	200	2/ 95	4	22	79
1925	180	2/ 93	3	23	61
1923	54	2/ 13	1	10	29
1921	11	n.a.	n.a.	1	n.a.
1919	8	n.a.	n.a.	n.a.	n.a.
1914	1	n.a.	n.a.	n.a.	n.a.

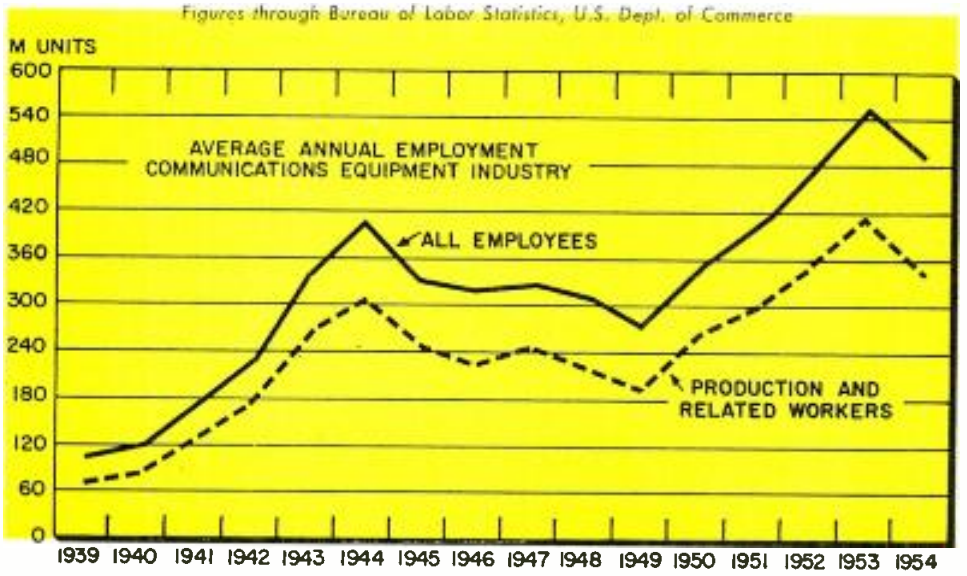
1./Data covers manufacturers' shipments in 1947 and later years, and production in 1939 and earlier years. The totals represent the factory value of production or shipments (output) of electronic products, whether incorporated in other products or used in maintenance and repair of end equipment.

2./Includes all radio receivers, commercial as well as home-type.

(Figures through Electronics Division of Business and Defense Services Administration, U.S. Dept. of Commerce)

Employment

Figures through Bureau of Labor Statistics, U.S. Dept. of Commerce



Films Producing Electronic Equipment

Product	1939	1944	1952	1955
Radio & Radar Equipment (End Equipment and Major Subassemblies	182	202	850	1,000
Test Equipment	34	60	180	200
Resistors	19	46	20	110
Capacitors	38	48	60	90
Transformers	42	100	105	110
Tubes	23	40	19	25
Electrical Indicating Instruments	35	43	20	20

(Figures obtained through Census Bureau, Electronics Div. of National Production Authority and Electronics Production Resources Agency, Dept. of Defense)

GOVERNMENT ELECTRONIC CONTRACT AWARDS

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

Accelerometers	123,320
Altimeters	305,711
Antennas, Radar	216,010
Audio Decoder	145,360
Computer Sets	1,930,786
Digital Information Processors	44,095
Electronic Test Equipment	98,316
Generators	138,706
Indicators, Control	980,576
Junction Boxes	61,541
Klystrons	32,640
Meter Test Set	161,751
Motors, Generator	34,234
Motor Generator Sets	25,575
Power Supplies	421,048
Radar Sets	401,023
Radar Sets & Indicator Groups	991,573
Radar Test Sets	67,196
Radio Remote Control Systems	99,117
Radio Sets, Model	5,036,904
Radiosonde Data Computer	50,112
Resolvers, Electric	55,914
Signal Generators	438,463
Sonar, Scanning	39,876
Storage Batteries, Aircraft	40,519
Switches	118,042
Telephone Cable	103,863
Tubes	1,316,488

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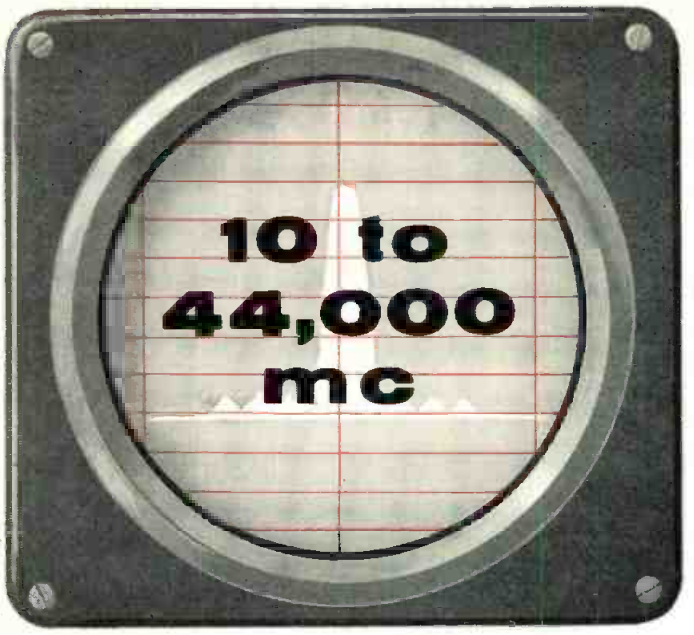
PROVEN RELIABILITY



DIRECT READING SPECTRUM ANALYZER

UNI-DIAL CONTROL

Years of day-in, day-out field operation by most exacting users, have proven the Polarad Model TSA Spectrum Analyzer to be a versatile test instrument of highest reliability and accuracy for both laboratory and production applications.

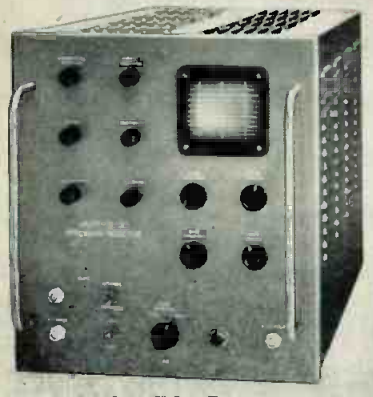
It is a broadband instrument with greatest pulse sensitivity over the band—10 to 44,000 mc. And each of its five interchangeable RF tuning heads operate with utmost simplicity and frequency stability. All tuning is by Uni-Dial control. Frequencies are read with 1% accuracy right on the linear dial as the set is tuned. No mode charts or interpolations necessary.

The Polarad Model TSA has been designed to save engineering manhours. Its 5 inch CRT display of the RF spectrum is bright and easily defined. And its 1 cycle sweep speed makes for fine resolution. For detailed specifications, contact your nearest Polarad Representative, or write directly to the factory.

APPLICATIONS

- Transmitter characteristics tests
- Broadband receiver for AM, FM, CW, MCW, and pulse modulated signals
- Component tests
- Frequency measurements
- Leakage, interference and radiation measurements
- Bandwidth measurements
- Modulation tests
- Adjacent signal channel tests
- Attenuation measurements
- Filter measurements
- Standing wave measurements

MULTI-PULSE SPECTRUM SELECTOR



MODEL SD-1

Increases the versatility of Polarad Spectrum Analyzers. It displays and allows selection for analysis of a specific train of microwave pulses, as well as any one pulse in the train; selects and gates a group of pulses up to 180 μsec. in length; and is designed to work with fast, narrow pulses; can be adjusted to gate any pulse including the first at zero time. Special circuitry discriminates automatically once pulses have been selected. Operates at any of the frequencies accepted by Polarad Spectrum Analyzers.

FEATURES:

Continuously variable sweep widths; 15 to 180 μsec. • Continuously variable gate widths for pulse selection; 0.4 to 10 μsec. • Continuously variable gate delays for pulse selection; .3 to 180 μsec. • Automatic gating of spectrum analyzer during time of pulse consideration. • Intensified gate (brightening) to facilitate manual pulse selection. • Triggered sweep on first pulse in any train. • No sweep in absence of signal.

SPECIFICATIONS:

Maximum Pulse Train Time 180 μsec. • Pulse Rise Time .05 μsec. Minimum • Minimum Pulse Separation .2 μsec. • Repetition Rate 10—10,000 pps. • Minimum Pulse Width .1 μsec. • Input Power 95 to 130 volts, 50/60 cps., 325 watts. • Input Impedance 50 ohms. • Output Impedance 50 ohms (to match TSA Spectrum Analyzer).

BROADBAND SPECTRUM ANALYZER

FEATURES

- Greatest signal sensitivity over entire frequency band.
- Single frequency control with direct-reading dial accurate to ±1%.
- Complete frequency coverage from 10 mc to 44,000 mc.
- Internal RF attenuator (RF Tuning Unit Models STU-1, STU-2A, STU-3A).
- Adjustable frequency display from 400 kc to 25 mc.
- Frequency differences as small as 40 kc measurable by means of adjustable frequency marker with variable amplitude.
- 25-kc resolution for all bands.
- Stable klystron oscillators using non-contacting plungers to insure longer life.
- No klystron modes to set.
- 5-inch CRT display.
- Portable and completely self-contained.

MODEL TSA

SPECIFICATIONS

Model No.	Equipment
Model Du.....	Spectrum Display and Power Unit
Model STU-1...	RF Tunning Unit 10-1,000 mc.
Model STU-2A.	RF Tuning Unit 910-4, 560 mc.
Model STU-3A.	RF Tuning Unit 4,370-22,000 mc.
Model STU-4	RF Tuning Unit 21,000-33,000 mc.
Model STU-5...	RF Tuning Unit 33,000-44,000 mc.

SPECIFICATIONS:

Frequency Range: 10 mc to 44,000 mc.
Frequency Accuracy: ±1%
Resolution: 25 kc.
Frequency Dispersion: Electronically controlled, continually adjustable from 400 kc to 25 mc per one screen diameter (horizontal expansion to 20 kc per inch)
Input Impedance: 50 ohms—nominal
Sensitivity:*
STU-1 10-400 mcs—89 dbm
400-1000 mcs—84dbm
STU-2A 910-2.200 mcs—87 dbm
1,980-4,560 mcs—77 dbm
STU-3A 4,370-10,920 mcs—75 dbm
8,900-22,000 mcs—60 dbm
STU-4 21,000-33,000 mcs—55 dbm
STU-5 33,000-44,000 mcs—45 dbm
Overall Gain: 120 db
Attenuation:
**RF Internal 100 db continuously variable, IF 60 db continuously variable
Input Power: 400 Watts
*Minimum Discernible Signal
**STU-1, STU-2A, STU-3A

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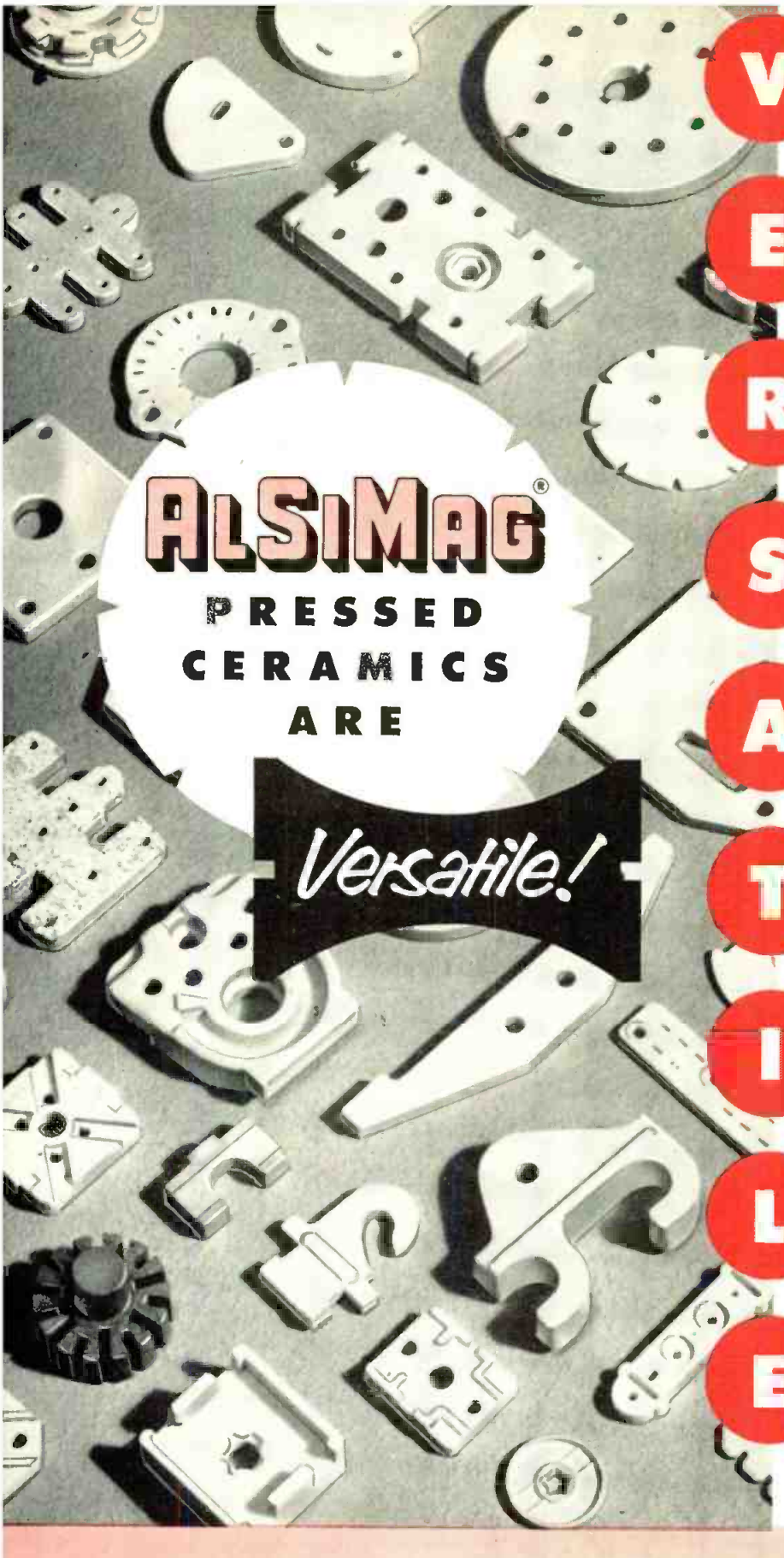
1—Growth of TELE-TECH's Unit Coverage of top-ranking engineers—the magazine's basic readership, preselected for complimentary subscriptions.

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

THE ELECTRONIC INDUSTRIES DIRECTORY

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



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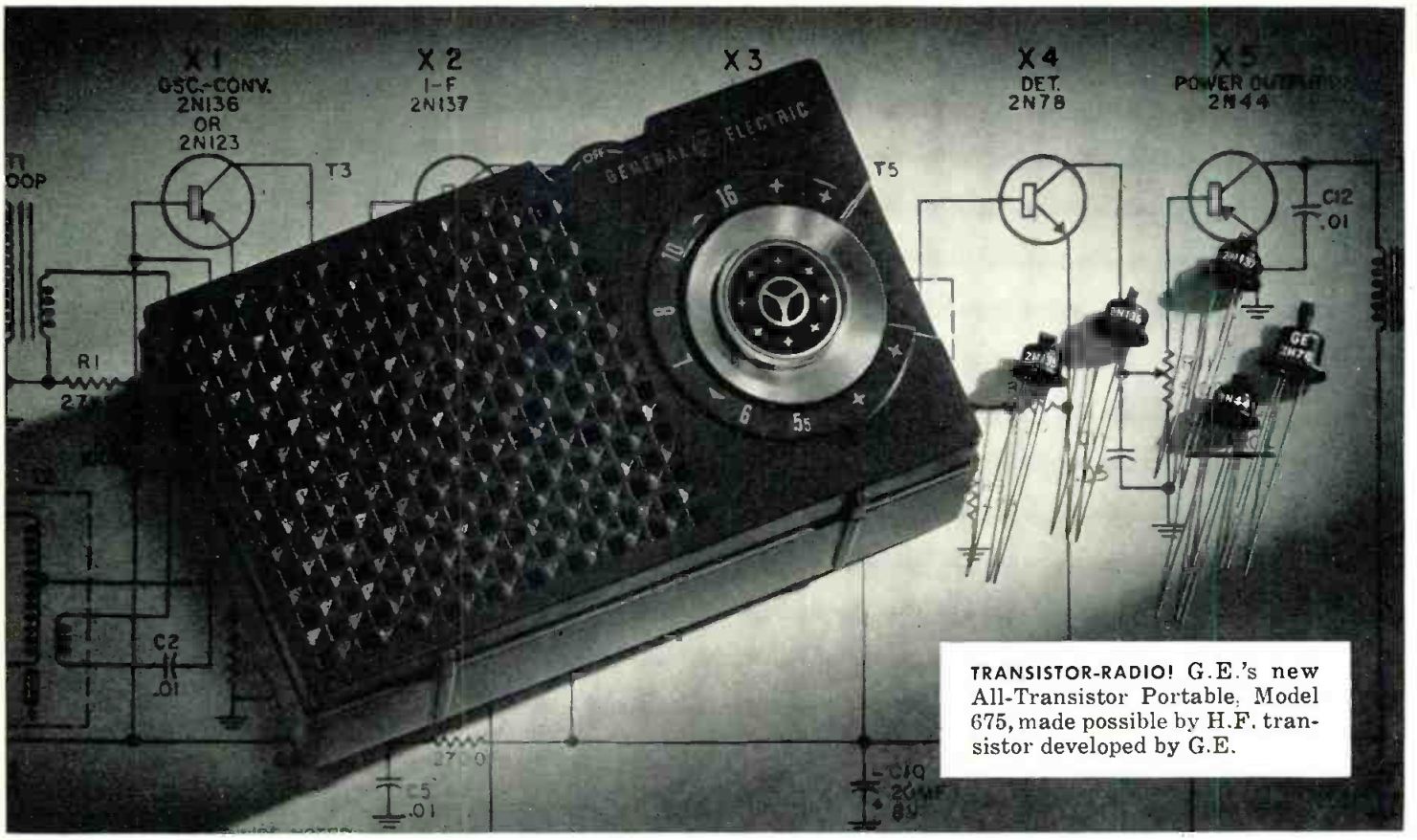

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New G-E H.F. PNP Transistors, 2N135, 2N136, 2N137, Complement the G-E 2N78 NPN

THIS new line of G-E High Frequency PNP Transistors offers immediate benefits to electronics manufacturers for use in RF and IF amplifier circuits. The new High Frequency designs, now in full production, were created specifically for use in radio circuits. The line provides minimum alpha cut-offs of 3 MC, 5 MC and 7 MC—coupled with a 5 ua maximum collector cut-off current. The result: all the high-gain and high-power advantages of other General Electric transistors, *plus* operating ranges extending from 3 to 15 MC depending on the transistor selected.

NOW IN COMMERCIAL RADIO CIRCUITS

In the circuit above, the 2N136 is used as a converter—its 5 MC minimum alpha cut-off assures stable oscillator performance and high conversion gain. The 2N137—with 7 MC minimum alpha cut-off—provides 33 db gain at 455 KC. The high frequency 2N135 offers a higher collector voltage rating for the second IF where it is needed. The 2N78 NPN transistor—originally designed for computer and RF circuitry—proved ideal as a power detector and audio amplifier to drive a 2N44 power output transistor with direct coupling.

PRODUCTION QUANTITIES AVAILABLE

General Electric's new high frequency line is in mass production now. Detailed characteristics and specifications of the G-E 2N135, 2N136, and 2N137 transistors may be obtained upon request. Your G-E Semiconductor specialist and our factory application engineers have the answers to your transistor radio circuit questions. Call them in, or write: *General Electric Co., Semiconductor Products, Section X48105, Electronics Park, Syracuse, N. Y.*

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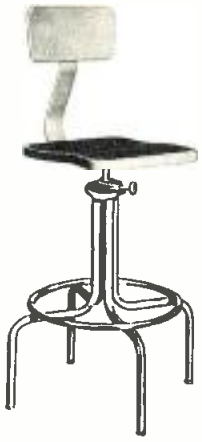

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From any angle, this all welded tubular frame swivel chair reflects the craftsman-like precision synonymous with Royal. Generous 14½" square, heavy steel seat is fitted with scroll shaped tempered Masonite. 4-way flexible backrest is adjustable to individual requirements. Complete with sturdy channel footrest. Height range from 27" to 33".

Royal's exclusive MICRO-HITE seat adjustment!

No tools . . .

Works instantly

Save time and effort, particularly where changing shifts or employees are involved. No need to turn chairs or stools over to adjust seat height. MICRO-HITE is safe, slip-proof, requires only fingertip effort. Simply raise seat to full height, tighten handwheel, sit down. Then turn control handwheel 'til seat lowers to comfortable working height and stop turning the control. *Never a need for maintenance men . . .* MICRO-HITE *adjusts effortlessly!*

No. 501T Stationary Stool

Royal's biggest budget value is this sturdy stationary stool...so handy to have in any shop or factory. 14" diameter, heavy gauge debossed steel seat is fitted with smart, tempered Masonite panel. All welded tubular frame features sturdy channel footrest. Seat height: 30".

Look to Royal for a practical solution to your factory seating problems

No. 621-T Swivel Stool

With round 14" diameter, heavy gauge debossed steel seat fitted with tempered Masonite panel. Tubular frame and channel footrest all welded. Micro-Hite seat adjustment for instant raising or lowering. Adjustable height range from 27" to 33".

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This impeccably tailored posture chair is skillfully proportioned to promote peak performance. Wide seat is deeply padded with 2" of thick foam rubber, upholstery is Super Tuftex...a durable vinyl plastic coated fabric. Shaped, upholstered back adjusts up or down, forward or back. Sturdy steel frame is rigidly constructed—easy to maintain. Complete with handy channel footrest.

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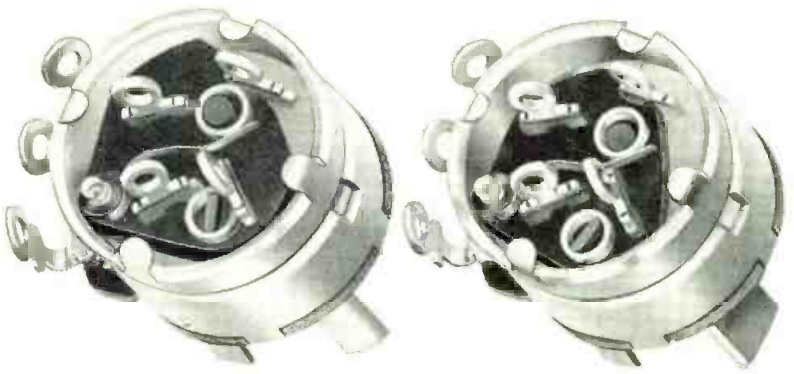
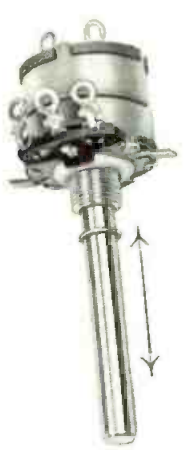


ON OFF

Switch life is greatly increased by this new contact action. Note how "floating" rings of special Mallory alloy make and break the line circuit as the shaft is rotated—providing a continually changing contact surface.

Long-lasting "Floating Ring" Switch* Now Available on Mallory Controls

NEW CONTROL SWITCH WITH PUSH-PULL ACTION



Try this sales-worthy feature in your new set designs. The on-off switch works by push-pull action. Push the shaft and the set turns off . . . pull, and the set turns on *at the same volume setting.* The set owner doesn't have to re-adjust volume, and the control element lasts far longer because it is moved only for minor volume changes. This switch uses the same type of "floating ring" contacts as the new rotary switch. It is available for use with all Mallory carbon controls.

A NEW TYPE rotary switch, embodying unique contact action, is now available on Mallory carbon controls. Make and break is accomplished by spring-snapped motion of rings of special Mallory contact alloy, with positive self alignment. The rings "float" on pins so they can rotate with each operation.

Extremely long service life, proved on actual tests. The floating action spreads wear and arc erosion around the whole circumference of the rings . . . gives cleaner make and break.

Protection against overload damage. The snap spring which moves the contacts carries no current . . . won't heat and anneal when overloads occur.

Positive "feel". Positive snap action "feel" provides definite assurance of switch operation, with minimum torque requirement.

Available for use with all Mallory carbon controls, the new switch *costs no more* than conventional designs. In combination with high stability, long-wearing, low-noise Mallory resistance elements—in values from 250 ohms to 10 megohms—it gives you unequalled control performance. For full facts, write or call Mallory today.

Expect more . . . Get more from

P.R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

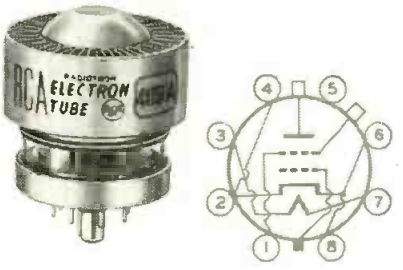
Parts distributors in all major cities stock Mallory standard components for your convenience.

*Patent applied for

RCA DATA FOR

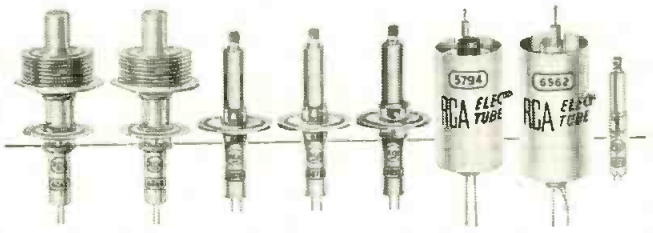
RCA "SPECIAL REDS" COVERED BY WARRANTY TO GIVE AT LEAST TWO YEARS OR 10,000 HOURS OF SERVICE

RCA "Special Reds"—built for long life—are specially designed to withstand extremes of temperature, humidity, atmospheric pressures, vibration, impact, and mechanical shock. Recommended especially for industrial electronics and airborne communications equipment.



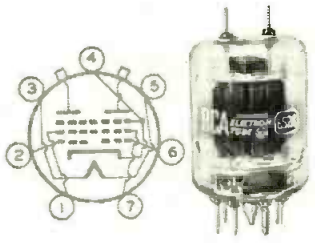
FOR DEPENDABILITY . . . RCA-4X150A BEAM POWER TUBE

RCA-4X150A . . . manufactured at RCA's modern Lancaster plant . . . is a compact, forced-air-cooled, beam power tube of coaxial-electrode construction—with a max. plate-dissipation rating of 150 watts. For UHF power amplifier, or oscillator service up to 500 Mc. Also may be used as wideband amplifier in video applications. The dependability of the RCA-4X150A has been proved in military and commercial applications.



RCA "PENCIL" TUBES FOR METEOROLOGICAL SURVEY, AIRCRAFT CONTROL EQUIPMENT, COMMUNICATIONS, AND UHF TEST EQUIPMENT

RCA-6263,-6264,-5876,-5675,-5893,-5794,-6562, and-6173 . . . eight types featuring small size, light weight, low heater wattage, good thermal stability, minimum transit time, low lead-inductance and low interelectrode-capacitances. These types include tubes for power amplifier, frequency multiplier, pulse detection and oscillator applications. Investigate these highly efficient tubes for your designs. For catalog information on RCA "Pencil" Tubes write for booklet RIT-104.



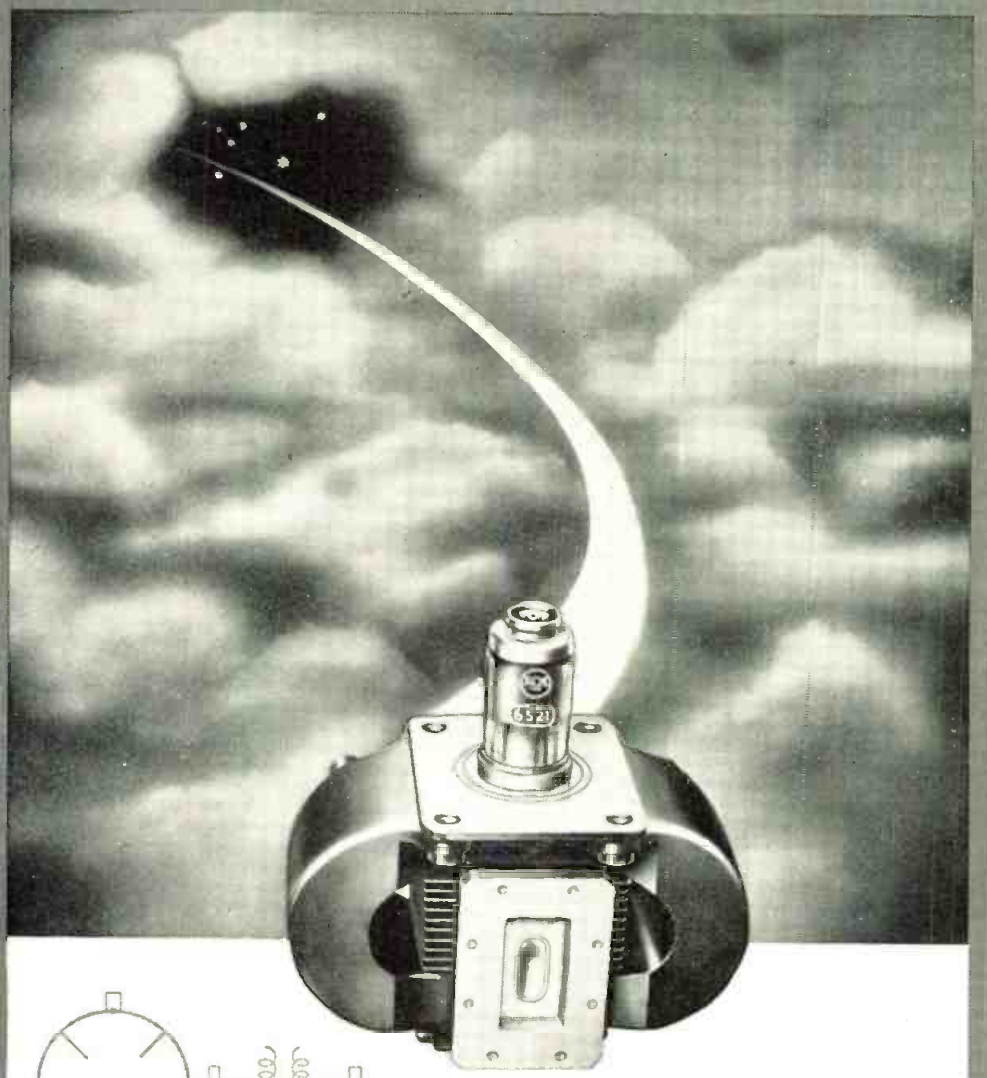
TWIN BEAM POWER TUBE FOR UHF COMMUNICATIONS SERVICES BETWEEN 450 AND 470 Mc

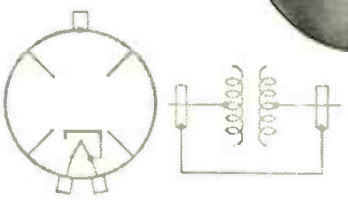
RCA-6524 . . . 25 watts max. plate dissipation (ICAS). As push-pull rf power amplifier in class C service (ICAS) at 462 Mc, the 6524 has a max. power input of 45 watts and can deliver a power output of approximately 20 watts. Features high power sensitivity, compact size, and sturdy construction. For use as push-pull rf power amplifier, frequency tripler, or audio modulator in fixed or mobile communications. (Medium-button septar 7, pin base.)

RCA® RADIO CORPORATION of AMERICA
TUBE DIVISION HARRISON, N. J.

DESIGNERS

ELECTRON TUBES
SEMICONDUCTOR DEVICES
BATTERIES
TEST EQUIPMENT
ELECTRONIC COMPONENTS





NEW "HEART THROB" OF THE AIRLINES

Air navigation, today, conquers stormy weather zones by means of "weather radar" which guides aircraft to the paths of least turbulence. The RCA-6521 Magnetron—the very heart of "weather-radar" equipment—was designed specifically for this service. Of the internal-resonant-circuit type with an integral magnet, the RCA-6521 is designed and conservatively rated for long, reliable performance as a pulsed oscillator at a fixed frequency of 5400 Mc. It is capable of giving a peak power output of 100 Kw.

TWO NEW RCA PUBLICATIONS

#PG101B . . . "RCA POWER & GAS TUBES" . . . 24 pages of technical data on 178 RCA vacuum power tubes including forced-air-cooled and water-cooled types, rectifier types, thyratrons, ignitrons, magnetrons, and vacuum-gauge types.

#RIT-104 . . . "RCA RECEIVING-TYPE TUBES FOR INDUSTRY AND COMMUNICATIONS" . . . 20 pages of technical data on 130 RCA small industrial tubes including "Special Reds", "Premium" types, "Pencil" and other types for special UHF applications, glow-discharge types, thyratrons, computer types, low-microphonic types, and many other types.

Call Your RCA Representative:

East: HUmboldt 5-3900
744 Broad Street
Newark 1, N. J.

Midwest: WHitehall 4-2900
Suite 1181,
Merchandise Mart Plaza,
Chicago 54, Ill.

West: MAdison 9-3671
420 S. San Pedro Street
Los Angeles 13, Calif.

FOR TECHNICAL INFORMATION

Write: RCA, Commercial Engineering, Section J 50R, Harrison, N.J. Use this coupon. Circle items in which you are interested.

"Special Reds" 6521 4X150A 6524
Booklet #RIT-104 Booklet #PG101B

Name_____

Position_____

Company_____

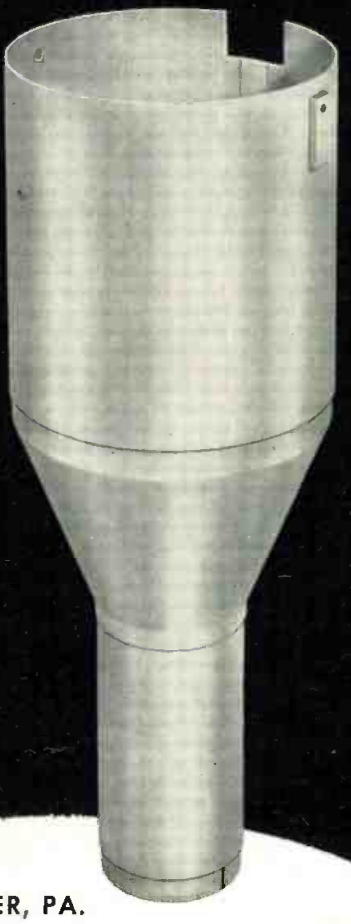
Address_____

PERFORMANCE-GUARANTEED

Magnetic Shields

COST NO MORE-

WHY TAKE LESS?



You're time and money ahead with Performance-Guaranteed Magnetic Shields, for our shields are *guaranteed* to meet the requirements of your circuit to mutually agreed upon shielding specifications. Dry hydrogen annealed, as required . . . of MuMetal, A.E.M. 4750, or whatever commercially available material is most suitable . . . fabricated or drawn . . . painted or lacquered to match any shade, or unfinished. Write for the industry's most complete catalog, MS-104, today.

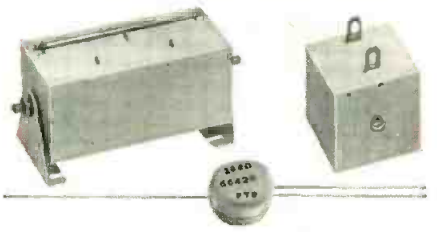
MAGNETICS inc.

DEPT. TT-26, BUTLER, PA.

Standard Heavy-Duty Stacks

Extremely long life . . . with no maintenance problems. Thousands of voltage/amperage combinations available. Sizes from 11/16" square cells to giant 6" x 10" plates . . . Federal can provide a power rectifier for almost every type of industrial and military equipment.

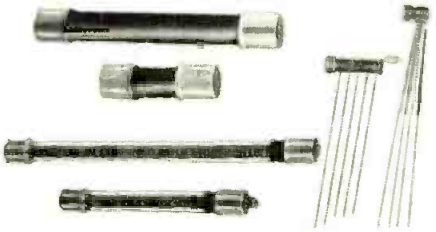
Encapsulated Rectifiers



Maximum resistance to impact, acceleration, and vibration. Complete protection from harmful atmospheric conditions. Other electronic components may be encapsulated with rectifier to form a rugged, replaceable "potted" circuit.

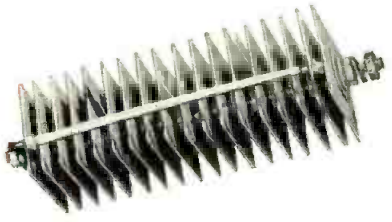
Why INDUSTRY and DEFENSE LOOK TO Federal FOR THE FINEST IN SELENIUM RECTIFIERS

High-Voltage Stacks



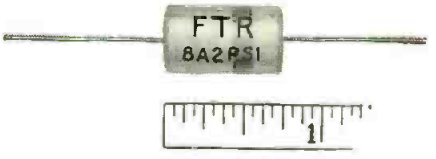
250 to 5000 volts/5 to 40 milliamps. Encased in paper, glass, Bakelite, nylon, or metal tubes. Simple fuse-clip mounting of ferrule terminal types. Also, hermetically-sealed types. Uses: CRT high-voltage supplies, photoflash, insulation testers, etc.

High-Temperature Stacks



For maximum operating life at ambient temperatures up to 150° C. A full range of voltage/current combinations for medium and high temperatures. Ideal for aircraft and military equipment.

Selenium Contact Protectors



Extend contact life by over 1000 times. Used in inductive circuits to prevent erosion of switch contact surfaces . . . to suppress arcing and rf transients. Minimum effect on release time. Hermetic sealing meets JAN specs. For relays, electromagnets, and telephone systems.

Magnetic Amplifier Rectifiers

Selenium cells and stacks precisely manufactured, tested, and selected to assure a high degree of stability and very low reverse current. For use with saturable reactors, regulated DC power supplies, etc.

LET US KNOW your AC-to-DC conversion problems. For further information on Federal Industrial Rectifiers, call NUtley 2-3600, or write to Dept. F-866

Pioneering Leadership

Federal is the *original* supplier of selenium rectifiers in the United States . . . leading the field in research, development and production.

Facilities and Service

Federal's facilities can handle the largest and most complex orders ...satisfy the rush requirements of customer production peaks. Every order—large or small—is processed through a skilled engineering staff.

Quality and Economy

Federal's modern fabrication methods, mass production, intensive quality control, and rigid testing assure a product of highest quality and greatest economy.

Federal Telephone and Radio Company

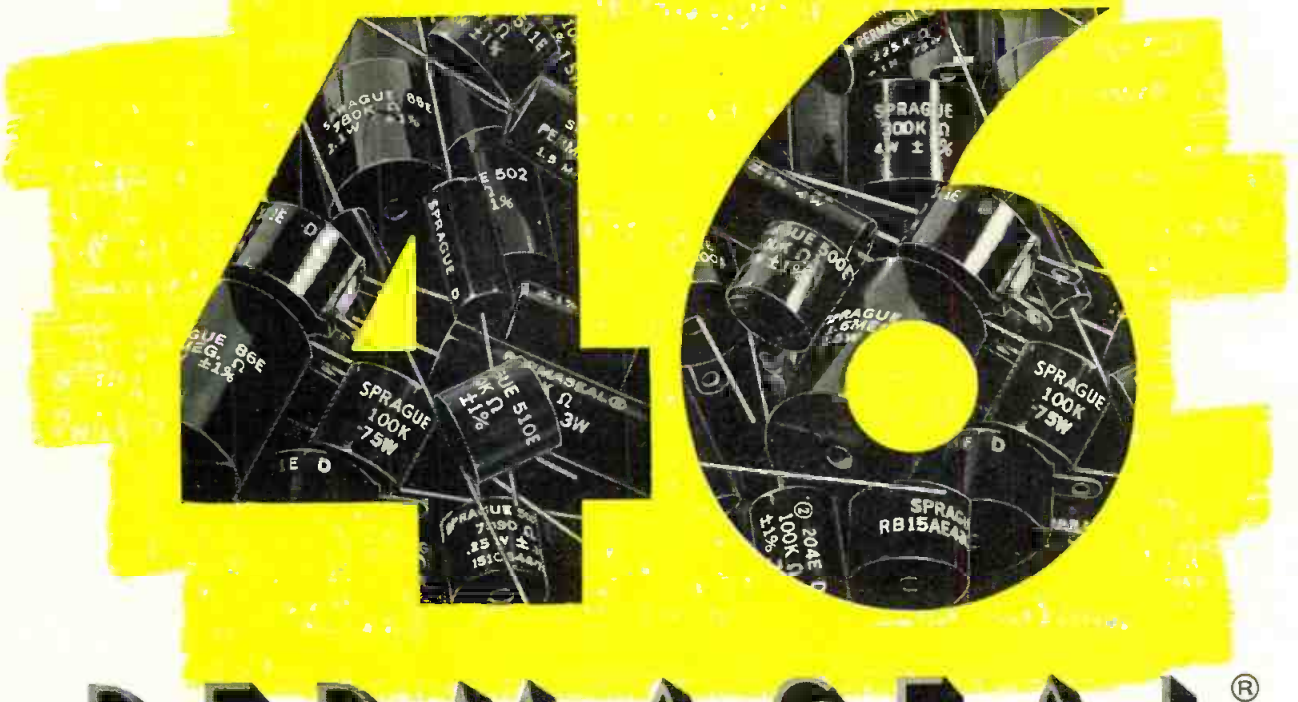
A Division of INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

COMPONENTS DIVISION · 100 KINGSLAND ROAD · CLIFTON, N. J.

In Canada: Standard Telephones and Cables Mfg. Co. (Canada) Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., New York

Federal
FEDERAL TELEPHONE & RADIO FTR
A DIVISION OF I T & T

A COMPLETE LINE OF DEPENDABLE ENCAPSULATED RESISTORS



PERMASEAL®

PRECISION, WIREWOUND RESISTORS FOR 85° AND 125° AMBIENTS

You can choose from 46 standard designs in tab and axial lead styles to meet requirements for all types of military and industrial electronic apparatus and instruments.

This complete line of Permaseal Resistors is designed for applications which require highly accurate resistance values in small physical size at 85°C. and 125°C. operating temperatures.

Protected by a special Sprague-developed plastic embedding material, Permaseal Resistors provide maximum resistance to high humidity (they meet severe humidity requirements of MIL-R-93A and proposed MIL-R-9444 USAF).

The winding forms, resistance wire, and embedding material are matched and integrated to assure long term stability at rated wattage over the operating temperature range.

These high-accuracy units are available in close resistance tolerances down to 0.1%. They are carefully and properly aged for high stability by a special Sprague process.

FOR COMPLETE DATA WRITE FOR COPY OF SPRAGUE ENGINEERING BULLETIN NO. 122A

SPRAGUE

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

As We Go To Press...

Emergency 2-Way Radio Cut Fire Damage

An emergency 2-way radio communication system that enabled fire-fighting crews to coordinate their activities after the plant's telephone system had been burned out was credited with confining the damage caused by the recent refinery fire at Whiting, Ind., to a relatively small area.

The first blast at the Standard Oil refinery came at 6:10 AM and within a short time a successful fire-fighting pattern had been established. Scores of truckloads of sand were rolling into the refinery for the construction of emergency dikes.

At this point the fire ate into the main telephone terminal block and the entire plant telephone system went dead, including outside lines.

Mobile radio units at strategic points along the plant boundary roads, at plant gates and close to the disaster scene itself directed the incoming trucks. Every key traffic area and critical zone had a mobile unit, with runners, which relayed orders from the fire marshal's office.

The 250-watt base station at the company's administration building went out of operation when the signal and control lines to the transmitter were destroyed. But dispatching was quickly restored by moving a mobile radio truck beside the fire marshal's office.

A total of five of the remote control points of the normal radio system went out of service. All were quickly restored by using mobile radio units as dispatcher stations.

BIRTHDAY PARTY: Dr. Lee DeForest cuts his 82nd birthday cake at a party given in his honor by Dr. and Mrs. C. J. Breitwesser (r and l). Dr. Breitwesser is vice-pres. of Lear Inc. Mrs. DeForest is at rear.

$5 Million Navy Contract For Navigation System

A $5,000,000 contract for the production of an advanced type automatic navigation system has been awarded by the Navy to the Ryan Aeronautical Co., San Diego, Calif.

The new equipment, known as the AN/APN-67 and developed over a four-year period by Ryan, enables Navy planes to fly to any point on the earth's surface without relying on ground facilities. The unit employs a continuous wave radar technique.

For the aircraft's navigator, the Ryan equipment provides continuous information on position, ground speed, ground mileage, drift angle, course error and ground track of the airplane. For the pilot, this information is automatically integrated and presented on a single instrument which permits him to fly directly to his destination.

Stromberg-Carlson Expands WC Activity

West Coast production facilities for two lines of automation and computer equipment have been taken over by the Stromberg-Carlson Division of General Dynamics Corp.

In San Diego, Stromberg-Carlson has taken over the production of the Charactron tube from the Convair Division of General Dynamics Corp., and in Los Angeles, the firm has acquired Electronic Control Systems Inc., which specializes in automation, electronic computers, and data handling systems.

These West Coast activities are being coordinated under Stromberg-Carlson—West Coast, with offices at San Diego and headed by Leonard Mautner; former asst. vice-pres. of Stromberg-Carlson.

New High Power Radar Announced By Marconi

A high power radar for use in storm detection has been introduced by Marconi's Wireless Telegraph Co. Ltd.

The new equipment, designated the Marconi SNW50, operates within the frequency band 9360 MC and 9460 MC (X-band) with a peak power output of approximately 50 KW. Standard equipment consists of four main items, transmitter, scanner, and display units.

MORE NEWS on page 22

Mobile Radio Fights Refinery Fire

Fire scene is shown (c) 30 Hrs. after blast. Dispatcher (l) directs traffic using 25-watt Motorola base station. Right, Fire marshal's office at height of blaze

SOMETHING NEW FROM VARIAN...

HIGH STABILITY

WITHOUT ELECTRONIC COMPONENTS

VA-1281
Stalo Cavity
with VA-201 klystron

VA-1282
Stalo Cavity
with X-26 klystron

VA-1280
Stalo Cavity
with VA-201 klystron

Now—with Varian's new line of high Q Cavities, frequency stabilized local oscillators (Stalos) utilizing direct cavity stabilization are commercially practical. Varian Stalo Cavities provide a very high degree of short time frequency stability. Stabilization is completely independent of the frequency of oscillator fluctuations and external disturbances . . . an inherent advantage over electronic stabilization systems utilizing the feedback principle. Elimination of all electronic components except the klystron oscillator also affords greater reliability and longer life.

The ratio of the oscillator modulation sensitivity to the modulation sensitivity of the stabilized oscillator defines the stabilization factor of the cavity. Varian Stalo Cavities are available in three models—VA-1280, 1281 and 1282—offer stabilization factors from 15 to 160 . . . cover a wide range of important applications, including stabilization of signal sources in high power klystron transmitters . . . airborne uses in conjunction with receiver local oscillators . . . laboratory testing. When used with Varian's new highly stable reflex klystron oscillators, stability comparable to that of many crystal controlled oscillators can be obtained.

COMPLETE TECHNICAL DATA and specifications are now available.

Your inquiry is cordially invited.

THE MARK OF LEADERSHIP

VARIAN associates
PALO ALTO 10, CALIFORNIA
Representatives in principal cities

KLYSTRONS, TRAVELING WAVE TUBES, BACKWARD WAVE OSCILLATORS, R. F. SPECTROMETERS, MAGNETS, STALOS, UHF WATERLOADS, MICROWAVE SYSTEM COMPONENTS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES

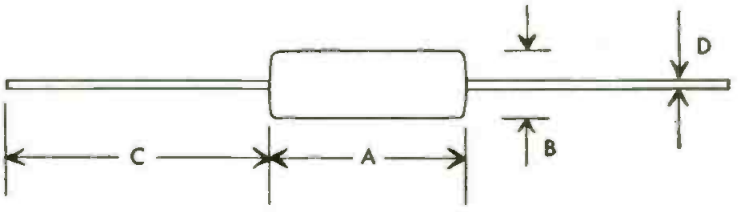
NOW

1/8, 1/4 and 1/2 watt *Molded* Precistors

IRC *molded* Deposited and Boron Carbon Precistors are now available in 1/8, 1/4 and 1/2 watt sizes. These 1% precision film type resistors combine the advantages of high stability, small size and low cost in either deposited carbon or boron carbon units. Ratings are based on full load at 70°C. ambient.

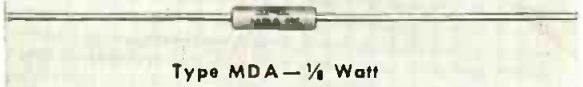
The *molded* plastic housing provides complete mechanical protection, minimizes the effect of moisture and improves load life characteristics.

Equivalent In Size To IRC's Popular Types BTS • BW½ • BTA



Precistor Types	IRC Size Equivalent	Dimension			
		A	B	C	D
MDA — MBA	BTS	13/32"	1/8"	1½"	.025"
MDB — MBB	BW½	5/8"	3/16"	1½"	.025"
MDC — MBC	BTA	23/32"	1/4"	1½"	.032"

MOLDED DEPOSITED CARBON PRECISTORS



Type MDA — 1/8 Watt

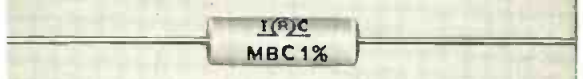
Type MDB — 1/4 Watt

Type MDC — 1/2 Watt

MOLDED BORON CARBON PRECISTORS

Type MBA — 1/8 Watt

Type MBB — 1/4 Watt



Type MBC — 1/2 Watt

Precision Wire Wounds • Ultra HF and Hi-Voltage Resistors • Low Value Capacitors • Selenium Rectifiers • Insulated Chokes • and Hermetic Sealing Terminals

Wherever the Circuit Says

Voltmeter Multipliers • Boron & Deposited Carbon Precistors • Controls and Potentiometers • Power Resistors • Low Wattage Wire Wounds • Germanium Diodes • Insulated Composition Resistors

IRC

INTERNATIONAL RESISTANCE CO.

Dept. 583, 401 N. Broad St., Philadelphia 8, Pa.

In Canada: International Resistance Co., Ltd., Toronto, Licensee

Send me data on:

- ☐ Molded Deposited Carbon Precistors
- ☐ Molded Boron Carbon Precistors

Name_____

Company_____

Address_____

City_____ State_____

For Generation of Pulse Voltages-

CHATHAM

MODEL 5C22

HYDROGEN THYRATRON

A three electrode zero bias thyratron with peak power handling capacity to 2.6 megawatts

ELECTRICAL DATA

	MIN.	BOGEY	MAX.	
HEATER VOLTAGE	5.8	6.3	6.8	Volts
HEATER CURRENT @6.3V	9.6	10.6	11.6	Amps
CATHODE HEATING TIME	300			Sec.
ANODE VOLTAGE DROP, PEAK	100	150	200	Volts

For detailed characteristic data request sheet DSW-104-1

MAXIMUM RATINGS — Absolute Values

Maximum Peak Anode Voltage	
Inverse	16 Kilovolts
Forward	16 Kilovolts
Minimum Peak Anode Voltage	
Inverse	800 Volts
Forward	4500 Volts
Maximum Cathode Current	
Peak	325 Amperes
Average	200 Milliamperes
Averaging Time	1 Cycle
Minimum D.C. Anode Voltage	4500 Volts
Maximum Operating Frequency (Note 1)	1000 cps
Minimum Peak Trigger Voltage	200 Volts
Maximum Peak Trigger Voltage	600 Volts
Maximum Heating Factor (Note 2)	3.2×10^9
Maximum Current Rate of Rise	1500 Amps/μs.
Maximum Anode Delay Time	1 μs.
Maximum Time Jitter	0.02 μs.
Ambient Temperature	+90 to −50°C

NOTE 1: This is not necessorily the upper operating frequency limit but represents the highest repetition rate for present life test requirements.

NOTE: 2. Heating factor is the product (epy x prr x ib).

CHATHAM TYPE VC-1257

Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of pulse power up to 33 megawatts.

CHATHAM TYPE 5948/1754

Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of peak pulse power up to 12.5 megawatts.

CHATHAM TYPE 5949/1907

Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of peak pulse power up to 6.25 megawatts.

CHATHAM TYPE VC-1258

Zero bias miniature hydrogen thyratron for the generation of peak pulse power up to 10 KW. Also available with a 28 v heater and in a super ruggedized type for extreme vibration.

Chatham Hydrogen Thyratrons are the product of many years of concentrated experience in this specialized field. Embodying the most advanced developments in the art, the tubes illustrated offer uniformly high performance when employed in the generation of pulse voltages in the order of microseconds. For complete data and specifications on Chatham Hydrogen Thyratrons, call, write or wire today — no obligation.

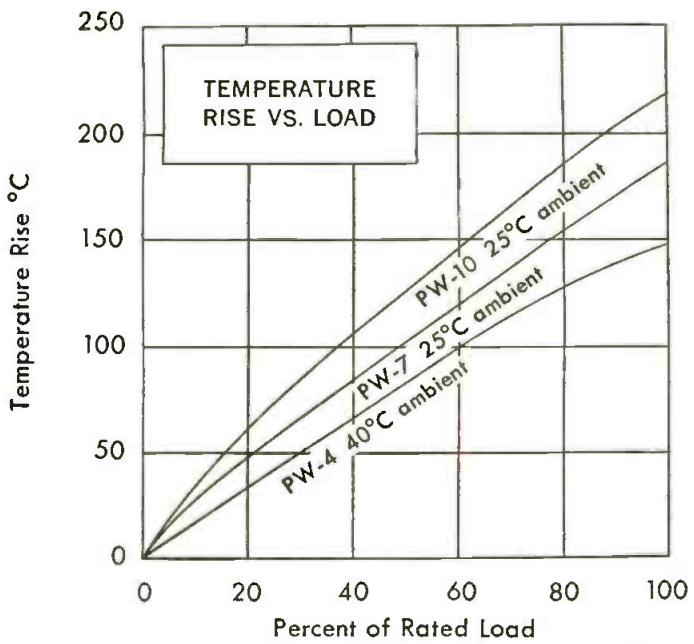
Chatham Electronics

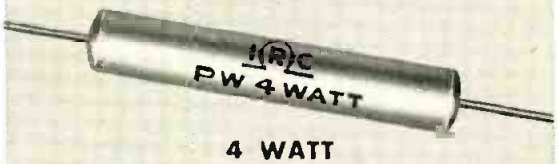
DIVISION OF GERA CORPORATION — LIVINGSTON, NEW JERSEY

NOW

3 *new* wire wound resistors

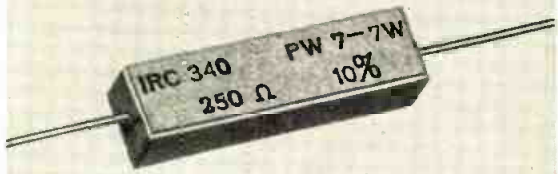
IRC's new power wire wounds are lower cost per watt than any other power type. At 4, 7 and 10 watts, they offer savings of several cents each in any application requiring compact, low cost, efficient power resistors. Types PW-4, PW-7 and PW-10 resistors assure safe operation in circuits where stability and low wattage dissipation are needed.





4 WATT

Type PW-4 allows safe operation with hot-spot temperatures up to 165°C. Fully insulated housing will not burn or support combustion.



7 WATT

Types PW-7 and PW-10 allow safe operation with hot-spot temperatures up to 275°C.

10 WATT

UNUSUAL DESIGN AND ASSEMBLY TECHNIQUE PROVIDES LOWER COST PER WATT.

SEND COUPON FOR DATA BULLETINS

Voltmeter Multipliers • Boron & Deposited Carbon Precistors • Insulated Composition Resistors • Power Resistors • Volume Controls • Low Wattage Wire Wounds •

Precision Wire Wounds • Ultra HF and Hi-Voltage Resistors • Selenium Rectifiers • Insulated Chokes • Hermetic Sealing Terminals •

IRC

INTERNATIONAL RESISTANCE CO.

Dept. 583, 401 N. Broad Street, Philadelphia 8, Pa.

In Canada: International Resistance Co., Ltd., Toronto, Licensee

Please send ☐ Bulletin P-1 on PW-4 Resistors
☐ Bulletin P-2 on PW-7 and PW-10 Resistors.

Name_____

Title_____

Company_____

Address_____

City_____ State_____

As We Go To Press . . . (Continued)

Electronic Lens Tester Developed by RCA

An electronic instrument which enables optical scientists to evaluate and grade the performance quality of lenses in objective mathematical terms has been developed experimentally by RCA.

RCA's M. C. Batsel demonstrates tester

An RCA spokesman pointed out that, until now, the lens sharpness, contrast and gradation had been determined solely by visual tests. With the new equipment lens users will be able to select by specific grade lenses with exact characteristics for given applications with unprecedented accuracy, speed and economy.

AIEE Elects Officers For Broadcast Committee

The American Inst. of Electrical Engineers recently announced the appointment of new officers for the 1955-56 term of the Committee on Television and Aural Broadcasting Systems.

Re-elected chairman was J. B. Epperson, chief engineer, Scripps-Howard Radio & TV; re-elected vice-chairman, C. M. Braum, consultant, Joint Committee on Educational Television, Washington; and secretary, Carl E. Smith, of Carl E. Smith Consulting Radio Engineers.

Bell System Adds WKRG-TV

Station WKRG-TV, Mobile, Ala. was recently connected to the Bell Telephone System network of TV facilities. Network programs are fed to WKRG-TV from a transmitter at Mt. Vernon, Ala., a station on the Meridian, Miss.—Pensacola, Fla. radio relay route. With the addition of this station network programs now reach 371 stations in 246 cities in the U. S.

IRE Medal Of Honor Awarded To Hogan

John V. L. Hogan, president of Hogan Laboratories and founder of station WQXR, has been named the recipient of the IRE Medal of Honor, the highest technical award in the radio engineering profession. The award, which was given "For his contributions to the electronic field as a founder and builder of The Institute of Radio Engineers, for the long sequence of his inventions, and for his continuing activity in the development of devices and systems useful in the communications art," will be presented during the IRE National Convention in New York City next March.

In 1912 Mr. Hogan helped found the Institute of Radio Engineers, which has since grown to an international membership of over 43,000. He also served as vice-president of the IRE from 1916 to 1919 and President in 1920.

SMPTE Award to O'Brien

Richard S. O'Brien of the Columbia Broadcasting System has been named the winner of the 1955 Journal Award of the Society of Motion Picture and Television Engineers for "the most outstanding paper originally published in the Journal of the Society during the preceding calendar year." Mr. O'Brien was selected for his paper "CBS Color Television Staging and Lighting Practices" which appeared in the Aug. 1954 Journal. The award will be presented to Mr. O'Brien on Oct. 4th, during the Society's 78th Convention at the Lake Placid Club, Essex County, New York.

Selenium Salvage Program

The acute selenium shortage, which has reportedly already forced a number of selenium rectifier manufacturers to shut down, has prompted the government, through other rectifier manufacturers, to make a plea for return of the used defective units for salvage purposes. Sarkes Tarzian Inc., Rectifier Div. announces that they are offering 10¢ merchandise credit for each rectifier returned, regardless of make.

New Advances in Silicon Rectifiers at Westinghouse

Power silicon diodes that will handle up to 3,000 watts of power with savings in space and weight of up to 70 to 1 over selenium rectifiers have been announced by the Semiconductor Dept., Westinghouse Electric Corp.

Technical specifications reveal that the voltage drop across the rectifier has been reduced to only 0.7 v. at 8 a.

Silicon rectifiers are exceptionally compact

and at a cell temperature of 190° C. Efficiency of the new rectifiers is greater than 99%, as compared to 95% for selenium.

The new power silicon diodes are available in four voltage classifications: 50, 100, 150 and 200 v. Forward current rating is 8 a. with natural convection cooling in ambient air at 25° C. Higher current ratings up to 40 a. can be achieved with forced cooling.

Emergency Phone System

A new phone system that enables firemen or policemen to talk directly to the person placing an alarm has been announced by Bell Telephone Labs.

Outdoor telephone sets in brightly painted housing are mounted at street corners. When the receiver is removed from the hook the caller is in direct contact with his local fire station. If the call is for police the call is transferred to the police department switchboard.

When the call is made a light flashes on a console at alarm headquarters which indicates the box number and location, so that the operator knows where the alarm is coming from even if the person reporting the emergency is too excited to talk.

More News on p. 24

Raytheon — World's Largest Manufacturer of Magnetrons and Klystrons

now available

NEW Consolidated Data Booklets for Raytheon Magnetrons, Klystrons and Special Tubes

WRITE FOR YOUR COPIES

These valuable free data booklets, which we will be glad to send you, list most of the principal unclassified types manufactured. They give maximum ratings, typical operating values, frequency ranges, and power levels. Indispensable to every engineer's file.

Raytheon is the world's largest producer of CW and pulse magnetrons, available in either fixed or tunable designs. A compact, efficient source of microwave power, magnetrons are being used in a growing number of applications.

Raytheon klystrons, which can be tuned mechanically or thermally, fit the widest range of requirements from 550 to 60,000 Mc.

The special tubes include backward wave oscillators, square law tubes, storage tubes and others.

Write today for your data booklets—or telephone WAltham 5-5860. There is no obligation, of course.

Excellence in Electronics

RAYTHEON

RAYTHEON MANUFACTURING COMPANY

Microwave and Power Tube Operations, Section PT-39, Waltham 54, Mass.

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

As We Go To Press (cont.)

Varian Expands Plant Facilities at Palo Alto

Two new wings, housing 25,000 sq. ft. of work space, are now in the process of construction at Varian Associates' Palo Alto, Calif. plant. The additional space will bring the total plant area to 63,000 sq. ft., reports H. Myrl Stearns, general manager.

The expansion has been dictated by Varian's increased work in the field of nuclear magnetic resonance, which has produced a growing line of spectrometers, and associated equipment, electromagnets, power supplies and graphic recorders. Varian microwave engineering has also been broadened to include radar transmitters and other electronic sub-systems.

Communications Conclave

A symposium on "Communication By Scatter Techniques," sponsored by the IRE Professional Group on Antennas and Propagation, the Professional Group on Communication Systems, and The George Washington Univ., will be held in Washington, D.C. on Nov. 14 and 15, 1955.

The technical program will include four sessions, on Propagation Mechanisms, Communication Systems, Antennas, and Propagation Studies.

Advance registration fee is $2.50, and the registration may be made by mailing a check or money order for that amount to "Scatter Symposium," Geo. Washington Univ., School of Engineering, Washington 6, D.C., prior to Oct. 31, giving a return address.

AIEE Transistor Study

An eleven-session education program covering "Transistor Theory and Application" will be given this Fall by the N.Y. section of the AIEE. The program, open to the public, is under the sponsorship of the Education Committee of the Power and Industrial Division.

The program will start on Sept. 27 with a lecture on the physics of semi-conductors by Dr. Wm. Shockley of Bell Labs. The sessions are being held on the Tuesdays of each week, from 6:30 to 8:30 P.M., beginning Sept. 27, 1955, at the Western Union Auditorium, 60 Hudson St., N.Y.C.

MORE NEWS on page 34

Label courtesy of Rembert Wurlitzer

MARK OF THE CRAFTSMAN...

Just as the mark of the master craftsman is applied only to those articles worthy of his reputation, the FXR seal on Precision Microwave Test Equipment marks each production line unit as a masterpiece of custom craftsmanship.

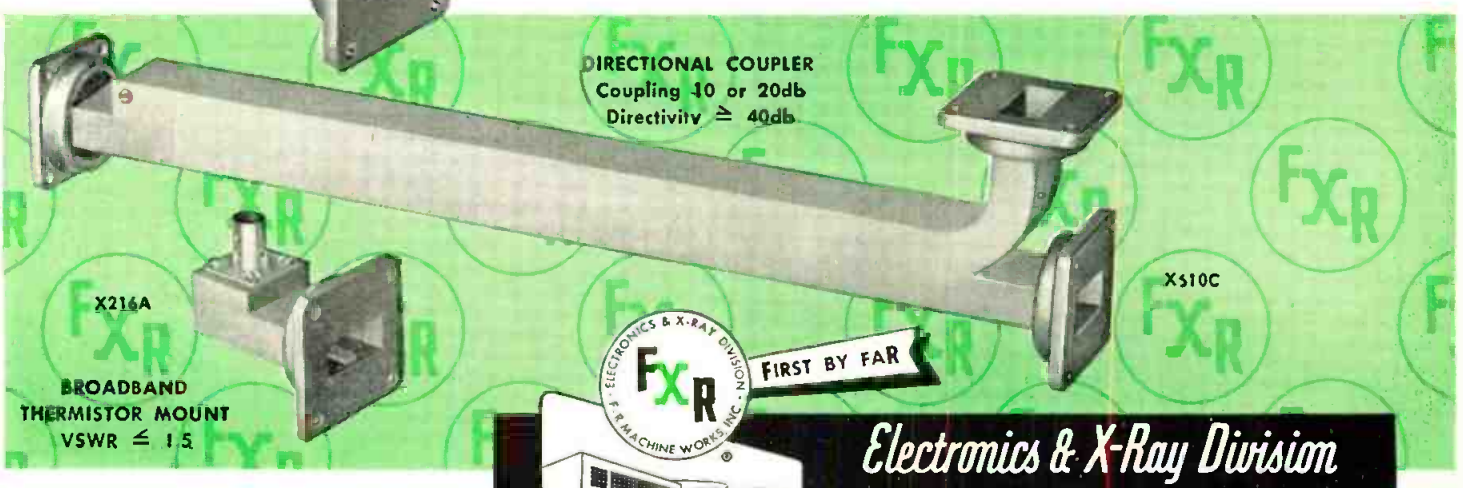
DEPENDABLE SUPPORT ITEMS FOR MICROWAVE SYSTEMS

Stradivarius aimed for the perfect violin. At FXR, the goal is perfection in microwave components. The Waveguide-to-Coax Adapter, the Directional Coupler, and the Broadband Thermistor Mount shown below were designed with excellent characteristics over the entire waveguide frequency range. They are only part of our complete line, each item of which is in its own way a masterpiece of mechanical design and electronic performance. These are products worthy of the name they carry and the industry they serve.

Send for the FXR catalog, showing a complete line of custom-crafted Precision Microwave Test Equipment.

WAVEGUIDE-TO-COAX ADAPTER
VSWR ≤ 1.25

X601B



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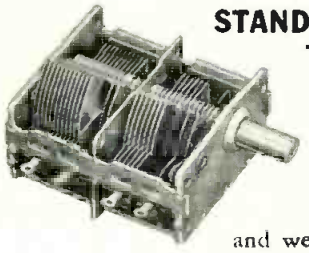
TUNE IN ON RADIO CONDENSER

For Variable Capacitors
Tuners
Electromechanical Assemblies

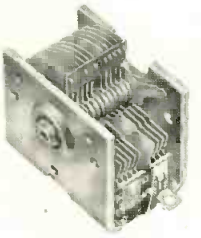
The experience of Radio Condenser in producing tuners and variable capacitors to individual requirements has consistently proved its value to manufacturers through the right combination of quality and cost. However unusual a problem may be, chances are that R/C specialists have faced a similar problem and solved it.

The products shown on this page are only a brief sampling of units designed, engineered, and manufactured by Radio Condenser. A more complete description of products in each category is given in our catalog, available on request. Or, we will be happy to arrange a direct interview with a Radio Condenser Engineer at your convenience.



STANDARD HOME RADIO TYPE CAPACITORS

R/C units cover every standard application, including AM-FM receivers. Each is a product of high quality, performance-proved, and well adapted to rapid, low cnst quantity production.

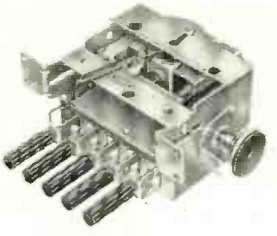


CAPACITORS FOR LIMITED SPACE

Among the most recently announced R/C developments is a miniature variable capacitor for transistorized radio receivers, also adaptable to color TV phasing contrnl. R/C accomplished important reductions in size with no sacrifice nf stability or calibration accuracy.

UHF AND VHF TELEVISION TUNERS

R/C has provided tuners for major TV manufacturers since the earliest days of commercial TV. While most .such tuners are secret designs, R/C has recently developed low cost standard tuners in several styles for UHF and VHF TV.



AUTOMOTIVE RADIO TUNERS

Approximately one-third of all American automnbiles are equipped with R/C tuners. Because every automobile radin tuner is an individual case, R/C custom manufacturing experience is an impnrtant asset to the radio manufacturer in this specialized field.

STANDARD CAPACITORS FOR SPECIAL APPLICATIONS

Always an important part of R/C activities, design and manufacture of variable capacitors of a special nature are handled by a special division. Products include units for every type of military service, test equipment, etc.

ELECTRO-MECHANICAL ASSEMBLIES

As a contract manufacturer of electromechanical assemblies for industrial and military electronic equipment, automatic data processing systems, etc., R/C also offers engineering assistance in development and modification, leaving you completely free of production worries and details. Complete information on this well-qualified division is available on request.

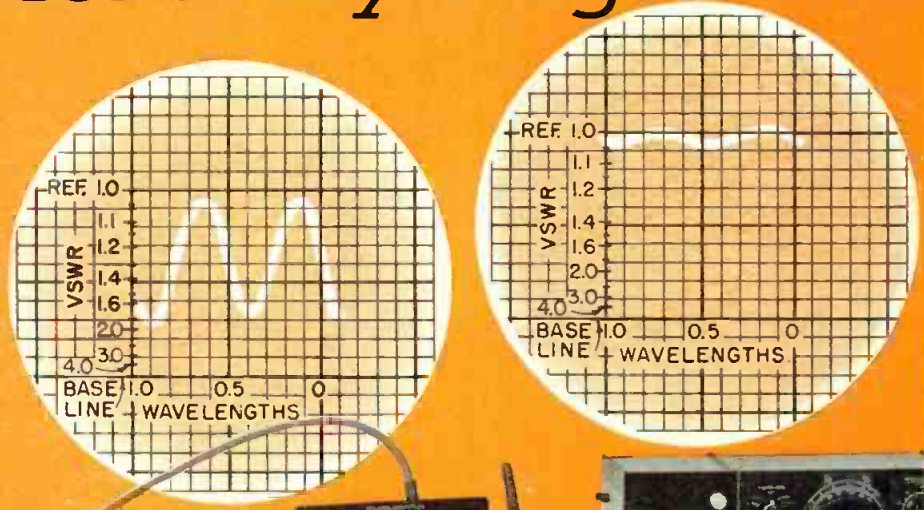
RADIO CONDENSER CO.

Davis & Copewood Streets • Camden 3, New Jersey

EXPORT: Radio Condenser Co., International Div., 15 Moore St., N.Y. 4, N.Y. CABLE: MINTHORNE

CANADA: Radio Condenser Co. Ltd., 6 Bermondsey Rd., Toronto, Ontario

for *Busy Engineers* ...not Lazy ones



VSWR of 1.8 to 1.02

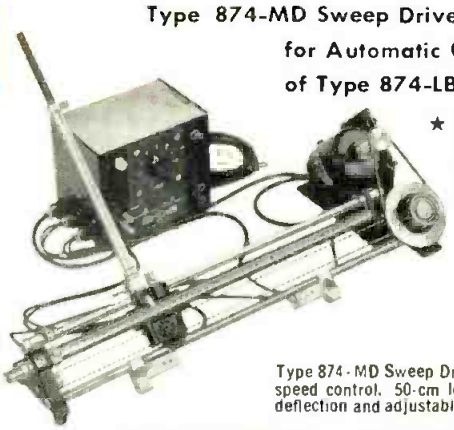
in a Fraction of a Minute

Anyone who has adjusted a three-stub matching network for minimum VSWR at microwave frequencies knows this is a time-consuming trial and error operation.

With the new G-R Type 874-MD Sweep Drive providing automatic sweep for the Type 874-LBA Slotted Line, this adjustment can be accomplished in 45 seconds. Without automatic sweep, the job could take as long as 15 minutes; two dozen or more stub adjustments and slotted-line hand-driven operations might be required before the matched condition is accomplished. This relatively simple application is an excellent example of the benefits which can be derived through an Automatic Sweep for the precision Type 874-LBA Slotted Line.

Wherever load adjustments or settings of any kind must be made in production or laboratory . . . to minimize VSWR, create a matched condition or to arrive at some desired impedance . . . the Sweep Drive can save hours of valuable engineering time. While the Slotted-Line probe carriage is automatically driven back and forth along the Line, the load adjustment or change is made slowly but *continuously*, as one notes the consequent change in VSWR pattern on the CRO face (or meter dial). The instantaneous indication of VSWR for each immediate setting provides the feedback link, via the operator's eye, which permits him to quickly "ease" the adjustable element in the load into the optimum position. There are no trial and error operations. The correct condition is arrived at the first time.

Type 874-MD Sweep Drive
for Automatic Cyclic-Sweeping
of Type 874-LBA Slotted Line



★ SWEEP SPEED — continuously adjustable from one full sweep (46 cm) in more than 10 seconds, to one full sweep in less than one second.

★ SWEEP RANGE — continuously adjustable from 1 cm to 46 cm.

★ CRO HORIZONTAL DEFLECTION SIGNAL — voltage divider with sliding contact on probe carriage provides d-c output.

Type 874-MD Sweep Drive . . . includes motor and drive mechanism, speed control, 50-cm long precision-wound potentiometer for CRO deflection and adjustable travel stops. **$220.00**

Type 874-LBA Slotted Line . . . with Adjustable Stub for tuning crystal rectifier. . **$231.00**

The uses for this new tool in research and development laboratories are many. With an oscilloscope, this equipment not only gives an accurate visual presentation of the standing-wave over a very wide range of frequencies, but also presents the phase of the reflection coefficient. Impedance is *directly measured* from information on the scope face. For production "Go, No-Go" testing, the scope face can be crayon-marked for maximum acceptable VSWR — the answer appears as rapidly as the terminations, coaxial switches, connectors or other elements are connected to the Slotted Line.

The combination of the G-R Slotted Line with Automatic Sweep provided by the Type 874-MD Sweep Drive can save valuable engineering man-hours each day, at a time when engineers are in short supply. *Keep in mind, this equipment is designed for busy engineers — not lazy ones.*

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275 Massachusetts Avenue, Cambridge 39, Massachusetts, U.S.A.

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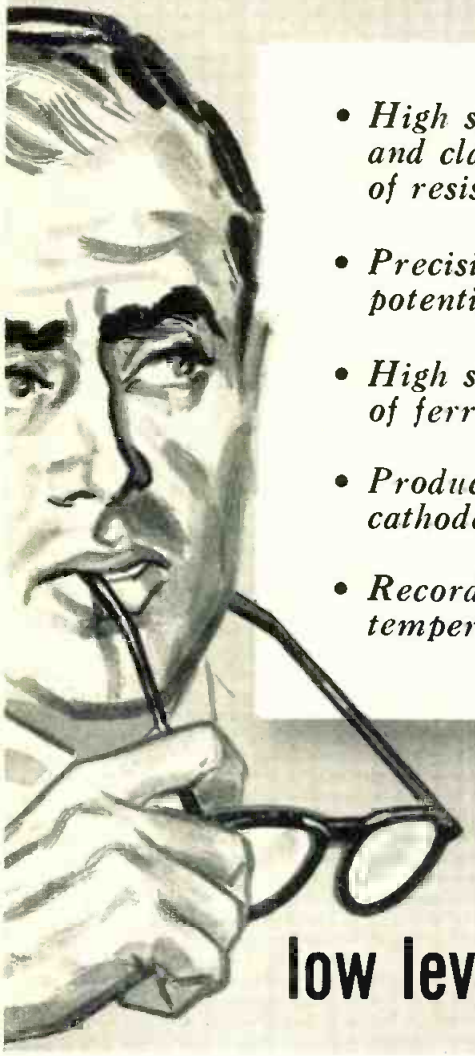
These or similar problems puzzling you?



- *High speed inspection and classification of resistive elements*
- *Precision control of minute potentials and currents*
- *High speed inspection of ferromagnetic materials*
- *Production testing of cathode ray tube brightness*
- *Recording extremely low temperature differentials.*
- *Continuously recording rate of temperature change in jet engine test stands*
- *R.M.S. regulation of a-c oscillators and generators*
- *Multiplication of two a-c or d-c signals to provide a precision product*
- *Precision low power factor measurements for production inspection of transformers and motors*

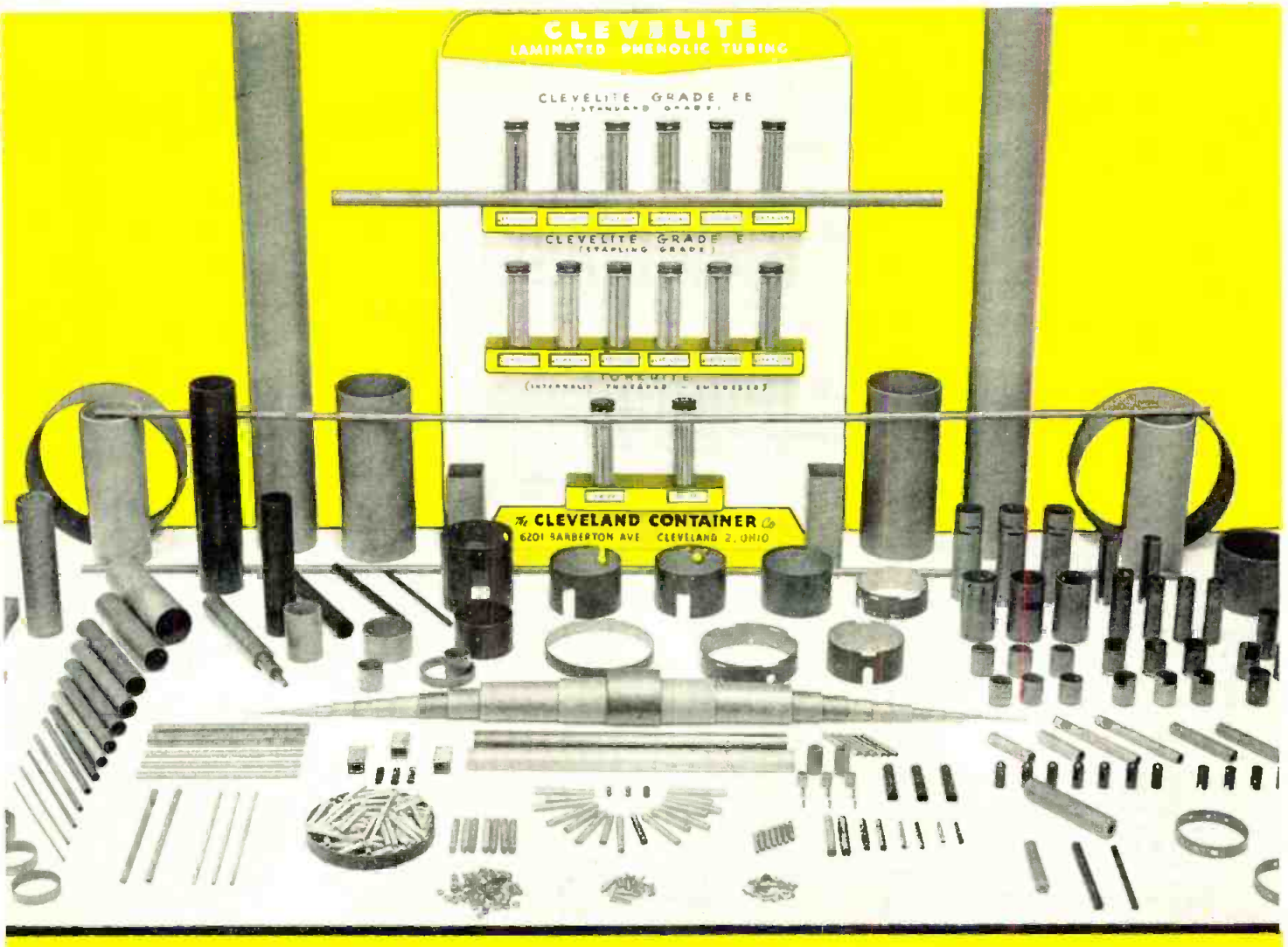
The INDUCTRONIC® SYSTEM of low level MEASUREMENT and CONTROL

Model 1475 Multi-Range Inductronic D-C Amplifier provides amplification of a complete span of direct current and voltage ranges of either polarity with no sacrifice in fundamental accuracy or speed. Has seven current ranges, from 10 to 1,000 microamperes — and ten voltage ranges, from 1 to 1,000 millivolts. All ranges immediately available by the turning of a switch; and an additional seventeen ranges become available by a knob adjustment which changes the instrument from zero left to zero center. Accuracy 1%. Accessories such as recorders and additional indicators can be inserted in the output to a total of 5,000 ohms without affecting accuracy or calibration.

Practical solutions to the above, and many other problems of low-level measurement and control have been supplied by the WESTON Inductronic System . . . an entirely *different* method of d-c amplification. Utilizing the deflection of a permanent magnet moving coil system, it converts extremely low-level d-c to a proportionate a-c signal and amplifies it to a *usable degree* . . . then reconverts to a d-c level. The system operates at a frequency of 200 KC, and provides a high order of sensitivity, accuracy and speed. And because of circuit simplicity, the system is stable and virtually maintenance free. To learn how you can apply the Inductronic System in research or production, call your nearest Weston representative, or write direct for bulletin B-36-B.

WESTON *Instruments*

WESTON ELECTRICAL INSTRUMENT CORPORATION, 614 Frelinghuysen Avenue, Newark 5, New Jersey



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INVESTIGATE

this outstanding coil form!

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* Reg. U. S. Pat. Off.

CLEVELITE* FOR EVERY USE

It possesses excellent electrical insulation properties, has good machinability, and is highly resistant to moisture.

Clevelite is structurally strong, very light and may be easily punched, machined or sawed . . . certain tough grades may be cold punched satisfactorily.

Clevelite chemical properties are also exceptional . . . unaffected by solvents and oils . . . resistant to normal strength basic acidic and salt solutions.

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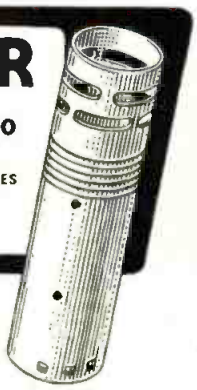

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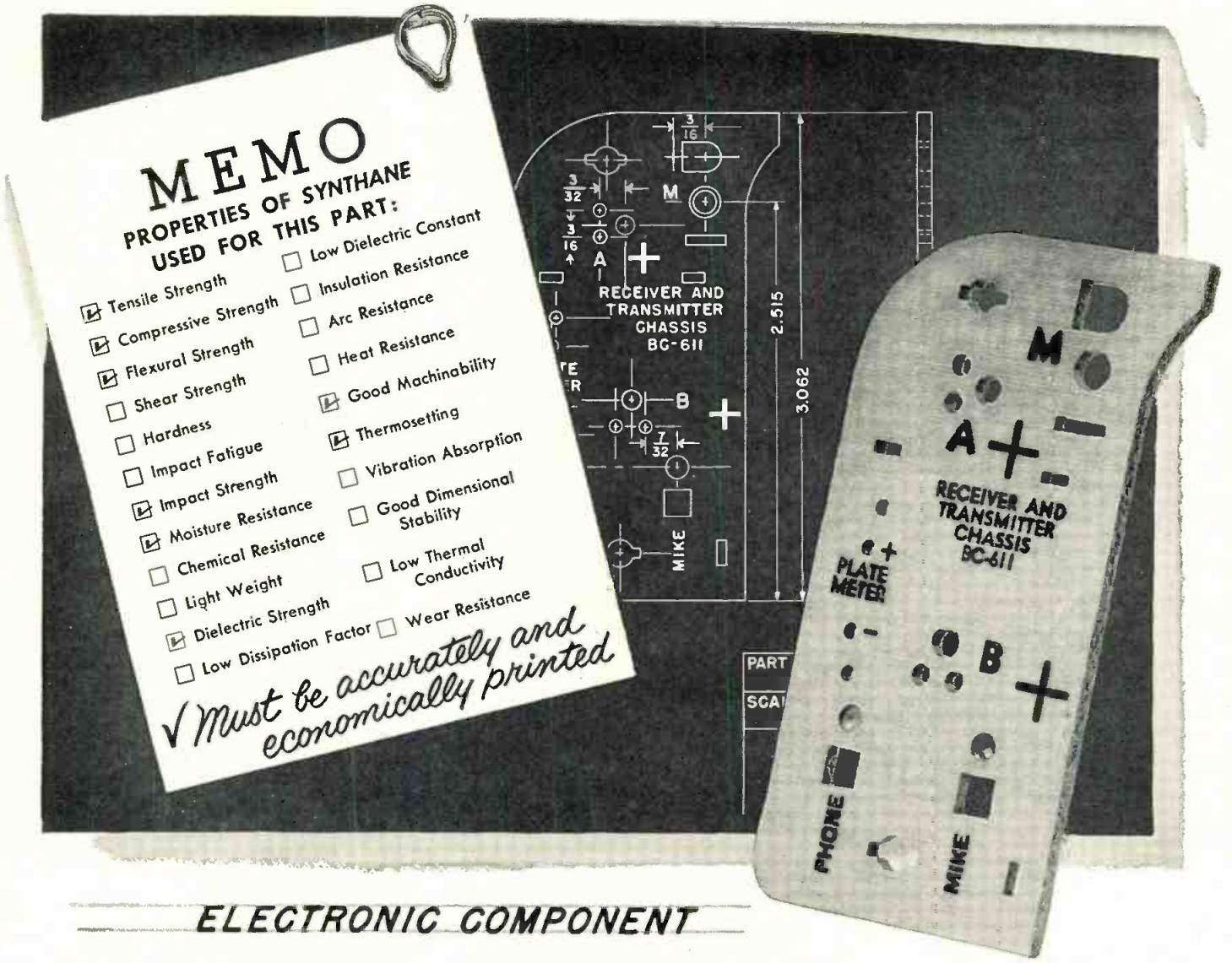
YOU FURNISH THE PRINT, WE'LL FURNISH THE PART



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Although this sturdy end plate will fit into the palm of your hand, it has in combination all the dielectric strength, the physical properties, and the printability the customer requires. It's made of *Synthane*, a laminated plastic, the same material used in hundreds of other electrical, mechanical, and chemical applications.

The blue print for this part calls for accurate machining, the punching of twenty holes of various shapes and sizes, and printing or engraving in three different colors. *Synthane* delivers finished parts exactly as specified, ready for the production line. The customer gets them promptly without problems of tooling up, waste, or rejects.

If you need components with many properties in combination, you will want to know more about *Synthane* laminates and the *Synthane* fabricating service. Send in the coupon for the full story.

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DISCRIMINATORS

FOR FM/FM TELEMETERING RECEIVING STATIONS

CHARACTERISTICS

Center Frequency
250 cycles to 110 kc

Deviation
±5% to ±40% of center frequency

Frequency Response
DC to 40% of bandwidth

Input Signal
0.01 volt rms minimum per subcarrier and 15 volts rms maximum for composite of all subcarriers

Amplitude Modulation
Less than 1% of bandwidth change for 10 db input steps

Output
3 single ended outputs providing 20 ma of output current

Stability
±0.4% after one hour warming

Sensitivity Stability
±0.25%

Linearity
±0.1% from best straight line

Power Source
105 to 125 volts, 60 cycles, 200 watts nominal

The new Bendix-Pacific TDA-9 Subcarrier Discriminator provides the accuracy and stability necessary to permit expansion of Frequency Modulation telemetering systems into high precision and automatic data handling facilities.

Normal, extended or reduced intelligence frequency response is selected by a switch. Signals from proper impedances are of sufficient level to directly accommodate many of the commonly employed data recording and handling equipment without additional amplifiers. Freedom from drift and gain instability is maintained by a chopper-stabilized DC amplifier.

The design of the band pass filters used in the TDA-9 discriminator includes a flat response over the pass band, a linear phase shift characteristic to provide constant time delay of the intelligence signal, and selectivity to provide adequate channel rejection, preventing systems intermodulation.

Provisions for fine balance adjustment of center frequency from a remote location as well as wow and flutter compensation during tape recorder playback have been provided.

Standard discriminators are available for operation on all RDB bands. The unit is also operable over an extended frequency range with center frequencies of 250 cps to 110 kc without deteriorating the performance characteristics. Operation using wide deviations up to ±40% of the channel center frequency can be provided.

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Coming Events

A listing of meetings, conferences, shows, etc. occurring during the months of Oct., Nov., & Dec., 1955

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.

Oct. 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. 27-28—Aircraft Electrical Society 12th Annual display of aircraft electrical equipment. Pan-Pacific Auditorium, Los Angeles, Calif.

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

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

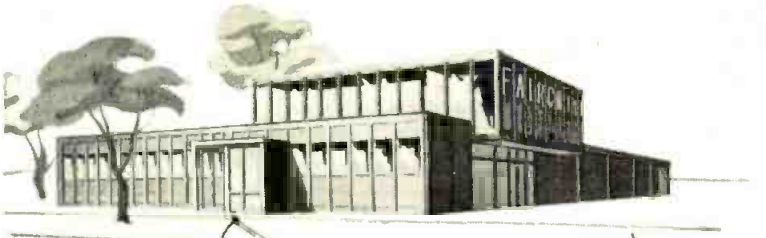
Nov. 3-4—The Eighth Annual Electronics Conference, sponsored by the Kansas City section of the IRE, the Town House, Kansas City, Kansas.

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.



Los Angeles, Cal.

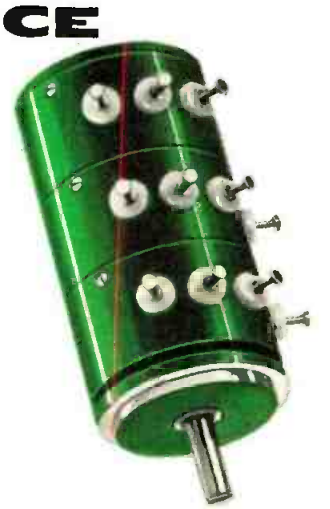
Fairchild announces the opening of a new plant in Los Angeles, California. The new plant will expand the manufacturing, sales and service activities of Fairchild's Potentiometer Division to provide equal facilities both in the East and the West. It will meet the growing need for its products by the expanding 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.

Hicksville, L.I., N.Y.

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 more 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
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Hicksville, L.I., N.Y.

WEST COAST
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Los Angeles, Cal.

FAIRCHILD
PRECISION POTENTIOMETERS

Electronic Industries News Briefs

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

AEROVOX CORP., Special Products Div., New Bedford, Mass. recently began using a wider choice of base materials for its Printed-Wiring process.

CALVIDEO TUBE CORP., Los Angeles, Calif., recently began 100% production of aluminized TV picture tubes which list at the same price as their former line of non-aluminized picture tubes.

CANADIAN WESTINGHOUSE LTD., Standard Electronics' Canadian representatives, recently handled a transaction involving the sale of their Model 10KW Transmitter, which had its debut at the NARTB Convention. The order was placed by Station CJOC, (Channel 7) Lethbridge, Alberta, Canada.

CARGO PACKERS, INC. of Brooklyn, N.Y. has been awarded a contract from the Mallory Air Force Depot at Memphis, Tenn. to design and produce a corrosion-proof, transparent, formed package for instrument bearings.

COIL WINDERS, INC., New York Ave., Westbury, N.Y. is constructing an additional wing to its present plant for engineering purposes. This new wing will provide for additional engineering facilities to meet the heavy demand for its special products.

CONSOLIDATED ENGINEERING CORP., Pasadena, Calif., has been awarded contracts totaling $573,000 for three high-speed data-processing systems to be installed at the U.S. Air Force's Arnold Engineering Development Center, Tullahoma, Tenn.

ALLEN B. DU MONT LABORATORIES, INC., Clifton, N.J. has made application to the FCC for approval of a transfer of television broadcasting stations WABD New York City and WTTG, Wash., D.C. to a new subsidiary corporation, the Du Mont Broadcasting Corp.

ERIE RESISTOR CORP., Erie, Pa. recently announced its large line of special assemblies engineered and produced on a custom basis exclusively at its new Electro-Mechanical Div., located in Erie, Pa.

GENERAL ELECTRIC TUBE DEPT., Schenectady. N.Y. recently created a new electronic tube sales district covering most of Indiana and part of Kentucky. Appointed sales manager for the new district is Frank A. Weeks, Jr.

GENERAL ELECTRONIC EQUIPMENT CO., Mantua Ave., and Glendale St., Easton, Pa., will operate as a wholly-owned division of Radio City Products, Inc., Centre and Glendale Sts., Easton, Pa.

G. M. GIANNINI & CO., INC., manufacturers of aircraft and industrial electronic instruments, has leased quarters on the 69th floor in the Empire State Bldg., for its Eastern sales engineering offices. Its Airborne Instrument Div. and head offices are in Pasadena. Calif., the Electromechanical Div. is in E. Orange, N.J., and the Giannini Datex Div. is in Monrovia, Calif.

INTERNATIONAL RESISTANCE CO., 401 No. Broad St., Phila., Pa. has acquired a new branch plant located in Burlington, Iowa. Increased demand for the products to be manufactured in this plant, Deposited and Boron Carbon type resistors, necessitated the expansion of plant facilities from the Philadelphia plant to Burlington.

THE INTERNATIONAL TELEPHONE AND TELEGRAPH CORP. will construct a new plant in Los Angeles for the expansion of manufacturing of electronic equipment by one of its divisions. the Federal Telephone and Radio Co. The plant will be constructed in five parts at a cost of nearly two and one-half million dollars.

BYRON JACKSON, west coast manufacturer of pumps, oil tools and electronic equipment has become the Byron Jackson Div. of Borg-Warner Corp. of Los Angeles, Calif. Present management and policies will be continued.

LANGEVIN MFG. CORP., a subsidiary of the W. L. Maxson Corp. recently announced completion of their move to new general offices and production facilities in L.I.C., N.Y. All inquiries should be addressed to 47-37 Austell Place, L.I.C.

LEEDS & NORTHRUP CO., 4934 Stenton Ave., Phila., Pa., announced that it has adopted the new temperature-emf tables for iron-constantin thermocouples recently prepared by the National Bureau of Standards and recommended as standard for industrial applications by the Scientific Apparatus Makers Assoc.

LITTON INDUSTRIES, Beverly Hills, Calif., has delivered the first of fifteen range timer units manufactured for the Naval Air Missile Test Center at Point Mugu, Calif.

THE MAGNAVOX CO.'s development of a new electronic data processing machine was recently announced by their president, Frank Freimann. The first machine was recently delivered to the Douglas Aircraft Corp. and is now being used as part of the system for measuring and calculating the performance of missiles and aircraft.

MAR VISTA ELECTRONICS CO. has purchased the semi-conductor production facilities of Hydro-Aire, Inc., Burbank, Calif. The new company will continue to function at 3000 Winona Ave., Burbank, for the next two months and then will move to facilities in the Los Angeles area. The firm will make available transistors in mass production quantities.

THE MINNEAPOLIS-HONEYWELL REGULATOR CO. recently made plans for the establishment in England of a technical training school to groom engineers and other technical personnel in the use of automatic control equipment used broadly in the U.S.

NUCLEAR DEVELOPMENT CORP. OF AMERICA, 5 New St., White Plains, N.Y. will establish a Westchester County Computing Center in White Plains. The center will be available to other organizations which plan to use computing machine methods in their businesses.

OLYMPIC DEVELOPMENT CO. of Stamford, Conn. has become the Barnes Engineering Co. It is now an independent engineering company. with Dr. R. Bowling Barnes noted physicist, as president. The company also owns the Clarksburg Television Cable Corp. of Clarksburg, W.Va.

ORRADIO INDUSTRIES, INC., Shamrock Circle, Opelika, Ala. has announced a new magnetic recording tape that is said will double the playing time over standard recording tape. Up to 4 hours can be recorded without a reel change at 1-⅞ speed, and 8 hours dual track. It will be known as Irish Double-Play Recording Tape, #7-2400.

PITTSBURGH PLATE GLASS CO., 632 Ft. Duquesne Blvd., Pltts., Pa., has commenced work on their multi-million dollar Glass Research Center in Harmar Township, near Pittsburgh.

RADIO CORP. OF AMERICA, Engineering Products Div., has contracted for the installation of a multi-hop microwave radio relay system for the office of Civil Defense, State of Calif.

RADIO FREQUENCY LABORATORIES, INC., of Boonton, N.J., electronics manufacturer, has awarded a contract for the construction of a 12,800 sq. ft. addition to their factory to the Luria Engineering Co. of Bethlehem, Pa. The new facility will be used for manufacturing and storage. It is scheduled for completion early in September.

RAYTHEON MFG. CO. has established a laboratory at the White Sands Proving Grounds, Las Cruces, N.M. The laboratory will conduct tests and evaluation of equipment which Raytheon, as prime contractor, is developing for Army Ordnance.

RAYTHEON MFG. CO. and Rensselaer Polytechnic Institute jointly announced the start of a cooperative plan whereby electrical engineering students at the Institute will receive practical training and experience from the Waltham, Mass. electronics firm.

RCA SERVICE CO., INC. has opened new facilities in New York City for the repair, modification and overhaul of all RCA commercial and industrial electronic equipment. Located at 419 W. 54th St., the shop supplements the company's present similar facilities in Camden.

THE J. B. REA CO. of Santa Monica, Calif., has acquired the equipment, inventory and personnel of the Robey Rotor Co. of Culver City, Calif., manufacturers of gyroscopes, blowers, and miniature motors for aircraft and guided missiles.

RYAN AERONAUTICAL CO., Lindbergh Field, San Diego, Calif., has received a $2.5 million contract from the U.S. Air Force for the advanced development of electronics guidance systems for supersonic missiles.

S.O.S. CINEMA SUPPLY CORP., New York, has opened a new sales office at 6331 Hollywood Blvd., Hollywood, Calif., which will serve nine western states. Alan C. Macauley has been named exclusive western representative for S.O.S.

SPERRY PRODUCTS, INC. of Danbury, Conn., has acquired Western Inspection, Inc., Midland, Texas. Western Inspection will become Sperry Western, Inc., with offices remaining in Midland and Odessa, Texas, and in Lake Charles, Lafayette, and New Orleans, La.

UNITED CATALOG PUBLISHERS, INC., 108 Lafayette St., New York City, are changing the name and revising the cover design of the annual buying guide and reference volume, Radio's MASTER. The 20th edition will be known as the Radio-Electronic MASTER.

UNITED TRANSFORMER CO., 150 Varick St., N.Y.C. recently began operations at the company's new plant, called the UTC-Pacific Div., located at 4008 West Jefferson Blvd., Los Angeles, Calif.

THE WESTINGHOUSE AIR BRAKE CO., recently purchased the capital stock of Corvey Engineering Co., 2610 Jefferson Davis Highway, Alexandria, Va. Corvey engages in electronics research and development and also provides specialized engineering services to industry and government.

MORE NEWS on page 44

E-I presents

NEW EXPANDED LINE OF HERMETICALLY SEALED

COMPRESSION TYPE END SEALS

*PATENTS PENDING—ALL RIGHTS RESERVED

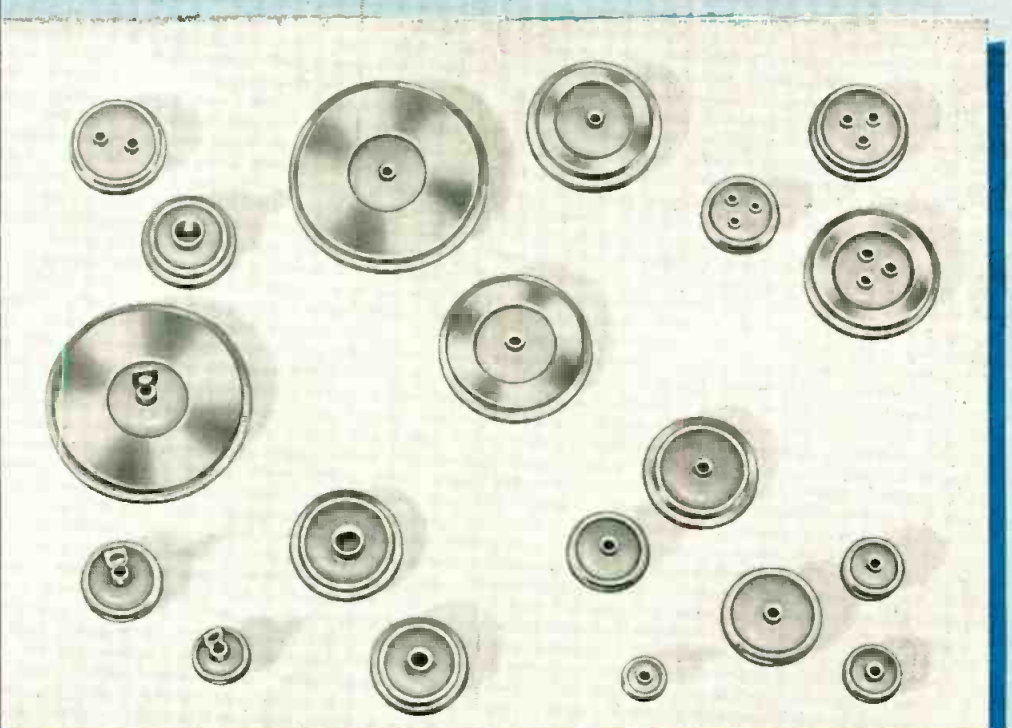
FOR HERMETICALLY SEALING CONDENSERS, RESISTORS AND OTHER TUBULAR COMPONENTS

E-I standardization now makes it possible to offer designers and engineers the economy of standard components in a wide selection of types and sizes. These rugged compression type end seals are available in a broad range of dimensions, in either flared tube or pierced terminals, with single or multiple lead terminations. Inquiries invited.

—here's how

COMPRESSION CONSTRUCTION PROVIDES THE TIME-PROVEN LASTING SEALS

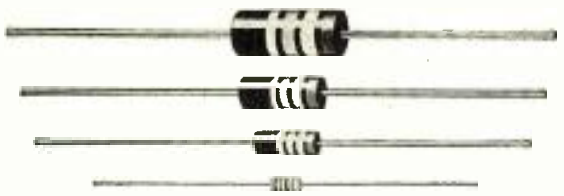
In this exclusive E-I compression construction, the glass remains under constant compression and is therefore extremely strong. These seals possess extraordinary immunity to shock, vibration and pressure changes. For all practical purposes E-I Compression Seals are indestructible. No special skill is required to apply and assembly is rapid as all metal parts are tin dipped for easy soldering.



E-I Leadership—in the field of hermetic sealing assures dependability, economy and fast delivery . . . specify E-I for multiple headers, octal plug-ins, transistor bases and closures, sealed terminals, end seals and color coded terminals.

ELECTRICAL INDUSTRIES

Division of Amperex Electronics Corporation • 44 SUMMER AVENUE, NEWARK 4, NEW JERSEY



Allen-Bradley molded fixed resistors are available in four sizes—Type TR 1/10 watt; Type EB ½ watt; Type GB 1 watt; and Type HB 2 watt. They meet RETMA, JAN-R-11 and MIL-R-11 specifications. Rated at 70C ambient, they require no derating if used on plastic board assemblies. When used according to published ratings, they will not open circuit nor have large erratic resistance changes. In cartons or on reels for automatic assembly.

Allen-Bradley Type J molded variable resistors are made in single, dual, and triple unit construction in total resistance values from 50 ohms to 5 megohms. They are rated at 2 watts at 70C ambient. They are outstanding for their low noise characteristics, initially and after use. Metal parts are made of corrosion-resistant materials. Taps can be supplied at 40, 53, and 68% of effective rotation. A Quality product throughout.

ALLEN-BRADLEY QUALITY COMPONENTS for ELECTRONIC CIRCUITS

Type G molded variable resistors (½ inch diam) are ideal for subminiature assemblies. Available with plain bushings or lock-type bushings with plain or screwdriver shafts. Rated at ½ watt. Total resistance from 100 ohms to 5 megohms.

Type T molded variable resistor (1 inch diam) are compact ½ watt rheostats or potentiometers for hearing aids and other compact applications. Rated at 70C ambient. Total resistance available from 100 ohms to 5 megohms.

Screwdriver slot — Lock-type bushing

Type T potentiometer

Type SO stand-off capacitors

Type FT feed-thru capacitors

Type FT feed-thru and Type SO stand-off discoidal capacitors exhibit no parallel resonance effects normally encountered with tubular capacitors in VHF and UHF frequency ranges.

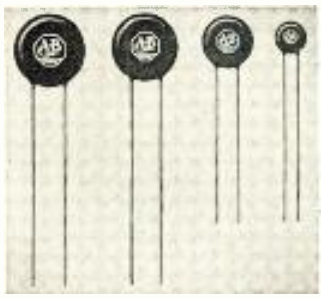
Type FT feed-thru capacitors are furnished with soldering tabs or with screw thread mountings.

Type SO stand-off capacitors have soldering tabs, screw thread mountings or self-tapping threads.

Both types are available from 5 mmf to 1000 mmf.

Ceramic dielectric capacitors Type GP—General purpose capacitors for by-pass and filtering at ambient temperatures up to 85C. In RETMA, JAN, and MIL values from 10 mmfd to .022 mfd in d-c voltage ratings of 500, 1000, 2500, and 5000 volts.

Other capacitors are Type TC temperature compensating; Type LB line by-pass; and Type DY deflection yoke capacitors for television scanning frequencies and voltages in standard nominal values from 5 mmf to 470 mmf.



Every step in the manufacture of these capacitors is performed in the Allen-Bradley plant.

Available in various shapes and sizes to fit black and white and color television circuits or for general electronic applications.

A-B ferrite cores are offered in 3 performance classifications—WO-1, WO-2, and WO-3. The WO-2 material has lower losses and higher permeability, making possible appreciable cost savings in designs of television receivers. Write for performance data on Allen-Bradley ferrite cores.

Allen-Bradley radio, electronic, and television components are a QUALITY line of basic units for all types of electronic equipment. Their stable performance characteristics and their conservative ratings make them ideal components for critical applications in military electronic devices. They are widely used in industry, and by manufacturers of radio and television receivers. There are many additional QUALITY items in the Allen-Bradley line, that are not shown here, which merit your consideration. Allen-Bradley sales engineers are located in principal cities from coast to coast. Call your nearest Allen-Bradley office for technical data, today.

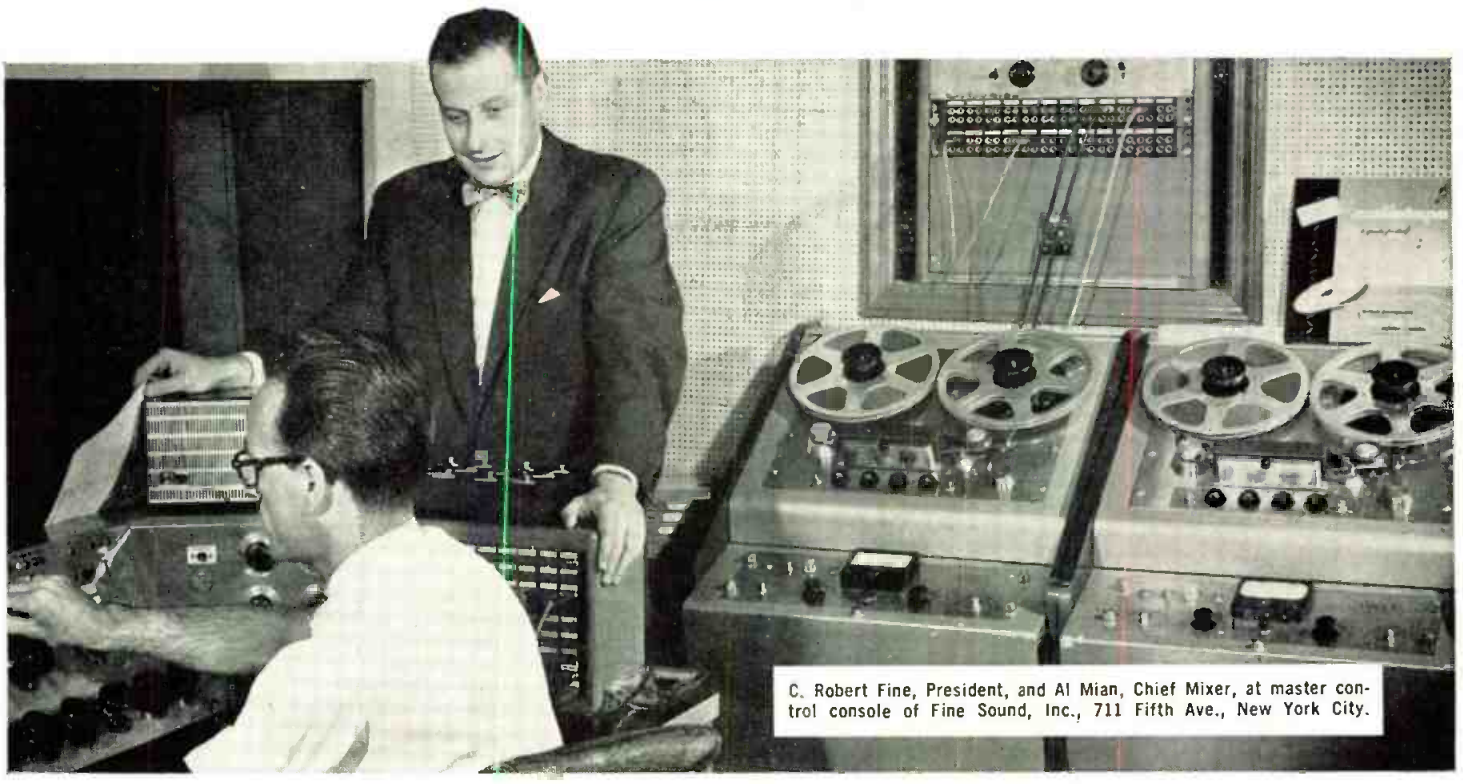
Allen-Bradley Co.
1342 S. Second St.
Milwaukee 4, Wis.

ALLEN-BRADLEY
RADIO & TELEVISION COMPONENTS
QUALITY

In Canada
Allen-Bradley Canada, Ltd.
Galt, Ont.

FOR FINE SOUND ALL AROUND

Bob Fine, of *Fine Sound Inc.*, has *standardized* on audiotape audiodiscs audiofilm

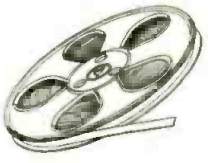


C. Robert Fine, President, and Al Mian, Chief Mixer, at master control console of Fine Sound, Inc., 711 Fifth Ave., New York City.

. . . because "No other sound recording media have been found to meet our exacting requirements for consistent, uniform quality."

In professional circles Bob Fine is a name to reckon with. His studio, one of the country's largest and best equipped, cuts the masters for over half the records released each year by independent record manufacturers. Movies distributed throughout the world, filmed TV broadcasts, transcribed radio broadcasts, and advertising transcriptions are recorded here at Fine Sound, Inc., on Audio products.

Every inch of tape used here is Audiotape. Every disc cut is an Audiodisc. And now, Fine Sound is standardizing on Audiofilm. That's proof of the consistent, uniform quality of all Audio products: these Fine Sound craftsmen use them exclusively.



audiotape* the finest magnetic recording tape you can buy — known the world over for its outstanding performance and fidelity of reproduction. Now available on ½-mil, 1-mil and 1½-mil polyester film base, as well as standard plastic base.

audiodiscs* exceed the most exacting requirements for highest quality professional recordings. Available in sizes and types for every disc recording application.

audiofilm* magnetically coated on standard motion picture film base, provides highest quality synchronized recordings for motion picture and TV sound tracks.

To get the most out of *your* sound recordings, now and as long as you keep them, be sure to put them on Audiotape, Audiodiscs or Audiofilm. THEY SPEAK FOR THEMSELVES.

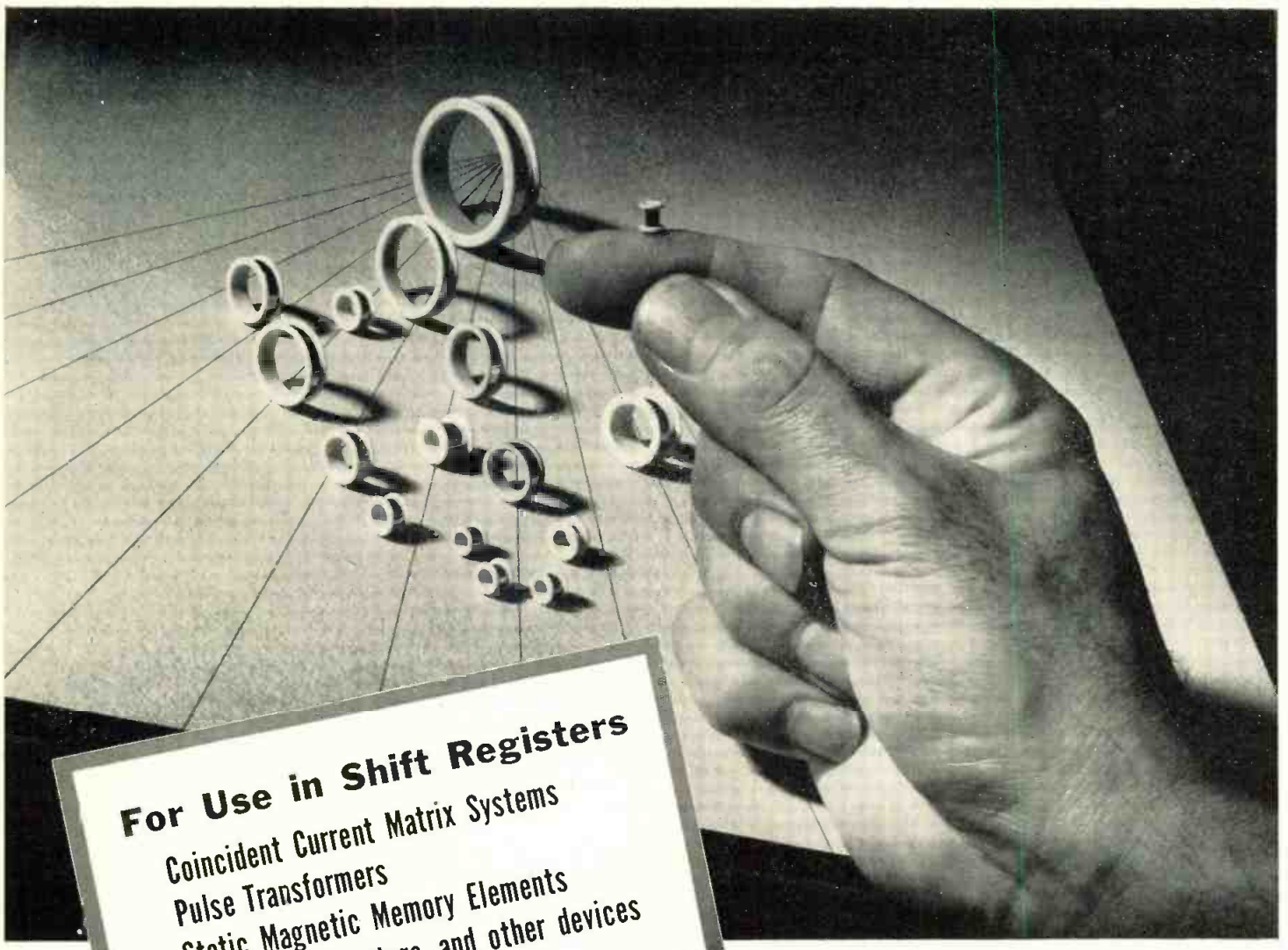
* *Trade Mark*

AUDIO DEVICES, Inc.

444 MADISON AVE., NEW YORK 22, N. Y.

IN HOLLYWOOD: 1006 N. Fairfax Ave. IN CHICAGO: 6571 N. Olmsted Ave.

Export Dept.: 13 East 40th St., New York 16, N. Y., Cables "ARLAB"



specify BOBBIN CORES by ARNOLD

Ultra-thin tape for bobbin cores is rolled to high precision standards for thickness and finish on our own 20-high Sendzimir cold reducing mill, beta-ray controlled.

Write for **BULLETIN TC-108**

"TAPE-WOUND BOBBIN CORES FOR COMPUTER APPLICATIONS"

Includes essential data on applications and properties, fabrication and testing of Arnold Bobbin Cores; lists standard sizes, etc.

ADDRESS DEPT. T-510

These cores, fabricated by winding ultra-thin tape of high-permeability magnetic materials on ceramic bobbin cores, possess ideal qualities for use in electronic computer assemblies as memory cells.

Specifically, their desirable properties include quite rectangular hysteresis loops, relatively low coercive values and high saturation densities; plus temperature stability and the ability to shift in a few microseconds from negative remanence to positive saturation, and vice versa, under conditions of pulse excitation.

Arnold Bobbin Cores are available in a wide range of sizes, tape thicknesses, widths and number of wraps to suit the ultimate use of the core. Magnetic materials usually employed are Deltamax, Square Permalloy and Supermalloy, in standard thicknesses of .001", .0005", .00025" and .000125". Special advantages derive from Arnold's position as a fully-integrated producer of wound cores, able to maintain precise control over every production operation . . . melting, rolling, winding, testing, etc.

● *Let us supply your requirements for bobbin cores or any other magnetic materials.*

W&D 5687

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

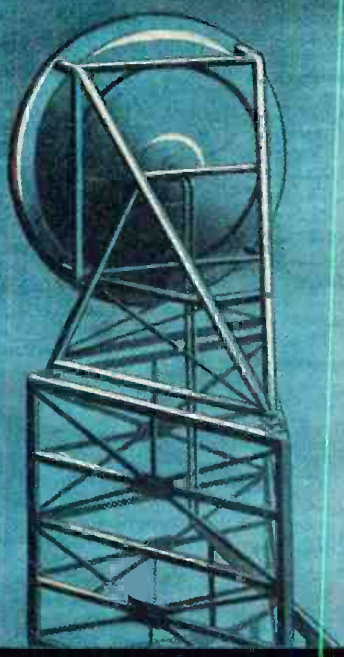
General Office & Plant: Marengo, Illinois

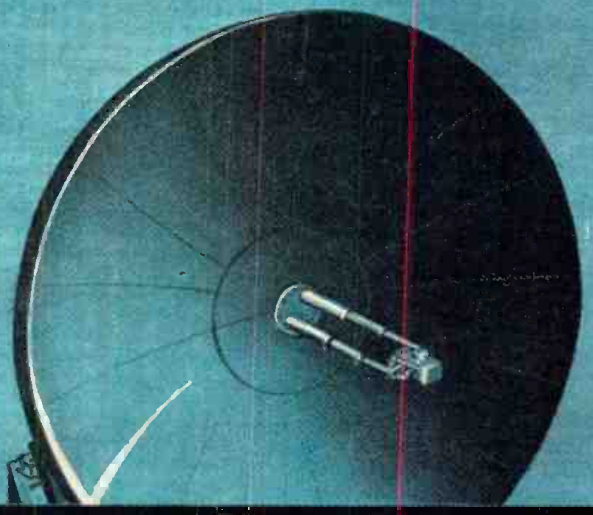
DISTRICT SALES OFFICES . . . New York: 350 Fifth Ave.

Los Angeles: 3450 Wilshire Blvd. Boston: 200 Berkeley St.

antennas

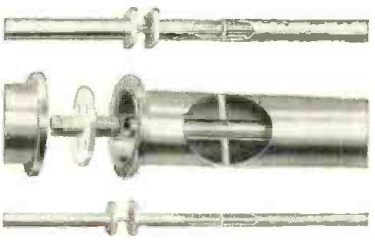
ANDREW designed and produced antennas have an outstanding record for performance in the field. They excel both in quality of engineering and construction. Our standard antennas range from FOLDED UNIPOLES to gigantic 60-ft. Microwave parabolics, for point-to-point, broadcast, and mobile communication services.





TRANSMISSION LINES

HELIAX®, a truly flexible air dielectric cable is recommended for all installations from AM through Microwave. It has a very low VSWR at any frequency, and is the easiest cable to install—no hanger or layout problems, and no special tools required.



RIGID AIR DIELECTRIC LINE—ANDREW designed and manufactured transmission line is noted for its mechanical and electrical excellence. VSWR on all ANDREW standard lines is low. Especially designed flanges and inner connectors make positive contact at all connections.

WAVE GUIDE is produced to the most rigid standards in the industry. The high efficiency, high power handling capacity, and low VSWR of this new copper clad steel wave guide make it the recommended choice for UHF-TV. ANDREW will design your complete wave guide system for easier and less costly installations.

SYSTEMS ENGINEERING . . . ANDREW designs and manufactures complete antenna systems for all applications, including antennas, transmission lines, hangers, fittings and related components. Write for our new general catalog and engineering guide.

Andrew CORPORATION

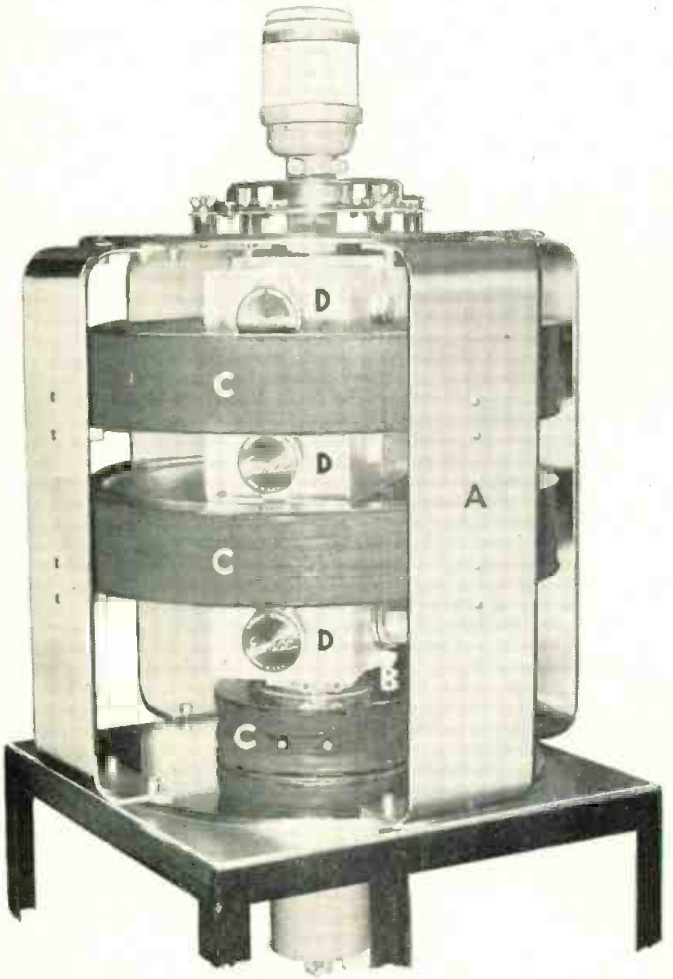
363 EAST 75th STREET · CHICAGO 19

ANDREW

Offices in: NEW YORK · BOSTON · LOS ANGELES · TORONTO

Eimac Amplifier Klystrons and Circuit Components

—the easy, economical approach to high power, UHF/microwave transmitters



Design and construction of a high power UHF/microwave transmitter for beyond-the-horizon communication and other microwave applications is simple and straight-forward with an Eimac amplifier klystron and circuit components. In fact, it's easier to build than a low frequency Class C amplifier. Eimac high power amplifier klystrons, plus Eimac circuit components consisting of A) Magnetic framework B) RF output load coupler C) Magnetic beam-control coils and D) Convenient tuning wide range RF resonant cavities comprise the essential elements of a final amplifier package. By adding conventional power supplies, control circuits, driver and cabinets to the Eimac klystron-circuit component package, high power at UHF is easily obtained. Eimac developed klystron and circuit components provide equipment manufacturers with the easy economical approach to high power microwave transmitters. In many cases, existing low power equipment can be used as a driver for the higher powered amplifier.

Radio Frequency circuitry is completed outside the vacuum system of Eimac klystrons through circuit components. This allows unmatched economy by eliminating repurchase of costly RF circuitry with each tube replacement.

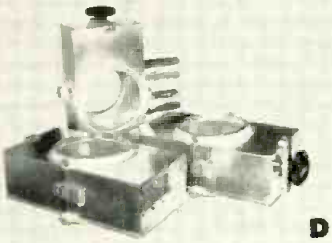
The reliability and performance of Eimac klystrons is proven, as they were employed extensively in established microwave scatter-type communication systems.

For an easy and economical approach to reliable high power microwave transmitting equipment, investigate the incomparable capabilities of performance-proved Eimac developed klystrons and klystron circuit components.

A **Magnetic frame work**

B **Output load coupler**

C **Magnetic beam-control coils**



D **Resonant cavities**

EIMAC AMPLIFIER KLYSTRONS

	FREQUENCY RANGE—MC	CW POWER
3K3000LA	400-600	2000w
3K3000LQ	760-980	2000w
3K20,000LA	470-580	5000w

	FREQUENCY RANGE—MC	CW POWER
3K20,000LF	580-720	5000w
3K20,000LK	720-890	5000w
3K50,000LA	470-580	10,000w

	FREQUENCY RANGE—MC	CW POWER
3K50,000LF	580-720	10,000w
3K50,000LK	720-890	10,000w
3K50,000LQ	850-1000	10,000w
4K50,000LQ	750-1000	10,000w

For further information write our technical service department.

EITEL-McCULLOUGH, INC.
SAN BRUNO • CALIFORNIA
World's Largest Manufacturer of Transmitting Tubes

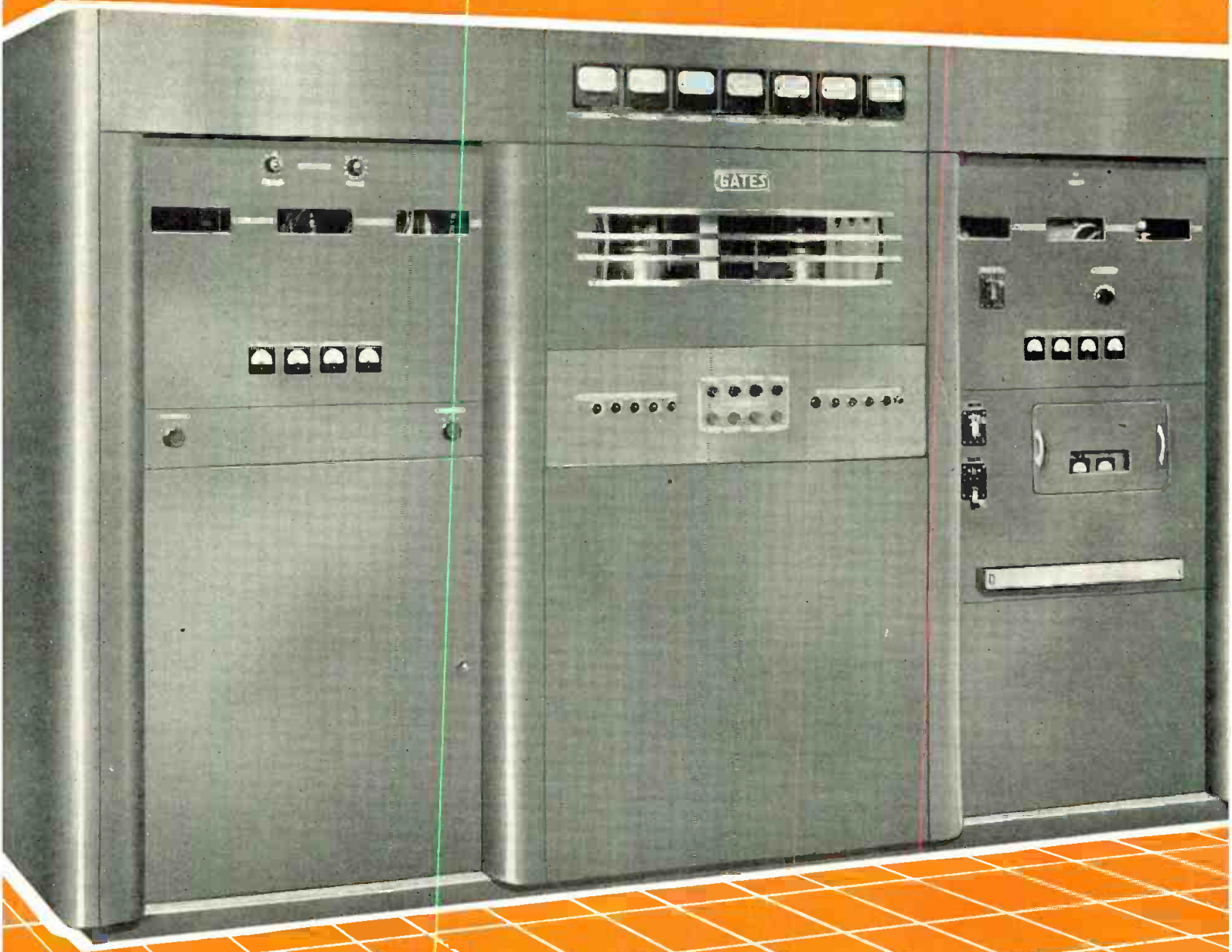
GATES

Hy-Watter SERIES

MORE WATTS PER DOLLAR INVESTMENT

MODEL BC5E

5000 WATT BROADCAST TRANSMITTER



THE BIG TRANSMITTER in the 5 KW field is now available at a new low price

GATES Leader IN SALES, DESIGN and ENGINEERIN IN BROADCASTING EQUIPMENT

New Mallory Cardboard Tubular Capacitors

. . . premium performance at no increase in cost

Never before has quality like this been built into cardboard tubular electrolytics. At no increase in price, this new series developed by Mallory offers you a combination of features unique in this type of capacitor:

Minimum size, high ripple current ratings, low RF impedance . . . obtained through use of genuine fabricated plate anodes.

Long life, high stability temperature rating up to 75°C . . . due to fabricated anode and etched cathode.

Low leakage current.

Low-resistance tab-to-lead wire connections . . . welding ends danger of intermittent or high resistance connection.

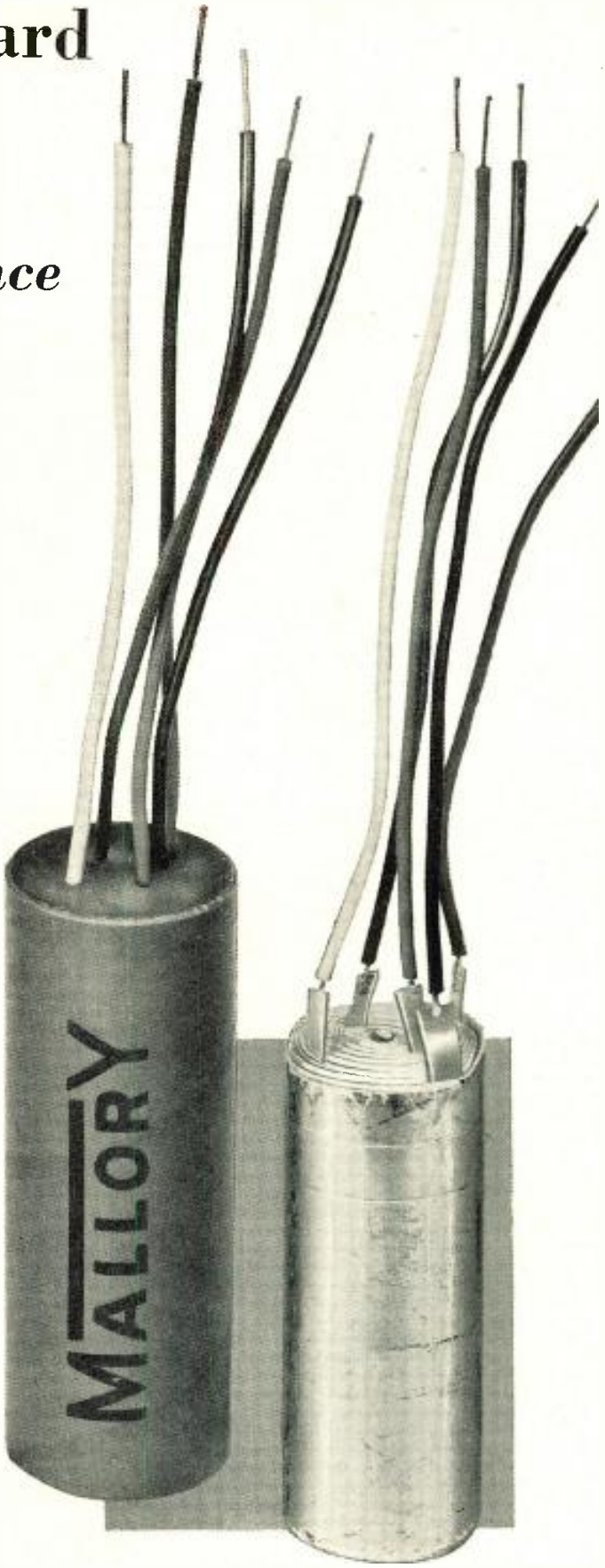
Low moisture loss . . . cartridge is foil wrapped: wax impregnated cardboard tube is sealed with wax at both ends.

High dielectric strength, exceeds U.L. requirements, due to improved low-moisture absorbent separators.

Rugged, flexible leads . . . covered with plastic insulation rated for 105° C, have U.L. approval.

The new series comes in single, dual, triple and quad sections, with leads all coming from one end or from opposite ends of the cartridge. A complete choice of voltage and capacity ratings is available.

For technical data, write or call Mallory today. A Mallory capacitor engineer will be glad to consult on your circuit requirements, to suggest possible cost-cutting simplifications based on Mallory's long experience in all types of applications for electronic components.



Inside of the case is this foil-wrapped cartridge. Tabs are welded to the leads, to prevent intermittent connections.

Parts distributors in all major cities stock
Mallory standard components for your convenience.

Serving Industry with These Products:
Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

JENNINGS VACUUM TRANSFER RELAYS

with self contained DC coil easily mounted by Aircraft Marine Products in their pulse forming networks

THREE Type RD1 Normally Open Vacuum Relays are soldered to the side of the pulse forming network so that each evacuated contact enclosure is immersed in silicone oil with the rest of the network. The use of these relays therefore results in fewer high voltage bushings, contacts that will not contaminate, and short lead lengths that minimize inductance and stray capacitance. This construction also permits the built-in DC actuating coils to be removed without disturbing the sealed network.

These relays easily meet standard vibration tests of 10 to 55 cps and shock tests of 15 G. Temperature requirements are −55° C. to +85° C. with 30 minute operation at 105° C.

The RD1 is a SPST relay, available with either normally open or normally closed contacts. A similar relay (Type RE2) has SPDT contacts and slightly larger models (Type RM2 and RM4) are made with 2PDT and 4PDT contact arrangements. These units have peak working voltage ratings up to 12,000 volts and continuous RF current ratings of 10 amperes rms at frequencies up to 30 mc. It is also possible to make and break under load with fast break times of less than 10 milliseconds. Switch capacitances are as low as 0.1 mmfd and contact resistances are as low as .005 ohms. As their contacts are sealed in a vacuum, contact resistance does not increase with usage. This factor makes them excellent general purpose relays for DC switching.

Write us regarding your own relay problems.
Literature mailed on request.

JENNINGS RADIO MANUFACTURING CORPORATION • 970 McLAUGHLIN AVE. P.O. BOX 1278 • SAN JOSE 8, CALIFORNIA

TELE-TIPS

MAGNETIC TAPE RECORDS standardization will be a topic of discussion at the Eastern Joint Computer Conference to be held early this November at the Hotel Statler in Boston. Manufacturers of computing equipment and other interested parties will be called upon to discuss technical problems concerning interchangeability of records.

ELECTRONIC DATA PROCESSING machine of an advanced type is now being used in the design of the Seawold, newest atomic powered submarine. The new IBM equipment is a 650 Magnetic Drum Data Processing Machine containing a memory unit capable of storing 20,000 digets and calculates more rapidly than previous installation. Machine is being used to determine nuclear shielding requirements within the vesel, vibration frequency analyses on equipment to be mounted in the submarine, expansion reactions and stresses in piping systems, heat transfer problems, hull structural strength calculations and sound attenuation problems.

ATOMIC ENERGY COMMISSION and Dept. of Commerce are cooperating to make public, as promptly as possible, non-classified AEC research reports of industrial significance. 961 reports are released and listed in new "List of AEC Research Reports for Sale" through Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D.C.

TV CAMERAMEN are promised quick easy relief from troublesome highlights that often result from the strong lighting required on television sets. A new aerosol anti-glare spray is now being marketed by E. I. DuPont de Nemours & Co. It is nonflammable. In fact, it reportedly acts as a fire extinguisher when sprayed on burning paper.

NEW ELECTRIC CABLE now being introduced by United Cable Corp. Harwood Bldg., Scarsdale, N.Y., features ability to stretch to over twice its own length. Current

(*Continued on page* 46)

PYRAMID SOLID DIELECTRIC GLASSEAL® CAPACITORS FO

6 POINT PREFERENCE

1 Especially sturdy capacitors capable of wi standing vibrational stresses of high acc eration and frequency, and severe sho conditions encountered in guided missiles c airborne equipment.

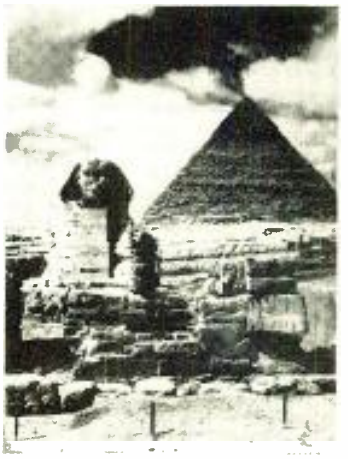
2 Utilize new, rugged compression-seal typ glass-to-metal solder-seal terminals. Ter nals will not work loose or rotate unc any operating condition.

3 Functional operating range from —55°C +125°C.

4 Operates normally under severe humid conditions.

5 Production tests for voltage breakdow capacitance, power factor, insulation res tance and seal are performed on a 100 basis.

6 Capacitance range: .001 mfd. to 1.0 mf voltage range: 100 to 600 V.D.C. operatin can be provided to standard tolerance ±20% or to closer tolerances, if desire



Burton Browne/New York

1. Hermetically sealed in metallic cases.
2. Power factor less than 1%.
3. Subminiature in size.
4. Available in both inserted tab and extended foil constructions.

+ FACTORS

For complete engineering information contact your local Pyramid representative or write to—

CAPACITOR DIVISION
PYRAMID ELECTRIC COMPANY

TELE-TIPS

(*Continued from page 44*)

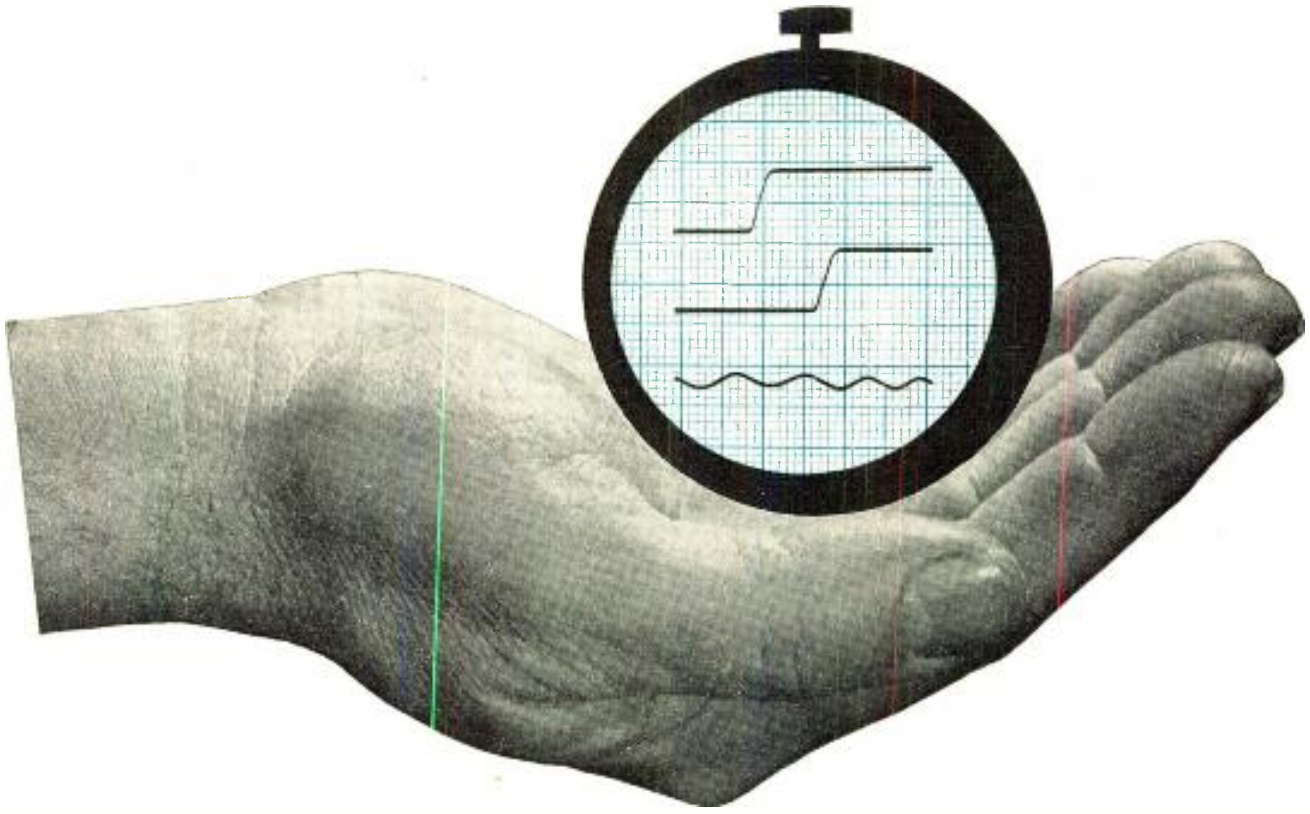
carrying capacity is up to 5 amps with insulation between conductors adequate to withstand 800 volts.

TRANSISTORIZED PORTABLES are apparently reliable and rugged. In a recent letter to Raytheon Mfg. Co. S. J. Carter reports that he stumbled and dropped such a receiver into 14 ft. of salt water. It was fished out after four hours, rinsed in fresh water and then set in the sun to dry. Replacing batteries three hours later, the set worked "not quite as well as originally, but still strong enough to get any of the stations in New England."

ZIRCALOY-2 is the name of a new zirconium alloy that is so resistant to the extremely corrosive action of high temperature, high pressure water in nuclear reactors that in a year's time only 0.0010-in. of corrosion can be measured. It was developed by Westinghouse atomic power division.

ATOMIC BATTERIES at present time, can be considered only for very low power applications, according to a recent paper by Dr. E. G. Linder, Paul Rappaport, and J. J. Loferski, all scientists at RCA's David Sarnoff Research Center, Princeton, N.J. Present possible applications lie only in the microwatt range of such devices as radiation meters, timing circuits and simple transistorized equipment. Practical energy levels for commercial applications will undoubtedly rise as the atomic energy industry develops, but what is needed is a radioactive material of low cost, low quantum energy and a suitable half-life.

CLOSED CIRCUIT TV installations, with features and performance to meet almost any task, for between $1000 and $5000 are now possible according to Max. H. Kraus of Jerrold Electronics Corp., Phila. Pa. Speaking at the Fall General Meeting of the AIEE, on the growing and bright future for this service, Mr. Kraus also pointed out that such installations previously cost $5000 to $9000.



time on our hands

Here's a handful of microtime . . . doled out in hundredths of a millimicrosecond. It's our new HELIDEL* delay line.

It's precise . . . wide-band . . . continuously variable. This is not an adwriter's pipedream . . . it's an engineer's, come true.

Which means that definitions are in order.

Precise = delay increments of only 2×10^{-11} sec; resolution 0.01% and better; linearity "better than ±1%" . . . actually, so fine it can't be measured.

Wide-band = transmission of pulse signals up to 20 mc with negligible phase-distortion, overshoot, or distortion of waveshape.

Continuously variable = a distributed-constant, electromagnetic type . . . dreamed up in 1946 . . . developed in helical form since 1951, by Helipot and DuMont.

The HELIDEL is already used successfully in color-TV broadcasting and oscilloscopes . . . and as a trimmer in transmission systems.

What can you dream up?

Helipot *first in precision potentiometers*

Helipot Corporation/South Pasadena, California
Engineering representatives in principal cities
a division of BECKMAN INSTRUMENTS, INC.

To help you dream, there's a 10-page technical paper on the HELIDEL, *presented at the 1954* WESCON . . . *and a new data sheet, with complete specs. For your copies, write for Data File 1004.*

444 *TRADEMARK

SIMPLIFY YOUR DESIGN PROBLEMS WITH

TABLE OF MAGNETIC PROPERTIES OF FERRAMICS®

PROPERTIES	UNIT	C	E	G	H	H-I	I	Q
Initial Perm. at 1 mc/sec.	—	250	750	410	850	550	900	125
*Max. Perm.	—	1100	1710	3300	4300	3800	3000	400
*Sat. Flux Dens.	Gauss	4200	3800	3200	3400	2800	2000	3300
*Residual Mag.	Gauss	2700	1950	1050	1470	1500	700	1050
*Coercive Force	Oersted	2.1	.65	.25	.18	.35	.30	2.0
Temp. Coef of Initial Perm.	%/°C	.40	.25	1.3	.66	.80	.30	.10 max
Curie Point	+°C	330	160	160	150	125	70	350
Vol. Resistivity	—	Med.	Med.	High	Med.	Med.	Med.	High
Loss Factor:	$\frac{1}{\mu_0 Q}$							
At 1 mcs/sec.	—	.00007	.00008	.00008	.00030	.0004	.0003	.000024
At 5 mcs/sec.	—	.0008	.0020	.00075	.00155	.0010	.0050	.00004

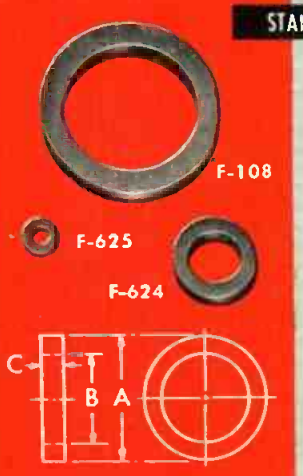
*Measurements made on D.C. Ballistic Galvanometer with Hmax = 25 oersteds. Above data is based on nominal values.

STANDARD FERRAMIC® CORES

by GENERAL CERAMICS

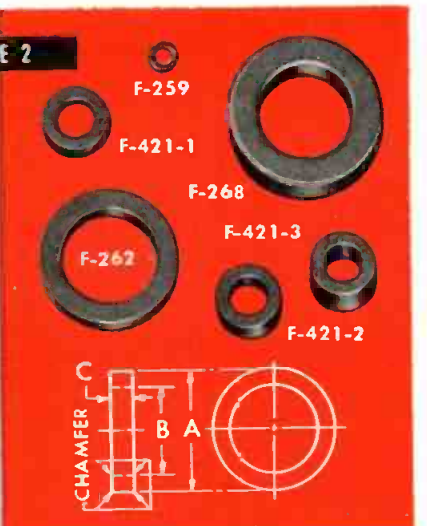
The standard parts listed offer maximum economy and faster deliveries. They are available in all the grades of Ferramics shown in the TABLE OF MAGNETIC PROPERTIES above. Cores of other sizes or shape can be made to your specifications. For additional information or quotations call, wire or write.

STANDARD TOROID CORES TYPE 1



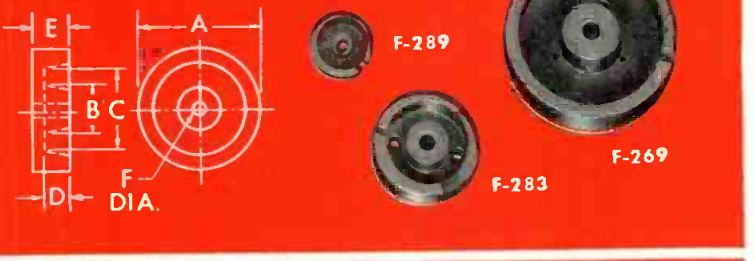
Part No.	A	B	C
F-108	1.875	1.375	.250
F-624-1	.870	.540	.093
F-624-2	.870	.540	.156
F-624-3	.870	.540	.250
F-625	.375	.187	.125
F-626-1	1.250	.750	.187
F-626-2	1.250	.750	.375
F-626-3	1.250	.750	.250
F-627-1	.500	.312	.093
F-627-2	.500	.312	.156
F-627-3	.500	.312	.250

STANDARD TOROID CORES TYPE 2



Part No.	A	B	C
F-109-1	.870	.540	.093
F-109-2	.870	.540	.156
F-109-3	.870	.540	.250
F-259	.230	.120	.060
F-262	.375	.187	.125
F-268-1	1.250	.750	.187
F-268-2	1.250	.750	.375
F-268-3	1.250	.750	.250
F-421-1	.500	.281	.093
F-421-2	.500	.281	.156
F-421-3	.500	.281	.250

STANDARD CUP CORES—TYPE 1



Part. No.	A	B	C	D	E	F
F-260	.937	.386	.718	.175	.312	.145
F-261	.590	.197	.468	.150	.250	.096
F-269	1.500	.500	1.250	.375	.500	.145
F-280*	.590	.197	.468	.150	.250	.096
F-283*	.937	.386	.718	.175	.312	.145
F-289	.563	.177	.450	.080	.150	.093

*Adjustable over a range of approx. 10 percent of effect perm.

STANDARD CUP CORES—TYPE 2

Part No.	A	B	C	D	E
F-210	.937	.386	.718	.175	.312
F-211	.590	.197	.468	.150	.250
F-290	.563	.177	.450	.080	.150

GENERAL CERAMICS CORPORATION STEATITE INSULATORS

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TELEPHONE: VALLEY 6-5100

GENERAL OFFICES and PLANT: KEASBEY, NEW JERSEY

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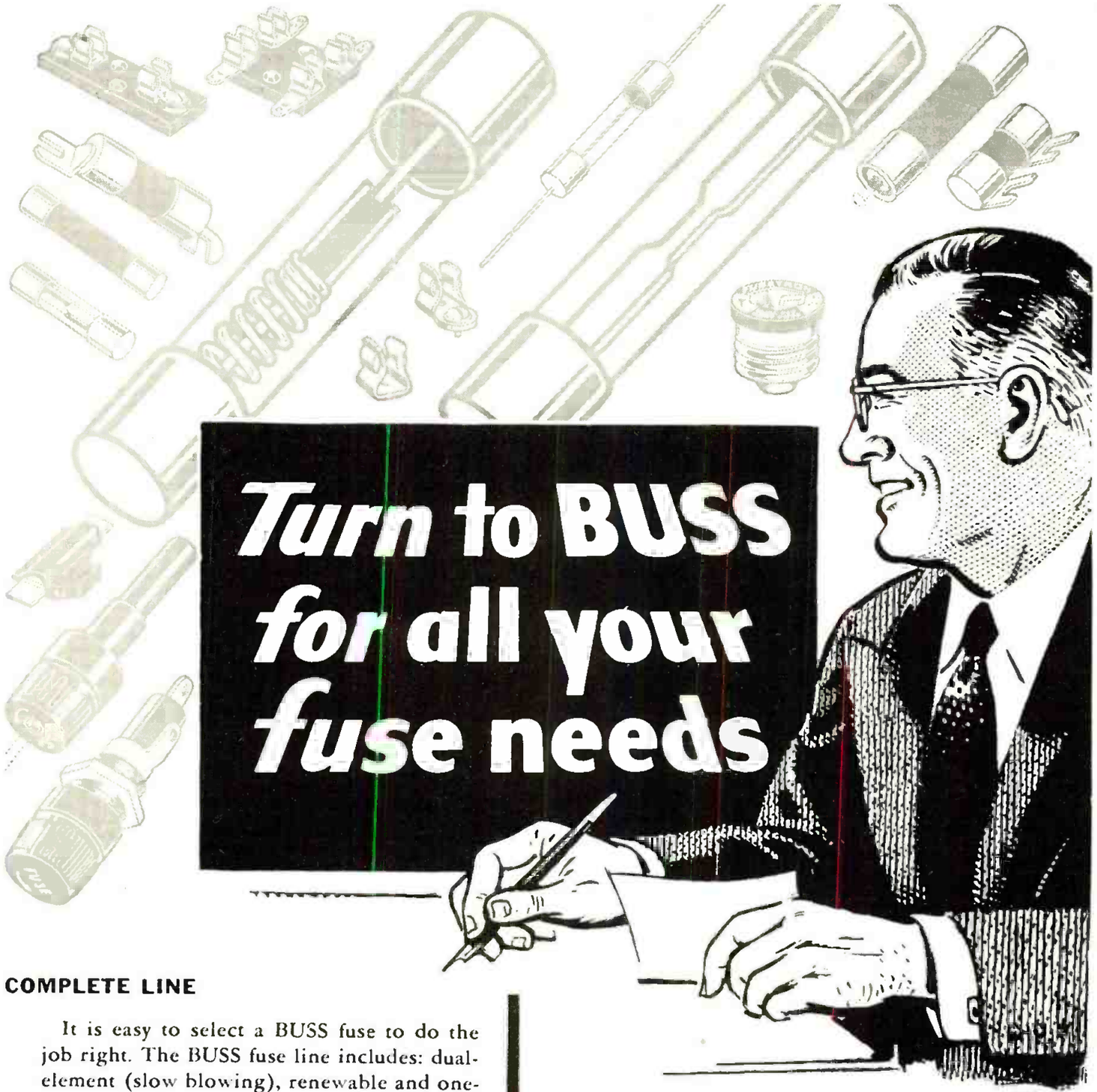

Turn to BUSS for all your fuse needs

COMPLETE LINE

It is easy to select a BUSS fuse to do the job right. The BUSS fuse line includes: 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.

BUSS FUSES ARE MADE TO PROTECT — NOT TO BLOW NEEDLESSLY

To assure unfailing dependability — 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.

With the cost of a fuse being so insignificant compared to the value of the equipment it protects and the value of your good name — it is just good business to refuse to take a chance on anything less than BUSS quality in fuses.

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

IF YOUR PROTECTION PROBLEM IS "DIFFERENT"!

You can save engineering time by letting the BUSS fuse engineers help you select the fuse best suited to your particular conditions. If possible, the fuse selected will be available in local wholesalers' stocks, so that your device can be easily serviced.

Be sure to get the latest information on BUSS and FUSETRON small dimension fuses and fuseholders . . . Write for bulletin SFB.

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

1055

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BOOKS

Magnetic Materials in the Electrical Industry

By P. R. Bardell, B.Sc., M.I.E.E., F. Inst. P. Published 1955, by Philosophical Library, Inc., 15 East 40th St., New York 16, N.Y.

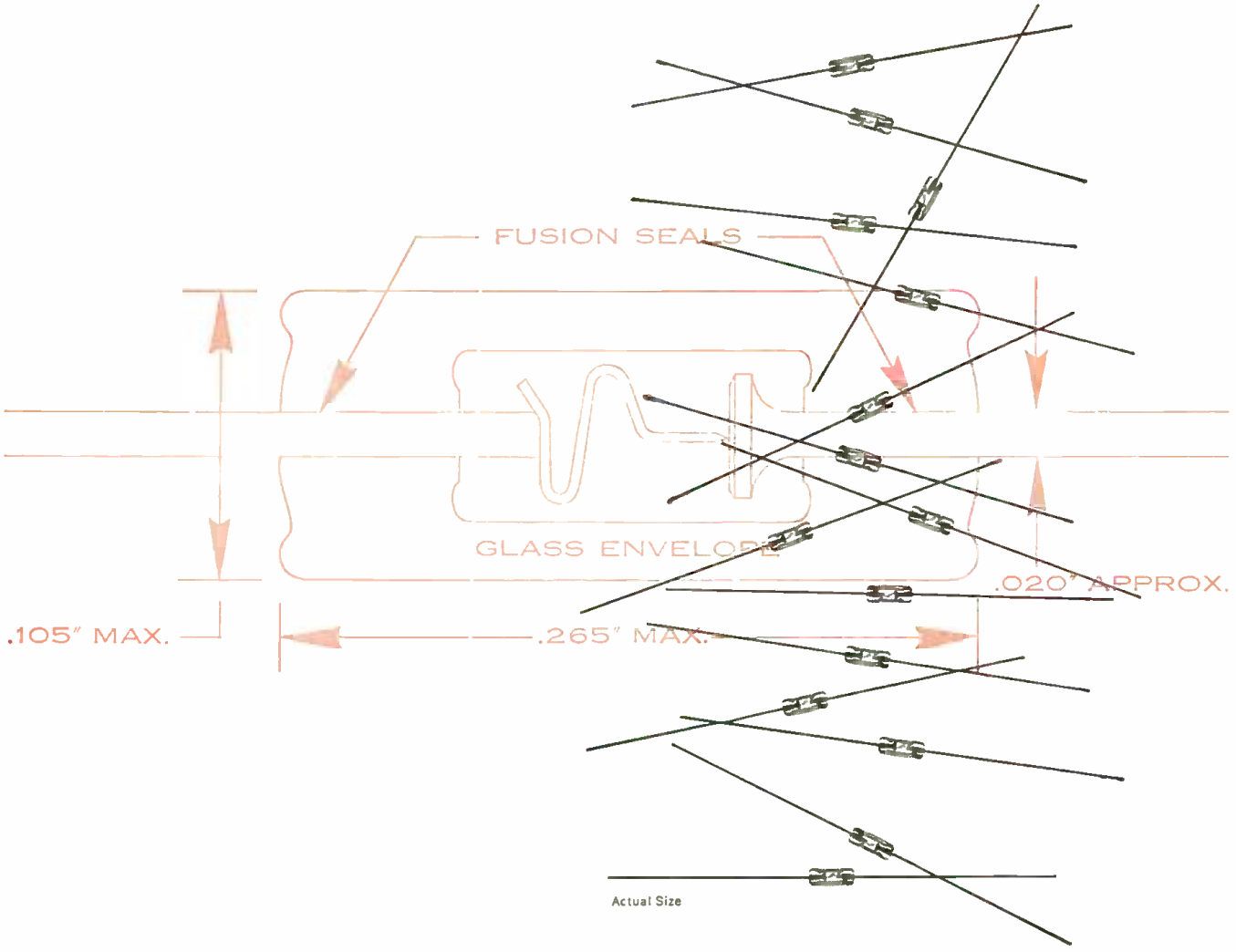
This book, written for engineers and physicists in industry, is primarily intended to bridge the gap between an academic study of the properties of magnetic materials and the limited treatment accorded the subject in textbooks for engineers. One of its aims is to link the properties of magnetic materials with their numerous applications. The ability of the author to make more understandable the chapters on the properties of the large numbers of magnetic materials now available will be of special interest to electrical engineers. Beginning with an outline of the theory of ferromagnetism, the author goes on to a discussion of the influence of magnetic theory on the development of materials. Subsequent chapters cover the historical development, application and testing of permanent magnets and of soft magnetic materials. Further chapters are devoted to sound recorders, non-destructive testers, transductors and transducers. A glossary of terms and units, and tables showing the properties of materials have been included to help eliminate the complexities caused by the variety of terms and units used commercially on the subject. Eleven chapters in all constitute a book which relates in an effective way electrical engineering practice to the scientific principles and physical phenomena of ferromagnetism.

Point-to-Point Radio Relay Systems 44 MC to 13,000 MC

Published Sept. 1954, by the Gov't. Service Div., RCA Service Co., Inc., Camden, N.J., for Air Force Cambridge Research Center, Air Research and Development Command. 226 pages, price $2.00.

Designed for use by engineers, this publication is a new manual on wave propagation and other aspects of VHF and microwave and radio relay systems. There are chapters devoted to such subjects as "Basic Wave Propagation," "Path Attenuation," "Fading," "Weather versus Propagation," "Siting," "Interference, "Ionospheric Transmission," and other technical points. Also contained are vast numbers of charts, curves, and nomograms, for fast and easy calculating. Additional information also presented includes computation of wave propagation based on a series of nomograms, general ionospheric transmission problems, and a section on testing and calibration. The material in this manual is intended to present, in a simplified fashion, the many problems encountered when operating radio re-

(Continued on page 56)



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With one of the most comprehensive families of diodes in the industry, Hughes offers a wide variety of germanium and silicon types. This gives you great freedom of selection—makes it possible for you to take advantage of characteristics peculiar to many devices. It means, also, that it is possible *impartially* to recommend and to supply specific Hughes diode types best suited to your exact requirements.

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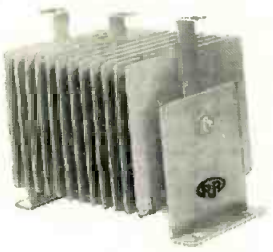
Los Angeles 45, California

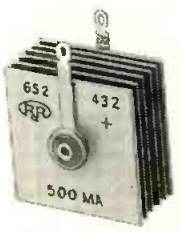
RADIO RECEPTOR

SELENIUM RECTIFIERS



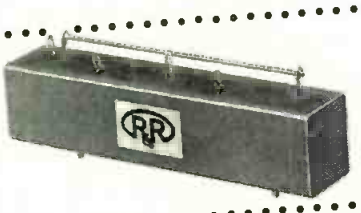
INDUSTRIAL TYPE RECTIFIERS

Years of service in every kind of application have proved the long life and dependability of these rugged units. Available in various voltage and current combinations up to several hundred kilowatts, they are useful in a multitude of industrial and power circuits such as power supplies, magnetic amplifiers, electro-plating, battery charging, etc.



RADIO TYPE RECTIFIERS

Millions of these stacks are in service in radio and TV circuits as well as many small power applications. Thoroughly dependable under all types of grueling conditions, they are specified by an increasing number of engineers in the U. S. and throughout the world. Available for black and white as well as color TV in ratings up to 750 MA.

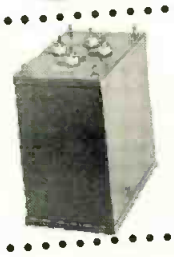


EMBEDDED RECTIFIERS

For top protection in military and other applications calling for the strictest requirements. Recommended for use where size and weight are important considerations such as in aircraft.

HIGH TEMPERATURE TYPES

High temperature rectifiers are now available in the larger cell sizes up to 5" x 6" to operate without derating at 125°C. Radio Receptor research has brought the cost down so that the field is now wide open for use in many applications once considered prohibitive because of size and price.



HERMETICALLY SEALED UNITS

Built to special requirements to meet unusually severe conditions. Designed to meet individual needs.

If you have a problem involving rectification, submit your requirements and our engineering department will be glad to aid you in the solution . . . without obligation, of course. See our catalog in Sweet's Product Design File and write for our latest bulletin No. T-7

RECTIFIERS FOR MAGNETIC AMPLIFIERS

Special designs will be submitted to meet individual requirements. However in many cases standard Radio Receptor stacks will give highly satisfactory performance in mag-amp applications, saving both time and money. Let us study your specs and make recommendations.

Semiconductor Division

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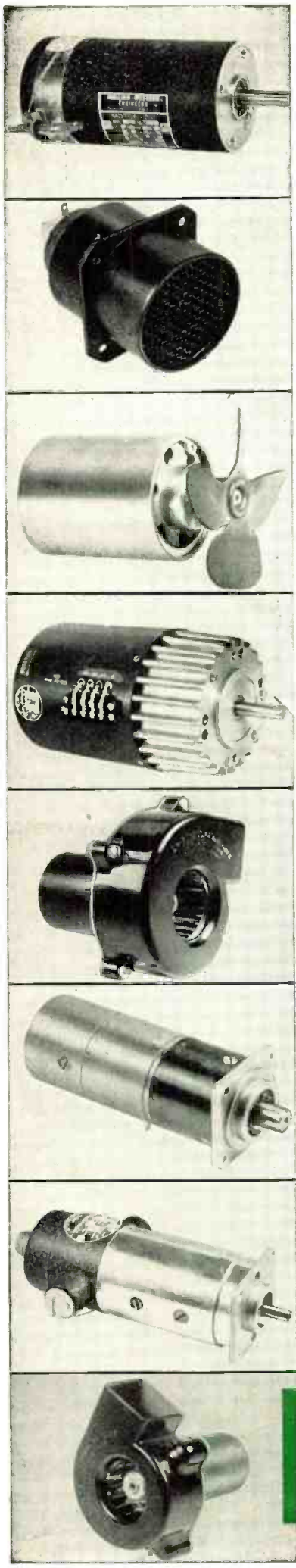

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- ball bearings throughout
- stainless steel through bolts
- bonded stators for greater strength
- full protection against humidity and fungus growth
- meet or exceed all AN specifications
- constant inspection and 100% performance testing
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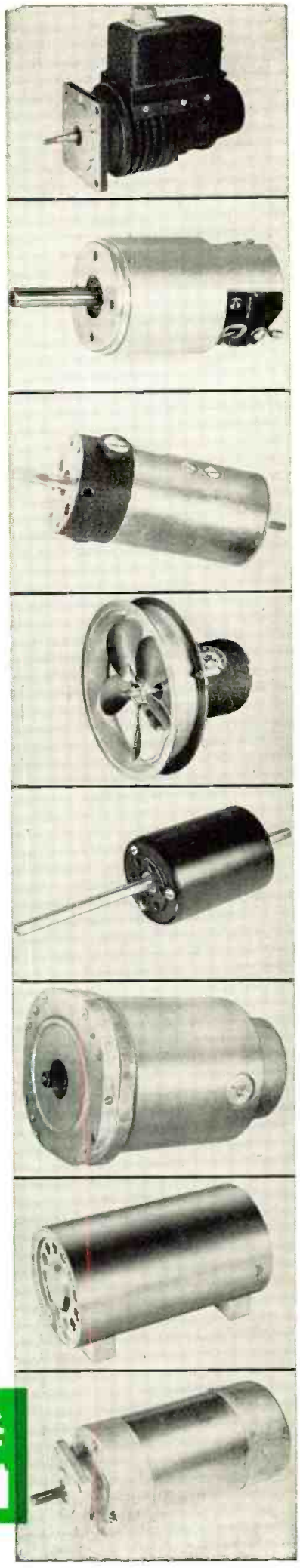
- complete engineering service to insure correct application

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.



"The difference is reliability" ★ *Since 1888*

5568

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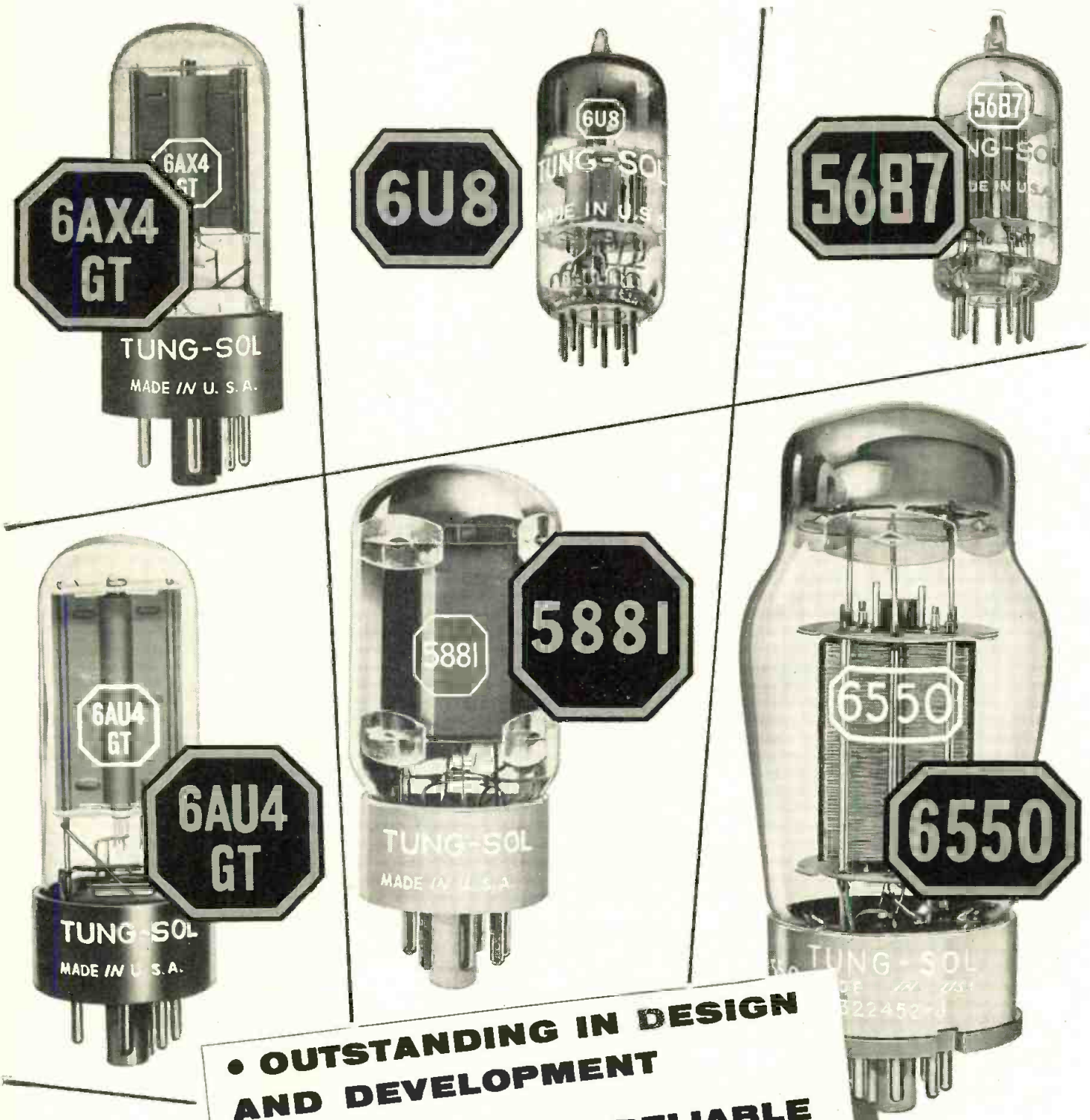

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- **VERSATILE AND RELIABLE IN PERFORMANCE**
- **ACCLAIMED BY THE ELECTRONICS INDUSTRY**

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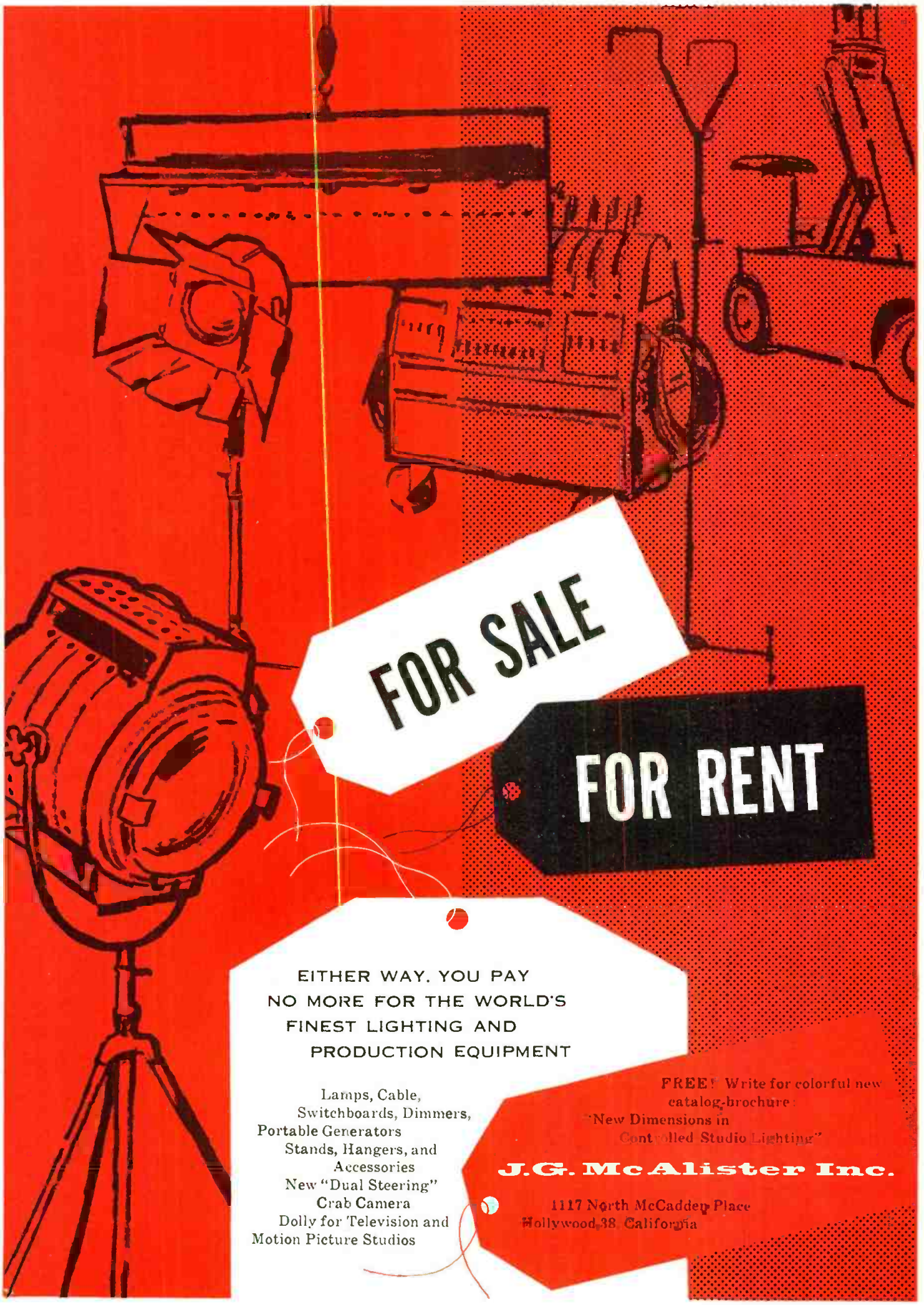
TUNG-SOL MAKES All-Glass Sealed Beam Lamps, Signal Flashers, Picture Tubes, Radio, TV and Special Purpose Electron Tubes, and Semiconductor Products.



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J.G. McAlister Inc.

1117 North McCadden Place
Hollywood 38, California

BOOKS

(*Continued from page 50*)

lay systems and is limited to the 44 to 13,000 megacycle range, since most radio relay systems are designed to operate within this range.

Sweep and Marker Generators for Television and Radio

By Robert G. Middleton. Published 1955, by Gernsback Publications, Inc., 25 W. Broadway, New York 7, N.Y. 224 pages, price $2.50.

With the advent of color television, many of the principles dealing with the capabilities and limitations of sweep and marker generators have created a need for clarification of the characteristics and principles of these instruments. Project engineers will find such subjects as: harmonic and cross-beats (spurious frequencies) in the output; spurious sweep outputs and spurious marker outputs; limitations of sum-frequency output from beat-frequency generators; and the nature of flatness (constancy) of output from a sweep generator as informative and helpful in clarifying the misunderstandings which have risen concerning these points. Ten chapters in all, with comments and observations gathered by the author from a host of engineers throughout the country help to make this book a worthwhile addition to all concerned with the characteristics of these instruments.

Books Received

Basic Principles of Parliamentary Law and Protocol

By Marguerite Grumme, Registered Parliamentarian, 3830 Humphrey St., St. Louis, Mo. 1955 edition, 68 pages. Of interest to engineers serving on committees is this monual on porliamentary law and procedure. Price $1.00. Copies may be purchased by organizations at various group rates. All copies are sold by Marguerite Grumme at the above address.

Government Publications

Research in Nonlinear 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. Dept. of Commerce, Wash, 25, D.C., price $3.75.)

Slip Casting of Barium Titanate.

Naval Research Laboratory, Feb. 1955. 11 pages. (Order PB 111629 from OTS, U.S. Dept. of Commerce, Wash. 25, D.C., price 50¢)

A Review of the Air Force Materials Research and Development Program

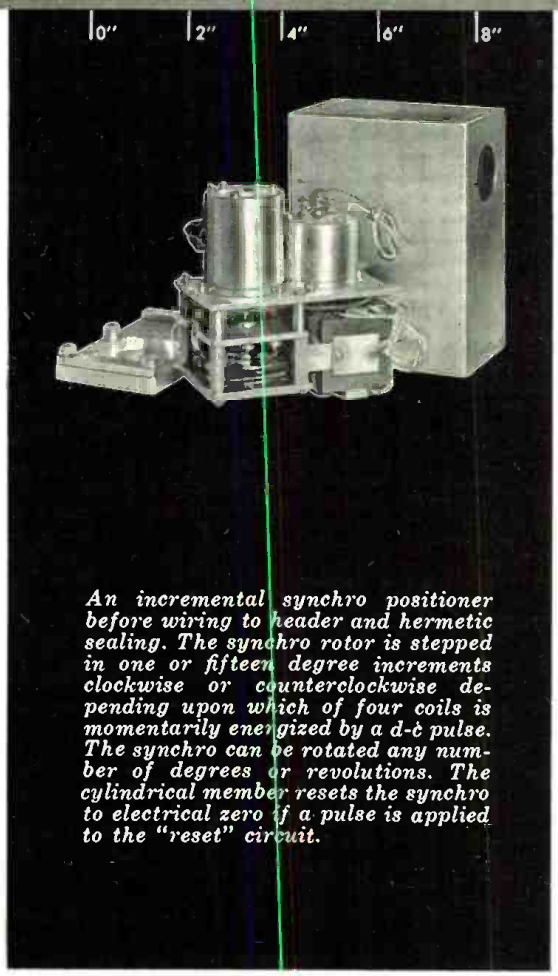
Contains 105 pages, may be ordered from OTS, U.S. Dept. of Commerce, Wash. 25, D.C., price $2.75.

Fabricating Techniques for Crystal Unit CR-23/U (49.9 to 51.1 MC)

Signal Corps Engineering Labs., Ft. Monmouth, N.J. Feb. 1953. 29 pages, including illustrations. (Order PB 111557 from OTS, U.S. Dept. of Commerce, Wash. 25, D.C., 75¢)

built to do just one servo control job . . .

perfectly



An incremental synchro positioner before wiring to header and hermetic sealing. The synchro rotor is stepped in one or fifteen degree increments clockwise or counterclockwise depending upon which of four coils is momentarily energized by a d-c pulse. The synchro can be rotated any number of degrees or revolutions. The cylindrical member resets the synchro to electrical zero if a pulse is applied to the "reset" circuit.

Like all Transicoil servo assemblies, this incremental positioner "does the job right" because it was designed for a single application . . . by a company whose major function is to provide complete servo assemblies precisely engineered and manufactured to solve individual servo control problems.

Of course, if you merely want servo *components*, you'll find Transicoil's control motors, motor-gear train combinations, motor-gear train-generator combinations, and servo amplifiers built to the highest order of precision and accuracy. But it is in the "package" engineering of unique assemblies that Transicoil's experience and creative imagination offer the greatest value. And in most cases, these assemblies cost no more than the individual components would purchased separately.

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Total number of tubes used?	59	87	72	68
Audio channel included in basic unit?	YES	NO	NO	NO
Color modification available for early monochrome models? Approximate cost (less shipping)	YES $350	YES $2,000	NO	NO
Field change of frequency, from 6,000 to 7,000 to 13,000 Mc.—without obsolescence?	YES	NO	NO	NO
Transmitter Monitor included?	YES	YES	NO	NO
Number of units for complete system?	4	5	5	6
Total weight of system (lbs.)	162	299	195	295

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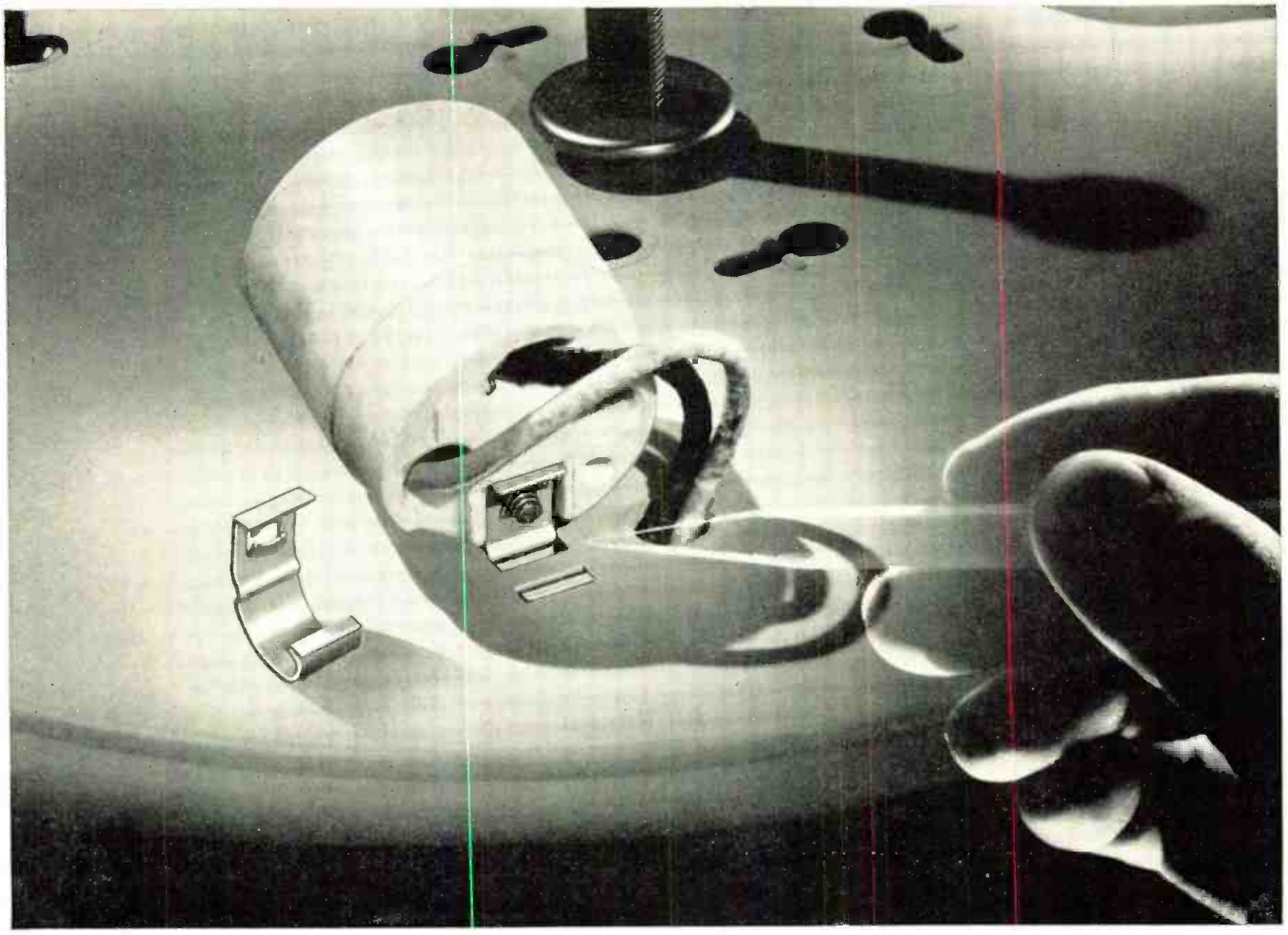

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Cat. No.	30D6	30D16
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Leakage Current (μA Max.)	2.0	3.0
Can Size D"	3/16	3/8
Can Size L"	1/2	3/4

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Squelching Commercials

In past years there have been a number of circuits devised which would either manually or automatically disconnect the sound portion of a radio or television receiver for the duration of a commercial announcement. None of these devices, however, enjoyed extensive commercial success . . . possibly because no major manufacturers ever evidenced great interest.

In recent months, a major manufacturer has taken interest, and has now in his line, a television receiver with a manually operated "commercial squelcher." Broadcast officials are viewing this with some concern. If the device captures the public fancy, and if because of pressing competitive situations, other manufacturers begin to produce such units in quantity, there can be some serious repercussions in commercial broadcasting as we know it today. We hope that this does not occur, because the commercial is, and has always been, the keystone of broadcasting. Better we should make commercials that people don't want to turn off and be more considerate in their application during program time!

TACAN Declassified

With the declassification of TACAN (tactical air navigation system), the Federal Telecommunication Laboratories, a division of the International Telephone and Telegraph Corp. of Nutley, N. J., last month provided an extremely interesting demonstration of the system's fine distance and bearing measuring accuracy in a DC-3 test flight involving some nine check points in the vicinity of the ground beacon over Manhattan, Queens, Westchester and Northern New Jersey. The completely automatic military AN/ARN-21 (airborne portion) and the AN/URN-3 (ground portion) equipments as well as the smaller manually operated civilian aircraft equipment, were checked against each other, and the resulting readings compared most favorably. An outline of TACAN operation and its features is included in this issue and starts on page 64.

The VOR DME-TACAN controversy has been widely discussed and much has been written on the subject. TACAN was developed essentially as a system for overseas application and integrates both bearing and distance information into a single equipment. After the Korean War, it became apparent that the tactical navigational requirement for the military was no longer restricted to overseas operations but involved the United States mainland as well. It was also recognized that TACAN satisfies the requirement for a common civil air navigation aid and it is this that ultimately has led to the declassification of its operating characteristics.

From a review of the operating characteristics it becomes apparent that in spite of extremely accurate bearing and distance information provided, the system itself is quite complex. As one might expect, the accompanying military airborne equipment is also complex, embodying some 75 to 80 vacuum tubes and their circuits. Complex systems and equipment are ripe targets for reliability and simplification techniques. Inspection of the component arrangement in the AN/ARN-21 indicates that much might be done here with transistors and printed circuits. With such a powerful aircraft navigational tool, and with both military and commercial aircraft constantly increasing in numbers, we can expect that this will be the case as more manufacturers specializing in various production techniques become interested. Today, only three organizations, Federal Telephone and Radio Corporation, Hoffman Electronics, Inc., and Stromberg Carlson make TACAN.

Copper & Brass

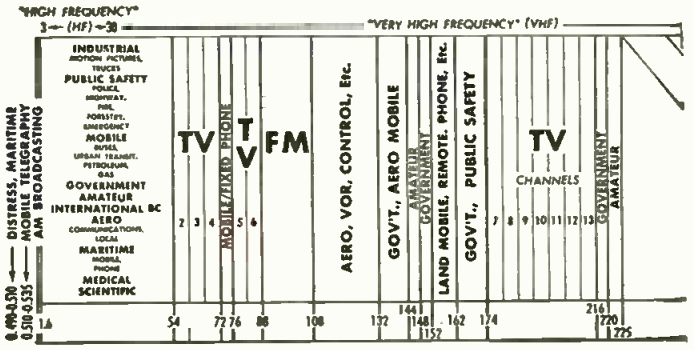
In the last month's editorial "Realistic Pricing," we pointed to the possibility of serious future material shortages. Copper and brass at this time are in such acute short supply and prices are spiralling. The Copper and Brass Warehouse Association, and the Wire and Cable Section of the National Electrical Manufacturer's Association recently have petitioned President Eisenhower to release some 100,000 tons of U. S. government stockpiled Chilean copper to save some 30,000 small manufacturing plants, employing some 850,000 workers, which soon may have to shut down. Disabling strikes and shutdowns earlier this year, the recent New England floods, and the current wildcat dock strikes which are forcing supply ships to turn back unloaded have created the crisis.

In the face of the current situation one might expect that the government would readily respond to such an appeal and release the raw material from the national stockpile. This, however, may prove to be an extremely difficult feat to accomplish without complete congressional resolution and action. The president does have the power to release raw materials during periods of national emergency and it is true that President Truman did so on one occasion during his tenure of office, but this action took place during the Korean War. In general, the national stockpile is figured on anticipated defense requirements, and to divert these materials from the stockpile for any other purpose, would involve both setting a precedent and, possibly serious weakening of the National Defense.

During this emergency, there is a separate defense production stockpile from which manufacturers of government equipment can draw to meet their production requirements, but for the electronic industries manufacturing consumer products and who annually need approximately 1¼% of the total copper used in the U.S., the outlook may not be bright for some time.

RADARSCOPE

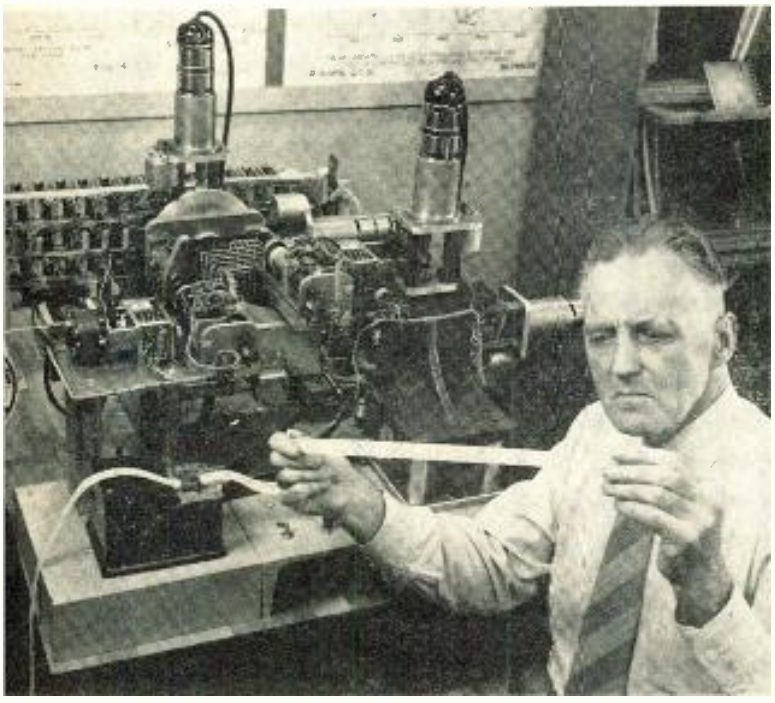
Revealing important developments and trends throughout the spectrum for radio, TV and electronic research, manufacturing and operation



PRESSURE-SENSITIVE RESISTORS that will change value from 100 megohms to zero ohms with a change in pressure of 12 lbs. are now being introduced to the market. Made of newly discovered "Celab" resistance material, these new units have precision stability and zero elongation. The contacts never move or open, have no wearing parts and cannot burn out with the temperatures encountered by the usual wire wound unit. The resistance can be increased to 10,000 megohms, if necessary, so the resistor can act as a switch or circuit breaker, without mechanically opening any contacts. Principal applications of the unit will be to weighing scales, inverters, strain and pressure gauges and voltage and speed controls.

"SKIN PACKAGING," in which a plastic film is used to both cover the product and secure it to the mounting cardboard is now being introduced to the market. The system works in this manner: Printed and coated cardboard sheets are laid on the working table. The product is located on the cardboard and plastic film is drawn over the parts. A special machine then heats the film and vacuum draws the film over the product and seals it to the cardboard. The manufacturer of the machine reports that any article can be packaged in this manner.

AUTOMATIC WIRING



The "M-4", shown here at Bell Labs with its designer, R. F. Mallina, is an automatic wiring machine developed to study apparatus and equipment designs best suited for automation. Machine, fed by instructions contained on punched tape, automatically wires complex electrical circuits using solderless connections made by wrapping six turns of solid-conductor wire around a rectangular terminal. Wiring is done on plastic panels on which various components are mounted.

THE TREASURY DEPT. has made public an outline of a proposed agreement with France concerning the application of French "turnover" taxes to license fees paid by French enterprises for use of American patents, copyrights, trademarks, manufacturing processes or formulas. Under the agreement American firms licensing "inventions" to French enterprises would be exempt from tax if they qualify as "inventors" with respect to a given royalty.

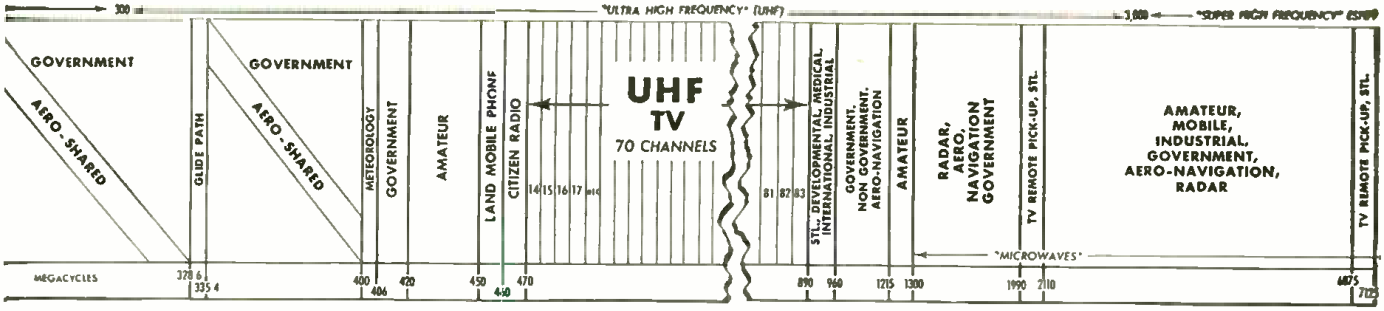
SMALL BUSINESS FIRMS are getting an increasing share of the defense contract awards. At the mid-point of the fiscal year 1955 the smaller concerns had received a total of $3.215 billion, or 21.8% of the total of net defense awards to business firms. Asst. Secretary of Defense Thomas P. Pike pointed out that this represents an increase of 4.2 percentage points over the average for the preceding four and one-half years, or, in dollar value, the equivalent of $620 million worth of business per year.

INDUSTRIAL TELEVISION

Largest compatible color TV system so far developed for other than entertainment purposes will be installed at the Walter Reed Army Medical Center, in Washington, D. C. The installation, which will be made by RCA, will provide three complete color TV systems for use in the Armed Forces Inst. of Pathology, the Walter Reed Army Hospital, and the Army Medical Service Graduate School. The three systems can be operated independently or joined for operation as a combined network. Each system will be equipped for both closed-circuit TV operation and for direct transmission to commercial TV network lines. As the announcement of this installation was being made, RCA was demonstrating before the International College of Surgeons a new color TV camera designed specifically for medical use.

ELECTROLUMINESCENCE

Mural TV, in the form of a thin screen decorating a wall, and controlled remotely from a small box beside the viewer, was described by RCA's Dr. E. W. Engstrom at the Western Electronics Show and Conference. The screen, said Dr. Engstrom, will consist of an electroluminescent material which emits visible light under the influence of an electric current. Such a material has already been created in the research laboratories. There remains additional research in miniaturizing other



elements in the TV receiving circuits, after which mural TV will become a reality.

AIRCRAFT RADIO

The radio interference which is suffered by aircraft flying through precipitation, ice or snow is the subject of intensive study at the Stanford Research Institute. The cause of the interference has been traced to the effects of individual precipitation particles. As they hit the plane's surface they leave a charge at their point of impact and bounce off with an opposite electrical charge. The many particles set up individual small, but steep-fronted, pulses of current at the antenna terminals. The sum of all these pulses arriving at a random rate produces a serious noise problem. SRI scientists are studying phenomena with the aid of a 150-gallon vacuum tank fitted with a quick-opening inlet valve at one end. A sample probe—representing the aircraft's surface—is placed within the tank at an angle to the inlet valve and the evacuated tank is placed in SRI's cold chamber. With the temperature at -35°, the chamber is seeded with dry ice and the inlet valve opened for a few seconds to allow ice fog particles to speed into the tank, striking the sample probe. With this equipment and sensitive instrumentation the research team has isolated and observed the effects of single particles.

SUBSCRIPTION TV

Pay TV found strong opposition in two separate comments filed recently with the FCC. The NARTB, opposing the authorization of Penn-Allen Broadcasting Co., Allentown, Pa. to conduct a "pilot" subscription TV service, raised the question of whether the FCC had jurisdiction in this case. Commented the NARTB, "no commercial authorization should be given at this time as it will prejudge one of the basic issues in the pending rule-making proceeding. This issue is whether or not subscription television constitutes a broadcast service." In a separate comment, C.B.S. Inc. urged the FCC to dismiss the pending pay TV petitions on the grounds that their licensing "is inherently adverse to the public interest." CBS called the claims of pay TV proponents that they would present new and better kinds of programs "vague" and "general," and recommended that they be disregarded.

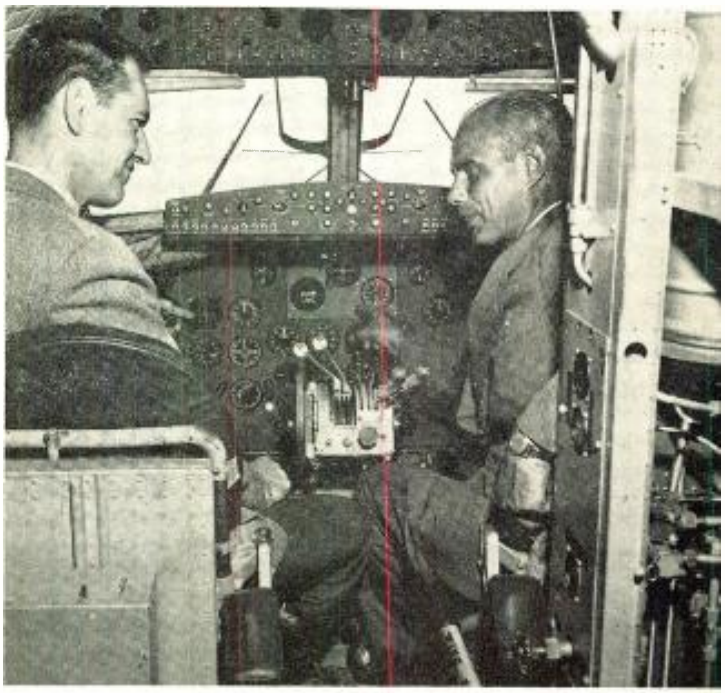
MICROWAVE

AT&T Long Lines Dept. has asked the FCC for authority to construct microwave relay facilities to provide an eastbound television channel between Dallas, Tex. and Jackson, Miss. Explaining the need for this link the Long Lines Dept. pointed out that the Dallas-Jackson radio relay system, which will be completed this Fall, will have five channels, two in each direction for telephone service, and one westbound TV channel which will be used to reroute from Atlanta one of the three major networks now serving Dallas from Kansas City. The rerouting is necessary, said Long Lines, to provide additional telephone channels between Kansas City and Dallas. AT&T added that there are now two westbound TV channels from Atlanta to Jackson, with an eastbound channel to become available in November. The Dallas-Jackson link is required, says AT&T, so programs can be routed eastbound from Dallas and points east of Jackson by connection with the proposed eastbound channel to Atlanta. The Long Lines Dept. estimated the cost of the new link at about $230,000.

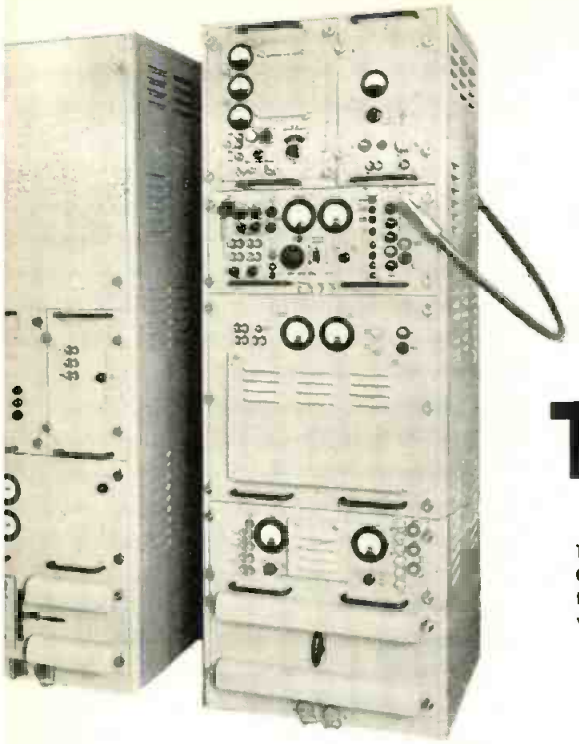
Coming Soon

December 1955—Annual Printed Circuit Issue
Readers contributions on this topic are welcome

NEW AIR NAVIGATION SYSTEM



E. DeFaymoreau, assoc. lab director of IT&T's Federal Telecommunication Laboratories, Nutley, N. J. demonstrates compactness of new TACAN bearing and distance indicator to Capt. Aubrey Swezey. New system developed for the military, and now being released for general use, provides pilot with precise indication of his position at all times, regardless of weather conditions. System utilizes fixed ground station as reference points. Airborne indicating equipment occupies space of an ordinary shoebox. More detailed information on the system will be found on p. 64 of this issue.



This system, originally developed as a military tactical air navigation bearing and distance indicating system for civil aircraft. Only recently

By ROBERT I. COLIN

TACAN—Operation

TACAN ground equipment. Crystal-controlled receiver and transmitter with associated video circuits

TACAN is a radio air navigation system of the polar coordinate type, illustrated in Fig. 1. That is, there is a *bearing facility* which provides the aircraft with a meter indication of its direction, in degrees of bearing, with respect to the geographical location of the ground beacon tuned in by the pilot. Then there is a *distance facility* which provides the aircraft with a meter indication, in miles, of its distance from the selected ground beacon. Knowing his bearing and distance from a specific geographic point, the pilot can fix his position on a chart; navigation and traffic control are thereby facilitated.

The system has been developed and built for the U. S. Navy and Air Force by the Federal Telecommunication Laboratories, a division of the International Telephone and Telegraph Corporation.

The bearing facility in the system is of a general type known as "omnidirectional radio range" (ODR), in distinction to other directional systems such as four-course ranges, radio compasses, direction finders, etc. The specific bearing function in TACAN will be referred to as the TACAN omnirange or bearing facility.

DME is an abbreviation for distance measuring equipment. Properly speaking, it refers in general to any radio aid which furnishes meter indications of distance. The specific distance function in TACAN will be referred to as the TACAN DME facility.

The expression TACAN is a code word for "tactical air navigation system." The military nomenclature for the equipment is AN/ARN-21 (airborne portion) and AN/URN-3 (ground portion).

System Features

An omnirange facility requires: on the ground, a transmitter in association with a special directional antenna; on the aircraft, a multichannel receiver. A DME facility requires: on the ground, a receiver-transmitter combination (transponder) with a non-directional antenna; on the aircraft, a multichannel transmitter-receiver combination (interrogator).

The elements of TACAN are indicated in Fig 2. The entire system operates in the UHF (1000 mc) band. One multichannel airborne receiver-transmitter, operating with pulses, provides both distance and omnirange functions. That is, the same radio signals, on any given r-f channel, convey both distance and bearing information. Actually, both a "coarse" and a "fine" bearing system are included in the omnirange function. Only one airborne antenna and channel selector are required.

TACAN has 126 two-way operating channels available for assignment; these are all established on the basis of "clear" radio frequencies. The frequencies are spaced 1 mc apart. For air-to-ground transmissions, there are 126 frequencies within the band 1025 mc to 1150 mc. For ground-to-air transmissions (serving both bearing and distance functions) there are 63 frequencies in the band 960 mc to 1925 mc plus

Fig. 1: Polar coordinate navigation

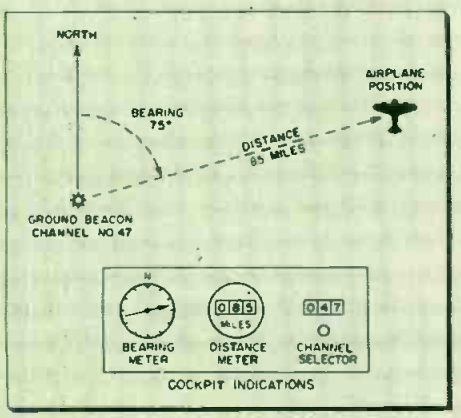


Fig. 2: Elements of TACAN system

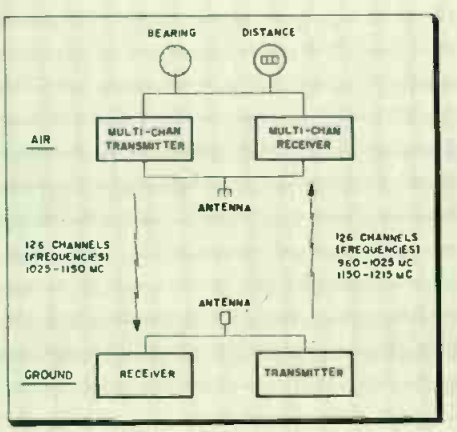
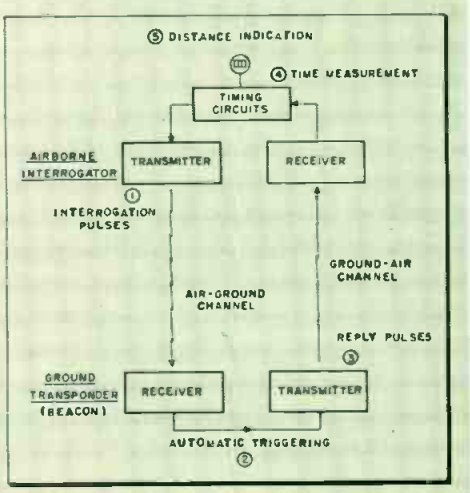


Fig. 3: Principles of DME operation



ystem for overseas application, is equally versatile as a continuous
eclassified, here is the first technical summary describing its operation

and Features

Fig. 4: TACAN ground beacon antenna design. Antenna is seen above installed atop the 300-ft. microwave tower of the Federal Telecommunication Labs., Nutley, N. J.

63 frequencies in the band 1150 to 1215 mc.

Pulse coding is used in TACAN, but only for the purpose of multiplexing together distance and bearing functions on each clear frequency channel. It is possible to multiplex additional navigational functions on these channels, such as localizer, glide path, marker, ATC transponder ("radar safety beacon"), etc. Some of these have already been demonstrated experimentally over airborne TACAN equipment. When the additional functions are so multiplexed, no additional r-f equipment is required, only relatively small video adapters and indicating meters. TACAN's saving in weight and size of airborne equipment and in r-f spectrum requirements would be even more pronounced if one were to take into consideration all navigational functions which might be multiplexed on its channels. These now operate individually, as follows: VHF omnirange, 112-118 mc; DME, 963-986 mc and 1188-1210 mc; localizer, 108-112 mc; glide path, 328-335 mc; and marker, 75 mc.

In TACAN operation there is no possibility that, because of the pilot's error in matching channels on two different equipments, or because of malfunctioning of a ganged tuning mechanism, bearing might be indicated from one ground station and distance from another, with consequent confusion in navigation. It is impossible because the two services are provided by the one radio set, on one operating channel. This situation is quite analogous to modern television service, where one r-f channel conveys the signals for both the video and the audio.

ROBERT I. COLIN, Asst. to Technical Director, Federal Telecommunication Laboratories Inc. Div. of International Telephone & Telegraph Corp. Nutley, N. J.

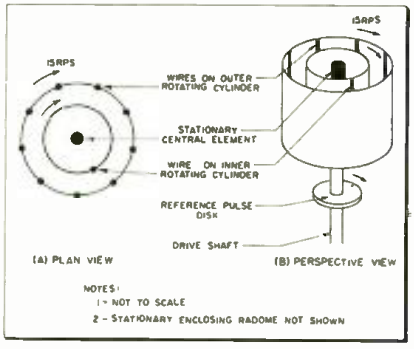
Distance Indication Facility (DME)

General DME Operating Principles

DME is an outgrowth of radar ranging techniques, whereby distance is determined by measuring the round-trip time of travel of radio pulses between the two points in question. In DME however, instead of cathode ray tubes, simple meters are used to display the distance readings. Also, instead of depending on natural reflections or echoes for the return trip of the pulses, a special radio transponder is used to produce artificial echoes. These are stronger, and their radio channel positively identifies the source of the echo and hence the geographic location of the echoing point.

Referring to Fig. 3, the airborne transmitter cyclically initiates a process of sending out very narrow, very widely spaced "interrogation" pulses. These are picked up by the ground beacon receiver, whose output triggers the associated transmitter into sending out "reply" pulses on a different channel. These replies are finally picked up by the airborne receiver. Timing circuits automatically measure the round-trip travel time, or interval between interrogation and reply pulses, and convert this into electrical signals to operate the distance meter.

For system operation, a given ground beacon may be interrogated simultaneously by a number of aircraft which are in the vicinity and which have tuned to its channel. The ground beacon will then reply to all interrogations; and each airplane will receive the sum total of replies to all airplanes. To permit interference-free operation under such normal conditions, it is arranged



that each airplane's interrogation pulses occur at a rate that, within limits, is randomly "wobbled." A strobe circuit initially "searches" among all reply pulses received on the airplane, examines them all in turn, and within a short time finds the one series of reply pulses which has the identical repetition rate as the airplane's own initiated interrogation pulses. The search process occurs only when a ground beacon is first tuned in. Thereafter, the strobe circuit "locks" on to the proper series of reply pulses and tracks them as their time delay slowly changes in consequence of the airplane's changing distance.

By this technique, common to all types of DME, up to 100 or more aircraft may simultaneously, and without serious mutual interference, obtain distance service from one ground beacon. Pulse repetition rates are of the order of 30 per second (temporarily higher during the search process), and the pulses are very narrow, of the order of a few microseconds. Hence the "duty cycle," or percentage of any total time interval during which r-f energy is being transmitted, is very low.

TACAN—(continued)

It is evident that in DME operation, the r-f channels are mostly empty, very large spaces existing between successive pulses. These spaces are used to transmit Morse code station identification by means of pulse groups; and in TACAN, also to transmit information for other navigational functions.

In actual designs of DME, the pulse signals are generally twin pulses, with a pre-arranged spacing of the order of 10 to 80 μsec. The receivers, ground and airborne, are followed by discriminators or twin pulse decoders, which are set so as to pass only pulse pairs of the prescribed spacing. Isolated single pulses, or groups with some other spacing, will not get by the decoder. The purpose of this arrangement is to make the system less susceptible to errors or interference caused by false signals. These might be produced by atmospheric noise or by other extraneous sources of r-f energy on the DME channels, but they will only rarely and accidentally have the right spacing to get by the twin pulse decoders. The formation and decoding of twin pulses of a set spacing are accomplished generally by use of delay circuits or lines, coincidence circuits, and similar techniques.

In TACAN DME, the twin pulse idea is used only for the purpose explained above. The spacing is 12 μsec on all air-ground channels and on all ground-air channels. Hence the ground and air equipments require a twin pulse encoder and a twin pulse decoder of fixed setting.

TACAN DME Channel Assignments

Problems in assignment of channels are minimized in the TACAN DME system. Since clear frequency channels are used, a ground beacon cannot be blocked, over-loaded, or affected in any way by interrogation pulses which are not meant for it. Its receiver will only pick up r-f energy that is destined for it to receive and act upon, since all other signals occur on a different radio frequency.

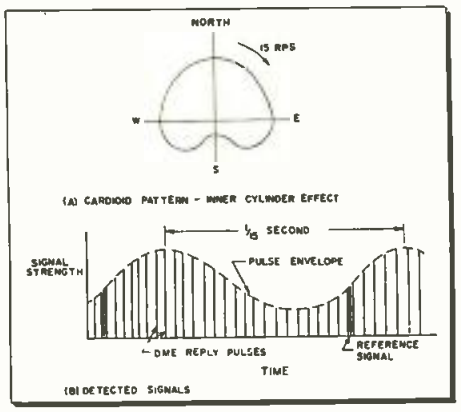
Also, all frequencies—ground and airborne—are stabilized through crystal control, as is usual for standard military and commercial equipment. Hence adjacent channel interference is not to be feared.

In assigning frequencies to clear channel, crystal-controlled navigational stations, the normal rule followed is the one applicable to most radio systems—broadcast, television, mobile, point-to-point, etc. That is, the identical frequency should not be assigned to two ground stations that are within likely interference range of each other. For TACAN DME, this distance would be of the order of 400 miles dependent somewhat on aircraft altitude owing to line-of-sight considerations. Beyond that restriction any frequency, adjacent or far-removed, may be conventionally assigned to any TACAN station, close by or distant.

Actually, however, two TACAN beacons, which are located so close to each other that an aircraft receives r-f energy from both of them simultaneously, may in practice operate safely on the identical r-f channel. Experimental tests under such circumstances have shown that, except in a very small region approximately midway between the stations, the TACAN aircraft equipment gives undisturbed and correct bearing and distance indications, corresponding to the nearer station.

The crystal control of frequency also makes possible more efficient use of r-f spectrum, by permitting close spacing of adjacent frequencies; this is 1 mc in TACAN DME. The other great advantage of clear frequency channeling is that pulse coding may be used for the multiplexing of other navigational functions on the DME channels, with consequent economy of r-f spectrum and airborne equipment. This will be explained in connection with the TACAN omnirange function; but relevant to that function, there is another special characteristic of TACAN DME operation that should be explained. That is "constant duty cycle operation."

Fig. 5: TACAN coarse omni-range principles



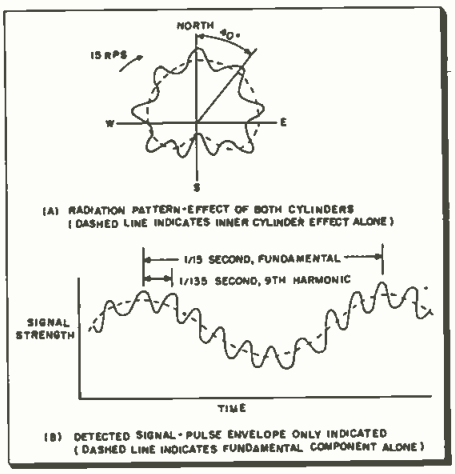


Fig. 6: Radiation pattern and detected signal

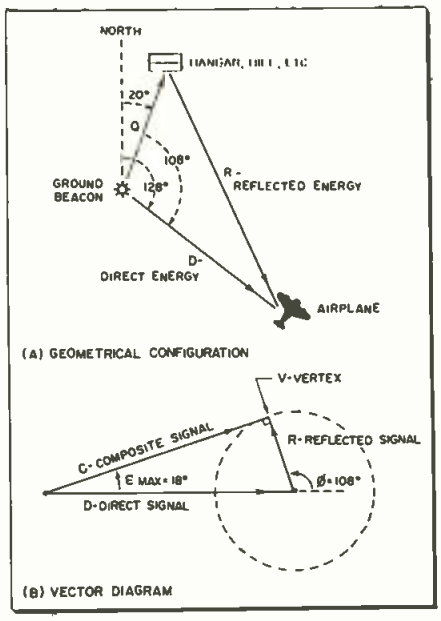


Fig. 7: Theory of site errors

TACAN Constant Duty Cycle Operation

In general, the transmitter of a DME ground beacon should reply only to such interrogations as are received from aircraft which are tuned to its channel. For each such aircraft, it would sent out approximately 30 pulses/sec. The total output of the beacon transmitter might then vary from zero to around 3000/sec, depending on the existing traffic. As the transmitter power output thus varies from zero to full load, the drain on the power source would also vary; and power supply voltages, even if regulated, would fluctuate somewhat. This fluctuation would have some deteriorating influence on the stability of the transmitted radio frequency.

To minimize this effect, TACAN DME beacons operate on the constant duty cycle principle, whereby the transmitter always puts out approximately 3000 pulses/sec. If, because of light traffic, this number is not being triggered off by reception of interrogation signals, then the deficit is made up, as required, by automatic triggering from a local

(*Continued on page* 137)

Automatic equalization of the firing and holding voltage points is achieved by testing 10 tubes together. Pulses are applied until tubes fire simultaneously

Improving Gas Diode Voltage Characteristics

Diode firing rack in operation at NBS Labs

AN INEXPENSIVE method for equalizing and stabilizing the voltage characteristics of cold-cathode gas diodes—such as neon indicator lamps—has been developed by D. C. Friedman and W. D. Urban of the National Bureau of Standards data processing systems laboartory. The tube characteristics are improved by a process of aging in which pulsed voltages are applied simultaneously to a large number of tubes. See Fig. 1. The method promises to provide an inexpensive, easily available component for many practical application in computer circutry.

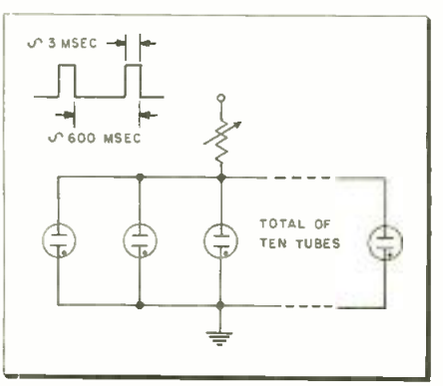
The aim of this investigation has been to devise a method to obtain high-quality gas diodes by inexpensive processing of low-cost indicator lamps. Therefore, the bulk of the work was done with NE-2 and NE-51 lamps taken from general stock.

The circuit for the equalizing process consists of a large number of tubes in parallel connected to a pulse power source through a common resistor. See Fig. 1. Pulses are continually applied until the firing potentials and holding potentials of all the tubes rise to common terminal values. Further processing produces no additional change. In the stability check, all the tubes are subjected to identical conditions. Providing a separate resistor for each tube minimizes mutual interaction, while the power supply and environmental changes are common to all tubes.

The first characteristic potential to be considered is the firing voltage—the minimum voltage necessary to start conduction in a tube which has been off a long time compared to its deionization time. The second is the holding or maintaining voltage—the voltage drop across the tube when it is carrying its rated current.

Since equalizing the tubes consists mainly of operating the tubes beyond their normal operating range, some means of obtaining pulsed operation was required. Two methods were used here. For very large overloads, a relay pulser was employed. The length of the pulse was determined by the break time of a set of relay contacts. When desired, this time could be lengthened by use of an RC circuit, but usually it was held to a minimum. The "off" time was set by a timing relay also operated with a variable RC circuit. Two relays were used to obtain "fail-safe" operation insofar as the tubes were concerned. For tests at higher duty cycles, full or half-wave 60-cycle voltage was used. To keep the overall duty cycle low, a clock-driven switch was used to obtain 25 or 75% duty cycles over aproximately 100-second periods. In all tests, bulb temperature was checked to make sure it did not rise significantly above ambient temperature.

Fig. 1: Tubes are connected in parallel and fed from pulse source through common resistor



After some preliminary tests, a set-up was devised for equalizing the characteristics of 10 tubes at a time. This was based on the assumption that at some time during the life of the tubes, when used as indicators, the characteristic voltages must rise, since end of life is indicated by the voltages rising to the point where the tubes will not operate in the circuit. It was also assumed that stability could not be attained until the tube characteristics had started on this rise. The 10 tubes were connected in parallel and fed from the pulse source through a common resistor.

Potentials Equalize

At first only one or two tubes would fire because they had much lower firing voltages than the others. However, since these drew a heavy current, they soon aged to the point where other tubes took up a portion of the burden. If the characteristic voltage of any tube should drop when processing started, that tube would carry an excess load and quickly raise its firing voltage back to the level of the others. In this way all 10 tubes were soon made to fire simultaneously. Since the current divided acording to the conductances at the holding potential, the characteristic holding potentials tended to become equal because of unequal aging. Thus, equalization of both characteristic potentials was obtained automatically.

Many tubes can be equalized at the same time in this manner, as

(*Continued on Page* 123)

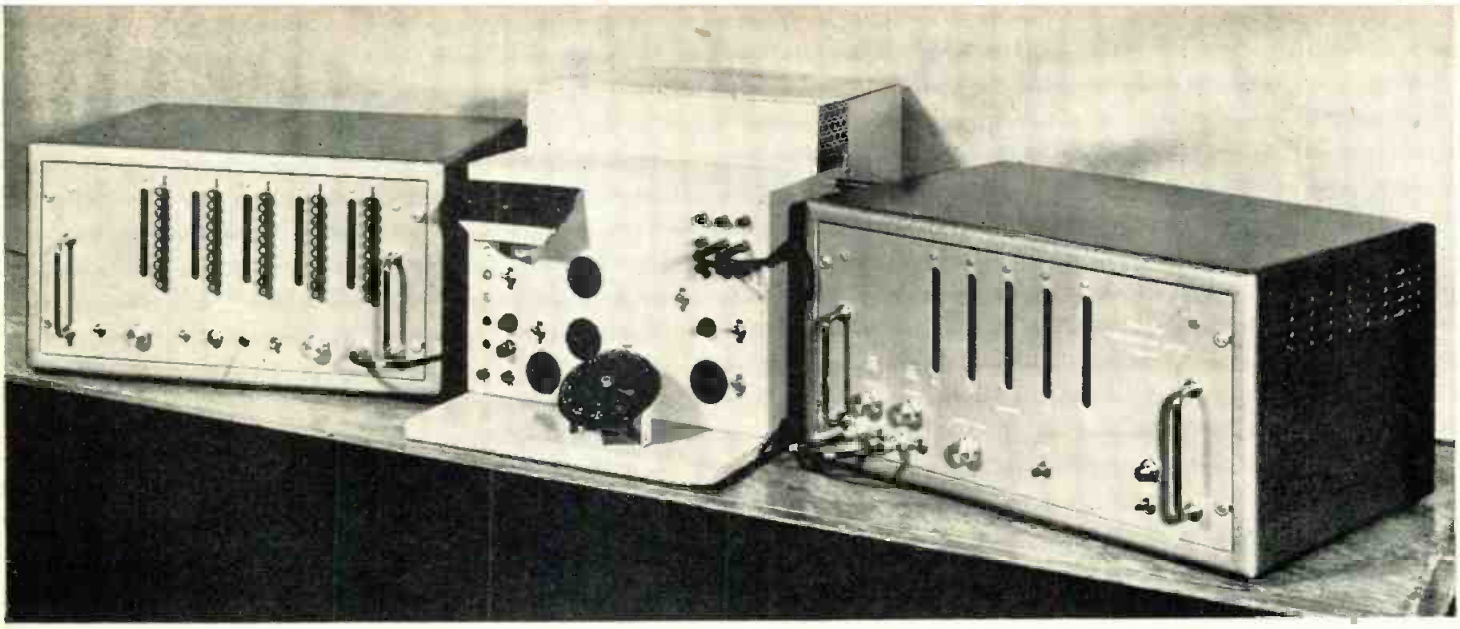


Fig. 1: Experimental model of contact timing instrument. Break time counter is at left and total time counter at right.

Time Measurement Of Sequential Contacts

Make, break and total time for single pulses or combinations of up to ten consecutive pulses can be quickly measured and recorded. Time is measured in increments of 0.0001 sec. using 10 kc frequency source gated to electronic counters

By K. L. MORTON

K. L. Morton

■ An instrument has been developed which provides an accurate method of rapidly determining the timing characteristics of pulsing or sequence stepping contacts. It records make, break, and total time for any single pulse or any combination of from two to 10 consecutive pulses. An accurate 10 KC frequency source is gated to electronic counters which record the measured time in increments of 0.0001 sec. The timing frequency is gated electronically to keep switching error at a minimum, while relays are utilized to set up the proper sequence of operation. The use of circuit selection relays lends versatility to time measurements; however, the measured periods must be of sufficient duration to allow the control relays to operate. When there are two or more distinct types of intervals in a sequence to be measured, such as the make and break times of pulsing contacts, the break time measuring circuit may be enabled during the make time, and conversely, to provide adequate switching time.

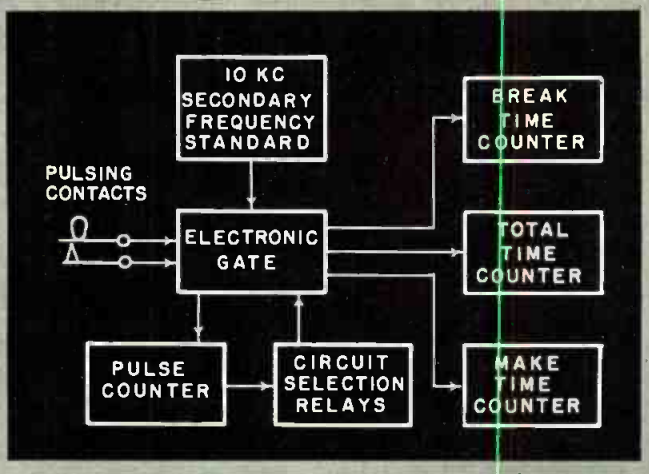
Circuit Description

Fig. 2 shows a block diagram of a test set primarily designed for measuring the timing characteristics of telephone dials. The set will yield data for determining percent break or percent dwell, speed, and auxiliary contact delay time.

Fig. 3 shows a basic circuit of the gate tube and amplifier. An accurate 10 KC timing source is applied to the grid of V2. The amplified signal is then coupled to the cathode circuit of the gating tube V1. This tube applies the timing frequency, free of switching transients, to the make time electronic counter when the contacts under test are closed and to the break time counter when the contacts are open. Extraneous pulses below a predetermined level, caused by contact bounce, are blocked from the grid of V1A by the discriminator circuit of Fig. 4.

Fig. 5 is a simplified circuit of the start control relays. When the rotating contact of the selector RLS1A steps to the second position, +48 volts dc is applied through the start switch S6A to the bottom of the coil of RL4. The other terminal of the coil is connected to −48 volts dc through a potentiometer, which supplies a bias current. By applying the proper bias current prior to the application of the operate current, the relay armature will close in less than its normal operating time. When RL3 is de-energized on the second closing of the input contacts, the operating time of RL4 is further reduced by the application of an over voltage pulse through a set of normally closed contacts on RL4. The bias current then holds up the relay. This same principle is also applied to RL5, RL6, RL7, and RL8. Relay RL5 is held inoperative by a set of normally open contacts on RL4, thus insuring the proper sequence of operation. This same interlock method is used on RL6, RL7, and RL8 in the stop circuit of Fig. 6. Another set of normally open contacts on relays RL4 to RL8 inclusive are connected in series with a sequence check lamp to indicate a completed measuring cycle. A lamp

K. L. MORTON, Test Set Design Engineer, Western Electric Co., Inc., Indianapolis, Ind.



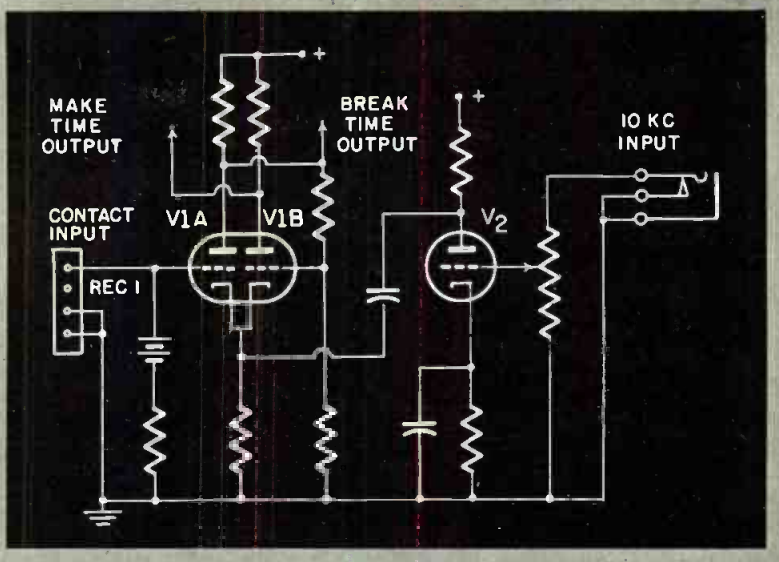
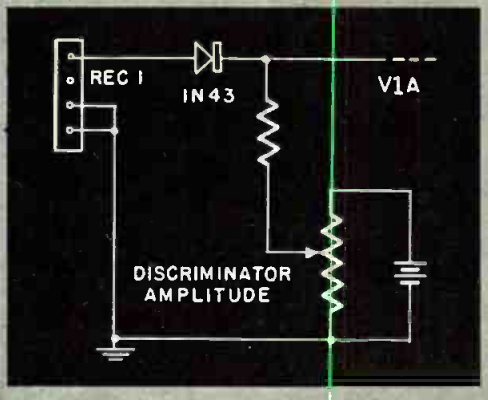
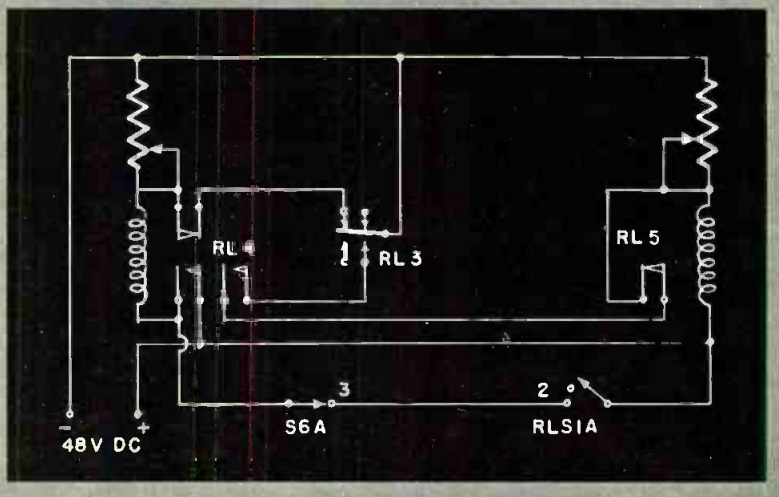


Fig. 2: Sequence contact measuring test set
Fig. 3: Ckt of the gate tube and amplifier
Fig. 4: The input-amplitude discriminator
Fig. 5: Simplified ckt of start control relays





will also be on in the start column and one in the stop column for displaying which pulses of a sequence were measured.

In the basic circuits of Figs. 7 and 8, the control of break and make timing outputs is shown. The break time output is enabled after the operation of RL4 and preceding the operation of RL6, while the make time output is enabled in the interval between the operation of RL5 and of RL7. To preclude the relay operating times from the actual timing process, the break time output is enabled by the operation of RL4 during the make time preceding the first break time to be measured. Vacuum tube V1 then gates the timing frequency to the break time counter. In a similar manner RL5 operates on the break preceding the first make time to be measured. Relay RL8 locks up the input circuit to terminate the test.

The total time of a preset number of pulses is displayed on an electronic time interval counter. Derivation of the start-stop pulses is shown in the simplified circuit of Fig. 9. When the contacts under test open to start the third pulse, as set on the start switch S6A, a positive pulse starts the time interval counter. The start circuit is then opened by RL5. After the operation of RL6, a positive stop pulse is obtained on the sixth break. The time interval counter then yields the total time of pulses three to five inclusive.

Auxiliary contact delay time may be measured by placing the start and stop switches in the "C" position and S5 in the "on" position. The delay time from the tenth make of the pulsing contacts to the opening of the auxiliary contacts is displayed

(*Continued on page* 136)

Fig. 6: Simplified ckt of stop control relays

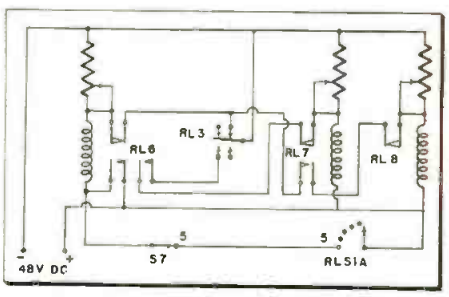
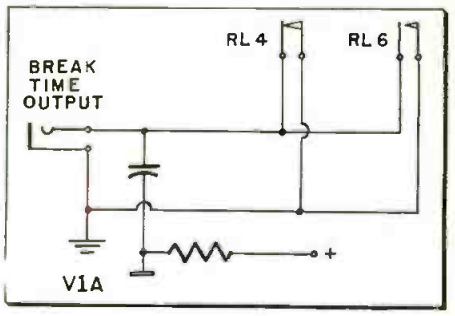
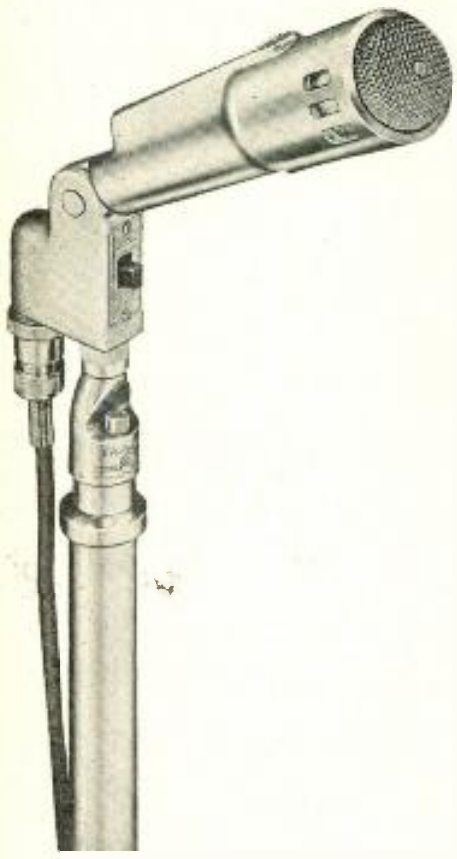


Fig. 7: Control ckt of the break time output





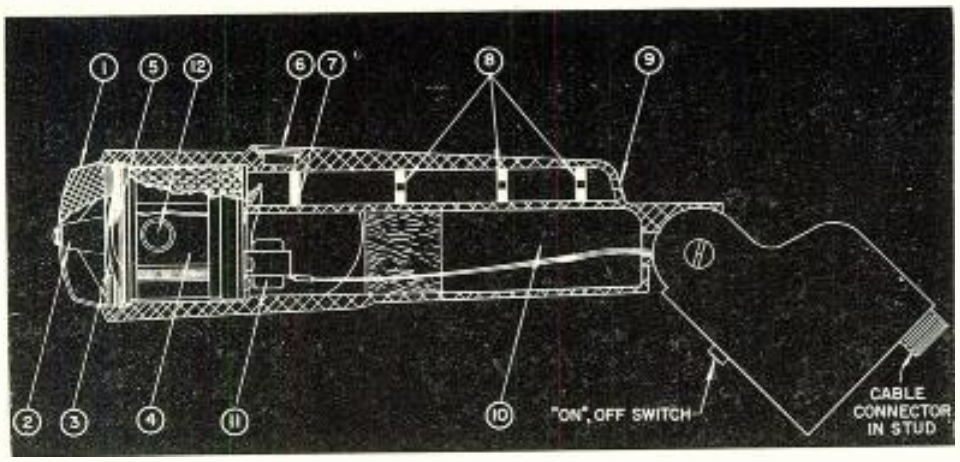


Fig. 1: Construction of Variable D Microphone. 1. wind screen 2. grill retainer 3. air space 4. magnetic assembly 5. diaphragm and voice coil assembly 6. mid-frequency entrance 7. heavy felt disc 8. felt discs 9. low frequency entrance 10. cavity, housing transformer and leads 11. step-up transformer 12. high-frequency entrance

A New Cardioid

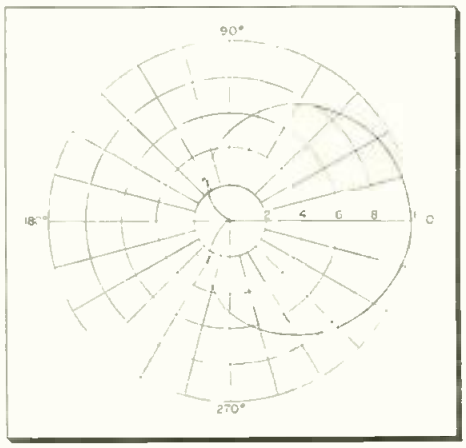
Variable D principle employs three distinct rear entrances, with acoustical filters; achieves flat response and good cancellation while eliminating proximity effect and susceptibility to shock.

IN many applications it is desirable for a microphone to have a polar response which heavily favors acceptance of sound from the front while rejecting sound from the rear. In the studio, such a microphone is in demand to accomplish the reduction of ambient-noise caused by camera dollies, light movements, microphone movements and reverberation; and to control audience participation. In P.A. work, the need is equally great for control of feedback and reverberation. The ideal cardioid microphone has the polar pattern to fulfill these requirements as shown in the polar response, Fig. 2.

The earliest attempts at the design of a cardioid microphone used two microphones in one housing. One microphone had a polar response that provided equal acceptance of sound in all directions, known as non-directional response. The second transducer was designed to accept sound equally well from the front and back while providing complete rejection on the sides, thus giving a bi-directional response pattern. When both microphones were connected in series and properly phased, a cardioid polar pattern resulted. Successful microphones were constructed using this principle, but there were numerous disadvantages. For example, the use of dual transducers made the microphones both cumbersome and uneconomical to build, since the units had to be matched carefully for both level and phase.

The customary approach to the design of a cardioid microphone utilizes a single generating element with one back entrance. In the following discussion this type of microphone will be referred to as the single D type. Although the disadvantage of two microphones has been eliminated, several other problems have resulted. The single D type cardioid microphone will be described making note of the compromises involved. A subsequent description of the Variable D microphones will show how these compromises are eliminated and the ideal cardioid microphone produced.

Fig. 2: Polar response of cardioid mike



Let it be assumed that the distance between the microphone and a single frequency sound source in Figs. 3 and 4 is very much greater than the distance between the front of the microphone diaphragm and the rear entrance. The sine waves, then, are a plot of the sound field or pressure at various times *t*. Fig. 3 and 4 are, therefore, analogous to a photograph of the behavior of both microphone and sound field at several instances of time. The lower set of sine waves indicates a sound source frequency of some greater value than that of the upper set.

Before proceeding further, one additional point must be clarified so that the operation of the single D microphone may be completely understood. A resistance and capacitance connected to an AC generator, which shifts the phase relative to that of the incoming signal, is shown in Fig 4. For constant values of resistance and capacitance, the phase shift will increase with frequency toward the theoretical maximum phase shift of 90°. As shown in Figure 4, an acoustical resistance connected to a cavity will perform similarly to the RC electrical network, and the phase relative to that of the incoming pressure will be shifted in accordance with the values of the acoustical resistance and volume. In view of this electrical-acoustical analogy, a final assumption (illustrated in Fig. 3 and 4 can be made: it is possible to so

N. FRIEDMAN and C. MacPHERSON, Electrovoice Inc., Buchanan, Mich.

choose the values of resistance and capacitance that the phase shift through this acoustical network equals the phase shift from time t_1 to time t_2.

The sound pressure at the front of the diaphragm is represented by sound wave A in the upper set of sine waves in Fig. 3 and the sound pressure behind the diaphragm is represented by wave B due to both the space (t_2) and acoustical (t_3) phase shift. The resultant pressure is the difference pressure between A and B and is shown by the dotted line.

If the microphone is now reversed as in Fig. 4 so that the rear faces the sound source, then the

Microphone

By N. FRIEDMAN
and MACPHERSON

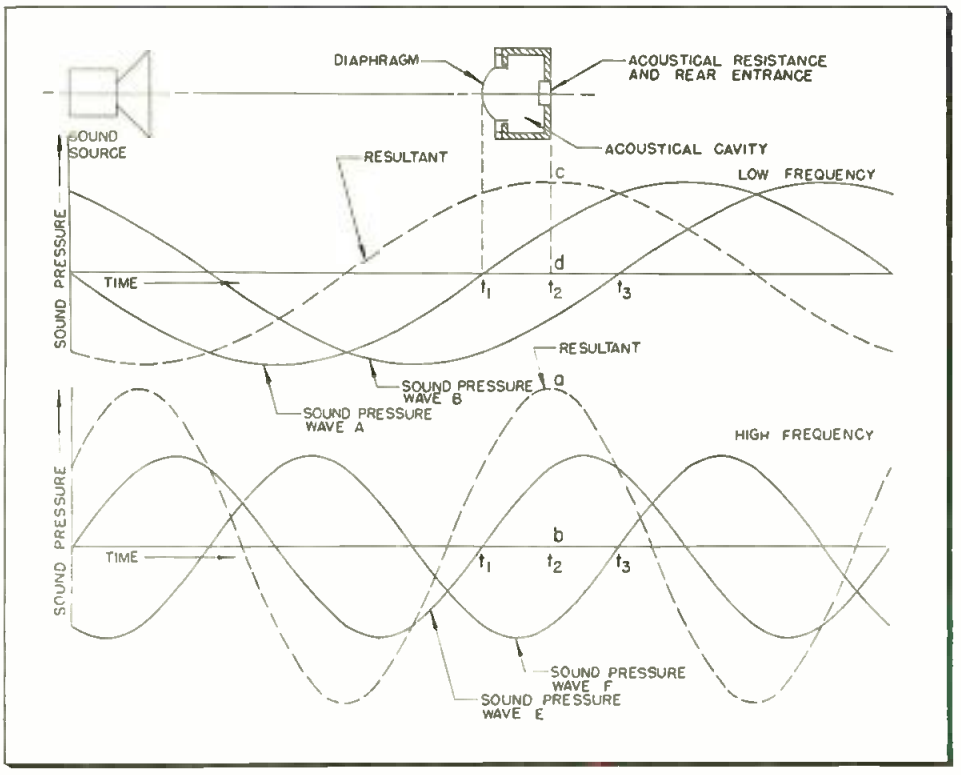
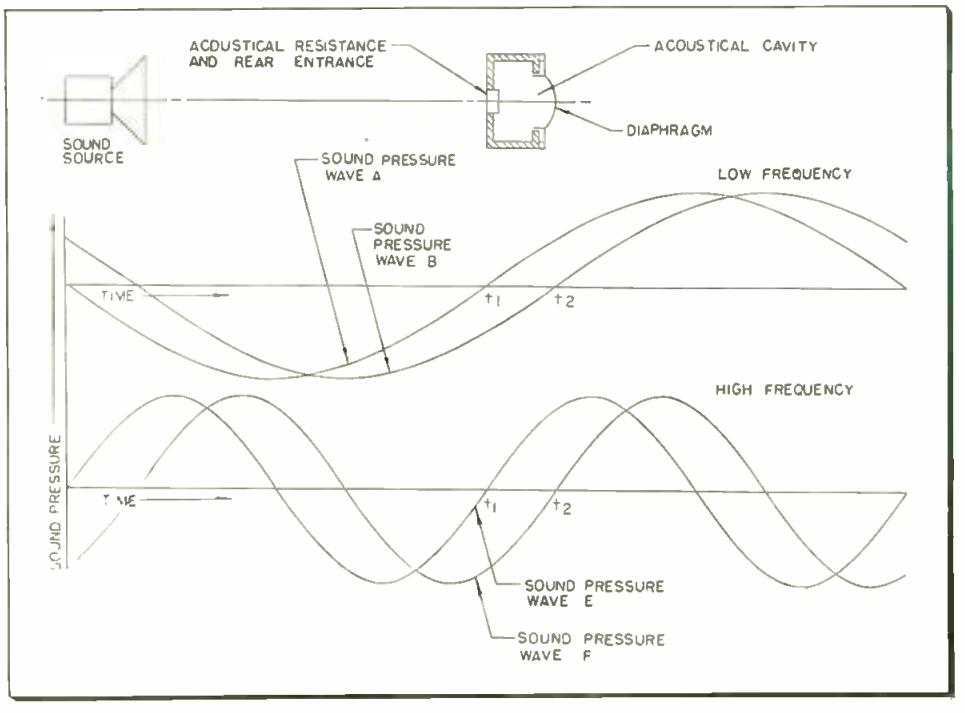


Fig. 3: (above) Behavior of both microphone and sound field at various moments of time, t
Fig. 4: (below) Magnitude of sound pressure fields at various instantaneous times, t. Mike reversed



sound pressure at the rear entrance is represented by wave A while at the front of the diaphragm it is represented by wave B. Since the shift through the acoustical network is equivalent to the space shift, wave B also represents the pressure at the rear of the diaphragm. With equal pressures on both the front and back the resultant pressure is zero.

On the basis of these facts, several conclusions can now be reached. If the front entrance faces the sound source, there is a resultant net pressure on the diaphragm. On the other hand, if the microphone is reversed, allowing the rear entrance to face the source, complete cancellation occurs. To make this feasible, the acoustical and space phase shifts must be equivalent, and since the acoustical shift is limited to 90°, the distance from front to back of the microphone must be less than one quarter of the wavelength.

Resultant Pressure

If the frequency is now increased as illustrated by the lower set of sound pressure waves in Fig. 3, and the above procedure repeated, it can be seen that waves E and F combine to give a resultant pressure indicated by the dotted line. The amplitude *ab* is obviously greater than *cd*, the amplitude of the resultant pressure at the lower frequency, indicating that the resultant pressure on the diaphragm increases with frequency. If a great many frequencies were to be plotted, the curve of Fig. 6 would result, showing the increase of pressure with frequency.

It can also be seen in Fig. 4 that F is now the pressure wave on both the front and rear of the diaphragm. Since cancellation occurs for higher frequencies as well, cancellation from the rear is independent of frequency.

To make the arguments to follow more understandable, the analogy between an electrical circuit and a mechanical system must be clarified. This analogy is illustrated in Fig. 7.

It is well known that when a generator drives a complete electrical circuit, a current flows and the circuit exhibits a given electrical impedance to current flow. In the mechanical system illustrated, if a pressure is applied, a velocity is given to the system and a mechanical impedance to the velocity is exhibited. From Ohm's law in electrical circuit theory the

$$\text{current} = \frac{\text{electromotive force}}{\text{impedance}} \quad (1)$$

Similarly, it is true in a mechanical

Cardioid Microphone (continued)

system free to move (i.e., a complete circuit) that

$$\text{velocity} = \frac{\text{pressure area}}{\text{mechanical impedance}} = \frac{PA}{z} \quad (2)$$

The basic principle of operation of any dynamic microphone lies in the fact that whenever a coil of wire (such as the voice coil of a microphone) moves in a magnetic field, an electromotive force is induced in the wire. This is known as Faraday's law and is expressed mathematically as $e = BLv \times 10^{-8}$ where e = open circuit voltage (v)
B = magnetic flux density (gauss)
L = length of conductor (cm)
v = velocity (cm sec.) (3)
Expressing the concept more simply, it may be said that for a given magnetic structure and coil (BL) the voltage output is directly proportional to the velocity of the coil.

If Eq. 2 is substituted into Eq. 3 then $e = [ABL \times 10^{-8}]\ P/Z$ (4)

Since the pressure has been shown to be proportional to the frequency, then the mechanical impedance must be proportional to frequency if the ratio $\frac{P}{Z}$, and hence the output voltage of the microphone, is to be independent of frequency. To make the mechanical impedance proportional to frequency, the microphone development engineer designs the mechanical system so that its resonant frequency is approximately equal to the lowest frequency desired. If the system is then undamped, the mechanical impedance will be proportional to frequency.

The single D microphone, then, can be made to produce a flat response curve with good cancellation. However, in gaining these two advantages several compromises have been made.

The first compromise stems from the fact that at low frequencies the mechanical impedance of the microphone is low, and as a result very little acoustical or mechanical pressure is necessary to produce an output. This causes the microphone to be highly susceptible to mechanical shock. Movement of the microphone stand and performer's hands rubbing on the microphone are only a few of the sources of highly objectionable noises.

The second compromise is the phenomenon of proximity effect. Proximity effect may be defined as the increase in bass response due to the location of the sound source near the microphone. When the source is brought near the microphone, the bass response is increased. As illustrated in Fig. 8, the sound pressure varies inversely with the distance from the source. For a given change in distance, the corresponding sound pressure change will be very much greater for a close source as compared to a distant source. Therefore, when the sound source is close, the magnitude of the sound at the rear entrance is

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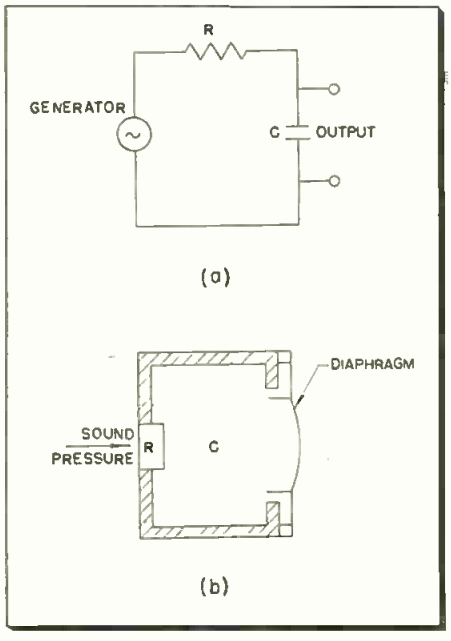
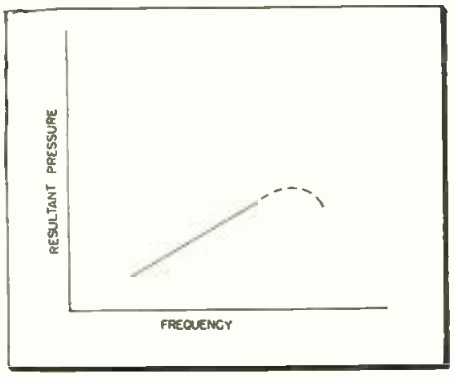


Fig. 5: Electrical-acoustical analogy of phase-shifting systems

Fig. 6: Pressure on diaphragm vs. frequency



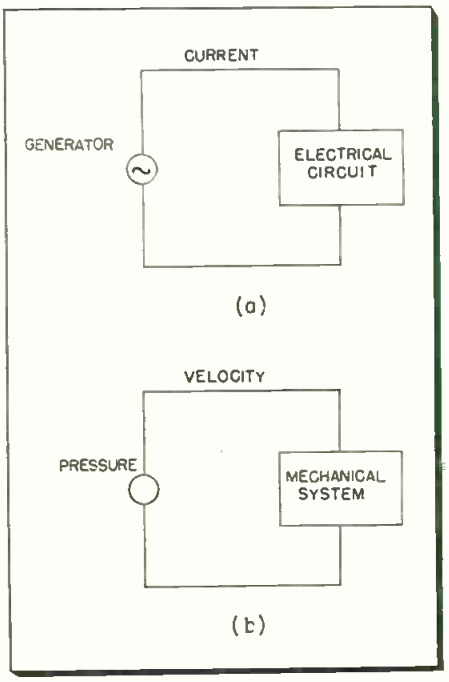


Fig. 7: Electrical-mechanical analogy of current and velocity

Fig. 8: Change is greatest for close sources

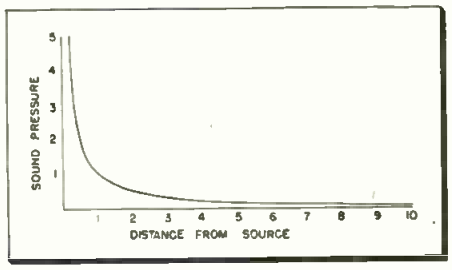
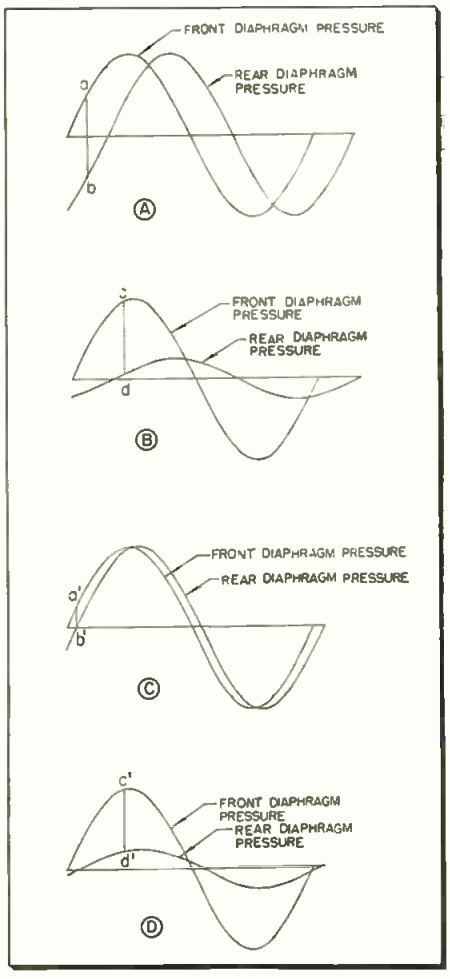


Fig. 9: Phenomenon of proximity effect a. distant source, 60° phase angle b. close source, 60° angle c. distant source, small phase angle d. close source, small angle



Automatic analog-to-digital converter converts voltage samples into a number proportional to logarithm of the voltage. Handles 10,000 samples/sec.

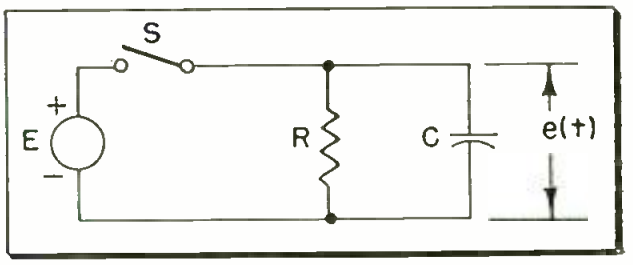


Fig. 1: RC circuit converts voltage to time

A Logarithmic Voltage Quantizer

By E. M. GLASER and H. BLASSBALG

AN analog to digital converter has been developed which converts voltage into a number which is proportional to the logarithm of the voltage. The device is completely

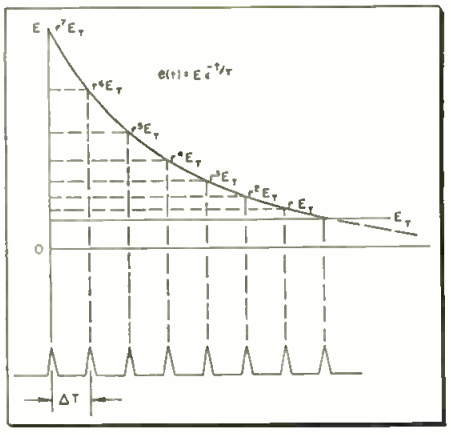
H. Blasbalg

E. M. Glaser

automatic. It can handle input data at the rate of 10,000 voltage samples per second and the accuracy of conversion or quantization is adjustable to either 5% or 10%. Samples of length greater than .5 μsec can be quantized.

The quantizer accepts a voltage sample and converts it to an equivalent pulse whose duration is proportional to the logarithm of the voltage of the sample. The pulse duration is quantized linearly by counting the number of pulses produced by a fixed frequency pulse generator during the interval. This number is then proportional to the logarithm of the input sample.

Fig. 2: Quantizer generates a pulse at the start of the exponential



The conversion from voltage to time is performed in a simple RC circuit. The mathematical analysis of the conversion and quantization is given below. From the analysis useful design equations are obtained.

Analysis

An RC network shown in Fig. 1 is charged to voltage E by closing of switch S. After the switch is opened at t = o, the voltage e(t) decays exponentially:

$$e(t) = E\,\epsilon^{-t/RC} \qquad (1)$$

Let T = time for e(t) to decay to a fixed voltage, E_T
Then,

$$E_T = E\,\epsilon^{-T/RC} \qquad (2)$$

or,

$$E = E_T\,\epsilon^{T/RC} \qquad (3)$$

and,

$$\log E = \log E_T + \frac{T}{RC} \qquad (4)$$

T is now subdivided into equal increments ΔT and the number of complete increments required for E to decay to E_T is counted.
Let E_n = value of E which decays to E_T in exactly nΔT seconds and E_{n+1} = value of E which decays to E_T in exactly (n+1) ΔT seconds then,

$$E_o = E_T$$

E. M. GLASER and H. BLASBALG, Radiation Laboratory, The Johns Hopkins Univ., Baltimore, Md.

From (4),

$$\log E_n = \log E_T + \frac{n\Delta T}{RC} \qquad (5)$$

and,

$$\log E_{n+1} = \log E_T + \frac{(n+1)\,\Delta T}{RC} \qquad (6)$$

Subtracting (5) from (6),

$$\log E_{n+1} - \log E_n = \frac{\Delta T}{RC} = \frac{\Delta T}{\tau} \qquad (7)$$

where

$$\tau = RC$$

Let,

$$\bar{E}_n = \frac{1}{2}(E_{n+1} + E_n)$$

and,

$$\Delta E_n = E_{n+1} - E_n$$

Then,

$$\frac{\Delta E_n}{\bar{E}_n} = 2\left(\frac{E_{n+1} - E_n}{E_{n+1} + E_n}\right) \qquad (8)$$

Also, by expanding,

$$\log E_{n+1} - \log E_n = 2\left[\left(\frac{E_{n+1} - E_n}{E_{n+1} + E_n}\right) + \frac{1}{3}\left(\frac{E_{n+1} - E_n}{E_{n+1} + E_n}\right)^3 + \dots\right] \qquad (9)$$

$$= \frac{\Delta T}{\tau}$$

Therefore, by neglecting all but the first term

$$\frac{\Delta T}{\tau} \approx \frac{\Delta E_n}{\bar{E}_n} \qquad (10)$$

with error

$$\delta \leq \frac{2}{3}\,\frac{S^3}{\sqrt{1-S^3}}$$

where

$$S = \frac{1}{2}\,\frac{\Delta E_n}{\bar{E}_n} = \frac{1}{2}\,\frac{\Delta T}{\tau} \qquad (11)$$

Voltage Quantizer (continued)

Eq. 11 gives the order of the error in the approximation in solving (9) for E_{n+1}. Substituting (11) and (8) and solving gives

$$E_{n+1} = E_n \frac{1 + \frac{1}{2}\frac{\Delta T}{\tau}}{1 - \frac{1}{2}\frac{\Delta T}{\tau}} = r\,E_n \quad (12)$$

where

$$r = \frac{1 + \frac{1}{2}\frac{\Delta T}{\tau}}{1 - \frac{1}{2}\frac{\Delta T}{\tau}}$$

From this

$$E_n = r^n E_o \quad (13)$$

The voltage levels E_n and $\overline{E}_n$, it should be noted, form geometric series.

The maximum quantization error will occur when either E_n or E_{n+1} is quantized as $\overline{E}_n$. This error will be, in either case,

$$\text{max. error} = \frac{1}{2}\frac{\Delta E_n}{\overline{E}_n}$$

$$\text{max. error} = S = \frac{1}{2}\frac{\Delta T}{\tau} \quad (14)$$

If N = maximum number of quantized time intervals, and

E_n = maximum quantizable voltage, then the dynamic range, R, of the quantizer is

$$R = \frac{E_N}{E_T} = \frac{E_N}{E_o} = r^N \quad (15)$$

$$\log R = N \log r = N \log \left(\frac{1+s}{1-s}\right)$$

$$= 2N\left(s + \frac{1}{3}s^3 + \frac{1}{5}s^5 + \ldots .\right) \quad (16)$$

and again, by neglecting all but the first term

$$\log R \approx 2\,NS \quad (17)$$

with error

$$\delta \leq \frac{2}{3}\frac{NS^3}{\sqrt{1-S^2}}$$

Then

$$N = \frac{1}{2s}\log R \quad (18)$$

The rate at which the exponential e(t) decays when $e(t) = E_T$ is

$$\left.\frac{de(t)}{dt}\right|_{t=T} = \frac{-E}{RC}\epsilon^{-T/RC}$$

and from (2)

$$\left.\frac{de(t)}{dt}\right|_{t=T} = \frac{-E_T}{RC} = \frac{-E_T}{\tau}$$

The rate of voltage decay at the threshold is therefore independent of the initial sample voltage E. The accuracy of the threshold amplitude comparator is therefore constant throughout the quantization range.

The equations useful for quantizer design are given below.

$$\text{max. error} = s = \frac{1}{2}\frac{\Delta T}{\tau} \quad (14)$$

The number of quantization intervals is given by,

$$N = \frac{1}{2s}\log R \quad (18)$$

The quantizer is designed to operate over a dynamic range of 30:1 with $E_T = 3.3$ v and $E_N = 100$ v.

The maximum error is 5% or 10%.

For s = .05

$$N = \frac{1}{2 \times .05}\log 30 = 34 \quad (19)$$

For s = .1

$$N = \frac{1}{2 \times .1}\log 30 = 17 \quad (20)$$

The quantizer generates a pulse at the start of the exponential, if $E \geq E_T$. At the end of each interval, ΔT, another pulse is generated repeating the process until the exponential falls below E_T. (See Fig. 2).

Voltage	No. of Pulses
$E < E_T$	0
$E_T \leq E \leq rE_T$	1
$rE_T \leq E \leq r^2E_T$	2
$r^2E_T \leq E \leq r^3E_T$	3
$r^{N-1}E_T \leq E \leq r^NE_T$	N
$r^NE_T \leq E$	N+1

For R = 30, s = .05 the maximum number of pulses generated is N + 1 = 18.

For R = 30, s = 1, the maximum number of pulses is N + 1 = 35.

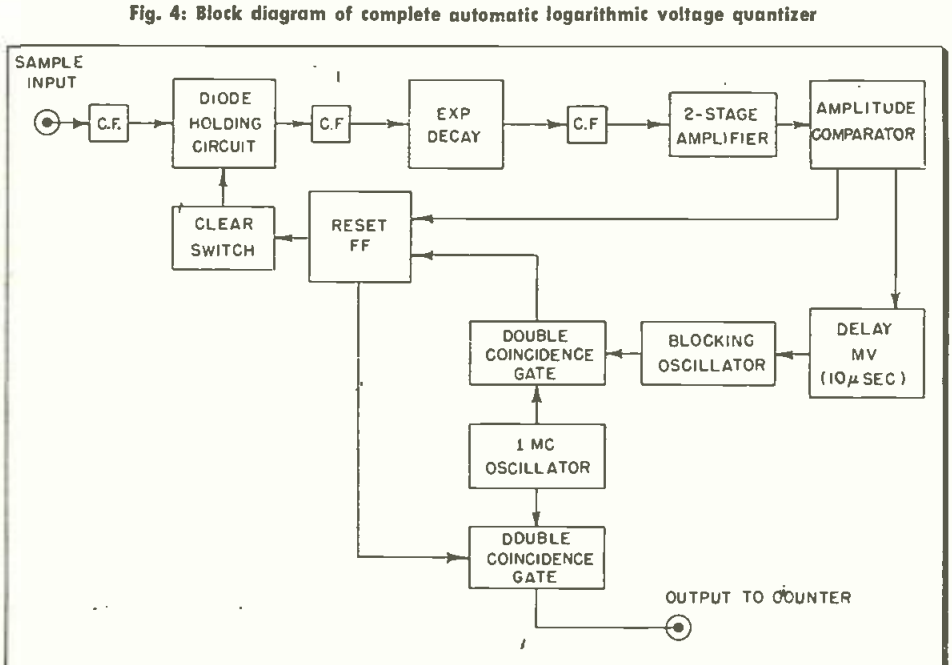
The time increment of quantization is 1 μsec. This minimizes analysis time without unduly complicating the device. The time constant is determined from (14).

For s=0.05

Fig. 3: Input vs. E_n and quantization level

S=.05 (5% QUANT)			S=.10 (10% QUANT)		
INPUT VOLTAGE	QUANT LEVEL	$\overline{E}_n$	INPUT VOLTAGE	QUANT LEVEL	$\overline{E}_n$
3.33-3.68	1	3.51	3.33-4.07	1	3.70
3.68-4.07	2	3.88			
4.07-4.50	3	4.29	4.07-4.97	2	4.52
4.50-4.97	4	4.74			
4.97-5.49	5	5.23	4.97-6.07	3	5.52
5.49-6.07	6	5.78			
6.07-6.71	7	6.39	6.07-7.41	4	6.74
6.71-7.41	8	7.06			
7.41-8.19	9	7.80	7.41-9.05	5	8.23
8.19-9.05	10	8.62			
9.05-10.0	11	9.53	9.05-11.1	6	10.1
10.0-11.1	12	10.6			
11.1-12.2	13	11.7	11.1-13.5	7	12.3
12.2-13.5	14	2.9			
13.5-14.9	15	4.2	13.5-16.5	8	15.0
14.9-16.5	16	5.7			
16.5-18.2	17	7.4	16.5-20.1	9	18.3
18.2-20.1	18	19.2			
20.1-22.2	19	21.2	20.1-24.6	10	22.4
22.2-24.6	20	23.4			
24.6-27.2	21	25.9	24.6-30.1	11	27.4
27.2-30.1	22	28.7			
30.1-33.3	23	31.7	30.1-36.8	12	33.5
33.3-36.8	24	35.1			
36.8-40.6	25	38.7	36.8-44.9	13	40.9
40.6-44.9	26	42.8			
44.9-49.6	27	47.3	44.9-54.8	14	49.9
49.6-54.8	28	54.2			
54.8-60.6	29	57.7	54.8-67.0	15	60.9
60.6-67.0	30	63.8			
67.0-74.1	31	70.6	67.0-81.9	16	74.5
74.1-81.9	32	78.0			
81.9-90.5	33	86.2	81.9-100.0	17	91.0
90.5-100.0	34	95.3			

Fig. 4: Block diagram of complete automatic logarithmic voltage quantizer



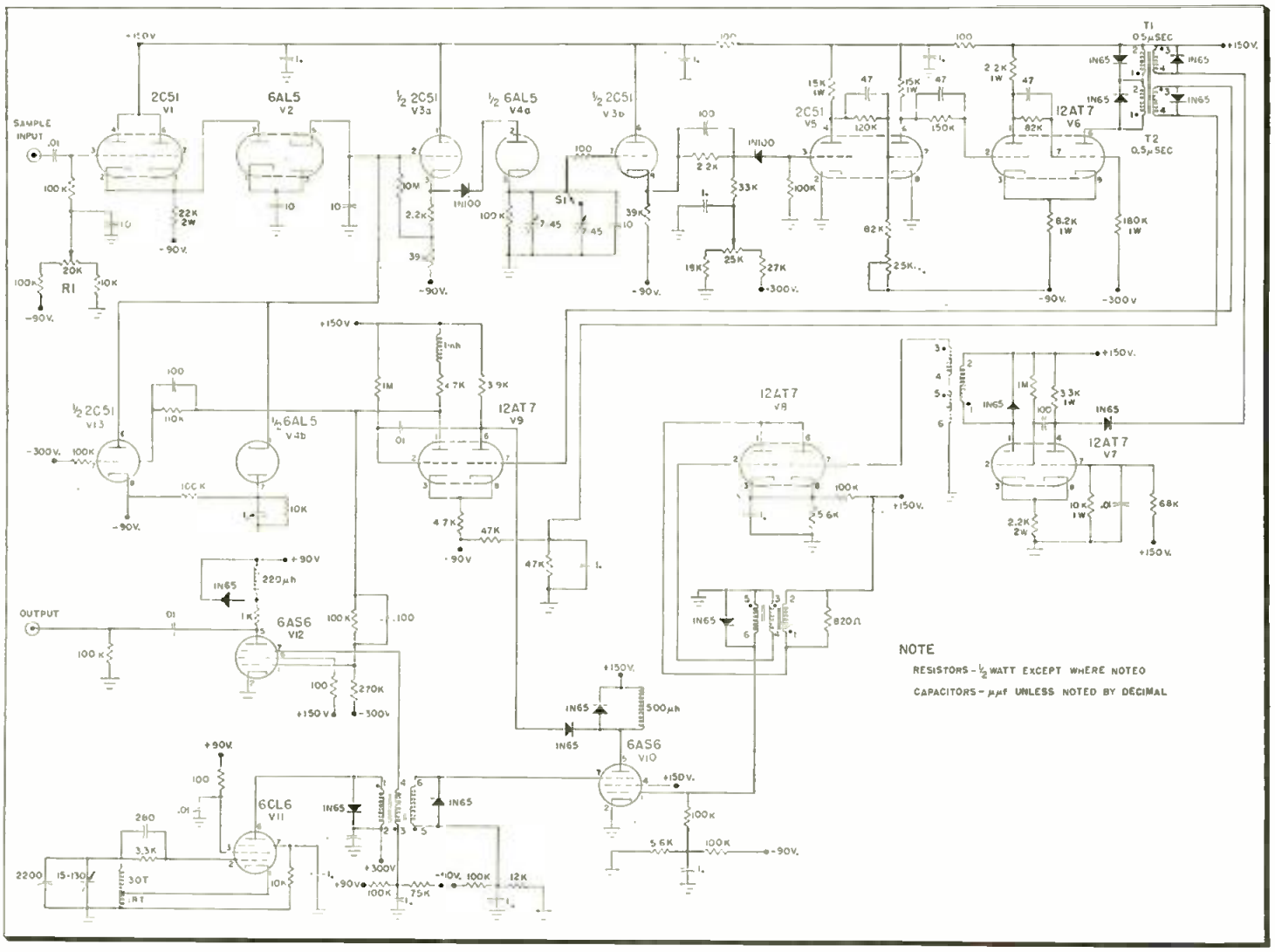


Fig. 5. Schematic diagram of quantizer. Circuit is designed to handle voltage samples ranging from 3.3 to 100 v.

$$\tau = \frac{\Delta T}{2s} = \frac{1 \times 10^{-6}}{2 \times .05}$$

$$\tau = 10 \times 10^{-6} \text{ sec.}$$

For s=0.1

$$\tau = 5 \times 10^{-6} \text{ sec.}$$

A table relating input voltage to $\bar{E}_n$ and the quantization level (number of output pulses) is shown in Fig. 3 for s = .05 and s = 0.1.

The maximum sampling rate of a waveform by the quantizer can be obtained by means of Eq. (18). The maximum time per quantization, T_q, is

$$T_q = N\Delta T = \frac{\Delta T}{2S} \log R \qquad (21)$$

Then the maximum sampling rate, F, is

$$F = \frac{1}{T_q} = \frac{2S}{\Delta T} \frac{1}{\log R}$$

$$F = 2Sf \frac{1}{\log R} \qquad (22)$$

where f = frequency of the pulse generator.

This equation allows for no recovery time of the quantizer between samples. Allowing, conservatively, a recovery time equal to the maximum quantization time gives for the sampling rate, F′

$$F' = Sf \frac{1}{\log R} \qquad (23)$$

For S = .05, $f = 1 \times 10^6$, R = 30

$$F' = \frac{.05 \times 10^6}{\log 30} = 14.7 \times 10^3 \text{ samples/sec}$$

For S = .10, $f = 1 \times 10^6$, R = 30

$$F' = 29.4 \times 10^3 \text{ samples/sec}$$

Circuit Design

The quantizer is designed to work with voltage samples ranging from 3.3 v to 100 v and a minimum duration of .5 μsec. A block diagram is shown in Fig. 4, and the circuit schematic in Fig. 5.

Input Cathode Follower, V_1: The cathode follower consists of both sections of a 2C51 operating in the high g_m region, thus permitting rapid charging of the capacitors in the diode holding circuit without drawing grid current.

Diode Holding Circuit: Two 6AL5 diodes in series charge the holding capacitor to the peak sample voltage. The low forward resistance permits complete charging of the capacitor in .3 microsecond.

Holding Circuit Cathode Follower, V_3a: The diode holding capacitor voltage is fed to the grid of a cathode follower consisting of one section of a 2C51. The low impedance output charges the RC exponential decay combination through another diode holding network. The output reference level of the cathode follower is adjusted by a potentiometer R_1 in the grid circuit of the input cathode follower.

Exponential Decay: The time constant of the RC decay circuits can be adjusted by trimmer condensers to either 5 microseconds or 10 microseconds giving either 10% of 5% accuracy of quantization.

(*Continued on page* 124)

R. R. Jenness
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O. I. Thompson
President

Carl G. Miller
Secretary

Preview of 1955

NATIONAL ELECTRONICS CONFERENCE

J. H. Enenbach
Treasurer

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Executive Sec.

THE 11th anniversary meeting of the 1955 National Electronics Conference convenes in Chicago's Hotel Sherman on Oct. 3, 4 and 5, 1956. The meeting is sponsored by the AIEE, IRE, Illinois Inst. of Technology, Northwestern Univ. and the Univ. of Illinois.

Products of 130 manufacturers will be on display, and a broad selection of technical papers will be presented in the scheduled 24 technical sessions.

Three conference luncheons are scheduled. The featured speakers will be A. V. Astin, Director, National Bureau of Standards, Washington, D.C., J. M. Robson, Atomic Energy of Canada, Ltd., Chalk River, Ontario, Can., and Ernst Weber, chairman, Dept. of Electrical Engineering, Polytechnic Inst. of Brooklyn.

Further information may be obtained from the National Electronics Conference Inc., 84 E. Randolph St., Chicago 1, Ill.

SUNDAY, OCTOBER 2

4:00 P.M. to 8:00 P.M.—REGISTRATION
Lobby

8:00 A.M.—REGISTRATION
Lobby

9:00 A.M.-9 P.M.—Exhibits
Displays of electronic equipment, components and new developments.

Entrance on Mezzanine.

MONDAY, OCTOBER 3

MONDAY MORNING—TECHNICAL SESSIONS

1. AUDIO AND ACOUSTICS

Program prepared in cooperation with the IRE Professional Group on Audio.

(a) "The Electrostatic Loudspeaker—An Objective Evaluation" by R. J. Larson, Jensen Manufacturing Co., Chicago, Ill.

(b) "Efficiency and Power Rating of Loudspeakers" by R. W. Benson, Armour Research Foundation of Illinois Institute of Technology, Chicago, Illinois.

(c) "Energy Distribution in Music" by J. P. Overley, Radio Manufacturing Engineers, Inc., Peoria, Illinois.

(d) "Bells, Electronic Carillons, and Chimes" by F. H. Slaymaker, Stromberg-Carlson Co., Rochester, New York.

2. TRANSISTOR AMPLIFIERS

(a) "Single and Double-Tuned Transistor IF Amplifiers" by J. B. Oakes and R. C. Rand, Applied Physics Laboratory, The Johns Hopkins University, Silver Spring, Maryland.

(b) "Transistor Amplifier with Extremely High Input Impedance" by R. A. Stampfl and R. Hanel, Signal Corps Engineering Laboratories, Fort Monmouth, New Jersey.
(c) "A Unilateral Transistor Amplifier" by W. G. Houser, Ordnance Research Laboratory, Pennsylvania State University, University Park, Pennsylvania.
(d) "The Hushed Transistor Amplifier" by W. K. Volkers, Volkers & Schaffer Manufacturing Corp., Schenectady, New York and N. E. Pedersen, Rensselaer Polytechnic Institute, Troy, N. Y.

3. ANTENNAS

(a) "Surface-Wave Beacon Antennas" by R. E. Plummer, Hughes Research and Development Laboratories, Culver City, Cal.
(b) "A Luneberg Lens as a Broadband Bipolarized Nonscanning Direction-Finding Antenna" by E. L. Back, L. K. DeSize, L. J. Kuskowski and W. H. Yale, Airborne Instruments Laboratory, Inc., Mineola, New York.
(c) "A Review of Circular Polorization as a Means of Precipitation-Clutter Suppression and Examples" by W. B. Offut, Airborne Instruments Laboratory, Inc., Mineola, New York.
(d) "Circularly Polarized Biconical Horns" by C. Goatley and F. D. Green, Melpar Inc., Falls Church, Virginia.

4. MAGNETIC AMPLIFIERS

Program prepared in cooperation with the AIEE Magnetic Amplifier Committee.
(a) "Flux Reset in Magnetic Amplifiers" by B. Seddon, General Electric Company, Schenectady, New York.
(b) "Current and Voltage-Metering Magnetic Amplifiers" by T. L. Panner, Bell Telephone Laboratories, Murray Hill, N. J.
(c) "A Magnetic-Amplifier Time-Delay Servo" by J. L. Behr, Vickers Electric Division, St. Louis, Missouri.
(d) "Application of High-Frequency Magnetic Amplifiers" by H. W. Collins, Westinghouse Electric Corp., Pittsburgh, Pa.
(e) "Zero-Signal Stability and Noise Suppression with Magnetic Demodulator-Amplifiers" by L. J. Johnson and S. E. Rauch, University of California, Goleta, California.

12:30 P.M.—LUNCHEON IN THE BALTABARIN

"Standards for Electronics" Luncheon Address by A. V. Astin, Director, National Bureau of Standards, Washington, D. C.

MONDAY AFTERNOON—TECHNICAL SESSIONS

5. SYMPOSIUM I: "Progress and Prospects in Solid-State Electronics"

Chairman: L. T. DeVore, Stewart-Warner Corp., Chicago, Ill. Invited papers:
(a) "Luminescence and Luminescent Devices" by P. D. Johnson, General Electric Research Laboratory, Schenectody, N. Y.
(b) "Compounds for Transistors and Rectifiers" by R. G. Breckenridge, National Carbon Research Laboratories, Cleveland, Ohio.
(c) Germanium and Silicon Transistors and Junction Devices" by R. M. Ryder, Bell Telephone Laboratories, Murray Hill, N. J.
(d) "Circuit Design for Transistors and Junction Devices" by J. B. Angell, Philco Corp., Philadelphia, Pa.

6. INSTRUMENTS AND MEASUREMENTS

(a) "A Direct-Writing Cathode-Ray-Tube Recorder" by L. N. Heynick, R. J. Wohl, and D. H. Andrews, U. S. Naval Material Laboratory, Brooklyn, New York.
(b) "An Accurate Magnetic Tachometer" by Henry W. Pattan, Collins Radio Company, Cedar Rapids, Iowa.
(c) "A High-Speed Low-Noise Switching Device" by A. Finlay, Battelle Memorial Institute, Columbus, Ohio.
(d) "Methods for the Precise Measurement of the Temperoture Coefficient of Capacitance" by I. Brady, Signol Corps Engineering Laborotories, Fort Monmouth, New Jersey.
(e) "Analysis of Low-Frequency Noise Using High-pass Filters and Analogue-Computer Techniques" by F. H. Kishi, R. N. Buland,

(*Continued on page 114*)

LIST OF EXHIBITORS

EXHIBITOR	BOOTH NO.
A-V Manufacturing Corporation, New York, N. Y.	169-170
Ace Engineering and Machine Co., Inc., Philadelphia, Pa.	161
Aerovox Corporation, New Bedford, Mass.	24-25
Allied Radio Corporation, Chicago, Ill.	6-7
Jay C. Angel & Co., Chicago, Ill.	77-78
American Phenolic Corporation, Chicago, Ill.	97
The Arnold Engineering Co., Marengo, Ill.	30
Arco Electronics Inc., New York, N. Y.	67
Aremac Associates, Pasadena, Calif	112
Ballantine Laboratories Inc., Boonton, N. J.	116
Barry Controls, Inc., Watertown, Mass.	153
Bendix Aviation Corp. Scintilla Division, South Bend, Ind.	13
Berkeley Division Beckman Instruments, Inc., Chicago, Ill.	8
Beta Electric Corporation, New York, N. Y.	35
Bomac Laboratories Inc., Beverly, Mass.	9-10
Boonton Radio Corporation, Boonton, N.J.	55-56
Bowmar Instrument Corporation, Fort Wayne, Ind.	182
Brush Electronics, Cleveland, Ohio.	117-118
Budd-Stanley Co., Inc. Long Island City, N. Y.	
Burroughs Corp. Electronic Instruments Div., Philadelphia, Pa.	45
Byron-Jackson Co., Pasadena, Calif.	141
Central Scientific Co., Chicago, Ill.	96
C. P. Clare & Co., Chicago, Ill.	71
Coil Winding Equipment Co., Oyster Bay, N. Y.	93
Color Television, Inc., San Carlos, Calif.	178
Communication Accessories Co., Hickman Mills, Mo.	84
Control Engineering Corp., Norwood, Mass.	115
Alfred Crossley Associates, Inc. Chicago, Ill.	37-38
Dage Television Division, Thompson Products, Inc., Michigan City, Ind.	111
Dynamic Instrument Co., Inc., Cambridge, Mass.	112
Allen B. DuMont Lab., Inc., Clifton, N. J.	50-51
Eastern Air Devices, Inc., Dover, N. H.	132
Eitel-McCullough, Inc., San Bruno, Calif.	26-27
A'G'A Division Elastic Stop Nut Corp. of Am., Elizabeth, N. J.	14
Electra Manufacturing Co., Kansas City, Mo.	85
Electrocraft, Div. of Hamilton-Pox, Inc., Chicago, Ill.	156
Electro-Measurements, Inc., Portland, Ore.	21
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Electro Products Lab., Chicago, Ill.	54
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ESC Corporation, Palisades Park, N. J.	124
Fairchild Camera & Instrument Corp., Potentiometer Div., Hicksville, L. I., N. Y.	70
Federal Telephone and Radio Co., Clifton, N. J.	105-106
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The A. W. Haydon Co., Waterbury, Conn.	65-66
Heath Co., Benton Harbor, Mich.	63-64
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Hewlett-Packard Co., Palo Alto, Calif.	61-62
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The Indiana Steel Products Co., Valparaiso, Ind.	87-88
The Institute of Radio Engineers, New York, N. Y.	89
International Electronic Research Corp., Burbank, Calif.	151
International Resistance Co., Philadelphia, Pa.	171-172
Kay Electric Co., Pine Brook, N. J.	1-2
Kay Lab., San Diego, Calif.	41-42
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Keithley Instruments, Cleveland, Ohio	76
Kepco Laboratories, Flushing, N. Y.	139-140
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Ringland M. Krueger Co., Chicago, Ill.	28
Erik A. Lindgren & Assoc., Chicago, Ill.	16a
La Pointe Electronics Inc., Rockville, Conn.	
Litton Industries, Inc., Beverly Hills, Calif.	31-32
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Hugh Marsland & Co., Chicago, Ill.	107-108
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Millivac Instrument Corp., Schenectady, N. Y.	104
F. L. Moseley Co., Pasadena, Calif.	43-44
Mycalex Corp. of America, Clifton, N. J.	5
The Narda Corp., Mineola, N. Y.	180
Newark Electric Co., Chicago, Ill.	185
New London Instrument Co., Inc., New London, Conn.	100
Norden-Ketay Corporation, New York, N. Y.	90-91
Offner Electronics Inc., Chicago, Ill.	34
John Oster Manufacturing Co., Racine, Wis.	86
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Panoramic Radio Products Inc., Mount Vernon, N. Y.	128
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Photocircuits Corp., Glen Cove, N. Y.	148
Pivan Engineering Co., Chicago, Ill.	36
Polarad Electronics Corp., Long Island City, N. Y.	123
Polytechnic Research & Development Co., Inc., Brooklyn, N. Y.	48-49
Potter & Brumfield, Princeton, Ind.	3
Radio & Television News (Ziff-Davis Publ. Co.), New York, N. Y.	46
Raytheon Manufacturing Co., Waltham, Mass.	73, 74, 75
Ridgway Engineering Associates, Chicago, Ill.	19-20
Robinson Aviation, Inc., Teterboro, N. J.	95
Rotron Mfg. Co., Woodstock, N. Y.	174
Rutherford Electronics Co., Culver City, Calif.	152
Sanborn Company, Cambridge, Mass.	59-60
San Fernando Elec. Mfg. Co., San Fernando, Calif.	130
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Servo Corp. of America, New Hyde Park, N. Y.	144
Sigma Instruments, Inc., South Braintree, Mass.	110
Signal Corps Supply Agency, Philadelphia, Pa.	158
Skydyne, Inc., Port Jervis, N. Y.	131
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Vectron, Inc., Waltham, Moss.	23-23a
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Waterman Products Co., Inc., Philadelphia, Pa.	16
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Waveline Inc., Caldwell, N. J.	142
Weckesser Company, Chicago, Ill.	179

Automatic sonic spectrum analyzer and curve tracer

By EDWARD F. FELDMAN

Audio Frequency Spectrum Analyzer

New instrument presents quantitative Fourier analysis of complex waveforms on CRT indicator. Employs logarithmic sweep, variable sweep widths and high sampling rates. Merits of logarithmic sweep mode are discussed.

AN instrument has been developed which presents, on a cathode-ray tube indicator, a quantitative Fourier analysis of complex audio frequency waveforms. Logarithmic and linear frequency and amplitude indications are provided. Variable sweep widths and relatively high sampling rates facilitate application for systems which contain low frequency modulated or hunting components. Transient phenomena are treated by suitable looped tape recording techniques.

The crux of the logarithmic sweep mode design lies in the relationship between df/dt, the rate of scan, and the maximum achievable adjacent frequency component separability or resolution. An approximate analysis is given of the criteria for selectivity of the intermediate frequency stages. By means of a dual swept crystal filter, the bandwidth of the i-f is varied in synchronism with the log frequency scan to maintain optimum resolution.

A relatively simple adjunct unit converts the spectrum analyzer into an audio frequency sweep generator and selective response curve indicator with unusually high dynamic range and a single line presentation.

EDWARD F. FELDMAN, applications engineer, Panoramic Radio Products Inc., 10 S. Second Ave., Mount Vernon, N. Y.

Comparisons between the conventional sweep generator which employs an oscillographic indicator and the current instrument are given.

Operation

The sonic analyzer embodies the extensions to lower frequencies of the widely used heterodyne type of spectrum analyzers. Fig. 1 illustrates the block diagram. Input signals are heterodyned with the output of a swept r-f oscillator in a linear balanced modulator. Following the mixer are a highly selective i-f and a linear peak sensitive detector which converts the responses to discrete frequency components into inverted "V" shaped pips on the vertical crt axis, as illustrated on the typical screen presentations, of Fig. 6. Each component amplitude may be read by the ordinate of the pip apex on the screen and by the multiplier indicated on the front panel attenuators. Two vertical amplifiers are provided, i.e., linear, with a maximum full scale sensitivity of 500 μv and logarithmic, with a two decade presentation. The swept oscillator is frequency modulated by a waveform derived from the horizontal time base generator so that the crt abscissas are directly calibrated in terms of input signal frequencies.

An ideal analyzer would be capable of very rapidly studying the entire audio spectrum of a complex input and of resolving closely spaced components such that the frequency and amplitude of each would be determined. A direct approach to such an instrumentation problem is a bank of parallel contiguous filters. However this becomes quite cumbersome and expensive for fractional octave units covering a band from say 20 to 20,000 CPS. With only a single filter, the current instrument has the virtue of relative simplicity but is subject to resolutions and sampling rates which are contingent upon the transient response of the i-f stages to a rapidly varying frequency modulated sinusoidal input. Thus, a basic design problem is determination of the best compromises between maximizing df/dt, the scan rate in cycles/sec/sec, and the mutually exclusive requirement for minimum frequency difference between barely visually separable components. The response of resonant circuits to a swept frequency input which at one point in the excursion passes through the natural frequency of the network has been described in the literature from the point of view of the response per se[1,2] and the optimum spectrum analyzer.[3,4,5,6]

To indicate the general nature of

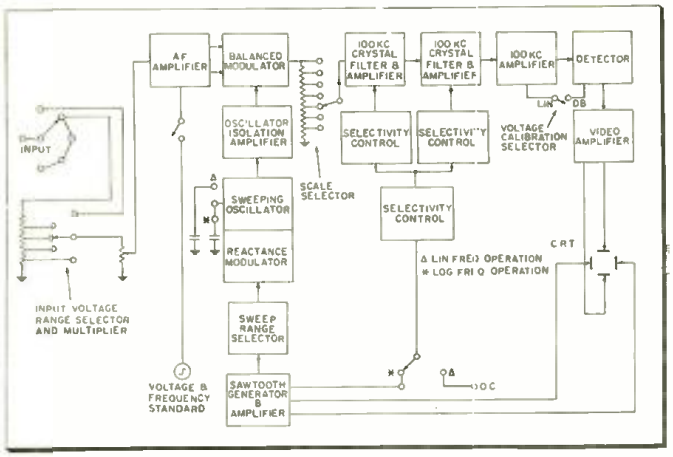


Fig. 1: Block diagram of sonic analyzer

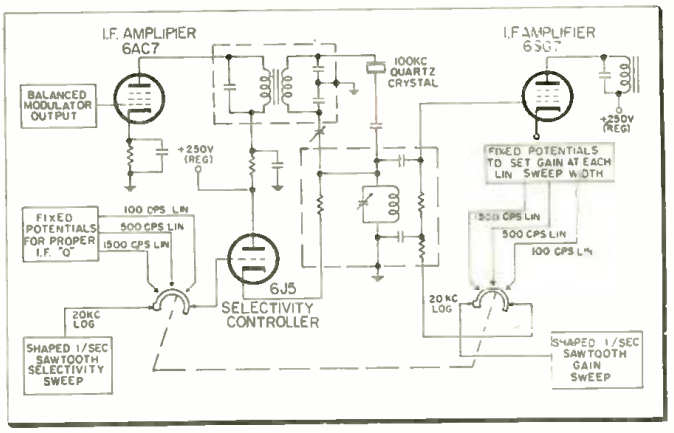


Fig. 2: Swept selectivity crystal filter in i-f section

the functional relationships, consider an i-f amplifier which can be characterized by −3 db. bandwidth, b, and resonant frequency, f_o. At arbitrarily small scan velocities, the minimum resolution of equal amplitude cw signals would almost equal b for intersection of the crt indications at −3 db. from peak. As df/dt is increased, the exponential build-up and decay periods in the i-f increase the apparent bandwidth and thereby degrade the resolution. An optimum condition is obtained when the transient time equals the time spent in the excursion of b cycles of the input spectrum.[3]

$$Q = \frac{F_o}{b} = 2\pi \frac{\text{Stored Energy}}{\text{Dissipated Energy/Cycle}} \quad (1)$$

During a small time, dt, the number of cycles is $f_o dt$, and

$$\frac{\text{Dissipated Energy}}{\text{Stored Energy}} = \frac{d\omega}{\omega} = \frac{2\pi f_o}{Q} dt \quad (2)$$

The tuned circuit amplitude increment

$$\frac{dv}{V} = \frac{d\omega}{2\omega} \quad (3)$$

and

$$\frac{dv}{V} = \frac{\pi f_o}{Q} dt \quad (4)$$

By making the approximation that the amplitude decline from peak may be approximately described by Eq. 4, which is applicable to a suddenly pulsed tuned single stage, the 3 db. decay time,

$$t_d = \frac{\ln 2}{2\pi} \cdot \frac{Q}{f_o}$$

The period required for both build up and decay is $2t_d$ which may be written in terms of the static bandwidth as

$$2\,t_d = \frac{\ln 2}{\pi\, b} \quad (5)$$

At the input to the filter, the time for an excursion of b cycles is set equal to $2t_d$ to achieve the condition stated above, so that

$$2\,t_d = \frac{b}{df/dt} \quad (6)$$

Solving for the optimum bandwidth and maximum rate of scan

$$b \cong \left(\frac{\ln 2}{\pi} \frac{df}{dt}\right)^{1/2} \cong 0.47 \left(\frac{df}{dt}\right)^{1/2} \quad (7)$$

$$\frac{df}{dt} \cong 4.5\, b^2 \quad (8)$$

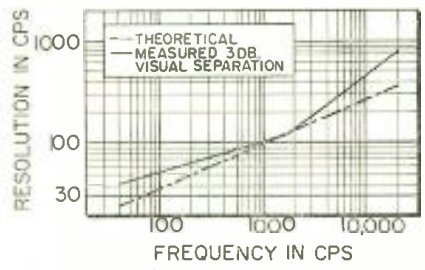


Fig. 3: Separability of components

Fig. 4: Log-log analysis of white noise source

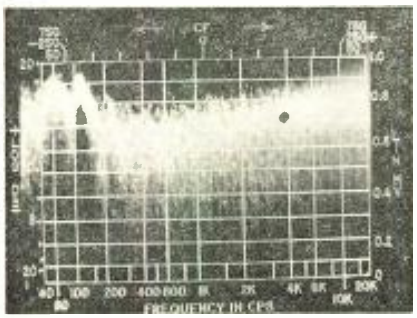
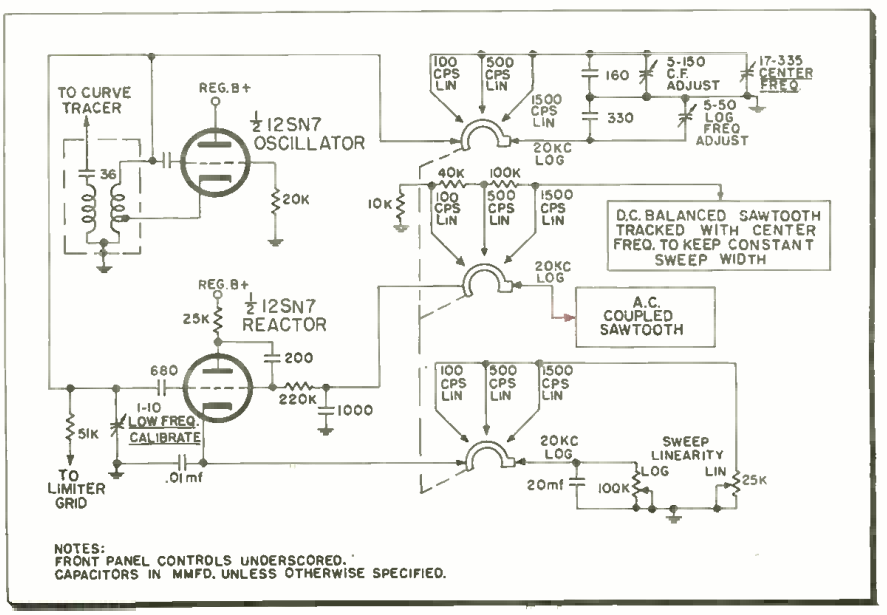


Fig. 5: Oscillator-reactor stages of sonic analyzer



Spectrum Analyzer (Continued)

This approximate derivation merely serves to establish the dependency of the proper filter bandwidth upon the rate of scan. No information is connoted about what visual resolution results except of course that it must be considerably greater than the static bandwidth. Hok[1] calculated the apparent bandwidths or minimum resolutions as a function of static filter bandwidth and scanning rates for a single tuned circuit. His curves indicate an optimum value for 3 db. resolution, R,

Fig. 6: Log freq.-Lin amplitude display

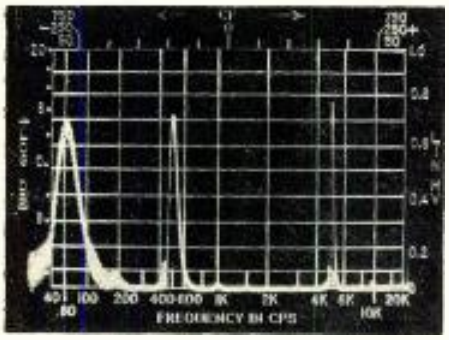


Fig. 7: Log-Log analysis, vibrations of motor

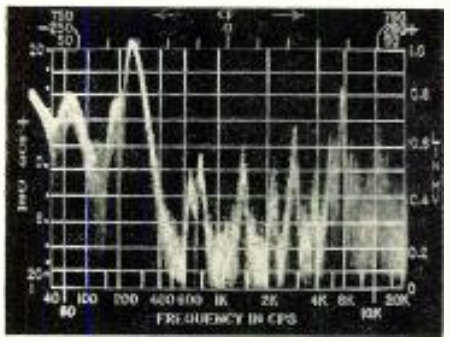


Fig. 8: Lin-Lin analysis, 30 CPS sidebands

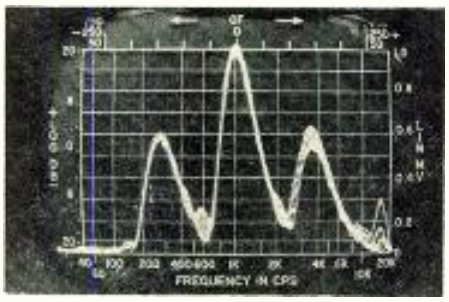
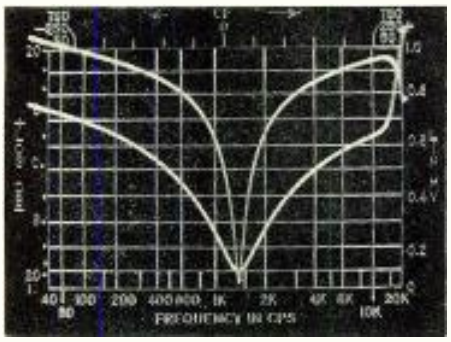


Fig. 10: Response of two rejection filters



approximately equal to the square root of the scan rate. The corresponding static bandwidths fall in a very broad range without serious impairment of the dynamic condition. For values of b from 0.25 (df/dt) $^{1/2}$ to 0.05 (df/dt) $^{1/2}$, the resolution is fairly uniform. The resolution data are in fairly good agreement with empirical information from typical panoramic equipments. For instruments with multistage i-f complements, it has been found[3,4] that for 3 db. resolution,

$$R_{min} \cong 1.3 \left(\frac{df}{dt}\right)^{1/2} \qquad (9)$$

The implied design latitude in the broad range of static bandwidths indicated above must be modified by some practical considerations. At the more selective settings, the shock excited oscillations or transient ringing endure for periods in the order of the response time thus interfering with possible subsequent indications of closely adjacent frequency components. When the second amplitude is small compared to the initial one, its presence may not even be noted even though it might be thought of as electrically resolved. The broader i-f's, in the region of 0.3 (df/dt) $^{1/2}$, are also preferable because of the greater peak amplitude responses, more symmetrical pip shapes, and more clearly defined maxims. A good rule of thumb is to associate a pip with a single notch of ringing near the baseline with the optimum i-f alignment.

The audio spectrum analyzer design was complicated by the requirement for scanning several octaves at a rate high enough for good intercept probability for transients. A logarithmic frequency scan was chosen for the wide band 40 to 20,000 CPS. sweep as the best time sharing arrangement. With decreased scan velocities at the lower end of the spectrum, better selectivity is obtainable where it is most needed. A compromising period of one second with a high to low scan direction is employed, thus fixing the description of the scanned input as follows:

$$f = 20{,}000\, \epsilon^{t/1 \ln (10/20{,}000)} \quad 1 \geq t \geq 0 \quad (10$$

$$df/dt = -20{,}000\, (\ln 500)\, \epsilon^{-(\epsilon n 500)t}$$

$$df/dt = -(\ln 500)\, F \cong -6.2\, F \qquad (11)$$

As previously indicated, the obtainable resolutions are proportional to the square root of the rate of scan. Thus a necessary adjunct to the log scanning mode is synchronous i-f bandwidth sweep to take full advantage of the opportunity afforded. In the present case of a 500:1 maximum to minimum frequency ratio, the bandwidths should vary approximately 22:1. Taking $b = 0.3\ (df/dt)^{1/2}$ as the criterion,

$$b(t) \cong 100\, \epsilon^{-3.1t} \qquad (12)$$

$$b(f) \cong \frac{3}{4} (F)^{1/2} \qquad (13)$$

This derivation applies to the overall bandwidth. In the sonic analyzer, only two of the i-f stages contribute materially to the selectivity, the others serving to increase the sensitivity. Two identical cascaded 100 KC crystal filters with swept selectivity are employed with individual bandwidths tracked at 150% of the value in Eq. 13. See Fig. 2. The variable resistance parameters are supplied by the cathode to ground impedances of the 6J5 cathode followers which are driven by a shaped sawtooth from the 1/sec. time base generator. Each crystal load circuit consists of a parallel resonant RLC combination tuned to the crystal frequency. As the impressed cathode follower impedance is decreased, the more closely does the overall response approach that of the crystal alone, thus increasing the selectivity of the stage. The theoretical (Eq. 9) and actual resolutions of the analyzer are plotted on Fig. 3. Good correspondence is obtained near the center of the sweep but considerable loss is noted at either end. At the high end, the discrepancy is largely due to the difficulty in visually separating two very narrow pips on the 5 in. cathode-ray tube. Auxiliary vertical and horizontal output jacks are supplied to facilitate use with larger "slave" indicators. At the low audio end, the discrepancies are due to two major effects; one is crystal mismatch and the other, and even more significant, is the phenomenon of video beats on closely spaced pips which tend to mask their indications. These beats on a pip are due to residual amplitude response in the i-f to the adjacent frequency and to the presence of the oscillator in the i-f bandpass, both of which are not completely attenuated by the skirt of the filter. Another factor in loss of resolution is that the effective scan period is less than one second by the flyback and necessary overscan[2] times.

Due to the resistance in the crystal and the crystal driving network, the gain at the i-f peak decreases with increased selectivity. Hence, a compensating gain sweep on an i-f

amplifier is used to bring the resulting sensitivity for resolved components to within 1 db. of uniformity throughout the band. The specification of resolved components for uniform sensitivity on log scan is necessary because of the dependence of other responses upon the instantaneous bandwidth. That is, with more than one strong signal within the i-f bandwidth, the output amplitude will vary or "bobble" on the screen from scan to scan. With a purely random input, the amplitude indications are smoothed out by the slow sweep. For white noise a rise of sensitivity at 20 KC approximately 13 db. greater than it is at 40 CPS. as shown on Fig. 4.

In addition to the logarithmic scanning mode of the local oscillator, three linear sweep widths are provided with variable center frequency from 0 to 20 KC as shown on Fig. 5. Upon selection of any of the three scales, 1500 CPS., 500 CPS., or 100 CPS., the grids of the 6J5 cathode followers are switched to the fixed bias which corresponds to proper i-f selectivity. The actual (6 db.) resolution specifications are 95 CPS., 50 CPS., and 25 CPS. respectively which are, of course, independent of center frequency. These linear narrow deviations are used to magnify desired sections of the spectrum for more detailed measurement than is feasible with the overall logarithmic presentation. See Figs. 6, 7 and 8. Intercept probability for recurrent transients increases with decreasing sweep width thus facilitating study of critical regions in pulsed spectra.

A Miller effect reactor stage and a grounded plate Hartley oscillator provide the swept frequency outputs to the mixer as shown on Fig. 5. Log sweep shaping is achieved by the RC integrator in the reactance tube cathode network which impedes the following by the cathode potential of the sawtooth grid waveform. Considerable effort was devoted to the oscillator design to achieve good linearity of frequency deviation per volt on the wide band log mode to obtain a properly spaced and reproducible calibration while maintaining the stability implicit in a low frequency analyzer. Typical current models of the instrument do not drift more than ±10 CPS. after warmup with excellent short time repeatability. A front panel oscillator trimmer and a 60 CPS. marker are used for any necessary readjustments. Between the swept oscillator and mixer stage is a type 6BN6 buffer limiter. A balanced modulator with front panel balance control is employed to minimize the "zero

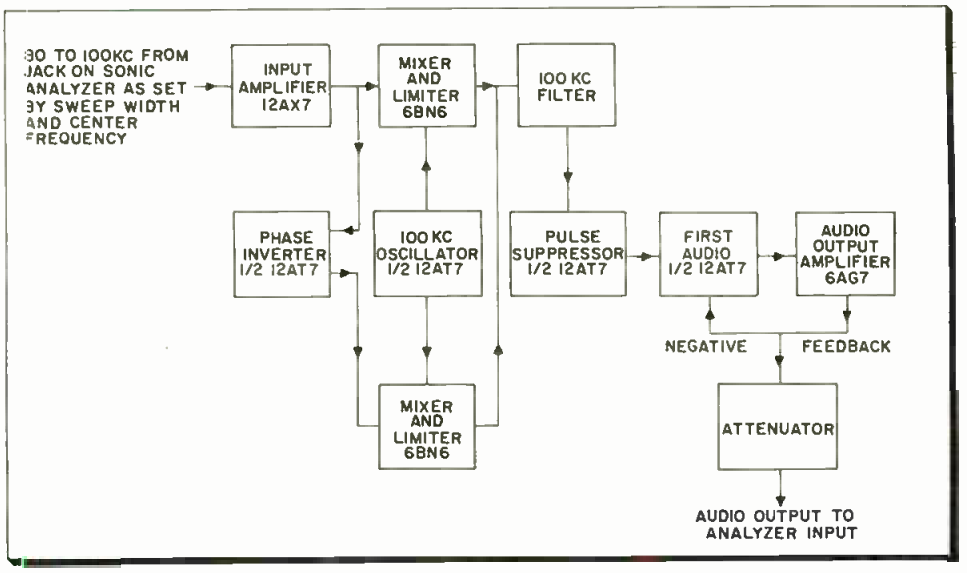


Fig. 9: Adjunct unit. Converts instrument to audio freq. generator and response curve indicator

frequency" pip which is the swept oscillator response in the i-f during the excursion through the low audio band. It also suppresses even harmonic signal distortion to better than −60 db. within its operating dynamic range.

Another interesting design is the logarithmic vertical deflection amplifier. When switched into the circuit, its function is to compress the amplitude indications so that the crt screen may be calibrated with a 40 db. scale. The instrument may be used to measure components as small as −60 db. from the largest amplitude present by driving the dominant indication 20 db. off scale with a calibrated attenuator. The rapid AVC action is obtained by feedback of the detector pulses through a low pass filter into the grid of the last i-f amplifier. This tube, a type 6AC7, is operated with low cathode and screen voltages in the region in which its g_m is approximately a log function of bias. The feedback circuit filter passes the highest video frequency, i.e. the sharp pulses at the 20 KC end of the wide band log sweep, but effectively rejects the i-f of 100 KC. Only two RC stages of filtering were included to prevent cumulative phase shifts from affecting the amplifier stability.

Recent improvements in magnetic tape recording techniques have increased the utility of the sonic analyzer for measurements of low frequency and non-periodic waveforms. With the bandwidths employed, the practical lower limit of the instrument is approximately 20 CPS. on the 100 CPS. sweep width scan. In many applications, especially vibrations of massive structures, motions of a few cycles/sec. are of interest. Such data may be treated by recording the transducer output on tape and playing back at a suitably greater speed thus multiplying and effectively dispersing the discrete frequency contents. Transients are often recorded on tape which is then spliced into a loop and played back into the analyzer. Relatively short bursts are examined during many scans with the analyzer and tape repetition periods not commensurable. Narrow band analysis of important sections of the spectrum are employed to reduce the number of scans required to get a statistically significant number of intercepts. Long time photographic exposures of the cathode-ray tube screen serve to describe the average spectral distributions. The general relationships between a non-periodic function and its periodic counterpart formed by the looped tape are described by A. E. Hastings.[7]

Sonic Response Indicator

The conversion of the spectrum analyzer into a curve tracer is achieved by mixing the output of the sweeping oscillator with that of a crystal controlled oscillator. This latter fixed frequency is adjusted for coincidence with the 100 KC i-f within a small fraction of the narrowest bandwidth employed. See Figs. 9 and 10 for the response indicator block diagram and a typical screen presentation. The heterodyne difference frequency from the mixer is thereby in exact registration with the instantaneous acceptance "slot" of the spectrum analyzer. The display resulting from merely coupling the swept difference frequency into

(*Continued on page* 133)

A separate plant group responsible for "reliable-izing" techniques is seen as key to problem. Methods for boosting reliability are described.

Part Three
Of Three Parts

Improving Electronic Reliability

By HERBERT B. BROOKS

THE number of circuit adjustments required should be held to a minimum. Characteristic values of parts sometimes vary too widely to permit proper circuit operation. The common "fix" is to provide a compensating adjustment, but this cure is strictly temporary unless all the characteristic values are stable in spite of aging and environmental conditions. Far greater reliability can be obtained by using more stable parts and/or redesigning the circuit to operate properly with wider variations in component characteristics.[6] Circuit design for parts tolerance mostly requires careful analysis and thorough consideration of all possible conditions; but one device that is almost always beneficial is to make circuit operation more dependent on stable parts, such as resistors[30] and capacitors,[13] and less dependent on more variable components, such as tubes, supply voltages and antennas.

Decision Elements

Many of the new circuits, such as multivibrators and blocking oscillators, are "go or no-go" devices. Each time a stimulus (trigger) is applied, they decide whether to react or not (see Fig. 6). If the circuit is impartial, its decision depends solely on the characteristics of the stimulus. But usually the circuit is not impartial and its decision is also affected by the tube and component characteristics, supply voltage ripple, wiring crosstalk, etc.

Briefly defined, a decision element supplies a limited or standardized output with various inputs. The limiting must be severe before popular usage regards that decisions are being made. Decision elements often contain large amplification and/or positive feedback to override irregularities in the input, and to speed up the decisions.

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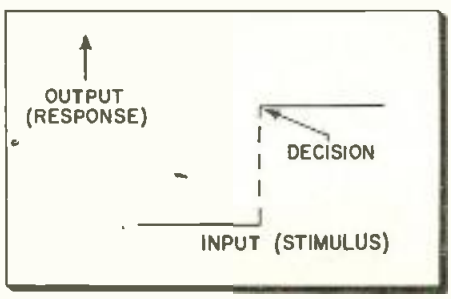
Decision circuits are sometimes called "triggers" or "triggered circuits." There is some confusion on this point, because circuits can be designed to react to trigger-pulses, and to perform many wave-shaping operations without positive feedback and without making sharp decisions.

Some decision elements "remember" their former condition until a contradictory stimulus exceeds the reverse-decision threshold (Fig. 5). The open hysteresis loop adds a degree of irrevocability that is sometimes useful. Snap-action decision elements are associated with the descriptive terms trigger, bi-stable, toggle, relay, binary, memory cell, flip-flop.

Decision Circuits

In frequency modulation, a strong signal suppresses interference more than in amplitude modulation. This "capture effect" provides better strong-signal communication, but perhaps poorer weak-signal communication. This decision effect is even stronger with pulse modulation systems,[10] wherein noise between pulses can be eliminated by clipping, the clipper then making the decision as to whether a pulse is present or not. Still greater strong-signal noise suppression is obtained by "quantizing" or standardizing the pulse durations (or spacings) into separate and discrete classes.[7] Quantized information can be transmitted through many repeaters with little degradation, each repeater regenerating the original waveform by deciding upon the duration of the original pulse, as well as its presence or absence.

Fig. 6: Action of "go or no-go" device



Digital computers utilize decision elements for accurate "memory" and communication, because of the complexity of their functions. The present trend in digital computers is toward compact "circulating" memories, in which a pulse-coded message is stored by travelling repeatedly through a delay line (mercury, quartz, etc.), distortion and noise being removed each cycle by decision elements. The fact that a complicated message can be remembered accurately for millions of such cycles, each cycle requiring thousands of correct decisions for accurate regeneration, staggers the imagination. Reliabilizing digital computers is a stiff challenge which has already resulted in a reduction of cathode interface formation and which should contribute many more improvements in components and design techniques[6] for reliability.

However, application of decision principles is not new. The telegraph relay developed a century ago not only amplified the signals, it also served as a decision element and restandardized them. The typewriter, the printing press, military uniforms, male and female customs of dress, all aid in making decisions of recognition.

Limitations

It is unfortunate for electronic reliability that decision circuits are being applied so profusely and indiscriminately since W.W. II. In a mature art, decision elements should receive their just share of popularity —no more, no less. Decision elements do not make electronic reliability easier to attain. Even where their application is potentially advantageous, decision elements usually require much more effort to reliabilize than do proportional elements, for two reasons:

1. Marginal operation and incipient failure are not obvious to the designer, operator, and repairman.
2. Failure is sudden and complete rather than gradual.

Many people are convinced that machinery is more reliable than electronic equipment. This is partly due to the tendency of the former to squeak, leak or overheat when it is in trouble. It behooves us to build failure-warning signals into our electronic equipment instead of suppressing such warnings by using decision circuits promiscuously.

A blocking oscillator or multivibrator can be carefully adjusted in the laboratory, and if the components are not overloaded it may continue to function correctly for many days. This does *not* mean that the circuit is reliable in the broad sense. From Fig. 7 it is evident that the total buildup of tolerances in the circuit for consistent 5:1 division is quite narrow. Factors which affect the division ratio are:

1. The time constant RC.
2. The voltage to which R is returned.
3. Peak grid current and pulse duration.
4. Input trigger amplitude and duration.
5. Plate and heater supply voltages.
6. Certain tube characteristics which are not usually controlled by tube manufacturers.
7. Supply voltage ripple.
8. Noise pulses picked up via stray magnetic fields and interwiring capacitance.
9. Error of the initial adjustment.
10. Regularity of input pulse spacing.
11. Output loading: if this stage is followed by another like divider stage, its operation will not recycle exactly unless the subsequent stage is thoroughly decoupled by a diode or buffer triode.

The circuit will function only until a few of the above-listed factors drift 2 or 3%. What a fantastic burden of stability to place on ordinary electronic tubes and parts! Not only that, but when the circuit is repaired or the tube replaced, the maintenance technician must have adequate test facilities and must readjust the device in the field just as carefully as it was adjusted in the factory to avoid even further degradation of its subsequent reliability. In fact, the repairman cannot be absolutely certain that he has even restored the original degree of reliability to a decision circuit unless he investigates the circuit almost as thoroughly as did the original designer. Equipment containing decision circuits saddles field maintenance facilities with a heavy burden of training and test equipment. The alternative of throw-away units is becoming more attractive under these circumstances.[22]

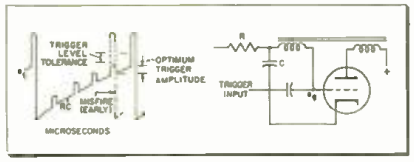


Fig. 7: The reliability of a blocking oscillator depends upon many factors

Locked oscillators have a very long but somewhat unhappy history in radio. Where they are required (as for frequency division), reliability can be improved by reducing the dependence of output frequency on extraneous factors, which can be accomplished by including a resonant circuit in the divider, and by designing for no output without input signal[10, 13] so that when failure comes it will at least be recognized.

The Operator

In the "big picture," the operator is an essential part of the overall system. What good is reliability inside the apparatus if the operator is encouraged to "goof up"?

To unite the operator and the equipment into an efficiently integrated system, the controls and indicators must be as simple and "natural" as possible.[34] The presence of two controls where one would suffice is poor design. The operator must understand at least in a general way how his equipment functions; and the manner of functioning should resemble familiar things rather than the strange and unknown.

Whenever possible, dials and meters should be marked in decimal multiples of 1 and 5 only; multiples of 2 may occasionally be necessary, but multiples of other quantities should be shunned like the plague. The current trend is to favor presentation to the operator of a number instead of a dial. This relief from decision undoubtedly decreases operator error where the number contains many digits, as can be proven by comparing an auto mileage indicator against a gas meter. On the other hand, where the operator is required to take rapid action depending on the indication, thus acting as part of a servo-system, proportional presentation of the data is preferable.

In moving a lever by hand, an operator can vary the force he exerts on the lever, and he senses its position and its resistance to movement. Contrast this with the frustration of pushing a button (a decision element) at the crucial moment and having the expected result fail to materialize. The simple old-fashioned lever is not only a control; it is proportional; and it even serves as an indicator. Separating these functions may burden the operator's motor and sensory organs unduly.

The designer should bear in mind that simple functions, such as gating a radar scope, do not require the decision ability of a one-shot multivibrator. Pulse stretching and clipping can perform this job without positive feedback, and component deterioration in the gating circuit will be indicated not by sudden failure, but by a gradual shortening of the sweep. This provides the operator with an indication of incipient failure, plus a reserve margin of useful performance, without making the equipment more complex and without adding to the operator's normal sensory burden.

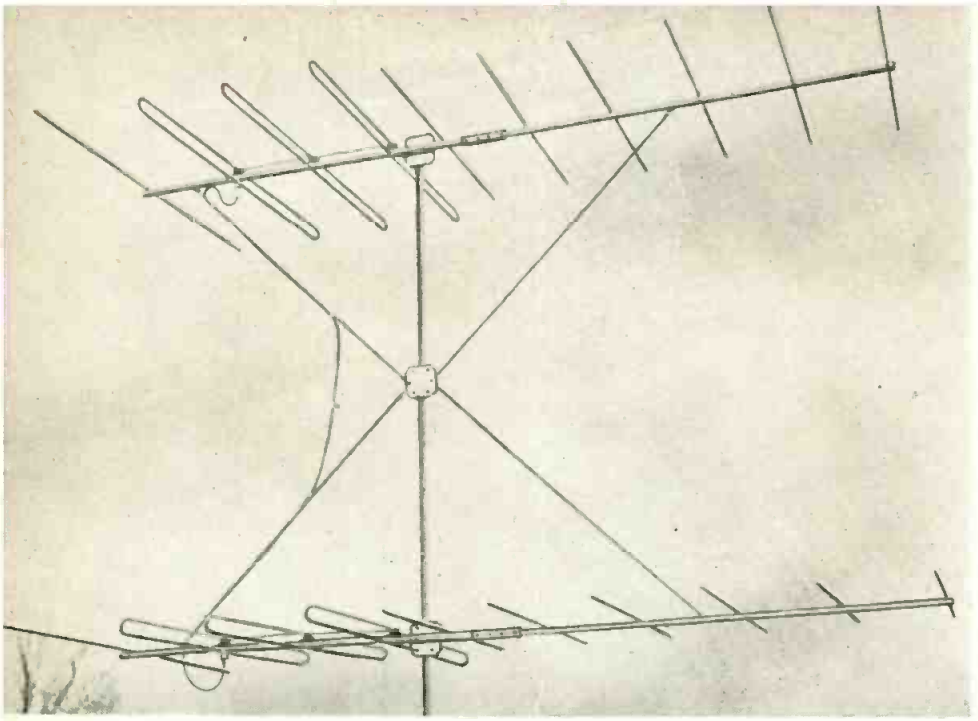
Operator error can be reduced by transferring the function of making decisions from him to the equipment. This usually makes the equipment more complex and less flexible and reliable. How automatic the equipment should be made is an engineering compromise peculiar to each application. Finding the best engineering compromise requires very thorough consideration of exactly how the equipment will be used in practice down to the small details.

It is urged that decision circuits be chosen over proportional circuits only after objective evaluation of all the consequences, and with very thorough effort to make the equipment worthy of its added responsibility.

Reliabilizing decision circuits. The duty of a relay is to "pull in" when the voltage applied to its coil exceeds some definite level, and to "drop out" when the voltage drops below some lower level. The pull-in voltage is affected by the following phenomena:

(*Continued on page* 110)

Magamps are highly reliable components



High gain, coaxial feed antennas employ unique matching technique to effect transition from balanced antenna to unbalanced line. Methods employed to strengthen construction and increase vibration resistance are discussed.

By ROBERT T. LEITNER

Fig. 1: Photo of 2 bay ruggedized Yagi especially designed for commercial applications

Ruggedized Yagi

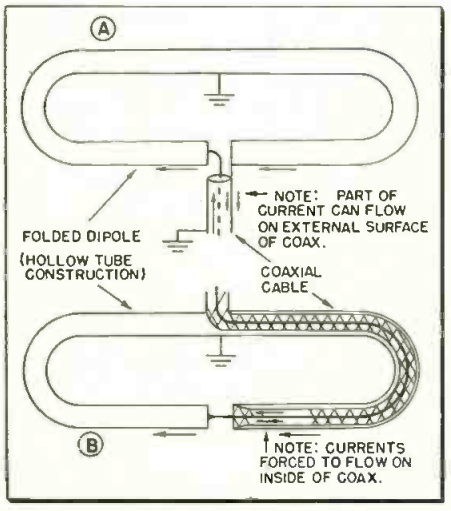
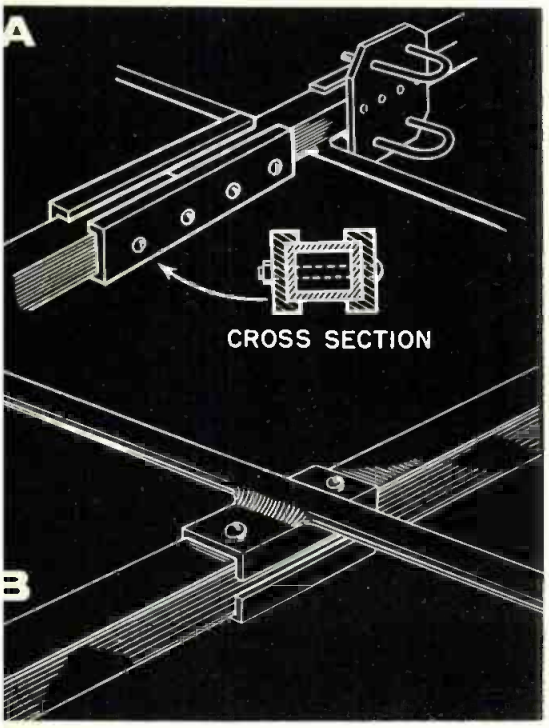


Fig. 2: Details of feed system on 5010 series

Fig. 3: Closeups show (a) use of square cross section crossarm and a heavy wall rather than brackets to hold the elements (b) elements are rigidly fastened by inert arc welding



WITHIN the past year it has become apparent that there is an increasing need for a uni-directional, high gain coaxial fed antenna. This antenna should operate in the range of 50 to 300 MC, and be capable of withstanding high wind loads and the environmental factors of moisture and corrosion. A few of the applications where an antenna of this type is desirable are as follows: 1) community TV systems; 2) multi dwelling TV systems; 3) Civil Defense; 4) industrial and municipal systems; 5) telephone communication channels; 6) telemetering; 7) military applications; 8) emergency pickup system for TV stations.

In the past we have been able to partially satisfy the need for an antenna of this type by adding a balun or transformer device to a regular 300 ohm antenna. Some attempt was also made in these special antennas to incorporate ruggedized features such as stainless steel hardware, heavy wall tubing and mounting brackets for special applications. With the request from a military agency for a special high quality rugged antenna in this frequency range it was obvious that an entirely new approach was necessary.

The antennas which we had built previously for the military were designed to withstand the most severe climatic conditions and found many applications such as on high speed aircraft and on submarines. It was decided to embody previously learned ruggedizing techniques into a commercial-type Yagi antenna series suitable for the aforementioned applications.

Since all yagi antennas are normally designed for a balanced feed system, it was obvious from the start that the most difficult problem was the conversion from a balanced antenna to an unbalanced coaxial line. We considered strapping a half-wave length of coax line to the crossarm of the antenna; we also thought of building a housing at the feed points for a transformer type network. Neither of these solutions however were desirable from the standpoint of cost, operation, reliability, wind load, or general appearance. The results of this preliminary investigation have led us to an entirely new type of array described below.

The operation of the new feed system is shown in Fig. 2. In general, a device to convert from balanced to unbalanced conditions must perform as follows:

1. The balanced condition of the antenna must not be upset by the device, i.e.; currents adjacent to and at the terminals must be of the same absolute magnitude. This means that the device must not upset the external electrical symmetry of the antenna.

ROBERT T. LEITNER, project engineer, Technical Appliance Corp. (TACO), Sherburne, N. Y.

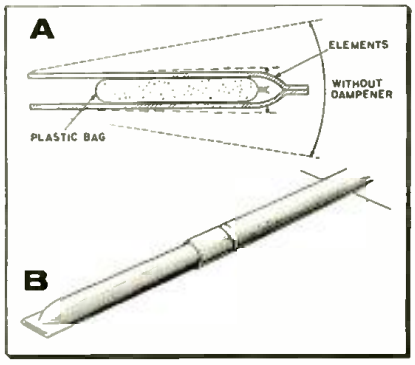


Fig. 4: (a) Interior and (b) exterior detail of antenna element showing dampening arrangement

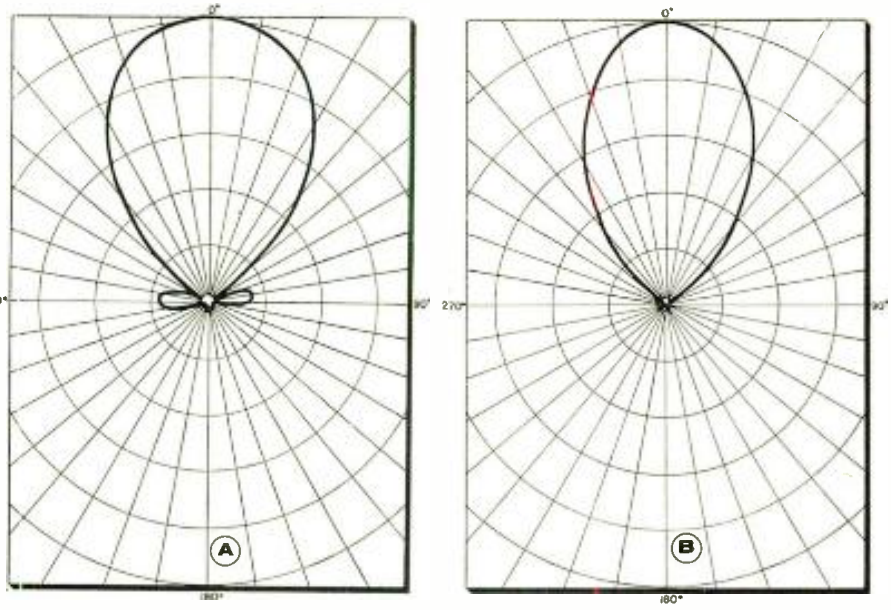


Fig. 5: Voltage patterns for 5010-8 units with (a) vertical and (b) horizontal polarization

Antennas For Commercial Applications

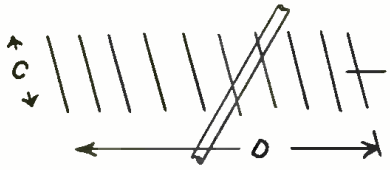
2. In traversing from the antenna terminals to the coaxial transmission line all currents must be confined to the internal surfaces of the coax. External currents are not controllable and cannot contribute to useful energy.

Neither condition 1 or 2 are satisfied by connecting a coax line directly to the antenna terminals as shown in Fig. 2A. The feed system shown in Fig. 2B does, however, and is the one devised for our 5010 series antennas. Both conditions 1 and 2 are satisfied in this system. The coax which is threaded through half the folded dipole is brought out at a point of ground potential and along a line of symmetry of the antenna. By virtue of the re-entrant nature of this system all currents are confined to the internal surfaces of the coax.

Conventional baluns utilize lumped or distributed circuit elements to maintain the conditions previously established. Baluns of this type have the following electrical and mechanical disadvantages and limitations:

1. They are frequency sensitive by virtue of their circuit element construction.
2. They usually have an impedance transforming characteristic which must be controlled and further adds to the frequency sensitivity in terms of impedance bandwidth.

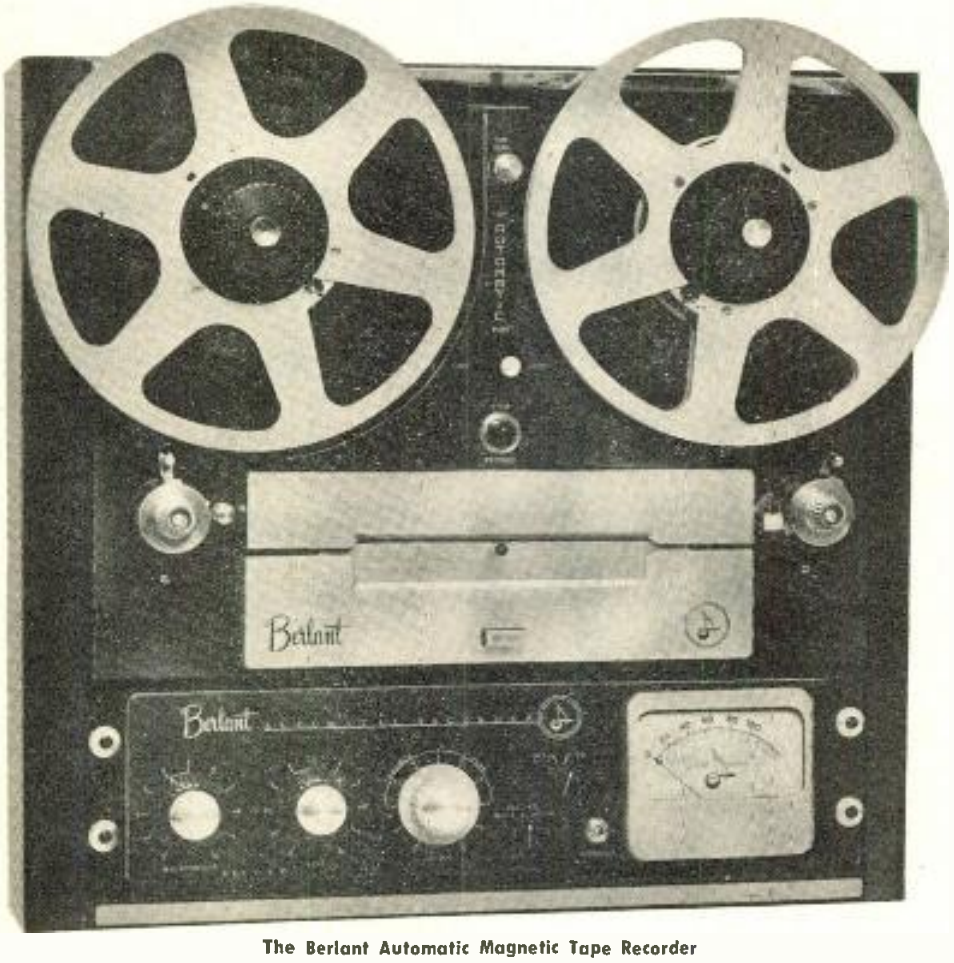
Technical Data for Commercial Single Bay Units 5010 Series Antennas



Type Number	Freq. Range (MCs)	Gain (db) over $\frac{\lambda}{2}$ Dipole	Half Power Beam Width (Degrees)		Average V.S.W.R.		Pounds Thrust Due to 85 MPH Wind With ½" Ice		Approximate Weight (Lbs.)		Approximate Physical Dimensions (Inches)		Number of Driven Elements
			Horiz.	Vert.	50Ω	72Ω	Horiz.	Vert.	Net	Pack'd	C	D	
5010-A	50-54	9.9	51	61	1.35	1.66	138	210	33	43	116	240	3
5010-2	54-60	10.0	55	55	1.24	1.64	128	196	30	40	106	219	3
5010-3	60-66	10.0	51	59	1.20	1.71	114	173	27	35	97	189	3
5010-4	66-72	10.2	48	58	1.27	1.69	104	158	25	33	89	170	3
5010-B	72-76	9.9	51	61	1.26	1.65	97	147	23	31	82	160	3
5010-5	76-82	9.8	48	65	1.21	1.59	91	138	22	29	77	150	3
5010-6	82-88	9.8	50	64	1.23	1.69	85	128	20	27	72	138	3
5010-C	88-96	10.1	49	59	1.29	1.61	79	120	19	26	67	132	3
5010-D	96-104	9.9	51	61	1.31	1.60	74	112	18	24	61	128	3
5010-E	104-112	10.0	51	59	1.29	1.55	69	105	17	22	57	119	3
5010-F	112-122	9.8	50	64	1.28	1.70	64	97	15	19	52	112	3
5010-G	122-132	9.9	51	61	1.25	1.65	58	88	14	18	48	104	3
5010-H	132-142	10.0	51	59	1.21	1.58	53	82	13	17	43	99	2
5010-J	142-152	10.1	50	57	1.26	1.60	50	80	12	16	40	92	2
5010-K	152-163	10.0	51	59	1.22	1.63	48	78	8.2	12	38	90	2
5010-L	163-174	10.2	48	58	1.28	1.66	46	76	8.0	12	36	88	2
5010-7	174-180	10.4	47	55	1.12	1.59	45	74	7.8	12	34	85	2
5010-8	180-186	10.3	48	57	1.18	1.52	43	72	7.6	10	33	81	2
5010-9	186-192	10.4	47	56	1.15	1.60	42	70	7.4	10	32	78	2
5010-10	192-198	10.3	46	58	1.13	1.54	40	68	7.2	10	31	74	2
5010-11	198-204	10.3	47	57	1.16	1.66	39	66	6.9	10	30	72	3
5010-12	204-210	10.3	47	58	1.16	1.60	38	64	6.7	9	29	69	2
5010-13	210-216	10.7	45	53	1.16	1.60	37	62	6.5	9	28	64	2
5010-M	216-235	10.5	45	55	1.17	1.55	35	59	6.1	9	26	62	2
5010-N	235-250	10.3	47	57	1.20	1.59	33	55	5.8	8	24	60	2
5010-P	250-268	10.4	44	59	1.15	1.58	30	51	5.4	8	23	56	2
5010-Q	268-285	10.4	47	56	1.18	1.60	27	48	5.0	8	21	53	2
5010-R	285-305	10.6	45	54	1.19	1.54	29	45	4.7	8	20	49	2

Designing

By BERT BERLANT



The Berlant Automatic Magnetic Tape Recorder

TO MEET the rigorous requirements of the professional recording engineer a magnetic tape recorder must provide three outstanding features. First, it must be highly dependable; second, it must meet the FCC requirements on performance for FM stations and third, it must be simple to operate. If it is to be adaptable to all applications, it should also be automatic—that is suitable for operation by relay or solenoid activation by remote control.

A unit which meets these requirements has recently been developed and in this article we will go into technical details of its construction.

Since dependability is of the utmost importance in this type of equipment, the first decision was that the equipment must be designed and constructed without the use of pulleys, belts, clutches or idlers, all of which have been found to be causes of operational and maintenance difficulties in the past. This meant that the tape supply and take-up spools would be directly mounted on torque type spooling motors of the highest quality, and that a direct drive capstan, involving two speeds, would be mandatory.

Since tape motion of the highest quality for audio purposes was required, namely, 0.1% total RMS. read on a carrier frequency of 3000 CPS, it was obvious that great care must be used in the selection of the capstan drive method. The final solution is in the use of a combination six-pole and twelve-pole hysteresis synchronous motor, constructed in a rigid cast housing, with the capstan an extension of the non-magnetic motor shaft ground to final dimension in the bearings of the motor housing itself in order to eliminate run out to the last possible degree. This motor operates at 600 and 1200 RPM. In order to dampen the minute oscillations resulting from the normal operation of a motor, a flywheel is provided on the side of the motor opposite the capstan extension. The dimensions of this flywheel are carefully selected to provide the maximum kinetic smoothing effect to the motion of the tape. The incorporation of air impeller blades cast integral with the flywheel effectively damps the flywheel action and simultaneously provides a boosting cooling system to insure operation of the hysteresis synchronous motor at reasonable temperatures during continuous service. This capstan motor assembly is mounted on a rigid metal plate which is attached directly to the die cast panel forming the base of the recorder. Connection to the control circuit is by plug.

Since elimination of clutches on spool reels meant that torque motors must be used on both supply and rewind, a special high resistance rotor, capacitor start and run motor was designed and tested for this specific application. To insure concentricity of reel action, the spindle is formed by an extension of the motor shaft, onto which a special die cast core is positioned by a set screw riding on a flat. Three driving pins for positive engagement of RTMA reels, or of the Reelok when driving the NARTB reels are mounted in this core and extend upward very nearly to the top of the spindle.

Since a new degree of versatility was desired, the decision was made to incorporate provision for up to five heads in the recorder. Normally only an erase head, a record head, and a playback head are provided in equipment of this type. The extra head positions make possible many new usages. For example, a common modification of this recorder for radio station use is the delayed broadcast version, wherein a playback head is positioned in front of the erase head, followed by the normal complement of erase, record, and playback heads. A switch is provided in the lower left hand corner of the panel marked "Delayed Broadcast" and "Normal." With the recorder in "Normal" position, a program may be recorder and monitored as a normal recorder. With the switch turned to "Delayed Broadcast," the recorder is utilized as follows: A tape previously recorded is

BERT BERLANT, Berlant Associates, 4917 West Jefferson Blvd., Los Angeles 16, Calif.

a Professional Tape Recorder

Examining the design considerations followed in the development of a high quality tape recorder for use by broadcast and recording engineers. Details of tape handling, head construction and dynamic braking are described and analyzed.

played from the playback head position #1, the tape is then erased by the erase head in position #2, and another program is then recorded on the freshly erased tape at position #3. This permits the recorder to simultaneously play a previously recorded program and to record an incoming program for rebroadcast at a later time; one instrument does the work normally required of two. The recorder is also available in a version involving full track erase and record heads in positions 1 and 2, dual track erase and record heads in positions 3 and 4, and a dual track playback head in position #5. A switch in the lower left hand corner then permits either the first set of full width heads or second set of dual track heads to be used, depending upon whether the tape is to be handled in the manner of a master involving utilization of the full width of the tape, or it is desired to store the recording for library purposes utilizing minimum tape storage. Another version of the recorder is the stereo-monaural recorder, wherein a dual track erase head is provided for the upper track at position 1, a special dual track erase head is provided to erase the lower section of the tape in position 2, an in-line record head consisting of two cores, each with its own coils, arranged coaxially in one housing is provided in position 3, and a similar coaxial playback head is provided in position 4. This set up is used with two associated amplifier equipments, and results in the ability to record two track stereophonic or binaural recording, single track recording by utilizing both tracks simultaneously, recording on the upper track only, recording on the lower track only, recording on the upper track a program already existing on the lower track and mixed with a subsequent signal, or vice-versa.

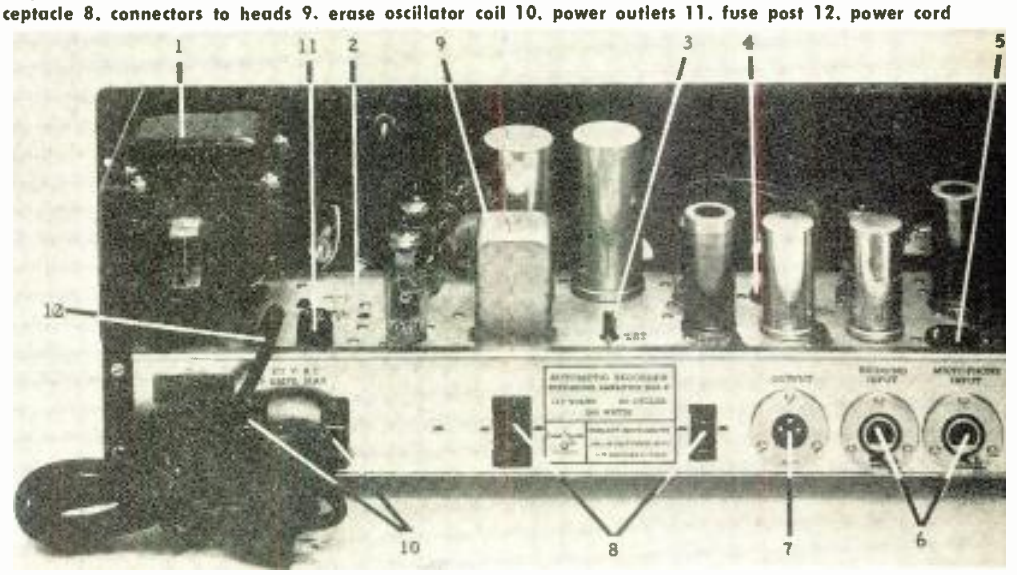
The construction of the heads is in accordance with the requirements of maximum performance and maximum life. They are of laminated core construction, of mu-metal, hydrogen annealed for maximum magnetic permeability, and all critical surfaces are precision lapped to optical tolerances. The heads, of balanced coil construction for minimum hum and extraneous field pickup, are potted in thermosetting plastic, within a shield of mu-metal which provides for maximum shielding.

The pole pieces protrude through an opening in the shield, and when the width of contact of the core against the tape is other than to provide full support for the width of the tape, additional support is provided by forming the shield material to the finish radius of the pole piece itself. In this manner no portion of the tape, rides unsupported in the contact area of the magnetic core.

The use of dynamic braking in this recorder provides a very smooth control completely independent of wear. This dynamic braking is accomplished by switching both take-up and rewind motors into a dc circuit, with provision for differential current providing maximum drag in the motor from which the tape is being spooled at the moment. Since dynamic braking is dependent upon the electrical supply, an additional light mechanical brake is provided, controlled by a solenoid. In the event of power failure, the mechanical brake falls safe to hold the tape steady or to stop it in the event the machine is in operation. This prevents spoilage of the tape should the current be accidentally cut off during rewind, with resultant damage to a recording.

The push buttons normally provided for use in recorders of this type have been replaced with toggle switch, positioned in the center of the drive panel. Mounted in a flexible rubber diaphram, the toggle is merely flipped momentarily or held in contact in any one of four positions to operate the recorder. Moving the control stick directly up places

Fig. 1: Rear view of amplifier chassis. 1. Power transformer 2. bias meter set 3. bias level adjust 4. output transformer socket 5. input transformer socket 6. input Cannon receptacles 7. output Cannon receptacle 8. connectors to heads 9. erase oscillator coil 10. power outlets 11. fuse post 12. power cord



Tape Recorder

(continued)

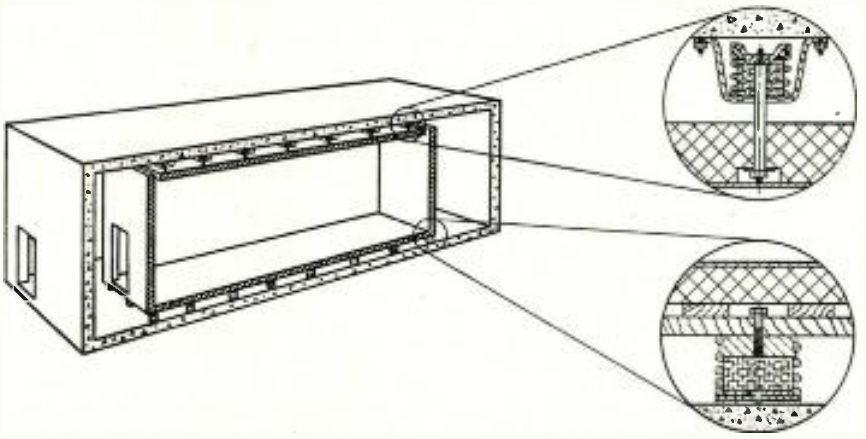
the recorder in run position. Similarly, moving the toggle lever from central position toward the user, or "down," if the recorder is rack mounted, causes the apparatus to stop. To the left causes the tape to rewind at high speed and to the right is for fast forward. The control may be moved between fast forward and fast rewind at will and the tape will shuttle back and forth without any spillage or slack.

The remote control units are connected through a multiple contact connector on the back of the drive mechanism. The entire control system is 27 dc and may be run in normal intercom wiring, without conduit. The positive circuit stop connection is quite unusual. Since the stop is accomplished by momentary closing of the circuit instead of by the usual momentary opening of the circuit, it is possible to have as many control stations on a single recorder as desired, with the remote control boxes provided with a matching plug. This means a remote control unit may be plugged into an outlet, used to exercise control over the recorder, and then unplugged leaving the recorder in operation.

Bias Level Check

All the electronics required for the operation of the recorder, including the power supply for the amplifier unit are shown in Fig. 2. Basically, the amplifier consists of a power supply, including dc filament supply, microphone preamplifier, record amplifier, erase amplifier, bias amplifier, playback preamplifier, line output amplifier, and all necessary equalization circuits required to conform to NARTB equalization. In addition a metering circuit is provided which may be switched to read "Record Level," "Bias Level" and "Output Level."

An outstanding feature of this equipment is the bias level check system. On the amplifier chassis are provided two controls in the bias system, one for bias level, the other for the meter reading position for proper bias level. When proper bias level is determined by setting the bias level control for any given tape in accordance with adjustment instructions, the meter adjustment is then screw-driver set to give a reading of 100 for that bias level. Readjustment of bias to compensate for unusual voltage conditions that may be encountered then becomes a simple proposition.



Chamber as constructed at RCA. Special vibration mounts support ceiling and floor of room

Anechoic Chamber Construction

Problem of screening out unwanted noise is answered by having room completely supported by vibration mounts

ANECHOIC chambers provide a special laboratory where acoustical manifestations may be measured and examined in their elemental, vibratory state and every square inch of the room must be constructed with this in mind.

The proposed site for three such structures to be constructed at RCA was at the new RCA Cherry Hill plant in suburban New Jersey. Proximity to five inter-connected laboratory buildings in the midst of an area planned as a shopping center and housing development did not hold much promise of success for echo-proof chambers. Other potential sources of noise interference were also liable to be transmitted to the chambers and register misleading information on the sensitive meters used in electronic measurement. Such conditions in modern industrial research installations are not unusual: there are few places in and around plants and even company offices that do not feel the effects of noise and vibration in one form or another.

Since any noise usually originates as a result of vibration it was deemed best to concentrate on the attenuation of the vibration itself. It was planned that high frequencies would be absorbed by adequate insulation and by complete closure of all joints around conduits, pipes, wall, ceiling and floor junctures. Low frequency impulses would be attenuated by a vibration-proof mounting system.

Interior Sound Escaping

Another consideration of the same problem dealt with the possibility of interior sound escaping from inside the chamber, thus reducing the necessary background of acoustic perfection in which the TV and radio equipment had to be tested.

Two architectural firms examined these particular requirements and submitted proposals for the construction of the room. One of the specifications laid down by the architects was that vibration mounts would have to be positioned underneath the flooring. This became a large scale test of the engineered mounting systems which Robinson has been producing for many years.

Each room was to be 12 ft. high and 20 ft. square with an area of 400 sq. ft. on the floor and on the ceiling. Such building and acoustical materials as 2 in. of concrete planking, 4 in. of concrete slab, an intermediate layer of 5 in. of fibreglass and a ½ in. metal footdeck comprised the bulk of the 25 ton weight. These are effective materials suitable for filtering and absorbing high frequency vibrations borne through the air as noise. The chamber was constructed inside the second floor room of the main building—a room within a room. The floor and four walls were supported on 327 individual columnar

(*Continued on page* 123)

CUES for BROADCASTERS

Practical ways of improving station operation and efficiency

Conelrad Alert Receiver

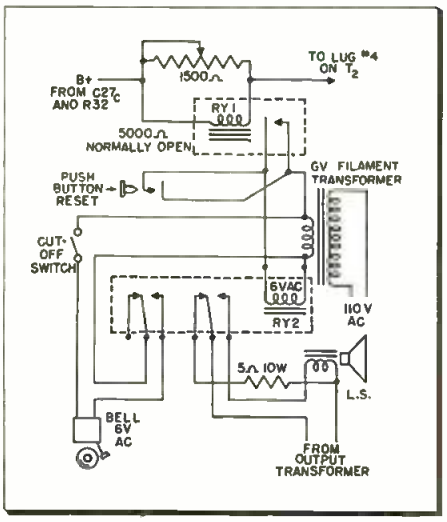
ROY L. GALLAGHER,
Chief Engineer
WWBG, Bowling Green, O.

MANY successful solutions have been developed for the problem of listening to Conelrad alerts. These range all the way from special receivers to makeshifts of all kinds. Because of the fact that new stations are still being granted and are going on the air regularly, the problem is still with us. Monitoring can be done most easily with a special receiver designed for that purpose and there are some very acceptable models on the market. However, they do cost money, and in many cases, that is something the small operation just "ain't got"!!

An ordinary radio receiver is very useful in many ways, and a communications type is even more useful. It can be used to monitor WWV for time signals; it can, at times, be used to pick up other stations for rebroadcast, etc., and it can be used to check for harmonic radiation. Also, it can easily be modified to serve as a highly successful Conelrad monitor with the addition of only a few parts, some of which may be purchased on the surplus market, if you're lucky.

We modified a Hallicrafter S-85 and it has been performing very well. The circuit depends on the AVC action of the set by making use of the difference in current flowing in the plate circuit of an AVC controlled stage between conditions of carrier and no carrier. In the S-85 there is a convenient place to break the B+ line at the terminal #4 of I. F. transformer T 2. This allows us to use the combined plate currents of the 6SK7 I. F. amplifier and the 6SG7 R.F. amplifier. These tubes are both controlled by the AVC action and use 23 ma. of plate current under no-carrier conditions. This drops to 13 ma. when our key station is tuned in. As a matter of interest, the plate current to these two tubes drops to 8 ma. when our own carrier is tuned in (with the receiver located at the transmitter).

Referring to the circuit diagram, you will see that relay RY 1 closes when the carrier goes off, thus supplying voltage to the coil of relay

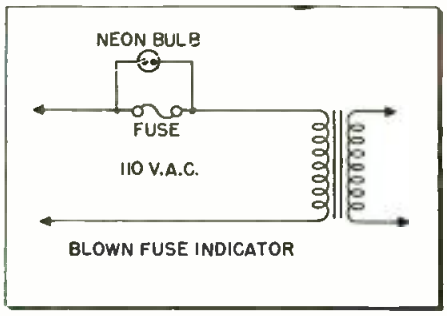


RY 2. This is a ratchet type relay which supplies power to the bell, and cuts in the speaker, so the operator can determine whether the alarm was caused by an elert, or by transmitter difficulty at the station being monitored. The ratchet type relay holds its position until it receives another pulse of current. This is supplied by the reset push button. The switch is simply to silence the bell when you desire to listen to the speaker. The 1500 ohm pot. across relay coil of RY 1 acts as a variable shunt across this relay, and serves as a sensitivity control. When the receiver is being tuned, the sensitivity control is set so that the relay is inactive. After the desired station is tuned in, the control can be set to the point which gives reliable action.

Neon Indicator

JACK FLEMING, Ch. Engr. Radio Station WYVE, Wytheville, Va.

HERE is a circuit which I believe could be helpful in many circuits in the broadcasting field. The circuit is a Blown Fuse Indicator. It



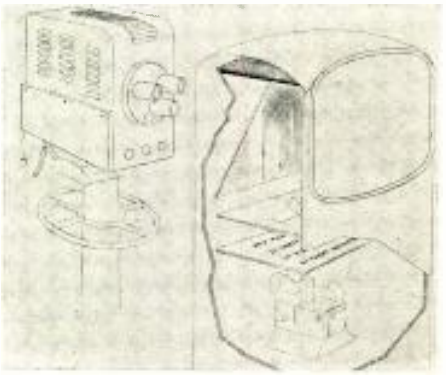
is very simple, and easy to install. A neon bulb is mounted next to the fuse holder, and is connected in parallel with the fuse. When the fuse blows, the bulb will light up and indicate that the fuse is blown.

New TV Prompter Permits Straight-Ahead Reading

A new prompting device that permits the TV speaker to read lines placed directly in front of him yet invisible to the TV camera is now being marketed.

Speaker sees lines imposed on screen

The device consists of mirrors and an angular light projection. One of the mirrors used in the device is transparent so that while it reflects an image directly to the speaker, the image itself cannot be seen by the audience since the TV camera looks



Unit employs projector and transparent mirror

right through the transparent mirror.

The device is available from Reflectone Inc., Post Rd. & Myano, Stamford, Conn.

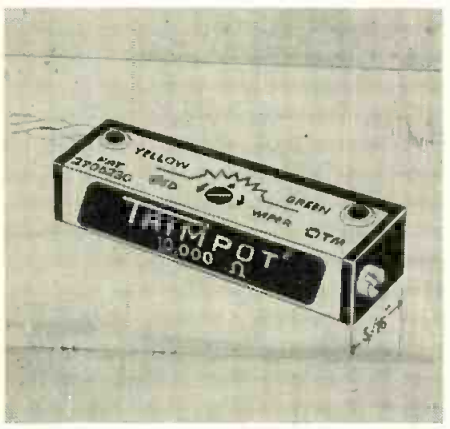
$$$ FOR YOUR IDEAS

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.

New Potentiometers

TRIMMING POTENTIOMETER

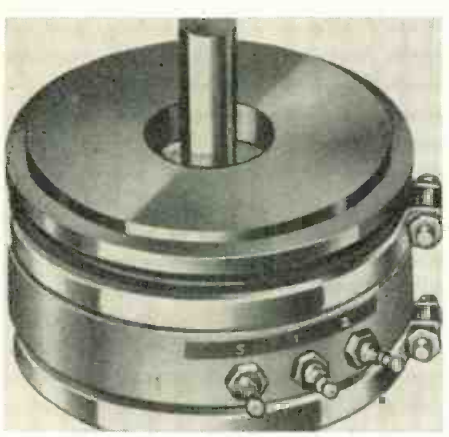
The Model 160 TRIMpot is most suitable for aircraft and missiles industries due to its high temperature and power rating characteristics. Operating temp. range —65°F to 350°F; power rating 0.6



w at 100°F and 0.5 w at 200°F. Resolution as low as 0.25% over the 25-turn adjustment range. Available in standard resistances from 10 ohms to 10,000 ohms. Unique self-locking shaft design eliminates lock-nuts. Units are splash-proof, dust-proof and corrosion resistant. Vibration; 10-20G: 10-20,000 cps. **Bourns Laboratories,** 6135 Magnolia Ave., Riverside, Calif. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-7)

POTENTIOMETER

Series Y precision potentiometer is a single turn continuous rotation component designed for servo or bushing mounting. As many as 14 sections may be ganged during manufacture and as many as 17 taps may be added to any section. Operating range is —55°C to +80°C. Power rating 3.4 watts at 25°C; 2.5 watts at 40°C. Linear models have a



standard linearity of ±0.5%. Models having non-linear output is ±1%. Diameter 1¾ in. by 1½ in. long, with a ¼ in. diameter shaft. **Helipot Corp., 916 Meridian Ave., So. Pasadena, Calif.** —TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-8)

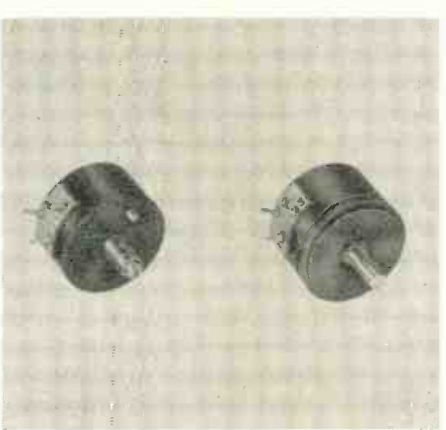
POTENTIOMETER

The #500 ACEPOT is a subminiature wire-wound precision potentiometer only ½" in diameter and is now made in special ganged units of high precision and accuracy. They are available in the

resistance range from 200 to 100,000 ohms. Standard accuracy of linear units is ±0.3% independent linearity, making them suitable for many computer and servo applications. As a result of the small shaft and shorter radius at which wiper friction operates, standard torque is .035 oz./in. @ 20° C. **Ace Electronics Associates,** 125 Rogers Ave., Somerville, Mass. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-9)

POTENTIOMETERS

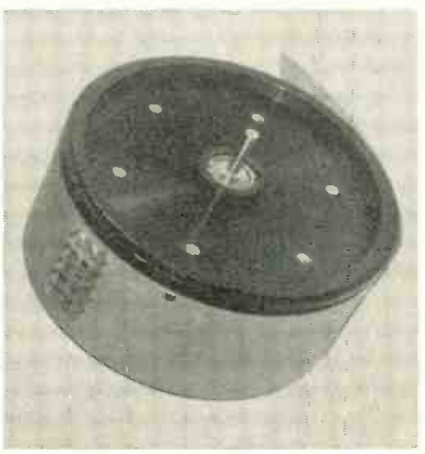
The C-158 series of precision ganging potentiometers are ideal for applications requiring a high degree of accuracy in limited space. Sturdy anodized aluminum housings are machined from solid aluminum for optimum linearity and ganging dimensions. Multiple ganged units can be electrically phased independently without disassembly. Precious metal contacts are used exclusively and permanent dust-covers en-



close all single and ganged assemblies. Available in threaded bushing and servo-mounting types. Diameter 1⅝ in. **DeJUR-Amsco Corp.,** 45-01 Nothern Blvd., L.I.C., N.Y. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-10)

POTENTIOMETER

The MP-10 is a comparison standard rotation-to-voltage transducer for basic measurement, potentiometer testing and calibration, and analog multiplication. Resistance range 5K to 200k, tolerance



5% standard. Temperature coefficient of resistance ±20 ppm per degree C. Rotation ten turns plus 90° electrical and mechanical overtravel at each end. The unit features linearities to .002% and is not susceptible to torque overloads (traveling-nut limit stop rated at 400 in./lbs. static torque) or burnout (slider is fused). **Analogue Controls Inc.,** 37 West 20th St., New York, N.Y. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-11)

TAPE POTENTIOMETER

The "TA'POT" is a 144 in. laboratory type straight slide-wire with direct calibration for use in precision bridges and electronic equipment. Direct reading, in digits, simplifies interpreting scale readings. The unit consists of a white vulcanized tape with a resistance element bonded to the edge. It is calibrated, after assembly, in linear or non-linear terms,

as required. Features are: Accuracy within ±0.1%; overall dimensions only 4⅞" x 3" x 2¼"; power dissipation 2 w; available from 75 to 30,000 ohms. **Howell Instrument Co.,** 1106 Norwood, Ft. Worth, Tex. TELE-TECH & ELECC-TRONIC INDUSTRIES (Ask for 10-12)

NOW -- CINCH
PRINTED CIRCUITS COMPLETE WITH COMPONENTS ASSEMBLED

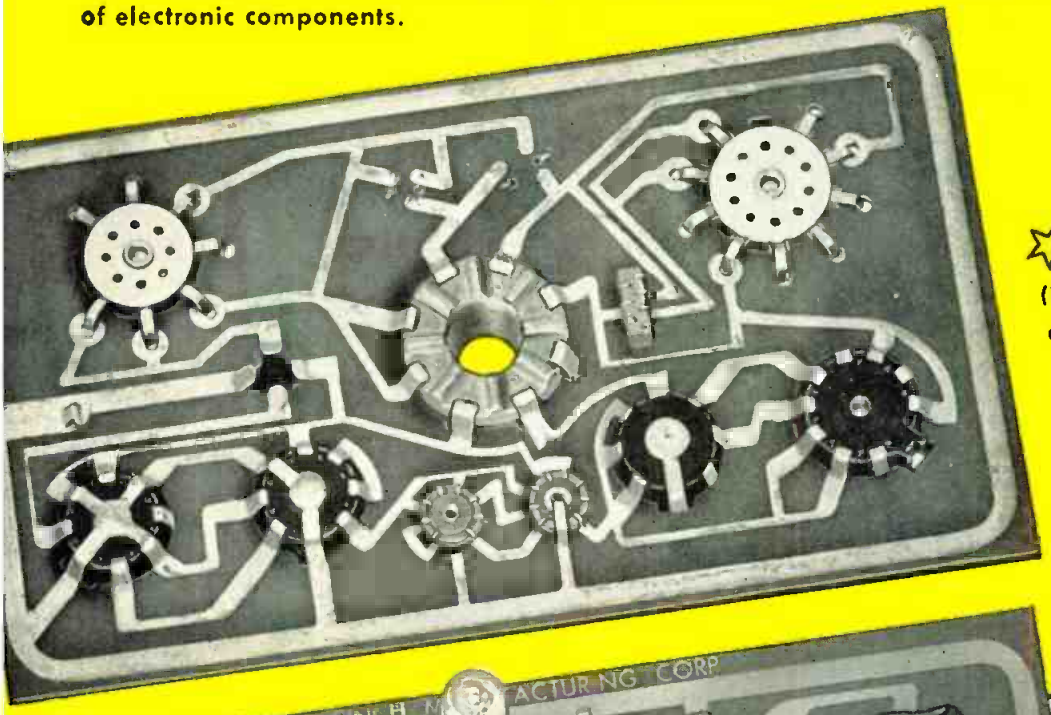
PANEL – PRINTING – ASSEMBLY
WITH CINCH "STANDARD" COMPONENTS COMPLETE

. . . and performance insured by the engineering, workmanship . . . quality materials . . . that for over a quarter of a century has produced the metal plastic assemblies for the foremost users of electronic components.

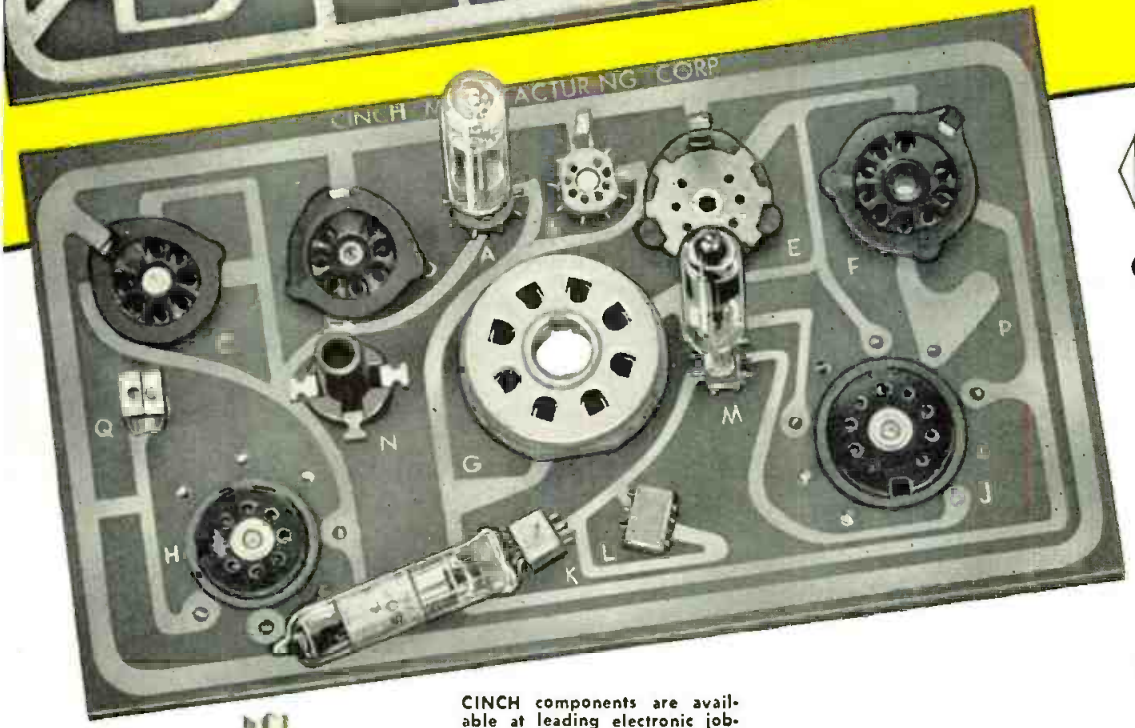
(Above) Subminiature socket for small sub-minar 8 pin base T3 tubes mounted perpendicular to chassis.

Five pin stem types for mounting tubes parallel to chassis and for printed circuits.

(Below) Seven pin stem type for tubes vertically mounted.



(Right) CINCH automatically made sockets assure the uniformity and quality mandatory for use in AUTOMATION in the End Users Equipment.



Printed Circuit reproduced here as an example is shown reduced in size.

CONSULT CINCH

The CINCH organization is flexible, readily adapted to any electronic componet requirement . . . in military or commercial emergency.

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.

CINCH components are available at leading electronic jobbers – everywhere.

Centrally located plants at Chicago, Shelbyville, Pasadena and St. Louis.

Cinch ELECTRONIC COMPONENTS

CINCH MANUFACTURING CORPORATION

1026 South Homan Ave., Chicago 24, Illinois

Subsidiary of United-Carr Fastener Corporation, Cambridge, Mass.

WASHINGTON News Letter

Latest Radio and Communications News Developments Summarized by TELE-TECH's Washington Bureau

70% OF NATION'S HOMES HAVE TV—On the basis of unofficial but authoritative projections of the US Census Bureau's June study of American households with one or more TV sets, TELE-TECH's Washington bureau's sources estimate that as of Oct. 1 the Census' June estimate of 32 million TV households, 67% of American homes, will have reached a total of 33 million homes. The Census Bureau pointed out in its June survey, the first government estimate of television circulation since TV became a national medium, that the total number of American households as of April was 47,788,000. The acceptance by the American public of television is also brought emphatically home by the fact that the April, 1950, decennial census recorded a 12.3% home TV saturation and a total of 5.1 million TV homes. About 5 million more video sets are in clubs, taverns, hotels, motels, offices, public schools, colleges, churches, restaurants and other public and semi-public places.

CIVIL DEFENSE PLANS—By the end of this year the Federal Civil Defense Administration according to its Warning & Communications Director's information to TELE-TECH, plans to have completed the warning systems of the nation's 250 principal target cities and to launch an emergency public radio service in which the country's police and fire department radio systems will be the major parts of the civil defense emergency mobile communications control centers. The FCDA through its matching funds estimates the total control center construction requirements will amount to $67 million. Another important communications system for civil defense, the FCDA told this magazine, will be the amateurs. There have been, it was stated, around 320 RACES (amateur civil emergency) plans approved or established in the cities, states and territories with more than 18,000 radio amateurs now actively engaged in the civil defense program.

HISTORIC USE—In forecasting and plotting the course of the late summer and fall hurricanes, the United States Weather Bureau made historic use of a new medium of radio-facsimile, tied into its radar installations along the Atlantic Coast. Because of the success and speedy transmission of photographs of hurricanes, starting with Hurricane Connie, the Weather Bureau is installing the radio-facsimile transmitters and equipment, supplied by the New York Times radiofax subsidiary, at 14 Weather Bureau radar installations on the Atlantic Coast with the terminal at the Washington National Airport headquarters of the Bureau. Photographing, development of the picture and its transmission, showing the hurricane as picked up on radar screens, requires only twenty minutes.

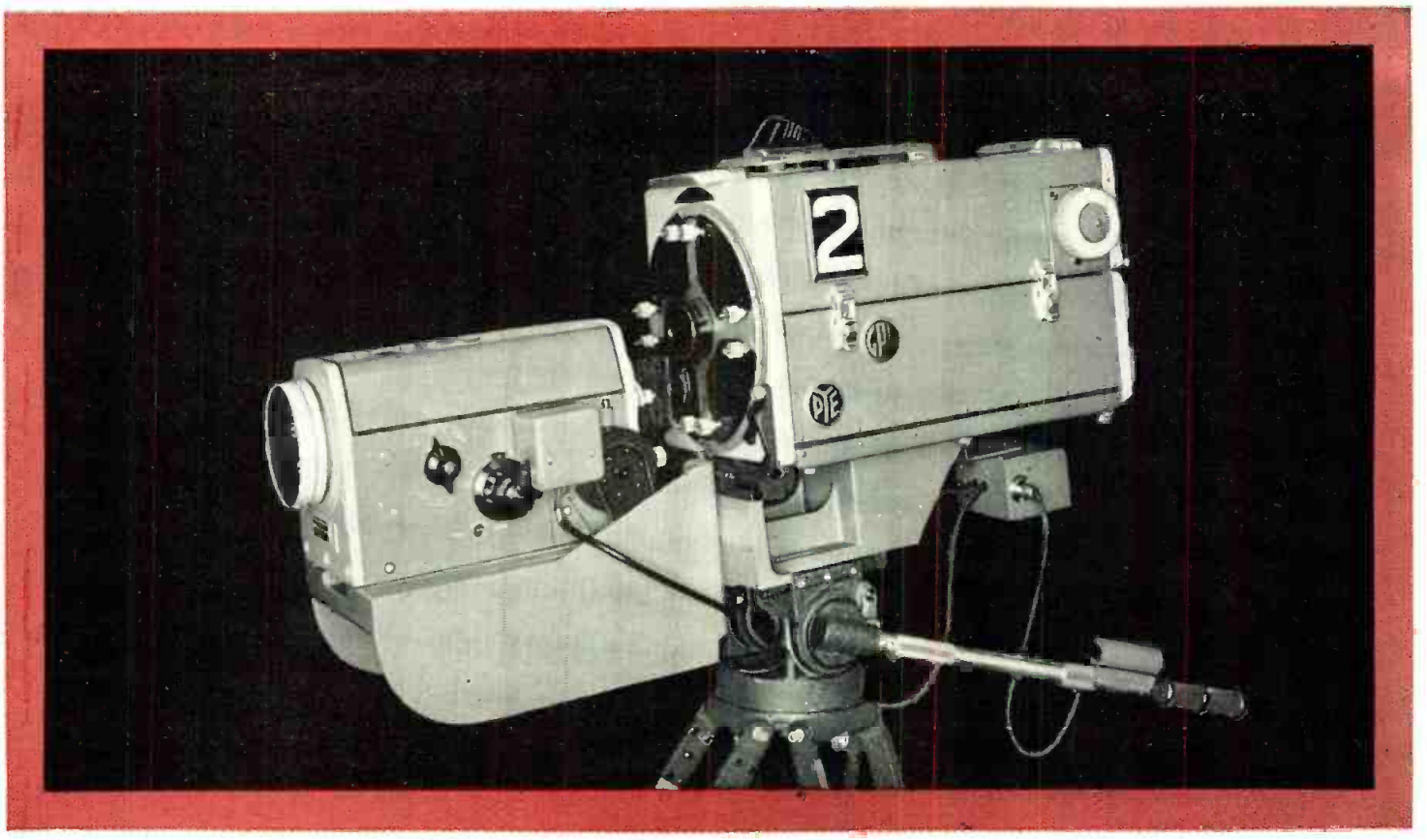
DEFENSE OUTLOOK—Selection of two outstanding authorities from the electronics field for key posts in the national defense organization—Secretary of the Air Force Donald A. Quarles and William H. Martin as the first appointee to the newly created position of Director of Research & Development for the Army—not only pinpoints the importance of electronics and radio in the building of the country's defense but augurs continued and emphasized reliance by the armed services upon the laboratories and manufacturing establishments of our industry for the supplying of the most effective weapons systems. Both defense officials came into full-time government service after lengthy and distinguished careers with the Bell Telephone Laboratories from which they retired. Because of their unquestioned capabilities and integrity, both Secretary Quarles and Mr. Martin have received high acclaim from governmental leaders and newspaper editors in connection with their appointments and their qualifications.

POLICY PLANNING—During this fall, the FCC is concentrating as much as it can with the huge workload of television authorizations and problems on the planning of policies and standards for the mobile radio and microwave services, the largest in terms of stations of the radio services under its regulatory jurisdiction. The blueprinting of the standards and rules and regulations in the mobile-microwave field has up to the present not been formulated from a long-range standpoint but has been carried on largely under a piece-meal or interim fashion. Now with a new chief of its Safety & Special Radio Services Bureau—Curtis Plummer, former Commission chief engineer and chief of its broadcast bureau, and Joseph Kinter, an able attorney who was assistant broadcast bureau chief—the Commissioners anticipate substantial assistance from its staff in the formulation of policies in this field which will aid not only in their regulatory responsibilities but will contribute to the constructive expansion of these services.

INDUSTRIAL RADIO—A "substantially" revised set of rules to govern the special industrial radio service, which have been in the mill in one form or another since 1950, have been finalized by the FCC in a move considered an interim measure until overall special industrial radio needs and the possibility of additional frequencies for this service can be explored. The FCC notice of adoption of the new rules, which become effective Nov. 1, pointed out that the new regulations "spell out in detail" those activities which form the basis of eligibility in the special industrial service.

National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington Editor



now the GPL Vari-Focal Lens gives you nine advantages

1 The GPL Vari-Focal Lens is equally useful in studio and field; fits all monochrome and color image orthicon cameras.

2 The GPL Vari-Focal Lens can handle an entire show with one camera; can perform most work ordinarily requiring two chains.

3 The GPL Vari-Focal Lens has a focal range nearly twice that of any other lens in the industry; can make a 10:1 change in focal length in two 5:1 steps—from 3" to 15" and 6" to 30". Once focused, object remains sharply focused, including corners, as focal length is varied.

4 The GPL Vari-Focal Lens has the same standard of resolution as high quality camera lenses of fixed focal length.

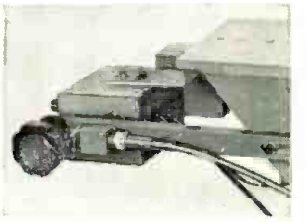
5 The GPL Vari-Focal Lens can zoom from a long shot to an extreme close-up, continuously, without disturbing pick-up continuity or camera orientation. Speed of full zoom is variable from 2 to 30 seconds.

6 The GPL Vari-Focal Lens eliminates the need and expense of additional lenses.

7 The GPL Vari-Focal Lens is silently motor-driven; can be operated from camera or control room.

8 The GPL Vari-Focal Lens is fully color-corrected; has flat field over entire range.

9 *AND NOW—A NEW FEATURE.* The GPL Vari-Focal Lens now is available with manual focal control, located at the cameraman's fingertips. Changes of the focal plane can now be accomplished by simple turns of the knob.



For full information or demonstration—phone, write or wire:

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New Electronic Products

POWER TETRODE

The 4X250B, a radial beam power tetrode cooled by convection and forced air, is unilaterally interchangeable with the 4X150A in nearly all cases. A new integral-finned anode makes it easier to

cool than the 4X150A. At equal plate dissipation, blower horsepower requirement of 4X250B is ½ that of the 4X150A. Unit now has a newly-designed oxide cathode and lower seal temperatures, and has an increased plate dissipation rating of 250 w, plate voltages of 2000 v, and doubled plate power of 500 w. **Eitel-McCullough, Inc., 798 San Mateo Ave., San Bruno, Calif.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-1)

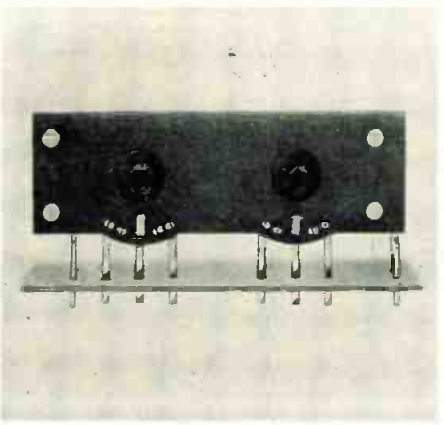
VOLTAGE TRANSFORMERS

Shown here is one of a line of miniature precision voltage ratio transformers. These precision units are especially useful where voltage division or multiplication is required to accuracies up

to 0.01%. They are available in plastic encapsulated form or in hermetically sealed cases. Units having up to 10 ratio taps are available. Accuracies are maintained with moderate output loading. This is a catalogued line of custom designed units and a number of stock types are described in Bulletin RT. **Hycor Company, Inc., 11423 Vanowen St., No. Hollywood, Calif.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-3)

CARBON CONTROLS

Designed specifically for printed circuit applications, these strip-type carbon controls have resistance wafers mounted directly on a phenolic panel. Controls have straight, tinned terminals



which project through punched slots in printed sheet for dip soldering. They are mounted at right angles to the chassis by means of shouldered tabs. To save space, multiple sections can be mounted about 1/2 in. behind each other. Single, dual and triple sections are available, in resistance values from 250 ohms to 10 megohms. **P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis, Ind.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-5)

LAMINATING RESIN

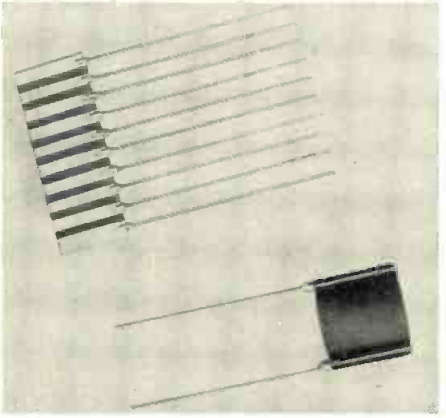
"Ecco L 65" is a new low loss laminating resin. Resin produces low dielectric constant laminates for use in radomes, antennas and printed circuits. It is easy to use with either fiber glass cloth or mat. Resulting laminates retain excellent properties to 300°F. Properties of a typical laminate made with Ecco L 65 are: Dielectric Constant—2.8; dissi-

pation factor—0.0008; Surface resistivity —above 10^{14} ohm; flexural strength—12,000 psi; water absorption—below 0.04%. **Emerson & Cuming, Inc., 800 Washington St., Canton, Mass.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-2)

PRECISION RESISTOR

Series 1300 type resistor is a single section, card type, precision resistor designed for applications where there is a lack of space for the ordinary round wire-wound types.

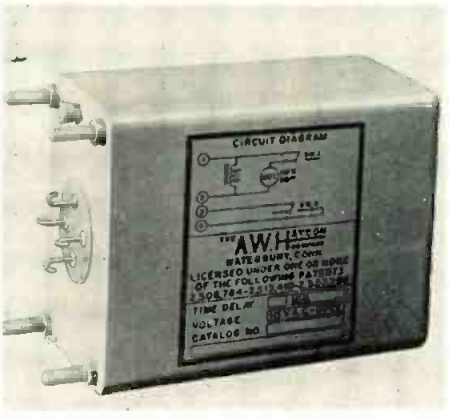
Unit is completely encapsulated for protection against humidity, salt-water immersion and extreme temperatures. On values up to 100K ohms, it is 1/2 in. x 1/2 in. x 3/32 in. thick. On values from 100K ohms to 1 megohm, card is



5/8 in. x 5/8 in. x 3/32 in. thick. It features precise operation from —55°C to +125°C. Wattage rating 0.06 w on each section. Tolerance ±1%. **Daven Electronic Sales Corp., 191 Central Ave., Newark, N.J.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-4)

TIME DELAY RELAYS

This new line of relays provides a proportional delayed reset after current interruption. They can be supplied hermetically sealed in an extruded aluminum housing, as shown, or in a standard dust cover. Their main function is to delay application of plate voltage in gas and vacuum power tubes until filaments or heaters have reached the proper temperature. Time delays from 5 sec. to 1 hour and reset times



from 30 sec. to 7 1/2 min. can be provided. Available in standard or governed D.C., or 60 or 400 cycle ac motors. **The A. W. Haydon Co., 232 No. Elm St., Waterbury, Conn.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-6)

MALLORY

New 1700 series Mallory split-reed vibrator uses special alloy leaves which serve both as contacts and as springs . . . eliminating usual button contacts. Life is greatly increased, constancy of output improved, and driving power reduced.*

**Patent Applied For*

New Heavy Duty Mallory Vibrator

gives far longer life, constant output

For the peak in dependability and performance, plan to use this newest Mallory vibrator in your communications equipment. A completely new idea in vibrator design eliminates conventional contact buttons. The spring leaves themselves . . . made of special contact alloy . . . act as contacting members. This design provides greatly increased contact area, with these important advantages:

Consistently Longer Life. Tests made on heavy duty cycles prove up to 100% greater service can be expected . . . with a high degree of consistency.

Steadier Output. The decreased rate of erosion means less change in contact spacing, less variation in voltage.

Flare-Proof Starting. The new low-mass design permits wider contact spacing to prevent start-up flare . . . without need for greater driving power.

Exceptional Uniformity of characteristics is made possible by the simplified design.

Minimum Size for heavy duty ratings.

The new design is available in the split-reed type shown here, for 6/12 volt service, and in the Duplex heavy duty model without the split reed construction. For full technical data, and for a consultation on your specific power supply requirements, write or call Mallory.

COMPLETE POWER SUPPLIES

It may be that you can save time and reduce over-all costs by employing a complete Mallory Vibrapack® power supply. Vibrapacks can be engineered around the new heavy-duty 1700 series vibrator to give long, reliable service. Design includes precise balancing of critical components. Normal ratings are conservative. Compact-sized Vibrapacks fit readily into crowded layouts. For further information, advise Mallory of your specific requirements.

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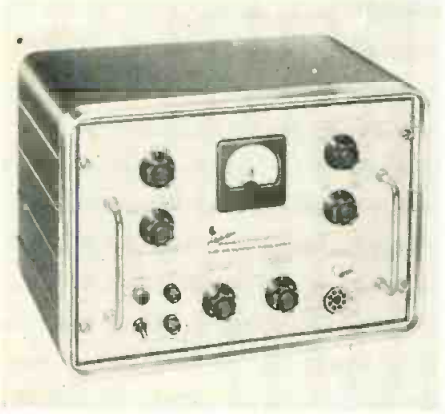
New Power Supplies

KLYSTRON POWER SUPPLY

Type 809 provides beam voltages from 250 v. to 600 v. at 65 ma, reflector voltages from 0 to —900 v. at 50 microamperes, square wave modulation between 400 and 200 cps and sawtooth



modulation at line frequency. Ripple and regulation are kept within tolerances comparable to more expensive units. A special feature is ease of changing from cw to square wave modulation for peak power measurements because top of square wave is automatically clamped to previously chosen reflector voltage. **Polytechnic Research & Development Co., 202 Tillary St., Brooklyn 1, N.Y.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-19)

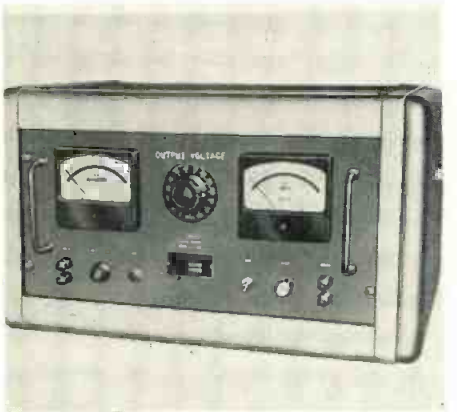
POWER SUPPLY

This strain gage power supply is useful in most strain gage systems as a direct replacement of a battery. Complete isolation from the input line results in less than 1 mv ripple from

either output side to ground. Output is 5-15 v in 2 ranges at 0-1 amp, continuously adjustable within 0.1%. Regulation is 0.1%. Ripple less than .05%. A 6 in. precision meter is located on the panel. Input 105-125 v, 60 cps. **Eagle Instruments, Inc., 14757 Keswick St., Van Nuys, Calif.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-21)

POWER SUPPLY

Model 140 is a 400 cycle regulated unit whose frequency is controlled internally by a secondary standard crystal at 400 cps ±.005%, and externally from a variable oscillator or similar source.



Frequency range is 375 to 425 cps. Waveform is sinusoidal with low distortion. Output 50 va max., 40 va optimum. Primary power 110-120 v, 60 cycle, single phase. Continuously variable single phase output voltage between 0-135 v RMS. Size is 23½" wide, 13" high, 16½" deep. Weight 75 lbs. Price $685.00. **The Geri Specialty Co., P.O. Box 103, Upland, Calif.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-22)

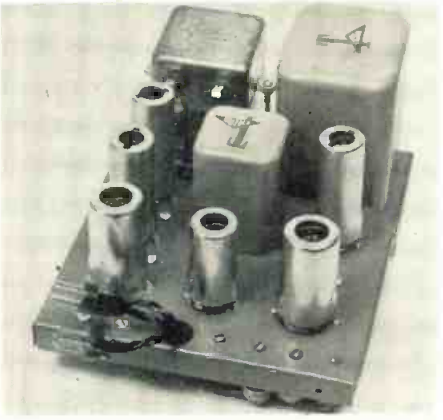
POWER SUPPLIES

This line of industrial high voltage power supplies includes the "Basic 20" safety and convenience features, which guarantees supplies are completely safe for use by unskilled production workers, are flexible and accurate enough for laboratory research. Some of the "Basic 20" features are: Reversible polarity; adjustable over-current trip-out—30%-150%; adjustable over-voltage trip-out

—100%-125%; three-range grounded voltmeter; three-range grounded milliameter; fail-safe automatic grounding switch; and Zero-start interlock. **NJE Corp., 345 Carnegie Ave., Kenilworth, N.J.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-20)

AIRBORNE POWER SUPPLY

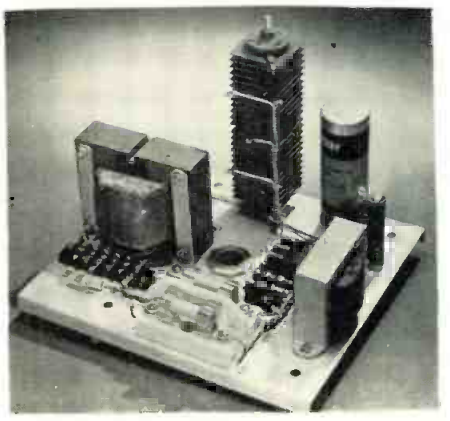
Model XF1006 is a compact unit designed for use in military aircraft. Its dimensions are limited to 240 cu. in. of space and its weight is less than 5 lbs. Stability is maintained within a temperature range of +120° F to —67° F. Input 105-125 vac at 400 cps, 100 vdc at 40 to 60 ma. Regulation held to 0.1%; ripple 2 mv. Has 6 miniature tubes and



uses type 85A2 reference tube to attain high stability. Hermetically sealed transformers used to accommodate temperature range specified. **Universal Electronics Co., 1720-22nd St., Santa Monica, Calif.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-24)

POWER SUPPLY

A continuous source of dc power is this selenium bridge rectifier type power supply, which can be utilized for all types of signal or control systems. It is used in fire alarm systems and is applicable for excitation of magnetic chucks, small motors, alternators or dynamometers. The unit has low internal impedance, choke-condenser hum filtering, and requires no



warm-up. Protection against short-circuit damage is incorporated in the supply. Available in power sources up to 500 vdc and 500 ma. **Slaughter Co., 1700 Nicklin Ave., Piqua, Ohio.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-23)

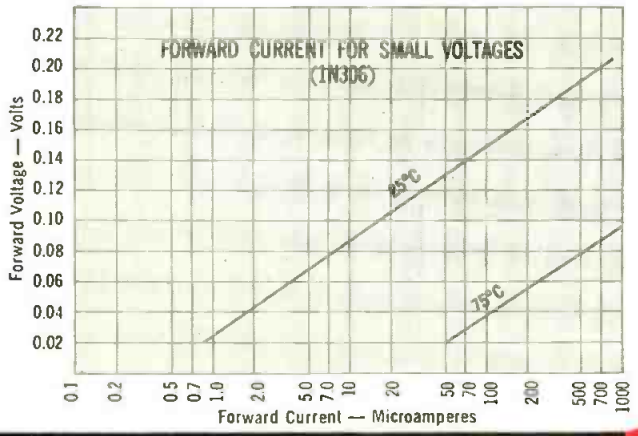
for predictable UNIFORMITY and STABILITY

specify RAYTHEON Gold Bonded Germanium DIODES

You'll find these small, rugged, hermetically sealed Raytheon Germanium Diodes ideal for Computers, Magnetic Amplifiers, Power Supplies, Detectors, Meter Protection or countless other applications where extremely low forward resistance and high reverse resistance characteristics are important. Here are some of the advantages you get when you specify Raytheon

1N305, 1N306 and 1N307 DIODES:

- **High forward current at low voltage**
- **Low saturation current**
- **Operable to 90°C with high uniformity and stability**
- **Mechanical ruggedness**
- **Small size**



	Forward Volts for 100 mA	DC mA. (max.)	Peak Inverse Volts	Reverse μA at −10V
1N305	0.8	125	60	2
1N306	0.8	150	15	2
1N307	1.0	50	125	5

Temperature rating −55°C to +90°C (Above ratings at 25°C)

MULTIPLE DIODE ASSEMBLIES

Raytheon can supply both germanium and silicon diodes, electrically matched, if required, in assemblies to meet your needs. For quotation, send your specifications to the nearest Raytheon office.

RAYTHEON MANUFACTURING COMPANY

Semiconductor Division

Home Office: 55 Chapel St., Newton 58, Mass., Bigelow 4-7500

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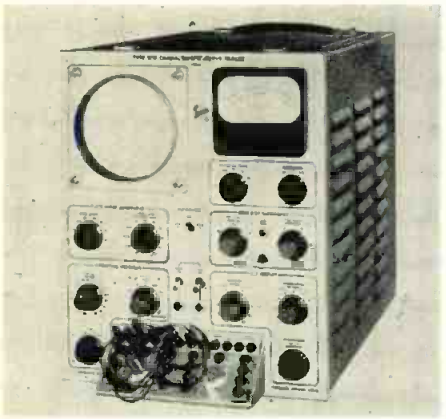
VISIT RAYTHEON BOOTHS 73-4-5 AT THE NATIONAL ELECTRONICS CONFERENCE, CHICAGO

New Test Equipment

CURVE TRACER

Type 570 Characteristic-Curve Tracer displays families of curves on face of a cathode-ray tube, calibrated to permit accurate current and voltage readings directly from screen. Features in-



clude: Ep-Ip, Eg-Ip, Ep-Ig_2, Eg-Ig_2, Ep-Ig and Eg-Ig; 9 voltage ranges from 0.1 v/div to 50 v/div; 11 current ranges from 0.02 ma/div to 50 ma/div; 8 plate supply sweep voltages from 5 to 500 v. peak; 11 series load resistors from 300 ohms to 1 megohm; 7 grid-step values from 0.1 v/step to 10 v/step; and 17 different heater voltages. **Tektronix, Inc., P.O. Box 831, Portland 7, Ore.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-25)

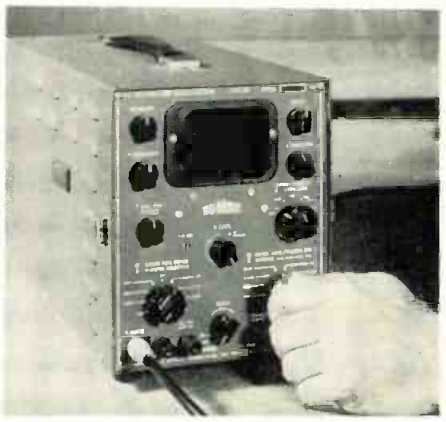
ANTENNA BRIDGE

The Millen 90672 Antenna Bridge is an accurate and sensitive bridge for measuring impedances in the range of 5 to 500 ohms at radio frequencies up to 200 MC. A variable capacitor capable

of high accuracy and permanency of calibration over a wide range of frequencies is used as the variable element, since the unit employs no variable resistors of any sort. The bridge may be used to measure antenna radiation resistance, antenna resonance, transmission line impedance, standing wave ratio, and receiver input impedance. **James Millen Mfg. Co., Inc., 150 Exchange St., Malden, Mass.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-27)

OSCILLOGRAPH

Type 331 is a cathode-ray oscillograph suitable for laboratory testing of many types of electronic computers. Unit can be used for time measurements from as short as 0.08 usec to as long as 2.5



sec. Functions as an ac/dc voltmeter, range 0.4-400 v, full scale, with an upper frequency limit of 4 MC (30% down). Uses Type 3WP-CRT; accelerating potential 1500 v. Power 140 w; size 7⅞" x 9" x 19½"; weight 19 lbs. Calibration accuracy within 5%. **Allen B. Du Mont Laboratories, Inc., 750 Bloomfield Ave., Clifton, N. J.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-29)

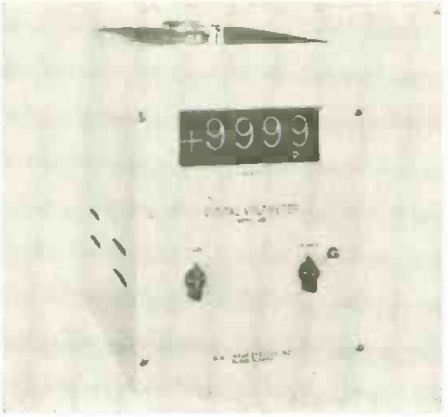
SPECTROPHOTOMETER

Color can now be electronically analyzed and immediately indicated on 3 meters in terms of their CIE (International Committee on Illumination) standard distributions with use of Tristimulus Spectrophotometer, Model 1602-A. Small, light, and portable, unit is designed for use by TV stations, TV tube manufacturers, photographic laboratories, dye and paint manufacturers, and many others. Three built-in high

gain amplifiers having gains of over a million times insure the sensitivity of this unit. 6" x 7" x 12" housing; 115 vac operation. **Telechrome Inc., 632 Merrick Rd., Amityville, N.Y.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-26)

DIGITAL VOLTMETER

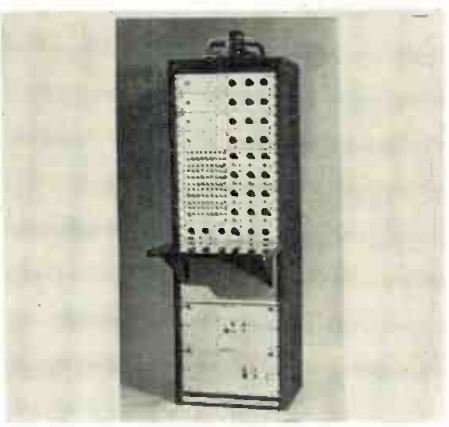
Model 451 provides automatic measurement of dc voltages and displays them in a horizontal line of four luminous numerals 1 in. high, plus the decimal point and polarity sign. Unit operates as a self-balancing potentiometer and is life-tested for 20 million readings. Voltage measurements are made in 3 ranges; Zero to ±9.999 vdc; ±09.99 to ±99.99 vdc; and ±099.9 to ±999.9 vdc. Resolution for the 3 ranges is



±0.001, ±00.01 and ±000.1 vdc. A series of mercury cells assembled in a battery-pack supplies the reference voltage for measurement. **Non-Linear Systems, Inc., Del Mar Airport, Del Mar, Calif.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-28)

PULSE CODE GENERATOR

Model 500-A features a 4-channel constant current output controllable in 100 MC steps with a fill-in in between from 100 ma to 1.1 amps per channel. Two are positive current and two are negative current, with the base line at ground potential. Constant current is assured by a sampling and feedback technique with each channel independ-

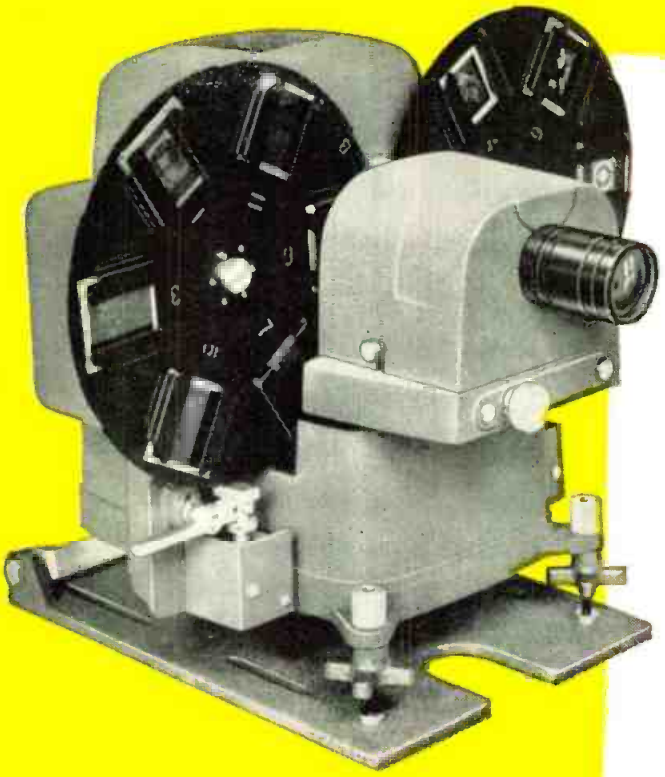


ent of the other. Unit can be used for core testing, data handling, countermeasures, beacon testing, and transistor testing. **Electro-Pulse, Inc., 11861 Teale St., Culver City, Calif.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-30)

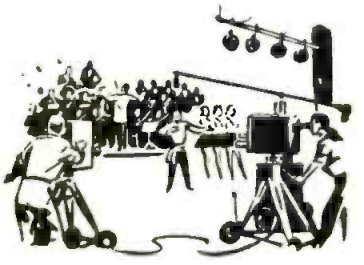
NEW SINGLE LENS

GRAY TELOJECTOR

STAR PERFORMER....



for TV commercials



Precision Projection

BETTER Commercials at LOWER COST

Yes . . . **now** you can use better 2" x 2" transparencies in uninterrupted sequence at lower cost. Important too, Gray Telojector is low in initial cost . . . ideal for budget-minded program directors. Telojector is compact, light weight, trouble-free. Two turrets take up to 12 slides at one loading. Additional loaded turrets are substituted in a matter of a few seconds . . . providing unlimited continual sequence. Controlled locally at the unit or remotely at the master video console. Also, can be used with the Gray 35B Manual Control Box to produce superposition, laps, fades and slide changes at any desired rate.

Complete Projection System

The New Gray 3B Telojector (2" x 2" Transparency Slide Projector) utilizes a single lens —permits superposing of two images on an optical axis . . . eliminates any need for external registration adjustment. The improved unit provides positive focusing of images on the camera tube with an uninterrupted sequence of slides for television commercials, news flashes and photographs or station and sponsors' identification.

GRAY RESEARCH

AND DEVELOPMENT CO., Inc., Hilliard St., Manchester, Conn.
Division of the GRAY MANUFACTURING COMPANY

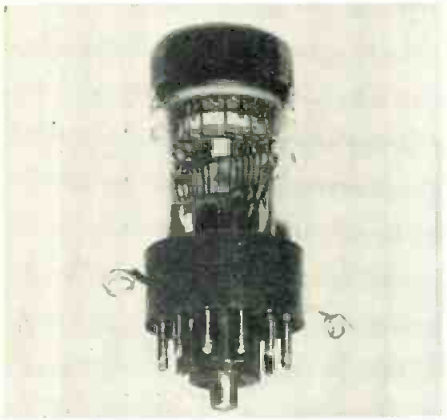
WRITE FOR:

Illustrated, detailed information on the NEW, SINGLE LENS GRAY TELOJECTOR and complete line of Gray Television-Broadcasting Equipment.

New Electronic Components

COUNTING TUBE

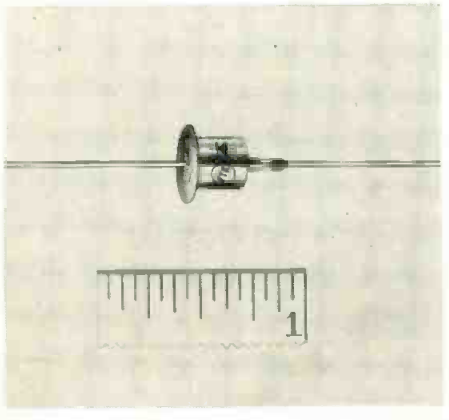
Model GS12D, a "Dekatron" cold cathode counting tube, has 12 cathodes brought out to pins on the base. It has a 13-pin base, plus 2 extra leads. Counting scale of 12 makes it valuable



in studies involving dozens, gross, inches, etc., and is a useful divider in many types of timing units. Counting rate from 0-4000 pulses per second. Tube 3.49 in. in length, bulb diameter 1.3 in., and base diameter 1.39 in. Max. total anode current 0.35 ma and max. voltage between electrodes 140 v. Min. supply voltage (anode to cathode) is 350 v. **Atomic Instrument Co., 84 Massachusetts Ave., Cambridge 39, Mass.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-18)

GERMANIUM RECTIFIERS

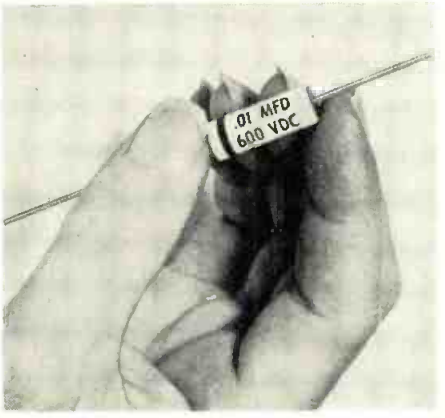
The IN91, IN92 and IN93 series, used for blocking, magnetic amplifier, and magnetic control applications, are said to have a reverse current 20% lower than RETMA specifications for this type. The IN368 rectifier is applied where high forward-to-reverse current ratios are required. RMS input voltages for the IN91, IN92, IN93 and IN368



under inductive load are 70, 140, 210 and 140 v; dc output currents, 150, 100, 75 and 100 ma; peak inverse ac voltages, 100, 200, 300 and 200 v. **Federal Telephone & Radio Co.,** 100 Kingsland Rd., Clifton, N. J. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-15)

CAPACITOR

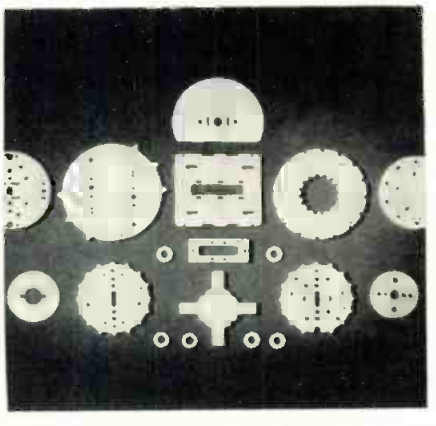
The Royal Cub is designed for applications requiring high temperature operation, high stability, and small size. The use of Polykane, a solid thermosetting compound, enables it to with-



stand severe vibration and shock. Operating temperature range —50° C to +100° C at full rated voltage. Insulation resistance at 25° C exceeds 4,000 megohms-ufd, with power factor less than 1%. Available in 100, 200, 400, 600, 1000 vdc working; capacitances from .001 to 1.0 ufd, depending upon voltage. **Cornell-Dubilier Electric Corp.,** 1006 Hamilton Blvd., So. Plainfield, N. J. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-13)

CERAMIC SHAPES

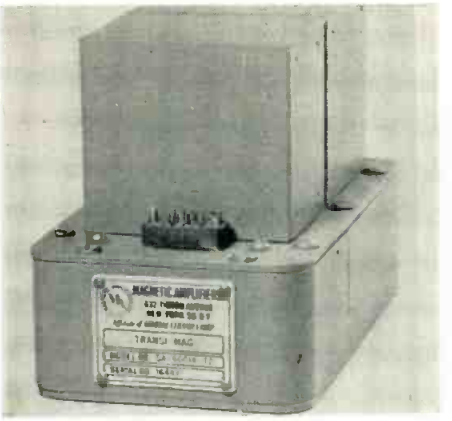
AlSiMag 393 custom made ceramics as thin as .009" are helping to overcome limitations of some of the currently used insulating materials in certain electron tube applications. Principal features are: ability to de-gas at higher temperatures; extension of operating temperature range for the finished tube; reduction of damage caused by fatigue failure of parts;



elimination of emission loss resulting from high temperatures, shock and vibration; resistance to heat deterioration. **American Lava Corp., Cherokee Blvd. & Mfgrs. Rd.,** Chattanooga, Tenn. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-14)

MAGNETIC AMPLIFIER

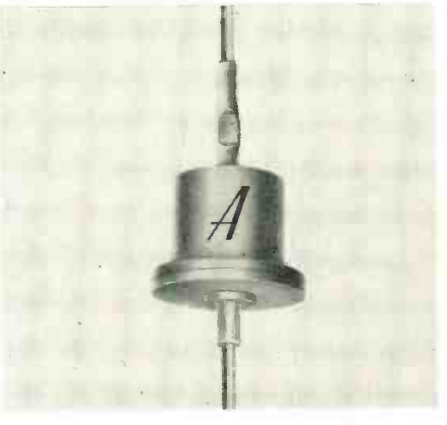
Transi-Mags are a standard line of transistor-magnetic servo amplifiers, featuring the use of static components, absence of filaments, high sensitivity and high input impedance with flexi-



bility in servo system applications. These units are available for almost all of the standard servo motors for operation on 400 or 60 cps. Standard ambient temperature range of —50° C to +71° C, but higher temperature units are available. Small size and light weight make them suitable for airborne applications. **Magnetic Amplifiers, Inc.,** 632 Tinton Ave., New York, N. Y. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-17)

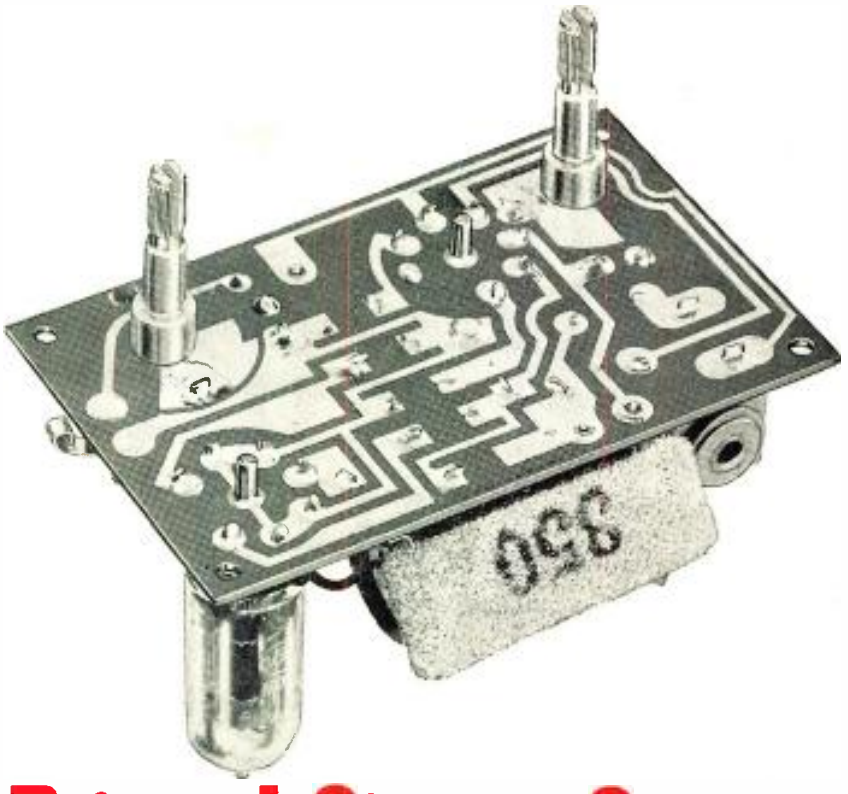
SILICON RECTIFIERS

These tiny power rectifiers are designed for use in equipment where miniaturization and high temperature are of prime importance. They take up 3/100 cu. in. of space and weigh 7/100 of an oz; have been tested to operate at as high as 200° C, are shock and vibration-proof. Available in 6 voltage ranges, can handle voltages up to 1000 v, with dc output currents from 300-400 ma. Reverse leakage currents under

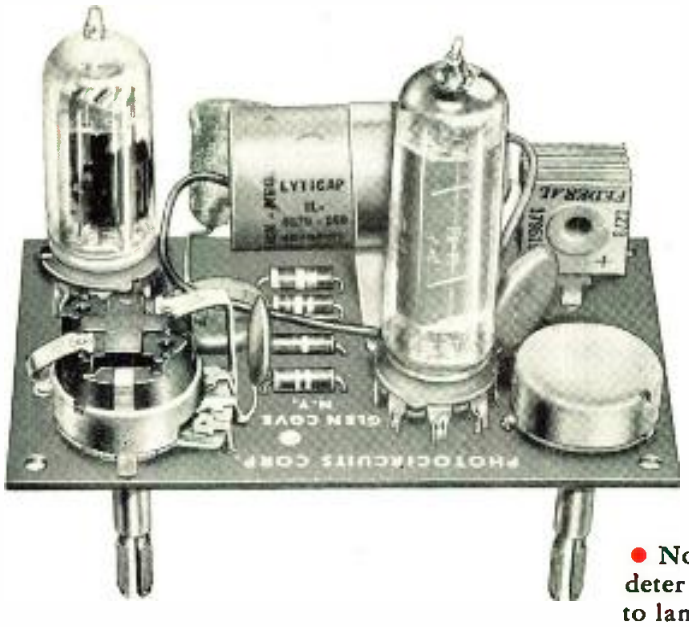


.05 ua, in many cases. Directly interchangeable in many instances with vacuum tubes, selenium or germanium junction rectifiers. **Automatic Mfg. Corp.,** 65 Gouverneur St., Elizabeth, N. J. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 10-16)

Speed up production with



REVERE ROLLED Printed Circuit Copper



Audio amplifier unit by Photocircuits Corp., Glen Cove, N. Y., using Revere Rolled Printed Circuit Copper.

Available NOW!

● Now that Revere *Rolled* Printed Circuit is available, nothing need deter you from switching to printed circuitry. This copper is supplied to laminators in standard coils of 350 lbs., in widths up to 38″, and in .0015″ and .0027″ gauges, weighing approximately 1 oz. and 2 oz. per square foot.

High in conductivity, uniformly dense through and through and side to side, Revere *Rolled* Printed Circuit Copper is easily etched and soldered.

When ordering blanks from your laminator, specify Revere *Rolled* Printed Circuit Copper.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

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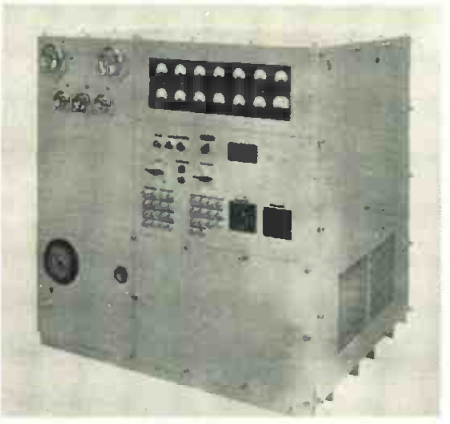
• • •

Mills: Baltimore, Md.; Brooklyn, N. Y.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Newport, Ark.; Rome, N. Y. Sales Offices in Principal Cities, Distributors Everywhere.

New Products

VHF-UHF AMPLIFIER

Model 23A amplifies 100 w to over 1000 w and operates over a frequency range of 225 MC-400 MC. Modulation frequency is 200 cycles to 20 kc. Distortion characteristic less than 3% at



full modulation. RF output and input impedance 52 ohms. Frequency response within 2 db. of the 1000 cycle reference level; carrier noise characteristic 50 db below full modulation. Spurious radiation value 60 db below carrier power. Input power required 208 v, 3-phase, 4-wire, 60 cycles. **Air Associates, Inc., Teterboro, N. J.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 9-34)

TIMING RECEIVER

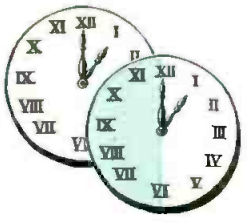
Model 2 PCM timing receiver, a highly sensitive, low-noise figure, superheterodyne is designed for reception of pulsed signals in 152 to 174 MC range. Accepts and reproduces pulses from 1-20 usec long. Receiver noise figure is 6-7 db, its bandwidth is 1 MC. AGC maintains a constant output with input signals varying from 5 uv to 10,000 uv, its frequency stability of ±.005% make manual adjustments unnecessary.

Mounts in a standard 19 in. relay rack by 10 1/2 in. high. Requires 100 ma, 200 v regulated dc and 6.3 vac power supply. **West Coast Electronics Co., 5873 W. Jefferson Blvd., Los Angeles, Calif.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 9-3)

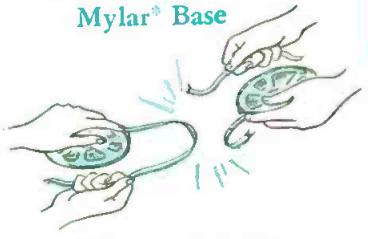
One of a series on what makes one magnetic recording tape better than another

Let's look at Soundcraft PLUS 50

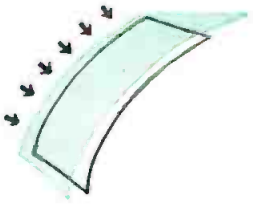
50% Extra Playing Time



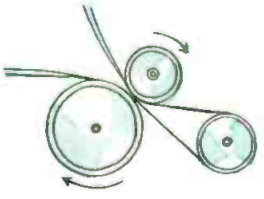
Extra Strength Mylar® Base



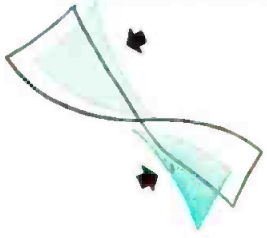
Full Depth Oxide Coating



Micro-Polished®



Lubricated Both Sides . . .



YET COSTS NO MORE

PLUS 50 Magnetic Recording Tape—newest in the famous Soundcraft line—brings you a combination of superior qualities that no other tape possesses. Qualities that let you capture and hear the true sense of violin strings, all the brilliance of brass, the color of wood winds . . . that faithfully record the human voice in all of its varied subtleties.

Plus 50's uniform output, inherently low signal-to-noise ratio, its 50% extra playing time, added strength and flexibility . . . its dimensional stability in any climate. These are the special qualities that make it the choice of professionals and amateurs, alike, wherever tape perfection is required.

And Soundcraft Plus 50 adds this special bonus: Its "Mylar" base assures virtually a lifetime of smooth, trouble-free service at no more cost per foot than other quality tapes. Like all Soundcraft products, Plus 50 is engineered and made by tape recording specialists. Get some Soundcraft Plus 50 Tape at your dealer's today.

FOR EVERY SOUND REASON

REEVES SOUNDCRAFT CORP.

Dept. N6, 10 East 52nd Street, New York 22, N. Y.

*Trade-Mark for DuPont Polyester Film

Yagi Antennas

(*Continued from page* 85)

3. They are usually housed separately and therefore impose some extra mechanical and environmental weathering problems.

The system used in the subject antennas possesses none of these limitations. Since there are no distributed circuit elements involved or no impedance transformation, the frequency sensitivity is limited only by the antenna itself. The mechanical problems as well as the cost and general appearance are greatly improved, since the system is housed completely within the antenna.

Wind Loading

Wind loading problems are very important in antennas especially those of a commercial nature as they are quite often mounted at

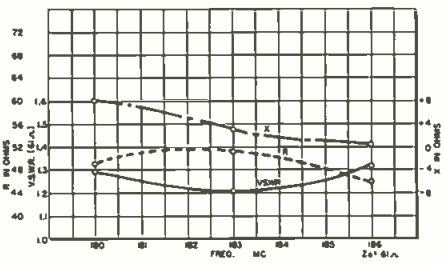


Fig. 6: Frequency range vs R, X and VSWR values for typical 5010-8 single bay design

high elevations and uninterrupted operation is of extreme importance. The following choices were dictated to some extent by the wind loading problem.

1. The yagi design since it offers an extremely small surface area for a given gain.
2. High strength aluminum alloy construction because of its strength in terms of weight, noncorrosive and electrical characteristics. (6061T6 aluminum used has tensile strength of 4500 lbs./in.^{2} compared to 21,500 lbs./in.^{2} for standard tubing).
3. Inert arc aluminum welded assembly. As shown in the table wind loading with 85 MPH wind with ¼ in. of ice is very small.

Mechanical Resonance

Extensive vibration testing was done to determine the mechanical resonance characteristics of the antenna. It was found that at natural resonance the amplitude of vibration in the long elements of the lower frequency antennas was quite high. This characteristic is very undesirable because of its destructive

STACKPOLE

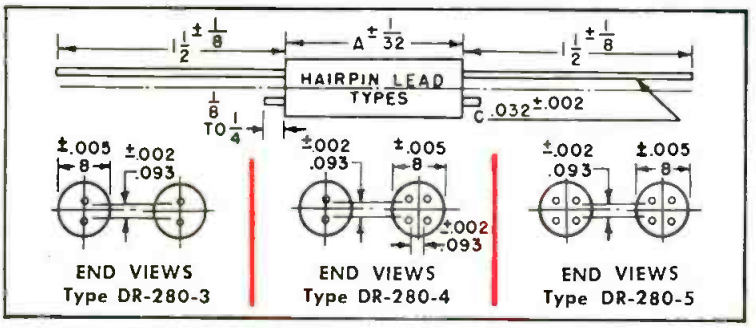
COIL FORMS

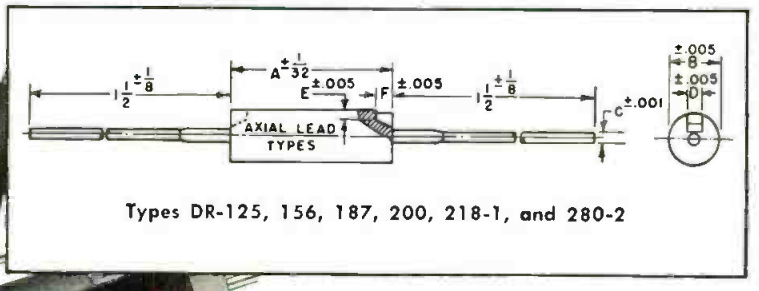
. . . 37 Standard Types for Immediate Delivery

PHENOLIC TYPES—Molded of dense, low-loss thermosetting resin, these forms are ideally suited for r-f coils, chokes, and other low-loss inductnrs. Axial lead types have end notches. Hairpin lead types isolate delicate windings from stress.

IRON TYPES—Designed for audio chokes, "Hash" chokes, r-f chokes, and similar uses. Molded of high-resistance powdered iron in standard Grades G1F and Z25. Other grades on special order.

PHENOLIC-with-IRON INSERT TYPES—Real space-savers for high-Q coils having several windings or multiple tapped windings. An iron core center section firmly molded to phenolic end sections combines the high-Q of iron types with the high insulation resistance of phenolic.

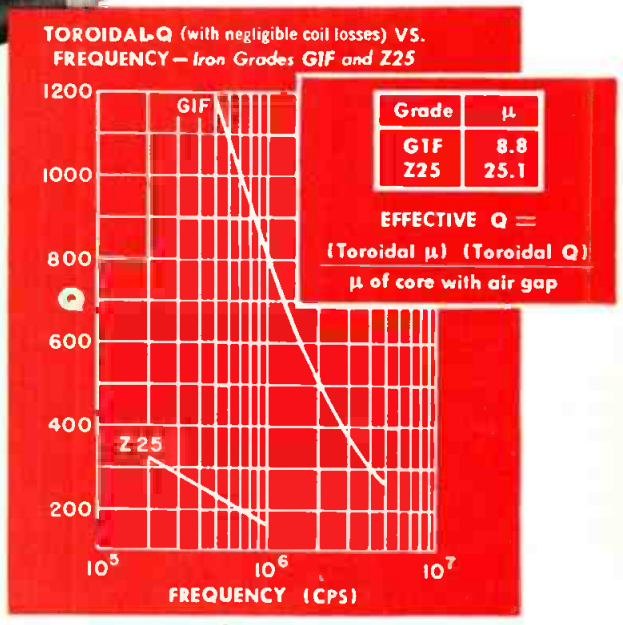




Types DR-125, 156, 187, 200, 218-1, and 280-2

TYPE	MATERIAL	LEADS	DIMENSIONS A (length)	B	C	D	E	F
DR-125	Phenolic or Iron*	2-axial	⅜", ½"	.125"	.028"	.035"	.014"	.035"
DR-156	Phenolic or Iron*	2-axial	⅜", ½"	.156"	.032"	.050"	.032"	.050"
DR-187	Phenolic or Iron*	2-axial	½", ⅝", ¾"	.187"	.032"	.060"	.031"	.060"
DR-200	Phenolic or Iron*	2-axial	½", ⅝", ¾"	.200"	.032"	.060"	.032"	.060"
DR-218-1	Phenolic	2-axial	¾"	.218"	.032"	.070"	.032"	.070"
DR-280-2	Phenolic	2-axial	⅞"	.280"	.032"	.070"	.032"	.070"
DR-280-3	Phenolic	1 hairpin each end	⅞"	.280"	.032"	—	—	—
DR-280-4	Phenolic	1 haripin one end, 2 hairpins other end	⅞"	.280"	.032"	—	—	—
DR-280-5	Phenolic or Phenolic-with-iron insert*	2 hairpins each end	⅞"	.280"	.032"	—	—	—

*NOTE: All iron types available in grades G1F and Z25 as standard.



Specially-tailored leads resist bending close to the form—protect delicate windings.

FREE COPIES OF THIS CHART . . . protected by laminated plastic for wall or desk use sent on letterhead request.

Electronic Components Division

STACKPOLE CARBON COMPANY, St. Marys, Pa.

In Canada: Canadian Stackpole Ltd., 550 Evans Ave., Etobicoke, Toronto 14, Ontario

Yagi Antennas

(Continued from page 104)

nature. The problem was solved in two steps as follows:

1. A sleeve is used over the center portion of the long elements. This lowers the natural frequency and stiffens the cross section at the center where mechanical strength is needed.
2. The amplitude of vibration was damped. This is accomplished by captivating a relatively high mass material such as gravel within the element tubing and at the extreme ends. (Fig. 4) For maximum effectiveness this material must have freedom of movement in all directions within the elements.

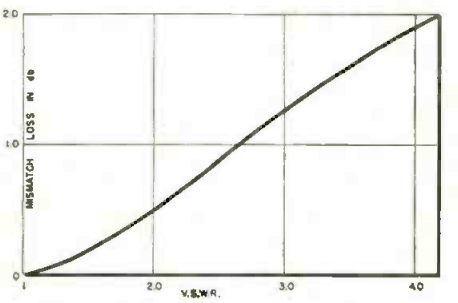


Fig. 7: Graph showing mismatch loss as a function of VSWR

It was found that these factors reduced the vibration amplitude by about six times. In no case in the final design does the natural resonance present a problem.

Packaging

The problem of packaging is extremely important regardless of the product. In general the following factors must be taken into account:

1. Does it contribute in an esthetic sense to the desirability for the product.
2. Does it fully protect the item in question.
3. Is its contribution to unit price economically justified.
4. Does its physical size or shape impose severe restrictions on shipping or storage.

To satisfy these requirements antennas in the range up to 72 MC are packaged with the elements unassembled to the crossarm. This is dictated primarily by the physical size as is evident after noting the physical dimensions given in the accompanying table. Field assembly is facilitated by simple match marking supplemented by easy to follow instructions.

The elements of antennas beyond

NEW V.L.I. (VERY LOW IMPEDANCE) DIODE

up to 300 ma at 1 volt with excellent stability and fast recovery time

V.L.I. DIODE CHARACTERISTICS @ 25° C

	Forward Current @ + 1V	Reverse Current Microamps Max.					Max. Reverse Working Voltage	Max. Average Anode Current
	ma min.	-10V	-30V	-50V	-100V	-150V		ma
1N447	25	20	60				30	60
1N448	25		30		100		100	60
1N449	50	10	30				30	60
1N450	50		30		100		100	60
1N451	50					150	150	60
1N452	100		30				30	80
1N453	100		30		100		100	80
1N454	200			50			50	100
1N455	300		30				30	100

The new Sylvania V.L.I. Diode is a significant development for electronic equipment designers with applications for high current carrying diodes. For the first time, you can expect high forward conductance combined with stable, drift-free performance, and fast recovery time.

The new Very Low Impedance diode is the result of recent technological advances in the diode field by Sylvania research engineers. It's the ideal diode for demanding computer applications in clipper, clamper, and logical circuits. In fact, it's the only diode wherever you want high forward conductance with high back resistance—high current carrying capacity with fast recovery time—and high rectification efficiency. The V.L.I. diode is designed into the Sylvania sealed-in-glass package and is 100% inspected for a positive, protective seal.

There's a full line of V.L.I. Diodes in a range of current-carrying capacity. Write for complete information or samples. Address Dept. K20R.

"another reason why it pays to specify Sylvania"

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N.Y.
In Canada: Sylvania Electric (Canada) Ltd.
University Tower Bldg., Montreal

SYLVANIA®

LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

Yagi Antennas

(*Continued from page* 106)

72 MC are factory assembled to the crossarm. However, the crossarms on these antennas are made in two and three pieces to arrive at a reasonable package size.

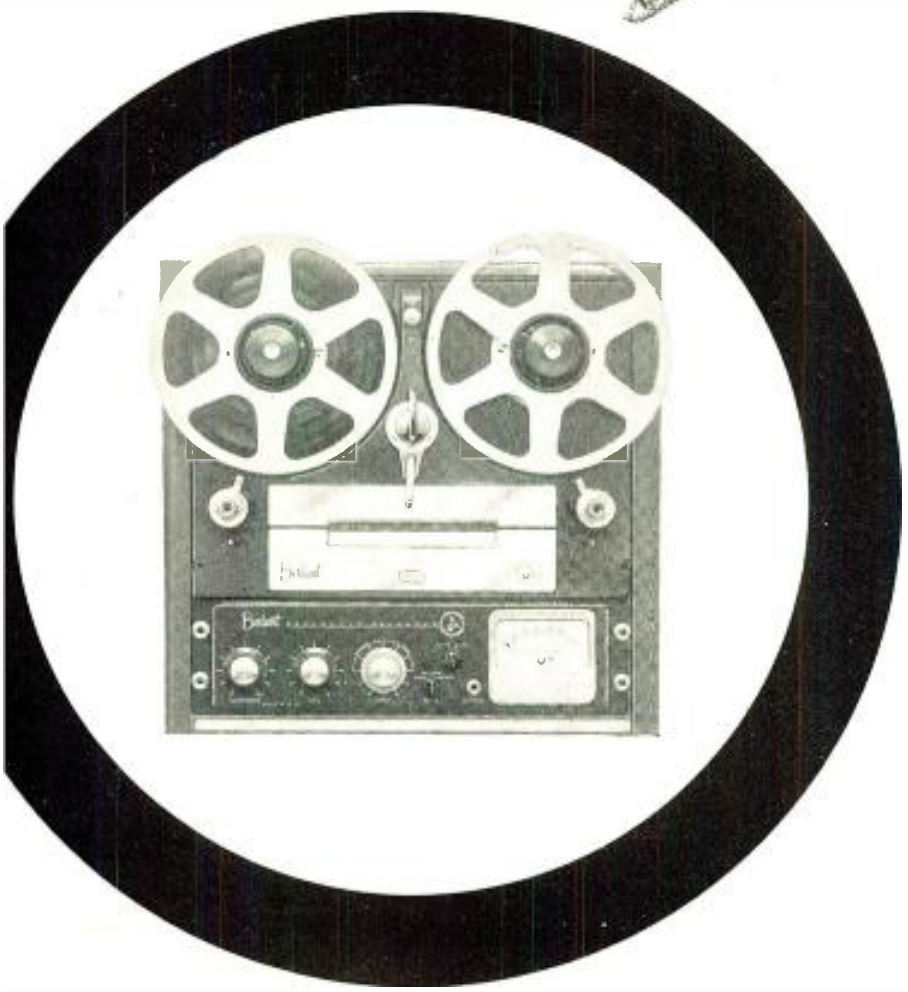
The 5010 series are now being manufactured in many different frequency ranges. The table which is attached lists twenty-eight (28) different variations of the 10-element Yagi. The frequency range starts at 50 MC and continues to 305 MC. The type number for the antenna ends in a letter such as A or B or a number. The number coincides with the television channels and these antennas cover the exact frequency range of the television channels. Although the chart gives only a single bay antenna, matching harnesses are available for two-bay stacking with either horizontal or vertical polarization and for four-bay stacking with horizontal polarization. The table gives the electrical data for each antenna type, including the VSWR for both 50 ohm systems and 72 ohm systems. The wind load of each antenna is tabulated for both vertical and horizontal polarization so that, the installer can take this into consideration in the tower design. The approximate overall dimensions will help in the design of frameworks, and structures for mounting these units.

Operation "Fisheye"

An underwater application of closed-circuit television is enabling the U.S. Fish and Wildlife Service Department of the Interior to observe and test the performance of experimental fishery methods and equipment under actual oceanic conditions.

The Service's underwater TV experiments were initiated with "Operation Fisheye," conducted recently in the Gulf Stream off the east Florida coast. A standard RCA ITV closed-circuit television system provided remote observations of experimental fishery gear towed at depths of more than 60 ft. The gear was illuminated only by natural sunlight, and the views produced on the TV monitor were sufficiently clear and sharp for photographing by both still and motion picture cameras.

What is the difference between Amateur and Professional tape recorders?



amateur	professional
2 heads	3 heads (provision for additional heads) The third head makes it possible to check the sound for proper balance while recording. Extra heads allow simultaneous recording and playback, sound on sound recording, stereo recording, etc.
1 motor	3 motors. Separate motors for take-up and supply ensure constant speed, permit faster forward and reverse. Additional motors for direct drive reduce distortion by eliminating clutches, belts, pulleys.
3.75 & 7.5 ips speeds	7.5 and 15 ips speeds. Most professional recording of tape masters is done at 15 ips. The faster the tape speed, the less flutter and wow.
Electric eye level indicator	Large signal level meter for accurate measure of input and output in order to reduce distortion due to overmodulation.
7 inch reels	10½ inch reels provide 1½ hours of recording. Entire operas and symphonies can be recorded without interruption.
None	Two channel input mixer allows recording of narration or song over music with independent volume control on each channel.
None	A-B Test Fader permits, while recording, monitoring for direct comparison of sound coming in with sound as recorded on tape, in order to achieve perfect reproduction.
None	Special Cueing and Editing positions for quick, accurate cueing and editing.
	Dependability of operation, timing accuracy, precision construction, exacting quality control are additional professional features.
	Take this handy check list with you when you go to buy a tape recorder!

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Electronic Reliability

(*Continued from page* 83)

1. Normally, the threshold (pull-in and drop-out) voltages vary with coil resistance. The temperature-resistance coefficient of copper being fairly high, the sensitivity of the relay thus varies with ambient temperature and recent operating history.
2. Pivot friction and spring hysteresis.
3. Welding of contacts upon closure.
4. Position (unbalance, gravity effect).
5. Vibration.
6. Dust particles on the contacts.
7. Stray magnetic fields.
8. Loss of spring tension.
9. Differences between units due to manufacturing tolerance.

Such an impressive array of factors affecting relay operation indicates that the applied voltage must be greater than the nominal or average pull-in voltage by a considerable margin of safety in order to achieve reliable operation. A 50% margin is not unusual.

If the defective relay fails under the eye of the repairman, his job is simple. But relays are decision elements, and not infrequently the repairman cannot confirm the reported difficulty in this way, perhaps because line voltage has risen slightly, or perhaps because the operator shut the equipment down and permitted it to cool off. So the repairman tests the relays for marginal operation. This can be done by applying subnormal voltage to the coil; where this is inconvenient, the margin of safety can be measured in force units instead of voltage, by means of a special spring balance. Best of all, relay failures can be reduced to a very low value by periodically checking their margin of safety and replacing those which develop a rapidly changing margin.

There are some applications where even momentary equipment failures will jeopardize life and property. Perhaps electronic equipment is not yet suitable for such applications. For most uses, rapid repair provides satisfactory reliability. The quickest way to repair electronic equipment is to replace it. Continuity of service can be obtained by providing two alternate systems, with easy or automatic switching from one to the other.[16, 37] Both should be kept "tuned up" and ready to go.

There is currently a trend toward interchangeability of chassis or units of the overall equipment. This has

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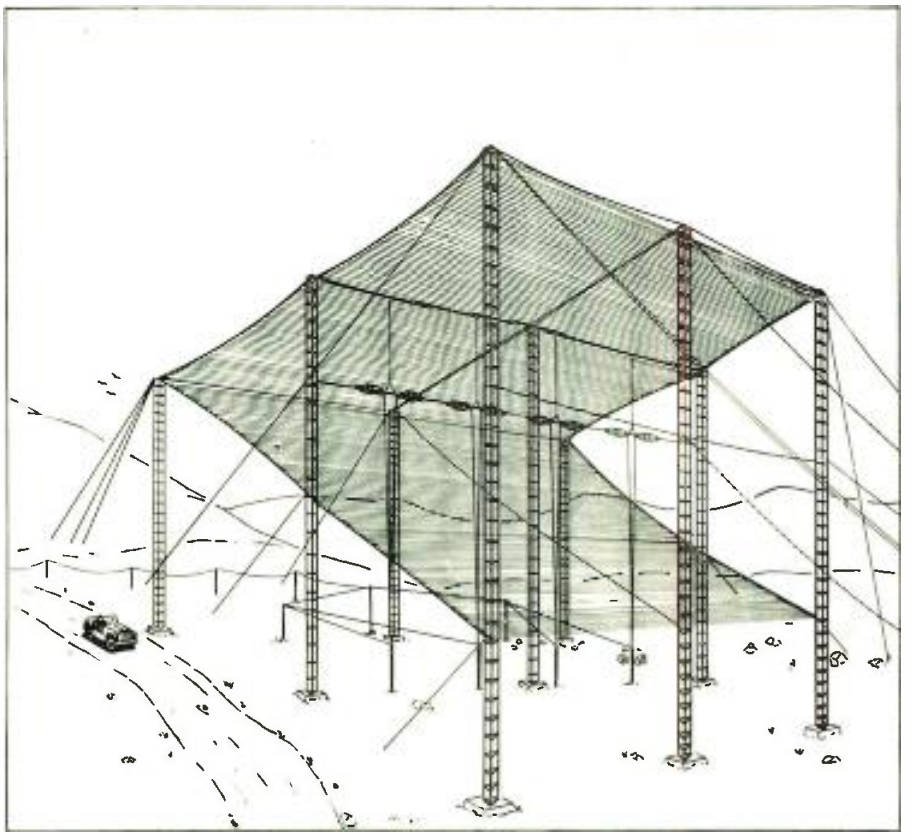

Page

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Openings for Qualified Engineers

Electronic Reliability

(*Continued from page* 110)

many good features, but its benefit to system reliability appears to be rather specialized. Unitization would not reduce the down-time of the average radio transmitter, because a complete set of spare units is no cheaper than a spare transmitter; and finding and replacing the faulty unit takes longer than switching over to the spare transmitter. But there are certain types of systems for which provision of two complete equipments with rapid change-over is not convenient or feasible; examples might be a large computer containing many identical units repeated, or test equipment to be used in high-rate production, which includes heavy equipment difficult to remove and install. In this case, unitization can drastically reduce down-time if:

1. The faulty unit is immediately obvious to the operator.
2. The faulty unit can be replaced quickly without retuning or recalibration, and
3. Circuits and parts which are subject to unavoidable failure are located in the quickly replaceable units, *not* in the portions of the system which are difficult to replace.

In striving for reliability and accuracy, we are seldom hurt by the factors that we know of during the development and design phase; it is the little unknowns and assumptions that jeopardize the reliability of the product. The avoidance of this weakness is simpler to state than to put into practice, but we cannot have reliability without it; if you must make assumptions, make them very reluctantly and deliberately. It is much better to analyze every part of the circuit in detail whether by exact calculation, reliable rule-of-thumb, or experiment. ■ ■ ■

References

6. Taylor, Norman H., "Rudiments of Good Circuit Design," *Proc. of the 1953 Electronic Components Symposium*, pp. 21-1 thru 21-8.
7. *"Reference Data for Radio Engineers,"* 3rd Edition, Federal Telephone & Radio Corp., 1949.
10. Terman, F. E., *"Radio Engineering,"* McGraw-Hill, 3rd Edition, Chapter 15.
13. Brooks, H. B., "Timing Circuits," *Trans. I.R.E.*, PGI-3 (Prof. Group on Instrumentation) April 1954.
16. McRae, J. W., "Reliability—A Challenge to Electronic Engineers," *Proc. of the 1953 Electronic Components Symp.*, pp. 5-1 thru 5-3.
22. Putt, Maj. Gen. Donald L., "What the Military Services Expect From Engineering Management in the Electronics Industry," *Record of the I.R.E. 1953 National Convention*, Part 6, p. 141-144.
30. Hooper, C. K., "Stability Characteristics Of Standard Composition Resistors," *Tele-Tech*, Sept. 1952.
34. Naval Electronics Lab., "Reliability Check List For Electronic Equipment Designers," *Tele-Tech*, Nov. 1954, p. 68-69.
37. Greenwood, J. H., "Reducing Transmitter Out Time," *Electronics*, July, 1951.

VARO Tuning Fork and Frequency Generator

The VARO Tuning Fork is designed for use as a high accuracy frequency or timing reference in ranges from 300 to 4000 cycles. Highly miniaturized and ruggedly constructed, the VARO Tuning Fork is designed to meet all applicable military environments including temperature extremes and vibration. When used as a signal filter, its high Q provides sharp and consistent characteristics. The VARO Tuning Fork is made to plug in a standard nine pin miniature tube socket.

The VARO Frequency Generator's accuracy is independent of input voltage variations and external loads. No oven or thermostat is required for its accurate operation in any environmental condition. The oscillator circuit of the VARO Frequency Generator uses silicon transistors in place of vacuum tubes. It is designed to plug into a standard octal socket. Special circuit and physical designs may be adapted to any application requirement.

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Accuracy:	0.1% over entire range of military environments. Higher orders of accuracy available on special request.
Frequency:	Available at any frequency within range of 300 to 4000 cps.
Size:	0.875 in. diam.; 2.750 in. high; Standard nine pin tube socket.
Weight:	2.502 oz. (Max.)

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Input:	28v ± 10%
Output:	2.5v nominal
Accuracy:	0.1% under all military environmental conditions
Size:	1.375 in. diam.; 2.750 in. high; Standard octal socket.
Weight:	4 oz

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Electronic Conference

(Continued from page 77)

and N. Furumoto, U. S. Naval Air Missile Test Center, Point Mugu, Port Hueneme, California.

7. ELECTRON-TUBE AMPLIFIERS AND OSCILLATORS

(a) "Design of Optimum Phase-Shift Oscillators" by D. L. Waidelich, University of Missouri, Columbia, Missouri.
(b) "Improvements in the Drift Stability of Constrained, Starved Amplifiers" by J. M. Cage and D. L. Johnson, Purdue University, Lafayette, Indiana.
(c) "Linearity Considerations in Feedback Pair Amplifiers" by W. L. Hurford, Radio Corporation of America, Camden, New Jersey.
(d) "Wide-Band Power Amplifiers and Transmitters" by T. R. O'Meara, University of Illinois, Urbana, Illinois.

8. COMPUTERS AND COMPUTER ELEMENTS

(a) "Precision Digital-To-Analog Converter Methods for Graphical Plotters" by M. B. Bain, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California.
(b) "Electronic Switching and Control in a House-Heating Anolog Computer" by N. P. Stucky, Minneapolis-Honeywell Regulator Co., Hopkins, Minnesota.
(c) "Manufacture of Disks for Optical Shaft Digitizers" by E. M. Jones, The Baldwin Piano Company, Cincinnati, Ohio, B. Lippel and K. Doering, Signal Corps Eng. Laboratories, Fort Monmouth, New Jersey.
(d) "An Electro-Mechanical Multiplier" by G. E. Pihl and R. B. Tilley, Technology Instrument Corp., Acton, Massachusetts.

TUESDAY, OCTOBER 4

8:15 A.M.—REGISTRATION
Lobby

9:00 A.M.-6:00 P.M.—EXHIBITS
Displays of electronic equipment, components and new developments.
Entrance on Mezzanine.

TUESDAY MORNING—TECHNICAL SESSIONS

9. COMMUNICATION THEORY

(a) "A Comparison of the Phase and Amplitude Principles in Signal Detection" by W. H. Huggins, Johns Hapkins University, Baltimore, Md., and D. Middleton, A. F. Cambridge Research Center, Cambridge, Massachusetts.
(b) "On the Improvement of Teletype Transmission by the Application of Protected Gaussian Codes" by H. F. Harmuth, Signal Corps Engineering Laboratories, Fort Monmouth, New Jersey.
(c) "Recording Techniques Applied to Filter Theory" by C. B. Brown, U. S. Naval Ordnance Laboratory, White Oak, Maryland.
(d) "A Synthesis Procedure of Sampled Data Systems" by G. V. Lago, University of Missouri, Columbia, Missouri.

10. MICROWAVE TUBES AND COMPONENTS

(a) "A Long-Life C-Band Magnetron for Weather Radar Applications" by W. F. Beltz and R. W. Kissinger, Radio Corporation of America, Harrison, New Jersey.
(b) "Magnetron Voltage Tuning in the S-Band" by P. H. Peters, Jr., General Electric Research Laboratory, The Knolls, Schenectady, New York.
(c) "Microwave Spectra of Spark-Gap Impulse Generators" by E. B. Hunt and R. H. George, Purdue University, Lafayette, Indiana.
(d) "New Criteria for Microwave Component Surfaces," R. D. Lending, Signal Corps Eng. Labs., Fort Monmouth, New Jersey.

tunes UP TIRED ASSEMBLY LINES

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Electronic Conference

(Continued from page 114)

(e) "A New Coaxial Directional Coupler" by R. I. Kyhl, General Electric Research Laboratory, Schenectady, New York.

11. TRANSISTOR APPLICATIONS

(a) "A Junction-Transistor Integrator" by F. H. Blecher, Bell Telephone Laboratories, Murray Hill, New Jersey.
(b) "A Transistorized Meacham Bridge Oscillator" by S. N. Witt, Jr., Georgia Institute of Technology, Atlanta, Georgia.
(c) "A Silicon-Junction Diode Modulator of 10^{-8} A Sensitivity For Use in Junction-Transistor DC Amplifiers" by N. F. Moody, Defense Research Establishment, Ottawa, Canada.
(d) "Transistorized Crystal Video Receivers" by E. F. Gallagher and R. L. Crosby, Sylvonia Electric Products Inc., Waltham, Massachusetts.

12. MEDICAL ELECTRONICS AND ULTRASONICS

Program prepared in cooperation with the IRE Professional Group on Ultrasonics Engineering.
(a) "Neuro-Sonic Surgery" by W. J. Fry, University of Illinois, Urbana, Illinois.
(b) "An Ultrasonic Flowmeter" by M. G. Haugen, W. R. Farrall, J. F. Herrick and E. J. Baldes, Mayo Clinic, Rochester, Minn.
(c) "A Vibration Pickup Utilizing a Doppler-Modulated Ultrasonic Beam" by H. C. Handy, Armour Research Foundation, Illinois Institute of Technology, Chicago, Illinois.
(d) "Detection of Ultrasound by Means of Phosphorescent Materials" by L. A. Petermann, Vibro-Ceramics Corporation, Metuchen, N. J. Paper to be presented by P. B. Oncley.
(e) "An Ultrasonic Spectrometer for Measuring Acoustic Absorption" by M. S. Cohen, Massachusetts Institute of Technology, Cambridge, Massachusetts.

12:30 P.M.—LUNCHEON IN THE BAL TABARIN

Luncheon Address: "The Canadian Nuclear Reactor Accident" by J. M. Robson, Atomic Energy of Conada, Ltd., Chalk River, Ontario.

TUESDAY AFTERNOON—TECHNICAL SESSIONS

13. SYMPOSIUM II: "Radio Astronomy Enlarges the Observable Universe."

Program prepared in cooperation with the IRE Professional Group on Antennas and Propagation.
Chairman: L. V. Berkner, President, Associated Universities, New York, New York.
Invited Speakers:
Helen W. Dodson, McMath-Hulbert Observatory, Pontiac, Michigan.
F. T. Haddock, Jr., Naval Research Laboratory, Washington, D. C.
R. C. Spencer, Air Force Cambridge Research Center, Cambridge, Massachusetts.
H. I. Ewen, Harvard University, Cambridge, Massachusetts.
R. N. Bracewell, formerly of the Division of Radio Physics, Commonwealth Scientific and Industrial Research Organization, Sydney, Australia.

14. MODERN METHODS IN CIRCUIT ANALYSIS

Program prepared in cooperotion with the IRE Professional Group on Circuit Theory.
(a) "Singular Transformations in Network Theory" by M. B. Reed, Michigan State University, East Lansing, Michigan, and S. Seshu, University of Illinois, Urbana, Illinois.
(b) "Philosophy of Transform Techniques" by G. I. Cohn, Illinois Institute of Technology, Chicogo, Illinois.
(c) "A Study of the Simultaneous Applicotion of Discontinuous Driving Currents and Driv-

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Electronic Conference

(*Continued from page* 116)

ing Voltages" by C. L. Coates, University of Illinois, Urbana, Illinois, M. B. Reed, Michigan State University, East Lansing, Michigan and E. Schwarz, Sangamo Electric Co., Chicago, Illinois.

(d) "Normalization of the Frequency Variable as an Aid in Network Design" by J. J. Hupert, A.R.F. Products, Inc., River Forest, Illinois.

15. SOLID-STATE DEVICES

(a) "The Power Photoconductive Cell" by J. E. Jocobs and C. W. Hart, General Electric Company, Milwaukee, Wisconsin.

(b) "High-Frequency Germanium PNP Alloy Junction Transistor" by A. P. Kordalewski, General Electric Company, Syracuse, New York.

(c) "Small-Amplitude Transient Response of P-N Junctions" by B. R. Gossick, Purdue University, Lafayette, Indiana.

(d) "Pulse Forming of Point-Contact Transistors" by J. S. Hanson, International Business Machines Corporation, Poughkeepsie, New York.

16. ELECTRONIC SYSTEMS

(a) "Integrating a Computer Into o Simulator Program" by J. R. Forester and O. J. Sullivan, Chance Vought Aircraft, Inc., Dallas, Texos.

(b) "Automation in Post Offices" by M. Levy, Post Office Laboratory, Ottawo, Ontario.

(c) "Community Television System for the Town of Raton, New Mexico" by J. J. Hupert, A. H. Maciszewski, J. J. Pakan and S. W. Torode, A.R.F. Products, Inc., River Forest, Illinois.

(d) "Use of Programmed Electronic Beam to Generate Symbols" by Theodore C. Viars, Signol Corps Eng. Laboratories, Fort Monmouth, New Jersey.

6:00 P.M.—HOSPITALITY HOUR

7:15 P.M.—N.E.C. PARTY IN BAL TABARIN
(Ladies Invited. Dress Informal.)

WEDNESDAY, OCTOBER 5

8:30 A.M.—REGISTRATION
Lobby

9:00 A.M.-9:00 P.M.—EXHIBITS
Displays of electronic equipment, components and new developments.
Entrance on Mezzanine.

WEDNESDAY MORNING—TECHNICAL SESSIONS

17. CIRCUIT THEORY

(a) "A New Approach to the Synthesis of Transversal Filters" by C. R. Ammerman, Pennsylvania State University, University Park, Pennsylvanio.

(b) "The Iterative Solution of Networks of Resistors and Ideal Diodes" by C. A. Desoer, Bell Telephone Labs, Inc., Murray Hill, New Jersey.

(c) "Laploce-Transform Determinotion of Energy Flow in Transient Circuit Analysis" by T. J. Higgins ond K. O. King, University of Wisconsin, Modison, Wisconsin.

(d) "On the Tabulation of Insertion-Loss Low-pass Chain Motrix Coefficients ond Network Element Values" by S. D. Bedrosian, E. L. Luke and H. N. Putschi, Signol Corps Eng. Labs., Fort Monmouth, New Jersey.

18. RADAR AND NAVIGATION

(a) "Statistical Study of the Combined Accuracy of the VOR System and the Arbitrary-Course Navigation Computer" by C. J. Styers, Collins Radio Company, Cedar Rapids, Iowa.

(b) "A Doppler Direction Finder" by R. E. Anderson, General Electric Company, Schenectady, New York.
(c) "A Radio Direction-Finder Bearing Computer and Data-Reduction Unit" by A. D. Bailey, University of Illinois, Urbana, Illinois.
(d) "Precision Interlaced C.R.T. Display" by A. Shulman, Airborne Instruments Laboratory, Inc., Mineola, New York.

19. ULTRASONIC DEVICES AND TECHNIQUES

Program prepared in cooperation with the IRE Professional Group on Ultrasonics Engineering.
(a) "Recent Developments in Ferroelectric Transducer Materials" by D. Berlincourt, Clevite Corporation, Cleveland, Ohio.
(b) "Low-Loss 1000 Microsecond Delay Line" by J. E. May, Jr., Bell Telephone Labs., Whippany, New Jersey.
(c) "Analysis and Application of Magnetostrictive Delay Lines" by J. A. M. Lyon and T. B. Thompson, Northwestern University, Evanston, Illinois.
(d) "Magnetostriction Frequency-Control Units and Oscillator Circuits" by E. A. Roberts, Armour Research Foundation, Illinois Institute of Technology, Chicago, Illinois.
(e) "Techniques in Ultrasonic Soldering" by B. Carlin, Alcar Instruments, Inc., Little Ferry, New Jersey.

20. FERROELECTRIC AND FERROMAGNETIC CIRCUITS

Program prepared in cooperation with the AIEE Dielectric Amplifiers Subcommittee.
(a) "Analysis and Design of the Ferroresonant Trigger Pair" by C. E. Gremer, Naval Post Graduate School, Monterey, California.
(b) "Sub-Miniature Nonlinear Capacitors for Application to VHF Wide-Range Tuning Devices" by H. Diamond, T. W. Butler, Jr. and L. W. Orr, University of Michigan, Ann Arbor, Michigan.
(c) "Pulse Control of a Variable-Frequency Oscillator Using Saturable Reactors" by H. J. Venema, M. F. Schlecht, B. Silverman, General Electric Company, Syracuse, New York.
(d) "A Predetermined Scaler Utilizing Transistors and Magnetic Cores" by R. I. Van Nice and R. C. Lyman, Westinghouse Electric Corporation, East Pittsburgh, Pennsylvania.
(e) "A Highly Reliable Pulse Scaler of Arbitrary Order" by J. R. Horsch, General Electric Company, Syracuse, New York.

12:30 P.M.—LUNCHEON IN THE BAL TABARIN

Luncheon Address: "Uniform Confusion or Diverse Regimentation" by Ernst Weber, Director, Microwave Research Institute.

WEDNESDAY AFTERNOON—TECHNICAL SESSIONS

21. ELECTRONIC CIRCUIT DESIGN

Program prepared in cooperation with the AIEE Subcommittee on Electronic Circuits and Systems Engineering.
(a) "On the Equivalent Circuits of Linear Amplifiers" by L. M. Vallese, Polytechnic Institute of Brooklyn, Brooklyn, New York.
(b) "Design Criteria for Low-Level Second-Harmonic Magnetic Modulators" by E. J. Kletsky, U.S.A.F., L. G. Hanscom Field, Bedford, Massachusetts. Paper to be presented by W. M. Grim, Jr., General Electronic Corp., Cambridge, Mass.
(c) "A Design Method for a Voltage and Current Reference Device Using a Silicon Diode" by D. A. Burt, Westinghouse Electric Corporation, East Pittsburgh, Pennsylvania.
(d) "Optimum Design of Common-Emitter Transistor Audio Amplifiers" by L. M. Vallese, Polytechnic Institute of Brooklyn, Brooklyn, New York.
(e) "Transistor Analog-Computing Amplifiers for Flight Simulators" by R. C. Weyrick, Goodyear Aircraft Corp., Akron, Ohio.

Electronic Conference

(*Continued from page* 118)

22. WAVEGUIDES AND TRANSMISSION LINES

(a) "Electromagnetic Propagation Through Waveguides of Orthogonal Parabolic Cross-Section" by T. V. Higgins and T. P. Tung, University of Wisconsin, Madison, Wisconsin.

(b) "The Physical Realizability of the Sommerfeld Wave on a Cylindrical Conductor" by B. G. King, E. H. Scheibe, and I. Tatsuguchi, University of Wisconsin, Madison, Wisconsin.

(c) "Non uniform Transmission Line as a Matching Section" by R. N. Ghose, Radio Corporation of America, Camden, New Jersey.

(d) "A Traveling-Wave Resonator" by P. Sierrazza, Sperry Gyroscope Company, Great Neck, New York.

23. SERVOMECHANISMS AND CONTROL

(a) "A Comparison of a Contactor Servomechanism with an Average-Power-Constrained Linear Servomechanism" by J. P. Magnin, Schlumberger Corporation, Ridgefield, Connecticut, and J. R. Burnett, Purdue University, Lafayette, Indiana.

(b) "Self-Balancing Magnetic Servo Amplifiers" by W. A. Geyger, U. S. Naval Ordnance Laboratory, Silver Spring, Maryland.

(c) "Stability Boundaries for Fifth-Order Servomechanisms" by H. A. Hogan, A-C Spark Plug Corporation, Milwaukee, Wisconsin, and T. J. Higgins, University of Wisconsin, Madison, Wisconsin.

(d) "Analysis of Feedback Control Systems Containing Carrier-Frequency Circuits" by Julius Tou, University of Pennsylvania, Philadelphia, Pennsylvania.

24. RELIABILITY CONSIDERATIONS IN ELECTRONIC EQUIPMENT

(a) "On the Time-Dependent Reliability of Networks" by G. H. Weiss, Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland.

(b) "The Effects of Temperature on the Characteristics and Reliability of Electron Tubes" by W. S. Bowie, General Electric Company, Owensboro, Kentucky.

(c) "Tube De-Rating in Electronic Systems Subject to Extreme Environmental Conditions" by E. S. Mockus, Raytheon Manufacturing Company, Newtan, Massachusetts.

(d) "Ambient Temperature Effects in New Reliable Voltage-Regulator Tubes" by E. J. Handly, Raytheon Manufacturing Company, Newton, Massachusetts. ■ ■ ■

"Germanium Power Rectifiers"

In the article, "Germanium Power Rectifiers," which appeared in the Aug. 1955 issue of TELE-TECH and Electronic Industries, authorship was credited to Joseph T. Cataldo and Noel Ile. This was a mistake. Noel Iles should have been listed as the sole author.

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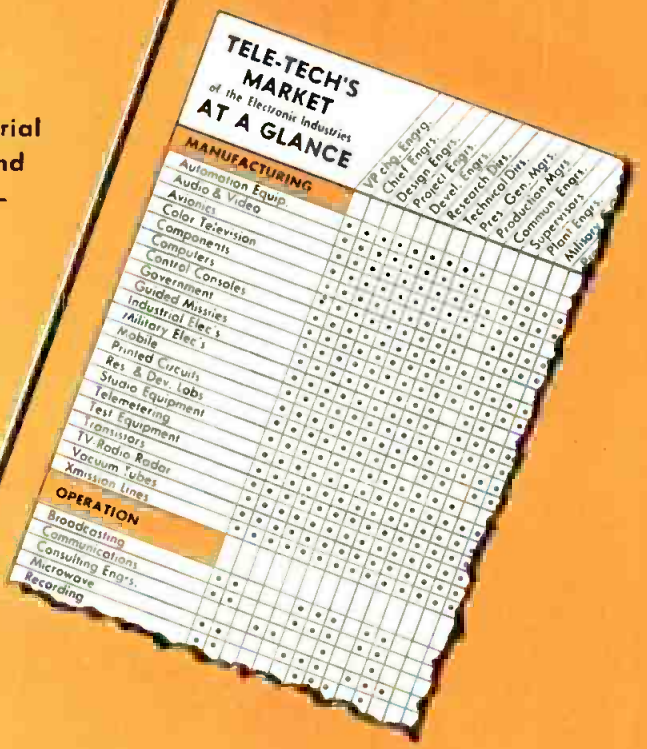

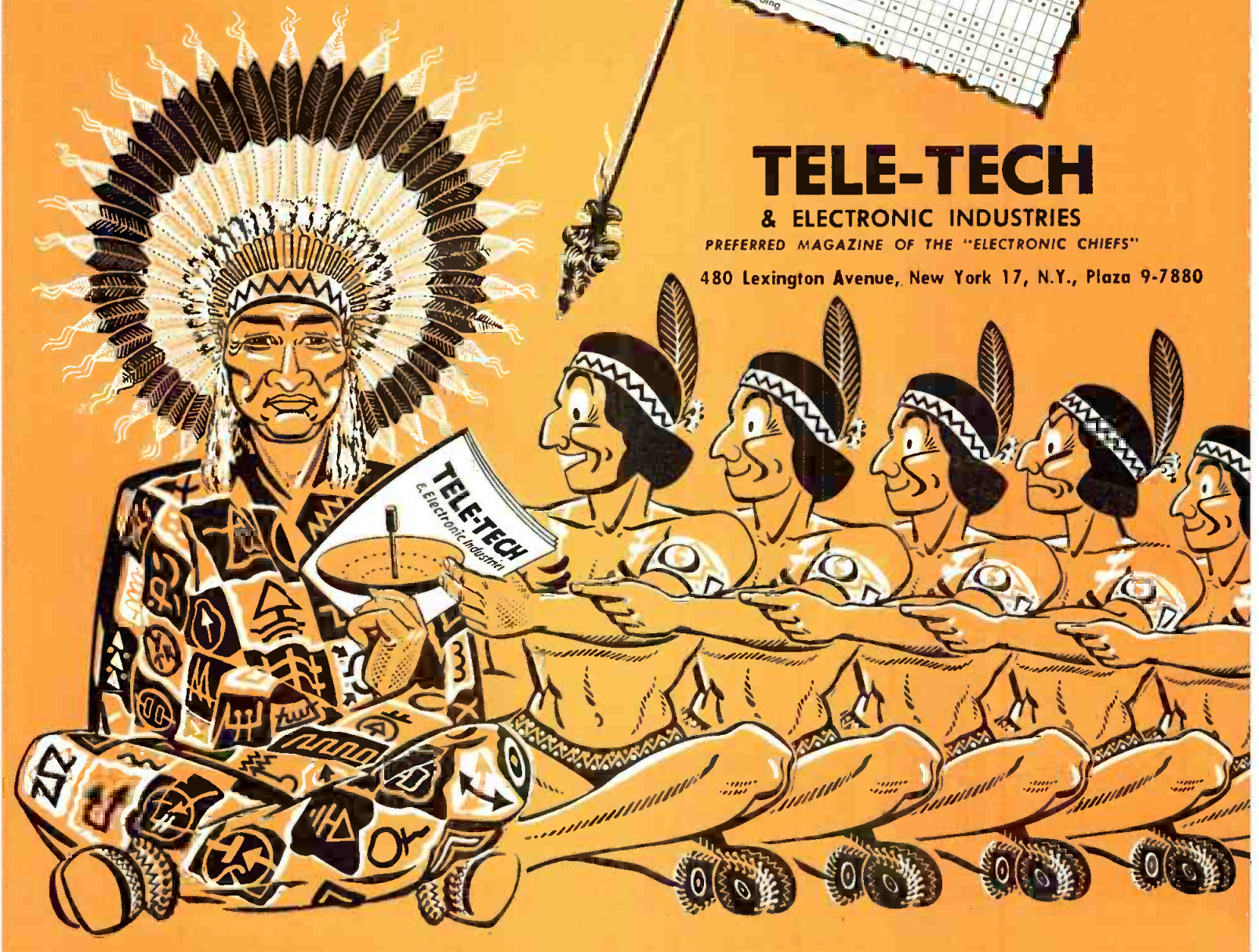

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News of MANUFACTURERS' REPS

Thomas B. Aldrich is now associated with **Leon L. Adelman Co.**, factory representatives. Mr. Aldrich was formerly sales manager of the Presto Recording Corp., Paramus, N. J. Together with Adelman he will set up the Adelman-Aldrich division for conducting industrial operations. Offices will be maintained at 141 Broadway, New York City, and at Palisades, N. J. The firm will cover metropolitan New York, including northern New Jersey.

Kurman Electric Co., 35-18 37th St., Long Island City, N. Y. has added the Are Kay Sales Co., 2600 Grand, Kansas City 8, Mo., and the Wm. Richter Corp., 3 Juniper St., Rochester, N. Y. as sales representatives for its line of relays. The former will cover Arkansas, Oklahoma, Kansas, Iowa, Missouri, southern Illinois and Nebraska; the latter, upper New York State.

William Brand & Co., Inc., manufacturers of turbo plastic insulated wires and cables, and coated and plastic electrical insulating tubing, have announced the appointment of the following sales representatives: **Robert O. Whitesell & Assoc.**, 2208 E. Washington St., Indianapolis 1, Ind., who will service Indiana and Kentucky; **W. E. Fry & Co., Inc.**, 406 W. 34th St., Kansas City 11, Mo., servicing Nebraska, Kansas, Iowa, southern Illinois and western Missouri.

James B. Lansing Sound, Inc., Los Angeles, Calif., has appointed **Wm. J. Peyser**, Colorado Springs, as sales representative covering the Rocky Mountain states.

Chicago Condenser Corp., appointed **M. Clifford Agress**, P. E., 891 Fulton St., Valley Stream, N. Y. as sales representative in the New York and New Jersey metropolitan areas.

The Reeves Instrument Corp. and **G. S. Marshall Co.**, its West Coast representative, presented and demonstrated in the Ambassador Hotel in Los Angeles, the corporation's new 400 series analog computer.

Technology Instrument Corp., Acton, Mass., appointed **Instrument Associates**, 1315 Massachusetts Ave., Arlington, Mass., to handle instrument sales in the New England Territory.

Elgin National Watch Company's electronic division named **Withers & Ropek, Engineers**, 5439 W. Division St., Chicago 5, Ill. sales agents for the **Advance Relay Co.**, an Elgin subsidiary. The representative will cover the Chicago area including Illinois, southern Wisconsin and northern Indiana, concentrating on industrial sales. At the same time the company announced the appointment of **A. H. Bruning Co.**, 2215 W. Wilson Ave., Chicago, Ill., as factory representative in the same midwest areas.

Electronic Engineering Representatives, a group composed of **RMC Associates, Burlingame Associates, G. Curtis Engel, I. E. Robinson and Gawler-Knoop Co.**, has been organized in the Philadelphia-New York area. The group is launching a traveling show at which the products of more than 58 manufacturers of precision electronic instruments and components will be displayed. **Gawler-Knoop Co.**, 178 Eagle Rock Ave., Roseland, N. J. announced that the show will be held at the Roger Smith Hotel, White Plains, N. Y., Oct. 17th; at the Garden City Hotel, Garden City, Long Island, Oct. 19th; West Orange Armory, West Orange, N. J., Oct. 21st; Hotel Sylvania, Philadelphia, Pa., Oct. 25th.

The Pyramid Electric Company, North Bergen, N. J. announced the appointment of **William Meily**, 4017 So. Garrison St., Fort Wayne, Ind., as industrial sales representative in the states of Indiana, Kentucky and Michigan.

Fred Falck, until recently the president of **Advance Electric and Relay Co.**, Burbank, Calif., has organized a manufacturers' representative business at 404 Bank of America Bldg., Glendale, Calif. The new company will handle industrial sales of electronic components and sub-components in Southern Calif. and Arizona.

Gerald L. ("Jerry") Carlson has joined **George E. Harris & Co., Inc., Sales and Engineering Representatives**, and will be working out of the Wichita (Kans.) headquarters at 1734 North Hillside. Among other lines represented, Harris handles powder-iron cores, steatite and allied products for **Henry L. Crowley & Co., Inc.**, West Orange, N. J.

Price Electric Corporation, Frederick, Md., manufacturer of the "Husky" relays and controls, has announced the recent appointment of Paul R. Sturgeon, Inc. as Sales Representative for the New England area. Main office of the new "Husky" representative is located at 25 Huntington Avenue, Boston 16, Mass. A branch office is maintained at 2½ Broad Street, Milford, Conn.

Anechoic Chamber

(*Continued from page 88*)

mounts, each one rated to support 625 pounds. The ceiling was suspended from the main room ceiling, free of structural attachment to the walls, by 148 units, each designed to hold 300 lbs. per mount. The free height of the mounts was 4 in. and under loading left a top and bottom clearance of 3¼ in. of space, between the anechoic chamber and the floor and ceiling of the containing room. The mounts were positioned equidistant from each other and in such a manner as to lessen the possibility of severe bending stresses on the floor foundation. The mass of the chamber in suspension, provided a large natural inertia against lateral movement; while the mounts were stable with equal spring stiffness in all directions. The possibility of structural "creep" was ruled out effectively. To provide absolute protection against the full range of disturbing frequencies, the mounts were designed and tested for a natural frequency of 4-5 CPS. This made the total system a very low frequency mounting ideal for filtering out high as well as low frequency and sonic disturbances that could be detected by the sense of feel. ■ ■ ■

Gas Diode Voltage

(*Continued from Page 67*)

long as not too much current is drawn by a single or a few tubes. To prevent such an overload, a power supply with poor regulation was used to operate both tubes and relays. A high current load automatically lowered the duty cycle and the pulse voltage. Such protection was especially convenient when the sputtered cathode material formd a conducting path between the electrodes of a tube. In this case the poor regulation of the power supply permitted the path to be evaporated open again without damage to tubes or equipment.

Indications are that the improvement over the usual characteristics of the NE-2 or NE-51 is probably due to coating the glass with material sputtered from the cathode. This coating acts as a selective getter, purifying the gas in the tube, and as a bulb coating which prevents the release of oxygen from the glass itself. It is to be hoped that sufficient stability for the circuits in which visual indication is required may be obtained with a partial coating. ■ ■ ■

Quantizer

(*Continued from page 75*)

Cathode Follower Driven by Decay Circuit, V_3b: A cathode follower isolates the exponential decay from the amplifier grid circuit. This prevents loading of the decay network by shunt resistance and Miller capacitance.

Two Stage Amplifier, V_5: The output of V_3b is direct coupled to a two stage amplifier consisting of direct coupled 2C51 triodes. Potentiometer R2 sets the grid bias of the first stage for maximum amplification at the threshold level. A germanium diode prevents grid current flow in the first amplifier stage and overloading of the cathode follower output when the output of the decay circuit is large. Potentiometer R3 adjusts the grid bias of the second amplifier and thereby controls the comparison level the following amplitude comparator.

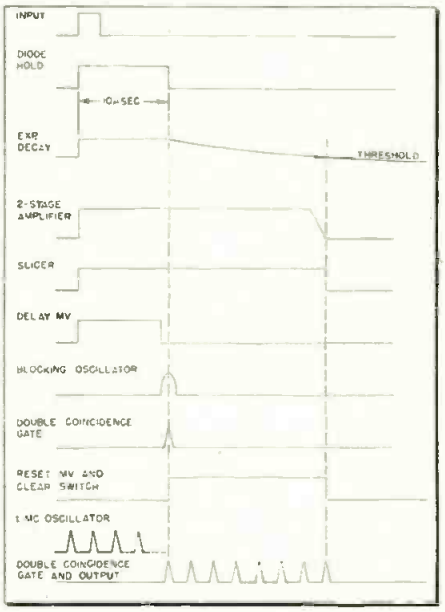


Fig. 6: Timing logic of voltage quantizer

Amplitude Comparator, V_6: The amplitude comparator is a conventional Schmidt circuit. It is turned on when the input to the RC network exceeds the comparator threshold and is turned off when the exponential voltage decays below the threshold. Because of the high gain amplifier which drives it, the comparator hysteresis has negligible effect on the overall performance of the quantizer.

The comparator output pulse is differentiated and the leading edge pulse used to trigger a delay multivibrator. The trailing edge pulse is used to trigger off the reset flip-flop.

Delay Multivibrator, V_7, and Blocking Oscillator, V_8: The delay MV is a one shot, 12AT7 multivibra-

tor with a quasi-stable state of approximately 10 μsec. The trailing edge of the pulse is differentiated in a pulse transformer and used to trigger a 2 μsec 12AT7 blocking oscillator. The blocking oscillator output pulse is fed to the control grid of the 6AS6 double coincidence gate. The delay period is arbitrary in length. It permits the input sample

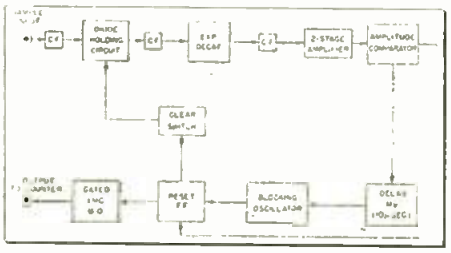


Fig. 7: Block diagram of improved quantizer

to reach its maximum before quantization begins.

One Megacycle Oscillator, V_{11}: Accurately spaced .1 μsec pulses are obtained from a one megacycle free running electron coupled oscillator. A 6CL6 pentode is operated as a Class C Hartley oscillator. Negative output pulses are derived from the plate. These are inverted in a pulse transformer. The pulses are then fed into the 6AS6 double coincidence gates.

Double Coincidence Gate, V_{10}: This is a gate which passes the one megacycle pulse when there is coincidence between one of these pulses and the blocking oscillator pulse. The output pulse triggers the rest flip-flop on.

Reset Flip-Flop, V_9, and Clear Switch, V_{13}. The reset flip-flop is a long duration one shot 12AT7 multivibrator. The output pulse drives the normally cutoff 2C51 clear switch into conduction, discharging the diode holding capacitor and starting the exponential decay. The output gate pulse is also supplied to the output 6AS6 double coincidence gate.

Double Coincidence Output Gate, V_{12}: This is another 6AS6 gate which passes the 1-MC pulses which occur at the same time as the reset flip-flop pulse. These two are in coincidence during the time that the exponential is above the preset threshold. The output pulses are 30 v in amplitude and of .1 μsec duration.

Timing Logic

Idealized waveforms of the quantizer are shown in Fig. 6 illustrating the timing logic of the quantizer.

In all pulse circuits timing will be affected by unavoidable delays in pulse transmission. In the quantizer there is a delay between the "on" triggering of the reset flip-flop

Quantizer

(*Continued from p. 125*)

and the start of the exponential decay. There is also a delay between the time the exponential decay falls through the threshold level and the

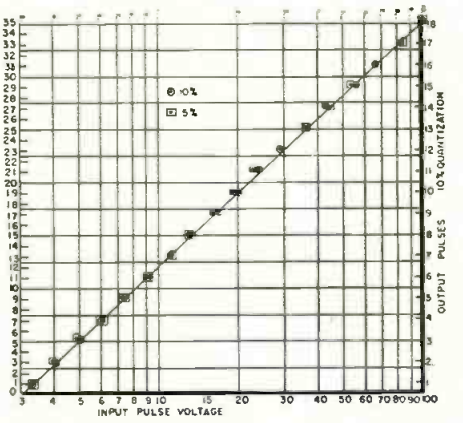


Fig. 8: Experimental transition voltages plotted against number of output pulses

"off" triggering of the reset flip-flop. These delays are constant regardless of the magnitude of the voltage sample. Because of the nature of the exponential decay, the delays are equivalent only to a change in the threshold level. Their effect can be completely eliminated by a simple adjustment of the threshold level. Delay lines are not necessary.

A more recent, somewhat simpler, version of the quantizer is shown in block diagram form in Fig. 7. Its feature is a gated 1-MC blocking-oscillator which eliminates the need for the coincidence circuits. The timing logic is the same.

Experimental Results

The quantizer was tested with one microsecond inout pulses at a two kilocycle PRF. (Fig. 8) Adjustments are made in three steps. First, the input pulse is set at 3.3 v amplitude and R2 is adjusted until one pulse is observed at the output. The input pulse is then set at 100 v. With switch S_1 in the 10% position, trimmer condenser C_1 is adjusted until 18 output pulses are observed. Then with S_1 in the 5% position, trimmer C_2 is adjusted until 35 output pulses are observed. For proper logarithmic quantization, it was found that R_1 should be set so that the voltage at the output of the holding circuit cathode follower is — .75 v.

The volage increment corresponding to each quantization interval is determined by measuring the change in input voltage at which the number of output pulses changes by one. Fig. 9 shows the theoretical transition voltages for 5% and 10% quantiza-

tion. Results of typical runs at 5% and 10% quantization settings are shown in Fig. 8. The straight line passes through the theoretical quantization voltages. The odd numbered 5% quantization levels correspond to the 10% quantization levels. The experimental points for these levels only are shown.

The overall accuracy of the quantizer as present is 12% for the nominal 10% range and 7% for the nominal 5% range. This has been caused principally by the difficulty of obtaining linearity in the cathode follower stages over the wide range of input sample voltages.

Drift in the transition voltages is negligible.

Applications

Any quantity which can be converted into an analog voltage can be quantized logarithmically.

In its present application the quantizer is used to measure to 5% accuracy the time interval between two successive pulses whose separation may vary between 1 and 27,000

TRANSITION VOLTAGE	NUMBER OF PULSES	
	5% QUANT.	10% QUANT.
3.33	1	1
3.68	2	
4.07	3	2
4.50	4	
4.97	5	3
5.49	6	
6.07	7	4
6.71	8	
7.41	9	5
8.19	10	
9.05	11	6
10.0	12	
11.1	13	7
12.2	14	
13.5	15	8
14.9	16	
16.5	17	9
18.2	18	
20.1	19	10
22.2	20	
24.6	21	11
27.2	22	
30.1	23	12
33.3	24	
36.8	25	13
40.6	26	
44.9	27	14
49.6	28	
54.8	29	15
60.6	30	
67.0	31	16
74.1	32	
81.9	33	17
90.5	34	
100.0	35	18

Fig. 9: Theoretical transition voltages

μsecs. Three linear sweeps 1-30 μsecs, 30-900 μsecs, 900-2700 are generated in sequence. Each range is quantized into 32 levels. The first pulse starts the sequence operation; the second pulse terminates the sweep and starts the quantization. When the sweep switches to the next higher range, 32 counts are read into the counter which measures pulse separation.

Multiplication of any two quanti-

Quantizer

(*Continued from p. 127*)

ties expressible as analog voltages is performed by logarithmic quantization of the inputs and their addition in a counter. The sum is the logarithm of the product of the two quantities. Division is performed by subtraction of the logarithms. In this connection it should be noted that the quantizer takes the logarithm of the ratio E/E_T. Therefore, in multiplication of E_a and E_b

$$\log \frac{E_a}{E_T} + \log \frac{E_b}{E_T} = \log \frac{E_a E_b}{E_T^2} \quad (24)$$

and in division

$$\log \frac{E_a}{E_T} - \log \frac{E_b}{E_T} = \log \frac{E_a}{E_b} \quad (25)$$

If E_T is made equal to ϵ in the design of the quantizer, multiplication of E_a and E_b yields

$$\log \frac{E_a}{\epsilon} + \log \frac{E_b}{\epsilon} = \log E_a E_b - 2 \quad (26)$$

If E_T is made 1,

$$\log \frac{E_a}{1} + \log \frac{E_b}{1} = \log E_a E_b \quad (27)$$

The quantizer will permit measureple and code a complex wave. Sampling is performed by synchronizing the quantizer at evenly spaced intervals equal to one over twice the signal bandwidth. The quantization accuracy, range, and timing interval determine the upper limit on the bandwidth of the signal which the quantizer can handle, as shown in Eq. (23) where F′ is twice the bandwidth of the sampled signal.

The quantizer wil permit measurement of amplitudes of pulses whose durations are as short as one-half μsec. Repetitive pulse trains are not necessary since only a single pulse is used for the measurement. ■ ■ ■

Presented at Wescon, 1954.

Engineer Openings

A U. S. Civil Service examination for Electronic Engineer has been announced for filling positions paying $4,345 and $4,930 a year at the McClellan Air Force Base in Calif.

No written test is required to qualify, applicants must show appropriate education or experience, or a combination of such education and experience. Applications will be accepted until further notice and must be filed with the Board of U. S. Civil Service Examiners, McClellan Air Force Base, McClellan, Calif.

Cardioid Microphone

(*Continued from p. 72*)

the rear for all frequencies together with a flat frequency response, the front to back distance must be small and the impedance of the mechanical system must be proportional to frequency. Because the distance from front to back must be small for good cancellation, the phase shift at low frequencies is small, giving rise to proximity effect. Because the impedance of the mechanical system must be proportional to frequency, the impedance and force are small at low frequencies, giving rise to the objectionable shock features. The user of the conventional cardioid microphone must, therefore, accept the disadvantages of proximity effect and shock susceptibility to obtain flat response and good cancellation.

Phase Shifts

These disadvantages can be eliminated if several changes are made. As shown in Fig. 3, if the phase shifts due to the space change and the resistance-capacitance network are held constant with respect to frequency, then the resultant pressure on the diaphragm will also be constant with frequency. More simply, if the front to back distance and the acoustical resistance and volume varies such as to subtend equal parts of a wavelength regardless of frequency, then the resultant pressure will be independent of frequency.

If the pressure can now be made independent of frequency, the mechanical impedance of the system must also be made independent of frequency in order to keep the response flat (Eq. 4). As a result, at low frequencies the impedance and pressure are no longer small and susceptibility to mechanical shock is reduced. Since the phase shift is constant regardless of frequency, the shift at the low end of the spectrum is no longer small and proximity effect is eliminated. All compromise is eliminated if the phase shift due to the front to back distance and the acoustical network is constant with frequency. This is effectively accomplished in the new cardioid dynamic microphones employing the Variable D principle.

As shown in Fig. 10, three distinct rear entrances, instead of the single rear entrance as previously described, are employed. A different acoustical filter is placed in each of the rear sound channels with pass

Cardioid Microphone

(*Continued from p. 129*)

sult of this arrangement is for frequency f_1 the distance from front to back (D) is long, for f_3 the D is shorter and for f_5 it is shorter still. This condition approaches the desired result:

$$D \text{ proportional to } \frac{1}{f}. \qquad (5)$$

However, as is indicated in Fig. 11 for an intermediate frequency f_2, some sound enters the low-frequency hole and some enters the mid-frequency hole. The resultant sound pressure at the rear of the diaphragm would be the sum of the two sound pressures as shown in Fig. 12. Since in this case the pressures at each of the two entrances are equivalent, the phase of the resultant pressure is shifted to a point midway between the two. It appears, therefore, as if the entrance for the resultant pressure is midway between the low and mid-frequency entrances. Similarly, frequency f_4 would appear to have an entrance midway between the mid-frequency entrance and the high frequency entrance. Each discrete frequency, therefore, seems to have a discrete place of entry along the microphone which makes

$$D \text{ proportional to } \frac{1}{f}. \qquad (6)$$

Constant Phase Shift

With D inversely proportional to frequency, the phase shift due to the front-back distance is constant with frequency which is one of the desired goals.

Similarly, the acoustical network phase shift can be held constant with frequency. An acoustic resistance is placed at the entrance of each of the three openings. The resistance at the low frequency opening is of such a value that the phase shift caused by this resistance plus the effective capacitance that the sound of frequency f_1 encounters in the system is equivalent to the space shift due to the distance between the low frequency opening and the front of the diaphragm. Similarly the value of resistance for the mid-frequency entrance results in an equivalent phase shift for frequency f_3, since f_3 enters the mid-frequency opening only. This is repeated, of course, for the high frequency entrance. Thus, this condition approaches the desired result in which the acoustical phase shift equals a constant. For frequency f_2

in Fig. 11, equal amounts of sound energy enter the low and mid-frequency entrances. As indicated in Fig. 12, the resultant sound pressure is shifted from the sound pressure entering the rear hole in exactly the same manner as was described for the space shifts, frequency f_2 acting as if it entered an entrance midway between the two entrances. This accomplishes the second goal of having the acoustical phase shift independent of frequency. Therefore, a microphone has been produced having both a flat response and good cancellation while simultaneously eliminating proximity effect and susceptibility to mechanical shock.

If, as shown in Fig. 9, the phase shift through both the space and acoustical networks is equal to 60°, then the maximum difference in resultant pressure for a distance source is ab. For a close source, the maximum difference in pressure is cd. It can be seen that ab approximately equals cd; but if the phase shift is small (which it is at low frequencies), the resultant pressure is $a'b'$ for a distant source and $c'd'$ for a close source. Clearly, $c'd'$ is much greater in magnitude than $a'b'$, indicating that an increase in bass response occurs when the source is moved close to the microphone only if the phase shift is small.

Compromises

To reiterate, in the development of present day cardioid microphones certain compromises must be made. To produce good cancellation from the rear for all frequencies together with a flat frequency response, the front to back distance must be small and the impedance of the mechanical system must be proportional to frequency. Because the distance from front to back must be small for good cancellation, the phase shift at low frequencies is small, giving rise to proximity effect. Because the impedance of the mechanical system must be proportional to frequency, the impedance and force are small at low frequencies, giving rise to the objectional shock features. The user of the conventional cardioid microphone must, therefore, accept the disadvantages of proximity effect and shock susceptibility to obtain flat response and good cancellation.

These disadvantages can be eliminated if several changes are made. As shown in Fig. 3, if the phase shifts due to the space change and the resistance-capacitance network are held constant with respect to frequency, then the resultant pres-

Cardioid Microphone

(*Continued from page* 131)

sure is used to vibrate the diaphragm-voice coil assembly. This, of course, provides useful output. Part of the incoming pressure, however, is used in vibrating the relatively stiff air in the small cavity under the diaphragm. The resultant pressure on the diaphragm is, therefore, reduced. This phenomenon is a problem at low frequencies only since the pressure used in vibrating the small cavity decreases with frequency. To relieve this situation and improve the bass response, cavity (10) is coupled to the small cavity by means of a small diameter hole through the microphone head. At low frequencies, therefore, the cavity is effectively large while as the frequency increases the small diameter hole decouples cavity (10); the "inertance" of the hole—analogous to electrical inductance—has an impedance which is high at high frequencies. Therefore, effectively, the cavity under the diaphragm reaches its original size for high frequencies. Thus cavity (10) solved the problem and conveniently provided space for the transformer and leads.

Standard Features

The cutaway view in Fig. 2 reveals many of the standard features used to improve modern microphone design. The wind screen (1) serves as a blast filter placing a high resistance in the path of sudden gusts of "wind" encountered when a microphone swings on a boom. Number (2) is known as a grill retainer and serves a dual purpose. First, it is a clamp holding the microphone head securely in the case. Secondly, its shape is carefully designed so that it acts as a "resonator" together with the volume (3) between it and the diaphragm to increase the high frequency response. Number (4) is the magnetic assembly providing a strong magnetic field for increased efficiency. As shown in Eq. 4, for the output voltage to be high, the flux density B must be high. The voice coil and diaphragm assembly is indicated by (5). Number (11) is a stepup transformer matching the relatively low voice coil impedance to 50, 200 and 25,000 ohm output.

The low frequency entrance is shown at (9) while the mid-frequency entrance is indicated by (6). Number (8) indicates tightly fitting discs of felt with a small hole through the center. These act ana-

logously to inductances, limiting the transmission of sound from entrance 9 to low frequencies. Number (7) is a heavier disc of felt without a center hole. This is part of the resistance in the resistance-capacitance network for the low frequency entrance. Across the mid-frequency hole is stretched a small section of vinylite, acting as part of a band-pass filter for the middle frequency range. Number (12) indicates the high frequency entrance; there is a similar one on the other side of the microphone.

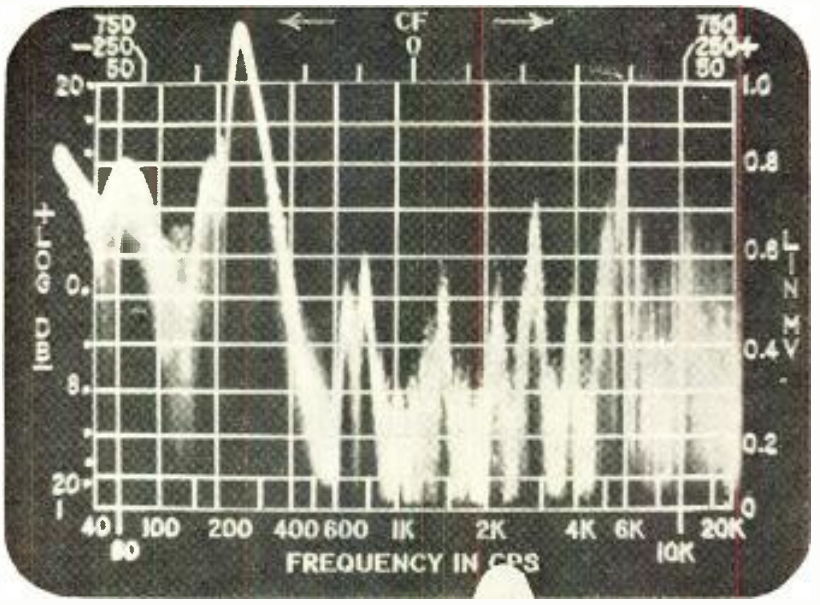
In Fig. 13 is shown the actual response curve of the Model 664 together with its response 180° off the axis. The excellent cancellation qualities shown make it ideal for both broadcast and public address work. All sound not originating in front of the microphone diaphragm is effectively reduced. The microphone can be placed some distance from the sound source since reverberation is drastically decreased. Or simply, the Model 664 is ideal wherever a cardioid or unidirectional pattern is desired over a wide frequency range.

Spectrum Analyzer

(*Continued from page* 81)

the analyzer input is a single line which is horizontal within the flatness of the system, better than ±1 db. When a device such as a filter or amplifier is interposed, a quite unique response tracer is obtained.

The interesting properties are obtained solely because of the conversion of the sweep generator output to a single frequency, the i-f in the analyzer as compared to the conventional wide-band or detected oscillographic indicator. The i-f selectivity assures response to fundamentals only down to very low audio. Thus, in high-pass or stop-band filters, the degree of attenuation is accurately indicated despite residual generator harmonics, which would tend to mask deep valleys in wide open systems. Similarly, hum and noise which may be picked up in the tested device are effectively discriminated against. Sixty CPS. power line frequency which often is present in amplifier outputs is seen merely as a bobble on the response curve only at 60 CPS. on the frequency axis. In measurements involving the total response of a highly distorting network, the oscilloscopic indication must be used, however.



Analysis of vibration resonances of a small motor. Actual analysis time 10 seconds.

Spectrum Analyzer

(*Continued from page* 133)

Presence of the i-f filter simplifies the problems associated with the single line plot and the logarithmic vertical deflection amplifier. In a conventional sweep generator a 40 to 20,000 CPS. logarithmic scale with a detected response would entail either a very slow sweep rate or synchronous variation of the detector time constant. Provision would have to be made for adequate slope response times at the high frequency end while maintaining a sufficiently large RC product to keep the dc output uniform at 40 CPS. In the current instrument the detector sees only 100 KC envelopes so that its design is not critical. Similarly, the logarithmic AVC action, described in the analyzer paragraphs, provides an equally convenient vertical decibel calibration for reading relative responses directly. This system is superior to the conventional logarithmic amplifier using compression diodes because of its more perfect resulting calibration and higher sensitivity.

Curve Tracer Operation

When the instrument operates as a curve tracer, somewhat different criteria for optimum i-f filter characteristics apply. Here again, the sweep speed is limited by the transient delay in the tuned circuitry. Excessive rates of scan through the critical regions of selective circuits result in horizontal translation of the response curve in the direction of the crt beam sweep, distortion of slopes, and incorrect readings for attenuation maxima and minima. The requirement for rapid response plotting is usually not as important as in spectrum analysis but a good pictorial display and rapid indication of the effects of re-tuning the tested device are very desirable. When networks which are much more selective than the analyzer i-f filter are tested it is apparent that their response times are the controlling element. In other cases, the maximum df/dt for a non-distorted plot is a function of the Q of the i-f. Ideally, the analyzer filter would be as broad as possible consistent with adequate harmonic attenuation on the high end plus hum and local oscillator rejection at the low frequencies. On the broad 40 to 20,000 CPS. logarithmic scan, the analyzer i-f is continuously made more selective as the low audio end is approached as described by Eq. 13. The sense of the variation is proper for

the sweep generator application but, especially at the higher frequencies, the filter is more selective than normally required. However, with the one second scan period, most audio devices are broadly enough tuned so that the db./sec. variation required is well within the capability of the i-f so that a desired static characteristic is obtained. When highly selective filters are tested, the linear sweep widths of 1500, 500 and 100 cps. may be conveniently employed. An auxiliary triangular wave generator has been developed to provide a symmetrical bidirectional time base with variable period for the linear deviation scales. Any value from 60 to 0.05 sweeps/second may be selected. The operational procedure involves starting with a high rate of scan and slowly decreasing it until the traces due to the forward and reverse sweeps superimpose on the cathode-ray tube screen. This condition corresponds to the fastest writing rate consistent with negligible phase delay. ■ ■ ■

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Patent Adviser Exam

The U. S. Civil Service Commission is holding an examination for Patent Adviser (Electronics) for filling positions at the Signal Patent Agency, Fort Monmouth, New Jersey. The salaries range from $3,670 to $7,570 a year.

No written test will be given. All applicants must have had appropriate education or technical or scientific experience in the field of electrical engineering or physics. In addition, for the higher grade positions, professional experience in patent work in electronics is required.

Further information and application forms may be obtained at many post offices throughout the country, or from the U. S. Civil Service Commission, Washington 25, D. C. Applications will be accepted by the Board of U. S. Civil Service Examiners, Fort Monmouth, N. J.

Time Measurement

(*Continued from page 69*)

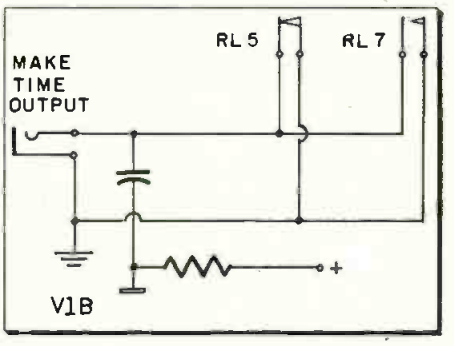

Fig. 8: Control ckt of make time output

on the make time counter. Switch S8 resets the step selector and operates RL9 which resets the electronic counters.

The set is used for obtaining statistical data on time variations of contacts caused by repeated operations, changed atmospheric conditions, or product design changes. For further interpretation, the data were not required. If other than 0.0001 sec. increments are desired, the frequency should be changed in integer powers of ten to facilitate the reading of time directly on the counters.

To simulate actual operating conditions the set applies a load current to the contacts under test. Normal circuit operation will be maintained for load currents of from a few microamperes to several amperes.

The pulse range of the set is from zero to 24 pulses/sec. An upper limit is imposed by the step selector and the pull-up time of the circuit selection relays. This limit can be extended to 50 pulses/sec with presently available relays and step selectors. Beyond this, electronic switching would be advantageous.

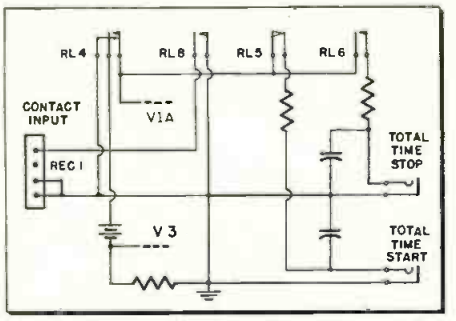

Fig. 9: Ckt of total time pulse control relays

The range of contact make, break, delay, and total times is from 0.0001 to 9.9999 ± 0.0001 secs excluding the accuracy of the timing frequency. A higher frequency may be used for timing, but due to the me-

chanical limitations of the devices tested, additional significant figures were not required.

While the set was designed primarily for telephone dial measurements, other test applications include:

1. Step selectors
2. Ratchet or impulse relays
3. Multiple sequence switching and
4. A sequence of voltage pulses of identical or of varying widths.

■ ■ ■

TACAN

(*Continued from page 66*)

source. This is accomplished by using random noise pulses, fed to the DME transmitter at the rate required.

These random pulses produce no interference with such regular DME replies as are intermixed with them. This type of operation has a further advantage. With the DME beacon always putting out some 3000 pulses/sec, from one source or another, there is provided a medium over which another navigational function can operate. As far as distance information is concerned, it is the timing of the pulses, not their strength (within certain limits) that matters. Variations in strength of the pulses—pulse amplitude modulation—may be used to convey additional information. The TACAN omnirange function, described in the next section, applies this principle (together with some pulse coding) for multiplexing purposes.

Bearing Indication Facility (Omnirange)

Antenna and Wavelength Relations

The TACAN omnirange operates in the UHF (1000 mc) region, which makes it practical to incorporate a number of advantageous features. The heart of any omnirange is the ground beacon antenna system. This must produce a specified directional radiation pattern, and somehow this pattern must be rotated or switched around a vertical axis.

For similar radiation patterns, the required physical dimensions of the antenna array depend on the operating radio frequency, or better said, the wavelength. Between the VHF band and UHF TACAN band there is a ten-to-one reduction in wavelength. This fact is substantially reflected in the order of magnitude of the dimensions required for comparably performing VHF and UHF ground beacon antennas. With the 10:1 ratio to play with, there is room to increase the TACAN antenna size

TACAN

(*Continued from page 137*)

considerably, in terms of wavelength, for superior performance, and still have a quite small antenna.

In a TACAN antenna installation the extreme diameter, that of the cylindrically shaped protective cover, is approximately 3½ feet; total height of assembly, including antenna proper and motor drive assembly, is around 7 feet. This assembly contains both coarse and fine omnirange and DME antenna elements. No counterpoise is required. If the TACAN omnirange function were only to comprise a coarse or cardioid system, the extreme diameter would be even smaller—under one foot. The internal arrangement and operation of the TACAN antenna elements are described next.

TACAN Antenna and Coarse Omnirange

Fig. 4 illustrates (not to scale) the arrangement of the TACAN ground beacon antenna, in plan and perspective views. The only portion of it which is fed with r-f energy from the transmitter is the central element, shown here as a vertical rod. This is stationary and has no directional effects in the horizontal plane. Actually, by itself, it is the regulation TACAN DME antenna, which is a vertical stack of discone radiator; diameter is a few inches.

Around this is an inner cylinder of insulating material (Fiberglas) with a diameter about 5". Attached to or embedded in this cylinder is a vertical metal wire which is completely isolated. It acts as a parasitic antenna, or reflector, since it intercepts some of the energy radiated towards it by the central element, and re-radiates it. Its distance from the central element is figured, in terms of wavelengths, so that it has the effect of distorting the original circular pattern of the central element into a cardioid. This is plotted at (A) in Fig. 5. The cardioid pattern is bodily rotated by means of mechanical rotation of the inner cylinder. Since no energy is fed from the transmitter to the rotating wire, no sliding contacts are required. The rotation rate is 15 rotations per second. Physically, the cylinder is supported by bearings at top and bottom.

As a result of the rotation of the cardioid pattern, the signal received along any given direction from the beacon goes through corresponding cyclic variations in strength as a function of time—similar to what an airborne receiver would experience if it were flown around a stationary

cardioid pattern at 15 orbits/sec. The nature of these variations may be shown by re-plotting the polar coordinate figure in rectangular coordinates, with time replacing direction angle as the variable of interest. Fig. 5 (B) is such a plot: the vertical axis represents signal strength (envelope of r-f) and the horizontal axis represents time. A cardioid thus transformed into rectangular coordinates is simply a sine wave. (For this discussion the d-c component may be neglected.) Since the cardioid is a single lobed pattern, it takes one full turn of the antenna pattern, or 1/15 second, for the received signal to go through one complete cycle of variation, say maximum to minimum to the succeeding maximum. In short, the airplane receives a 15-cps modulation, from which an audio sine wave signal may be extracted by radio detection methods.

In omniranges it is the electrical phase of this audio signal which is important. Referring to the polar plot, Fig. 5 (A), it is clear that if at a given instant of time, the maximum of the lobe points due north, then this maximum will not aim due east until some time later, 1/60 sec to be exact. This is a way of saying that, along progressively clockwise directions around the beacon. the electrical phase of the received 15-cps audio modulation is progressively retarded, in comparison with the phase received due north as a reference. In the particular case of the cardioid, a single lobed pattern, there is a one-to-one correspondence; for each degree of geographical bearing change, there is a one degree change in electrical phase of the 15-cps audio signal. It is only necessary to measure the electrical phase of the received signal, and to use it to position the pointer of a bearing indicator.

For phase measurements, one must have another wave of the same frequency as a fixed reference, received at all directions around the beacon with identical phase. As a standard, its phase might be adjusted so that its maximum occurs at the same instant of time that the maximum of the rotating cardioid lobe aims north. In this case, the airborne electrical phase difference measurement would numerically represent the airplane's geographic bearing, which is conventionally measured clockwise from north.

The purpose and operation of the outer cylinder indicated in Fig. 4 will be described after the following explanation of the way the TACAN omnirange is arranged to operate

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(*Continued from page 139*)

with pulse transmissions instead of CW.

Pulse Operation of TACAN Omnirange

The source of r-f energy to the central element of the antenna is the TACAN DME transmitter. Under constant duty cycle type of operation, explained previously, some 3000 pulses/sec are produced at all times. Some of these may be DME reply pulses, others are more or less random "filler" pulses. Coming to the antenna from the transmitter, they are of absolutely equal amplitude. Their strength however, as radiated from the antenna, is controlled by the shape of the antenna's directional pattern. Considering only the effect of the inner cylinder for the time being, this shape is a cardioid, as plotted at (A) in Fig. 5.

The result is that the airplane receives an amplitude-modulated series of discrete pulses, as shown at (B) in Fig. 5 by the spaced vertical lines plotted on the graph. The envelope of the amplitude of these pulses is indicated by the wavy dashed line. This is a sine wave of 15-cps frequency. The phase of this envelope gives bearing information, just as in the case of a CW system, but this envelope is extracted by a "peak-riding" type of detector, one whose output follows the tops of the pulses.

With a 300-ops average pulse rate, during a 1/15 second modulation period there are some 200 pulses (actually twin pulses). This is a sufficient number so that the output of the peak riding detector is a faithful reproduction of the sine wave corresponding to the pulse envelope. The depth of modulation is intentionally kept well below 100% (somewhere between 12% to 30%) in order to avoid complete nulls in the envelope. This is done to insure that at no time, in no direction, are pulses for DME or other purposes seriously weakened in strength.

All that remains for the phase measurement to be performed is a reference signal. For this purpose, non-directionally radiated pulse signals at the correct time and frequency (15 cps) serve as well as a complete wave. These pulses might be sent out, for example, each instant that the maximum of the rotating cardioid pattern aims due north. The reference signals are distinguished from the regular DME signals, which are actually twin pulses with a certain spacing, by virtue of a different pulse spacing.

The reference signal is illustrated in Fig. 5 (B) by a group of extra close pulses, for the case of an airplane due east. For an airplane at a different bearing, the time of arrival of these pulses, relative to the maximum of the 15-cps pulse envelope, would be different from that shown in the figure.

The reference signal is produced on the ground in this manner: Referring back to Fig. 4 (B), there is an aluminum disk attached integrally to the drive shaft of the rotating cylinder, with a very thin iron slug attached to its periphery, in line with the direction of the maximum of the cardioid pattern lobe. A stationary pick-up coil is mounted close to the periphery of the disk, and is positioned due north from the center of the antenna. Hence, once each turn of the antenna cylinder, at the correct instant, a signal is inductively generated in the pick-up coil. This in turn triggers the DME transmitter into sending out the specially coded reference signal. On the airplane this is separated from the DME pulses by a special pulse decoder, and is then used as the timing reference for the measurement of the phase of the pulse envelope wave.

As far as the operation of the TACAN fine omnirange is concerned, the techniques used for pulse operation are the same, so that the following explanation will be confined to the essential point of the different radiation pattern.

TACAN Fine Omnirange

This is the feature of the TACAN omnirange facility that produces very greatly improved accuracy over any cardioid system. Errors in omniranges arise from two main sources: imperfection of the phase measuring circuits, which have only some finite limit of accuracy; and radio propagation effects known as "site errors." Both types of error may be significantly reduced by means of the technique to be described.

In the case of the TACAN antenna, the necessary increase in size still leaves a quite compact assembly. Referring back to Fig. 4, the inner cylinder has a diameter of only some 5". Now attention is directed to the outer cylinder, which is approximately 33" in diameter. It is constructed of Fiberglas like the inner cylinder, and rotates integrally with it at 15 cps. The outer cylinder however, has nine wires embedded in it, spaced uniformly 40 degrees apart. These wires also are parasitic, nonfed antenna elements, and have an intentional distorting effect on the heretofore considered cardioid pat-

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(*Continued from page* 141)

tern, produced by the central antenna plus inner cylinder wire. The resulting composite pattern is plotted in polar coordinates at (A) in Fig. 6. The over-all cardioid or single lobed variation is still present, and predominant in fact; superimposed on this are nine secondary variations or ripples. The maxima of these ripples, or minor lobes, are spaced 40 degrees apart.

To indicate the nature of the cyclic variations in pulse amplitude received by an airplane at a given bearing, the composite radiation pattern is transformed into rectangular coordinates. In this graph, (B) in Fig. 6, for simplicity sake only the envelope of the pulse amplitudes is shown, since the matter of pulse operation, peak riding detection, etc., has been explained in connection with the coarse system.

This envelope signal has a basic 1/15-second period, as before, because of the predominant fundamental component due to the 15-cps rotation of the inner cylinder. The outer cylinder also makes one complete turn in 1/15 second, but from this cause nine ripples or minor lobes sweep past the airplane. Hence the composite envelope wave also contains a 9th harmonic sine wave component, with a frequency of 15 x 9 or 135 cycles per second. The 135-cps and the 15-cps sine wave components are separable by means of filter circuits, an the electrical phase measurement is performed on each. For this purpose the ground equipment is arranged to transmit appropriately timed and coded 135-cps reference signals, in a manner similar to that explained for the coarse system.

However, in the case of the 135-cps signal the relation between electrical phase and geographic bearing is quite different. Referring to the polar plot, Fig. 6 (A), and directing attention to the nine little ripples, the following is clear: As an airplane progresses through a 40-degree arc of bearing (the angular width of a minor lobe), the phase of the received 135-cps signal will move through one complete cycle, or 360 electrical degrees. In proportion, each degree of bearing change is evidenced by a nine-degree change in the measured electrical quantity, the phase of the 135-cps signal. This gives a pronounced magnifying effect in the process of detecting changes in bearing, hence the name "fine" system.

If the bearing indication were

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(*Continued from page* 143)

given by a pointer which made one dial revolution to indicate 360° of bearing, then the circuits should be arranged to produce a 9 to 1 gearing reduction effect, from the phase measurement to the bearing pointer. One degree of phase shift must produce 1/9-degree of dial movement of the pointer. The practical significance of this follows: Phase measuring circuits necessarily are limited in accuracy. Suppose, for example, that this limit were one degree of phase, either side of the correct value. Then the bearing meter indication resulting from measurement on the coarse TACAN (15 cps) signal would also be correct to within one degree. But the bearing meter indication resulting from phase measurement on the fine TACAN (135 cps) signal would be correct to within 1/9 degree.

By itself, the fine system has a nine-fold bearing ambiguity. From inspection of the polar plot, Fig. 6 (A), it is evident that along any nine directions which are exactly 40 bearing degrees apart, airplanes will see the identical phase as regards the 135-cps signal. A given measurement on this signal would indicate accurately where one was inside of some 40-degree bearing sector, but one could not know which sector was the correct one. This is analogous to the situation in a clock where the fast moving minute hand (fine indicator) by itself tells the exact minute, but past any one of 12 hours; the slow moving hour hand (coarse indicator) by itself reveals the correct hour sector, but only roughly tells the minutes past.

In TACAN the 15-cps phase measurement is used to resolve the ambiguity of the 135-cps phase measurement. For this purpose it has more than enough accuracy to do the job safely. However, the idea of a vernier or clock type bearing indicator with two pointers, where one dial revolution of one pointer corresponds to 360° of bearing, and one dial revolution of the other pointer corresponds to 40° of bearing, is not presently used. Pilots, for convenience and simplicity of interpretation, prefer a conventional 360° bearing dial with one pointer. In the TACAN instrumentation, the 15-cps coarse system phase measurement only initially moves the pointer to within the correct 40-degree bearing sector, and thereafter ensures that it remains in that sector; but the exact positioning of the pointer within that sector is under control of the 135-

cps fine system phase measurement, suitably geared down. The very accurate 135-cps signal bearing information is also available for operation of left-right meters, automatic pilots, computers, etc.

Site Error Considerations

The most troublesome source of errors in omniranges is not instrumental but rather propagational. With reference to Fig. 7 (A), energy reaches the airplane not only along the desired direct path D, but also via an indirect path Q and R. In the illustration the airplane is at a 128° bearing, and along the direct path the cardioid modulation that it receives has a 128° phase. Some large building, prominent hill, etc., which is at a 20° bearing (for illustrative purposes) also intercepts some energy from the beacon, along path Q; this will have a 20° electrical phase. A weak, but sensible portion of this energy may reach the airplane along path R by reflection or re-radiation. This may produce appreciable errors, since the composite signal will have an electrical phase that in general differs from the phase of the desired direct signal, and the airplane receiver can only respond to the composite energy (D + R) that reaches it along all paths.

Since we are dealing with waves, the characteristics of the composite signal (D + R) are determined by vectorial addition, taking into account the phase and the magnitude of the individual signals. In the illustration shown in Fig. 7 (B) it is seen that the composite signal C has a phase which is 18° different from the phase of the desired direct signal. The bearing meter in the coarse omnirange would therefore indicate a geographical bearing which is 18° in error. As the airplane moves about, the geometry of an actual situation changes in a very complex manner; different reflecting objects in different directions may all simultaneously interact with the direct signal. The bearing meter may fluctuate in quite an erratic manner.

To minimize such effects, the ground beacon should ideally be located over very flat terrain, with no large buildings, metal structures, hills, etc., within considerable distance. Such an ideal location cannot often be found, in practical cases; and is far from obtainable on board a ship, with its complicated superstructure. Siting difficulties have always been a bugaboo for omnirange installations, especially in rough terrain.

This type of error is also greatly reduced by use of the nine-lobed, fine omnirange operation of TACAN.

TACAN

The ultimate theoretical improvement is ninefold, for this reason: It may be shown by mathematical analysis, that for objects of the same re-radiating power, in a multilobe system the maximum electrical degrees phase error between direct signal and composite signal is the same as in a single lobe, cardioid system. This is next explained by reference to Fig. 7.

First, it is clear that the difference in phase between direct signal and reflected signal, denoted by the angle $\emptyset$ in Fig. 7 (B), will depend on the particular geometrical configuration of beacon, airplane, and reflecting object. And that for the identical geometrical configuration, this angle $\emptyset$ will be generally different in a cardioid and a multilobed system, because of the different relation between bearing angle and signal phase. But in either system, considering all possible geometrical configurations, the range of all possible sizes of the angle $\emptyset$ is still effectively the same, namely from 0° to 360°, since we are dealing with phase angles. This is indicated in the figure by the dash-line circle, which represents the locus of all possible orientations of the reflected signal vector R compared to the direct signal vector D in either type of system, for a given, and small value (a justifiable assumption in practice) of the reflection coefficient. In some configurations in one system, and other configurations in the other system, the reflected signal vector may fortuitously be aligned along the direct signal vector, and would then produce no error, since the phase of the direct and composite signals would be the same.

It is evident that the largest possible size of the angle ε, which angle is the error in phase between direct and composite signal, occurs when the geometrical configuration is such that at the vertex V in the corresponding vector diagram there exists a right angle. In a cardioid system, the corresponding geometrical configuration might be, as shown in Fig. 7 (A), a 108° relative bearing between airplane and reflecting object; in a nine-lobe system, the geometrical configuration might be a 108°/9 or 12° relative bearing between airplane and reflecting object. But in either system, if the reflected signal R is $\frac{1}{3}$ the magnitude of the direct signal D (for illustrative purposes), the maximum value of angle ε is the same, approximately 18°.

In a cardioid system, this would

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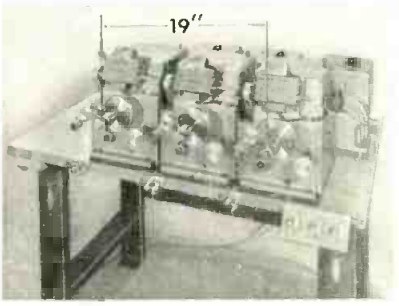

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TACAN

(*Continued from page* 146)

produce a maximum bearing indication error of 18°. But in the nine-lobe system each degree of electrical phase angle of the signal corresponds to 1/9 degree of bearing, hence the fine system maximum bearing indication error would be only 2°. To use the analogy offered previously, suppose that by accident (simulating a site error) one were to displace both the hour and the minute hands of a clock by 90° of dial angle, a full quarter turn. The coarse, or hour hand reading, would be in error by three full hours or 180 minutes of indicated time. The fine, or minute hand reading would be in error by only 15 minutes of indicated time, a twelve-fold smaller time indication error produced from the same mechanical disturbance.

The considerations studied in connection with Fig. 7 show that the bearing indication error produced by a given reflecting object in either a cardioid or a multilobe system may vary from some maximum value down to zero depending on the particular bearing of the airplane. It is significance however, to note that as the airplane flies all around the beacon, some average value of error will be experienced, and that the statistical average error is approximately 64% of the maximum error, in either system. In other words, a multilobe system will accomplish the same percentage reduction in average bearing indication errors as it does in maximum bearing indication errors, compared to a cardioid system. Hence, the site error improvement comes into play not only from the point of view of isolated extreme errors, but also from the more practically important point of view of statistical or average behavior.

The improved "site freedom" of the TACAN omnirange, due to the fine system, is one of its most useful attributes. With the present equipments, which do not exploit the full potential accuracy of the principles used, comparative experimental tests at various locations have shown very substantial reduction in average and extreme bearing errors caused by site effects, as compared to cardioid systems. At sites where a VHF omnirange is practically useless, a TACAN beacon can still give fairly good service. For producing quite accurate bearings, the site requirements are much easier to meet with TACAN than with VHF omniranges.

Vertical Directivity Considerations

In radio systems it is possible to

provide greater range of service without increased transmitter power by concentrating the energy in a desired direction by means of directional antennas. In a point-to-point communication system both horizontal and vertical directivity may be used. In an omnidirectional navigation system, obviously only vertical directivity may be used for this purpose.

Airplanes that are distant from a beacon, even if at a considerable altitude, are located on a line-of-sight that is very close to horizontal with respect to the beacon. For a steeply inclined line-of-sight to exist, the airplane must be quite close to the beacon; in this case signal strength is no problem. The direction of maximum radiation should preferably be slightly "uptilted" above the horizontal; in this manner there is less likelihood of strong energy hitting low lying nearby structures and hills, and thereby producing site errors by re-radiation.

To achieve directivity in the vertical plane, the controlling factor is the vertical height of the antenna, in terms of wavelengths. The 1000-mc DME antennas use this principle to good advantage; with the 100-mc omniranges only moderate use can be made before the physical heights would become impractical. With TACAN operating wholly in the 1000-mc band, both bearing and distance functions make use of considerable vertical pattern directivity, with practical antenna heights. The TACAN antenna central element is a vertical stack of seven biconical radiators ("discones") totaling 48" in height. The uptilt of the direction of major radiation is approximately 5° above the horizon.

System Performance

Complete system errors include instrumental and propagation or site errors, the latter quite variable depending on the location. These are very substantially reduced by the TACAN fine system. The extensive evaluation tests conducted by the Air Navigation Development Board (ANDB) are reported to indicate that over-all equipment and propagation errors average about three to five times greater with VHF omnirange than with TACAN. Average VHF omnirange errors in the field are about 3°, average TACAN omnirange errors are about ¾°.

Distance accuracy is fundamentally limited by the pulse widths used, but in practice depends on the refinement of the time measuring circuits used in particular models of airborne equipment. With present

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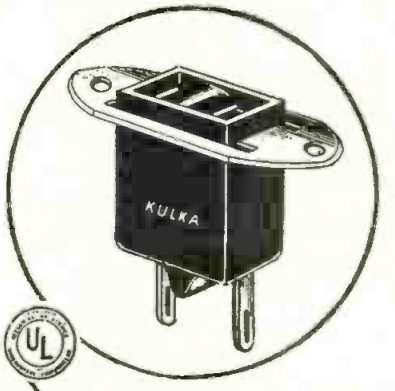

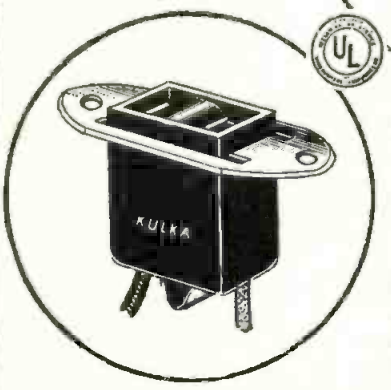

No. 221 (above) with soldering terminals and steel bracket with # 6 clearance mounting holes. Also No. 222 with 6-32 tapped mounting holes. No. 223 (left) with 8" #14 or #16 plastic wire leads and steel bracket with #6 clearance mounting holes. Also No. 224 with 6-32 tapped mounting holes.

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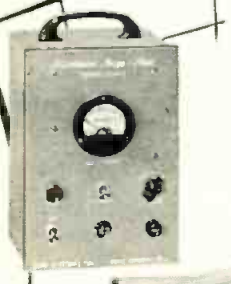

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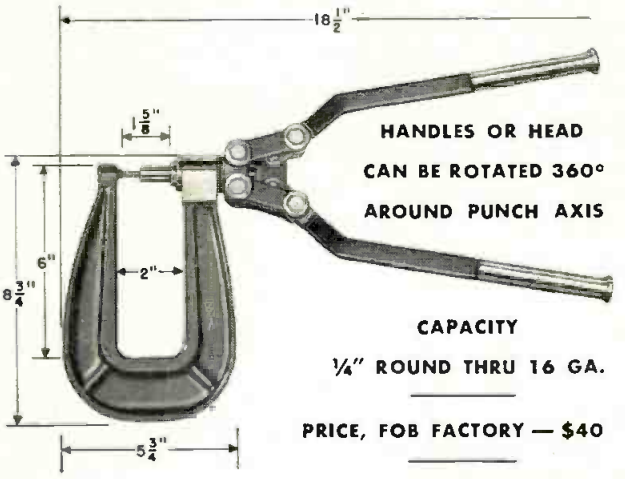

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equipments of DME systems, the errors are of the order of ½ mile at 100-mile range, proportionally less at closer ranges, down to a minimum error of about 0.1 mile.

In VHF and in UHF bands service range is limited not only by transmitter power and receiver sensitivity, but more practically by line-of-sight considerations, as affected by the airplane's altitude. Both the VHF and the TACAN omniranges reach out to 200 miles or more, subject to line-of-sight limitations.

DME service in practice is additionally limited by the built-in maximum "search range" of the strobe circuits and the associated maximum scale of the distance meter. The TACAN DME serves out to 200 miles (nautical) and so matches the range of its associated omnirange function.

Equipment Models

So far, only military specification models of the equipment have been quantity-produced. Under development by FTL for civil use is a less expensive and smaller airborne set for private fliers. It gives bearing and distance, with multichannel service under crystal control, but some of the automatic refinements of the military equipment are lacking. The distance is displayed on a number wheel or Veeder indicator, as in the ARN-21, but bearing indication and channel tuning require some manual control. A preliminary model of this type of equipment has already performed in initial flight tests. Also under development is a civil airlines specification version of an airborne TACAN type DME only. Both of these civil TACAN models will have, in addition, built-in provision for ATC transponder ("radar safety beacon") service.

1955 Transistor Specifications

In this chart, appearing as Section 2 of the Sept. 1955 issue of TELE-TECH and Electronic Industries and listing all the transistors commercially avtilable, the address for General Electric was given as the Tube Division, General Electric Co., Schenectady, N. Y. The company advises that the source should be more correctly listed as: Semiconductor Products Sect., Technical Products Dept., Electronics Division, General Electric Co., Electronics Park, Syracuse, N. Y.

BULLETINS

Resistors

A 20-page catalog covering its encapsulated resistor line has been issued by Cinema Engineering Co. Div. of Aerovox Corp., Burbank, Calif. Dimensional detail, wattage ratings, maximum resistance and military equivalents are described, and both the CE 100, CE 200, PW 100 and PW 200 series are illustrated.

Resistors

Catalog Data Bulletin G-1a giving comprehensive data on construction, specifications, installation, tolerance, voltage coefficient, ratings, insulation and others, on type MV high voltage resistors, 8 pages in all, is offered by International Resistance Co., 401 No. Broad St., Phila., Pa.

Isolator, Ceramic and Ferrites

Raytheon Mfg. Co., Foundry Ave., Waltham, Mass., has available four technical data sheets, one being on the X-Band Isolator, two on the R-22 and TL-20 Ferrites, and one on the R-95 Ceramic. Each data sheet contains a digest of approximate properties.

Crystal Diode

Bulletin E-217, a second edition including germanium and silicon diodes, glass-encased and plastic-encased, is offered by CBS-Hytron, Danvers, Mass. It contains three parts: 1. Construction and advantages. 2. Electrical and mechanical data. 3. Selection and application.

Power and Gas Tubes

The Tube Div. of the Radio Corp. of America, Harrison, N. J., has brought out a completely revised edition of the Power and Gas Tubes booklet. This 24-page booklet (Form No. PG-101B) contains technical data on 178 vacuum power tubes including forced-air cooled tubes and water-cooled tubes. Each tube is covered by a text description, tabular data, and a base or envelope connection diagram. Price 20¢.

Transmission Towers

Bulletin No. 2509 is available upon request from the Structural and Tower Dept., Blaw-Knox Co., Pitts., Pa., describing body and leg extensions to both double and single circuit towers, in order to obtain desired height.

Miniature Tubes

A 12-page booklet describing the General Electric Tube Dept.'s "Operation Snow White" is available from the regional equipment sales offices in Chicago, Los Angeles and Clifton, N. J. The booklet illustrates the successful lint and dust control process employed by G.E.'s receiving tube sub-department in the manufacture of the company's "Five-Star" line of high reliability miniature and sub-miniature tubes.

Parabolic Antennas

A two-color 14-page bulletin describing parabolic antennas used for radio and television microwave relay has been announced by Prodelin Inc., 307 Bergen Ave., Kearny, N. J. Antennas described are of the mesh-reflector, dipole-feed type in 4, 6, and 10 foot sizes.

Laboratory Instruments

Frequency meters and extenders, universal counters and timers, digital recorders and data converters, preset counter controllers, double pulse generators, and electronic analog simulating equipment are described in short form Catalog C-701, released by Berkeley Div. of Beckman Instruments, Inc., 2200 Wright Ave., Richmond, Calif.

Proximity Meter

The Fielden Instrument Div. of Robertshaw Fulton Controls Co., 2920 No. 4th St., Phila., Pa., is offering free a 28-page booklet describing the proximity meter, a precision electronic instrument that measures without touching the specimen. The booklet is aimed at helping industry and research installations find solutions to a wide variety of problems in precision measurement.

TELE-TECH ADVERTISERS — OCTOBER, 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

Robert S. Butts, formerly associated with Crosley Radio Corp. and Federal Tel. Labs and a member of the IRE, has been promoted to the position of Ass't Chief Engineer of Melpar, Inc., Falls Church, Va. Robert E. Miller, also with Melpar, has been promoted to Project Mgr. of a group of sections dealing with research and development resulting in complete systems for the Armed Services.

R. S. Butts

A. B. Essex

Alois Berny Essex was recently appointed Administrative Engineer of Ford Instrument Co., Div. of Sperry Rand Corp., 31-10 Thomson Ave., L. I. C., N. Y. Mr. Essex is holder of eight patents for inventions that added punch to the nation's guided missile and anti-aircraft gun defenses.

H. T. Sterling, president of Waveforms, Inc., N. Y. C., has appointed **Dr. D. B. St. Clair,** formerly with Freed Electronics and Control Corp., as Director of Research. Dr. St. Clair will be responsible for the company's contract research program, and instrument development.

Charles W. Barbour, formerly ass't chief engineer with Teletronics Lab. of L. Island, N. Y., was recently added to the staff of Phebco, Inc., 3640 Woodland Ave., Baltimore, Md., as Vice-President for Engineering.

Philip Chamberlain, formerly Senior Design engineer at Phaostron Co., 151 Pasadena Avenue, South Pasadena, California, has been named Chief Engineer.

Rudolph F. Gagg has been named group executive staff engineer for the eastern divisions of Bendix Aviation Corp.

Bert Solomon has joined the staff of Cinema Engineering Div. of Aerovox Corp., at Burbank, Calif., as an electronic engineer, according to **Frank Churchill,** manager of the product engineering section.

Robert C. Puydak, Houchang Handjani, Gerald J. B. Crawford, and **Bernhard J. Bastian** have joined the staff of the Edison Research Laboratory of Thomas A. Edison, Inc., West Orange, N. J. as research engineers, and **Juliana D. Sareske** and **Elizabeth M. N. Bovard,** as research chemists.

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. . . ABOUT PRODUCTS ADVERTISED IN

Use the convenient postage-free cards below to get information on products listed here and on next page—all advertised in this issue. The extra card is for the use of pass-on readers.

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& Electronic Industries

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602 Acme Electric Corp.—TV power transformer
603 Aircraft Armaments Inc.—Envelope detector
604 Alford Manufacturing Co., Inc.—Directional antenna
605 Allen-Bradley Co.—Electronic components
606 Allied Radio Corp.—Free electronic parts catalog
607 American Elite, Inc.—Microphones
608 American Lava Corp.—Pressed ceramics
609 American Phenolic Corp.—Cable assemblies
610 Andrew Corp.—Antennas
611 Apex Coated Fabrics, Inc.—Coated fabrics
612 Arnold Engineering Co.—Bobbin cores
613 Audio Devices, Inc.—Audio products
613A Audio Instrument Co. Inc.—Oscilloscope, meters
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617 Berlant Concertone—Distributors for recorders
618 Berndt-Bach, Inc.—Sound-on-film recording
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622 Burnell & Co., Inc.—Adjustable toroid
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624 Camera Equipment Co.—TV camera accessories
625 Canoga Corp.—Ferrite circulator
626 Chatham Electronics—Hydrogen thyratrons
627 Cinch Manufacturing Corp.—Printed circuits & components
628 Cinema Engineering Co.—Resistors
629 Cleveland Container Co.—Phenolic tubing
630 Commercial Plastics Co.—Plastic clamps
631 Conrac, Inc.—Monitors
632 Corning Glass Works—Glass capacitors
633 Crosley Div., Avco Mfg. Corp.—Engineering personnel
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635 Eitel-McCullough, Inc.—Amplifier klystron
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640 Factory Enterprises, Inc.—Wire cloth
641 Fairchild Controls Corp.—Precision potentiometers
642 Fairchild Engine & Airplane Corp.—Transistor analyzer
643 Federal Telephone & Radio Co.—Selenium rectifiers
644 Ford Instrument Co.—Gear differentials
645 Ford Instrument Co.—Servo motors
646 Freed Transformer Co. Inc.—Megohmmeter
647 Frequency Standards—Microwave filters & pre-selectors
648 Gabriel Electronics Div.—Parabolic antennas
649 Garde Manufacturing Co.—Terminals & mounts
650 Gates Radio Co.—Broadcast transmitter
651 General Ceramics Corp.—Ferramic cores
652 General Electric Co.—High frequency transistors
653 General Precision Laboratory, Inc.—Focusing lens
654 General Radio Co.—Sweep drive
655 Good-All Electric Mfg. Co.—Capacitors
656 Grant Pulley & Hardware Corp.—Industrial Slides
657 Graphite Metallizing Corp.—Brushes, contacts & sliprings
658 Gray Manufacturing Co.—Engineering personnel
659 Gray Research & Development Co.—TV Projection system
660 Helipot Corp.—Delay line
661 Hickok Electrical Instrument Co.—Tube testers
662 Hughes Aircraft Co.—Diodes
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672 Kearfott Co., Inc.—Microwave components
673 Kennedy & Co., D. S.—Antenna
674 Kester Solder Co.—Solder
675 Klein & Sons, Mathias—Pliers
676 Kulka Electric Mfg. Co., Inc.—Power outlets
677 Librascope, Inc.—Analog-digital converter
678 Lockheed Missile Systems Div.—Engineering personnel
679 Magnetics Inc.—Magnetic shields
680 Mallory & Co., Inc., P. R.—Vibrator
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692 Radio Condenser Co.—Capacitors, tuners, assemblies
693 Radio Corp. of America—Transistors
694 Radio Corp. of America—Electron tubes
695 Radio Receptor Co., Inc.—Selenium rectifiers
696 Raytheon Manufacturing Co.—Germanium diodes
697 Raytheon Manufacturing Co.—Microwave links
698 Raytheon Manufacturing Co.—Data on magnetrons & klystrons
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702 Revere Copper & Brass Inc.—Printed circuit copper
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704 Royal Metal Manufacturing Co.—Industrial furniture
705 Rust Industrial Co., Inc.—Remote control systems
706 Shallcross Manufacturing Co.—Decade resistances & voltage dividers
707 Solar Manufacturing Corp.—Component & assembly designs
708 Sprague Electric Co.—Capacitors
709 Sprague Electric Co.—Wirewound resistors
710 Stackpole Carbon Co.—Coil forms
711 Stephens Manufacturing Corp.—Microphones
712 Stevens Mfg. Co., Inc., George—Bobbin winder
713 Sylvania Electric Products Inc.—Diodes
714 Sylvania Electric Products Inc.—Engineering personnel
715 Synthane Corp.—Laminated plastics
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718A Tower Construction—Towers & reflectors
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734 Westinghouse Electric Corp.—Silicon power rectifier
735 Weston Electrical Instrument Corp.—Inductronic D-C amplifier
736 Whitney Metal Tool Co.—Punch

FACILITATING INQUIRIES THROUGH READER SERVICE

Many of the advertisements in this issue of TELE-TECH contain data on the latest developments in their respective fields or data on the newest features of a particular product.

Although the facts are presented concisely in the advertisements, much additional information is available to you on request. It is offered by the manufacturers, all of whom invite your inquiries.

Hence TELE-TECH publishes these reader service cards each month to make your task as easy as possible.

Whether you are interested in only one or many of the products advertised, a single card will probably meet all of your requirements. The extra card is furnished so that when the magazine is routed to others in your organization, or referred to by others, they too will have an opportunity to use this simple system of getting information. In processing the many requests before they are forwarded to the manufacturers, TELE-TECH has a fast, ingenious method which protects the confidential nature of the requests at all times.

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125 MW
REFLEX KLYSTRON

BL-800/6780 FOR X-BAND APPLICATIONS

A new and important addition to Bomac's line of microwave products is the BL-800/6780 Reflex Klystron.

Rugged and reliable the BL-800/6780 klystron offers improved local oscillator performance and dependability for X-band radar systems.

Unexcelled high altitude operation, without pressurization ond eose of installotion without disrupting associated components or plumbing is now possible.

Controlled manufacturing procedures and rigid testing standards assure the user electrical uniformity and mechanical stability.

FEATURES

1. Light-weight, rugged construction
2. Low microphonics
3. Rapid warm up
4. Lock-nut tuning
5. Viking connector for convenient installation

GENERAL CHARACTERISTICS

Frequency Range	8.5 to 10.0 kmc
Heater Voltage	6.3 v
Heater Current	1.2 amps

MAXIMUM RATINGS

Resonotor Voltage	350 v
Resonator Current	42 ma
Reflector Voltoge	0 to —1000 v

MECHANICAL CHARACTERISTICS

Output Connection	Bolts to UG-39/U flange or UG-40A/U choke for 1 x ½ x 0.050 inch waveguide
Base	Molded flexible leads. 7 inch leads terminoted in Viking Connector (VP5/2AA1 plug — VS7/23C1 hood)
Cooling	Convection
Tuner	Lock-nut

We invite your inquiries regarding
- ENGINEERING
- DEVELOPMENT
- PRODUCTION

Bomac Laboratories, Inc.
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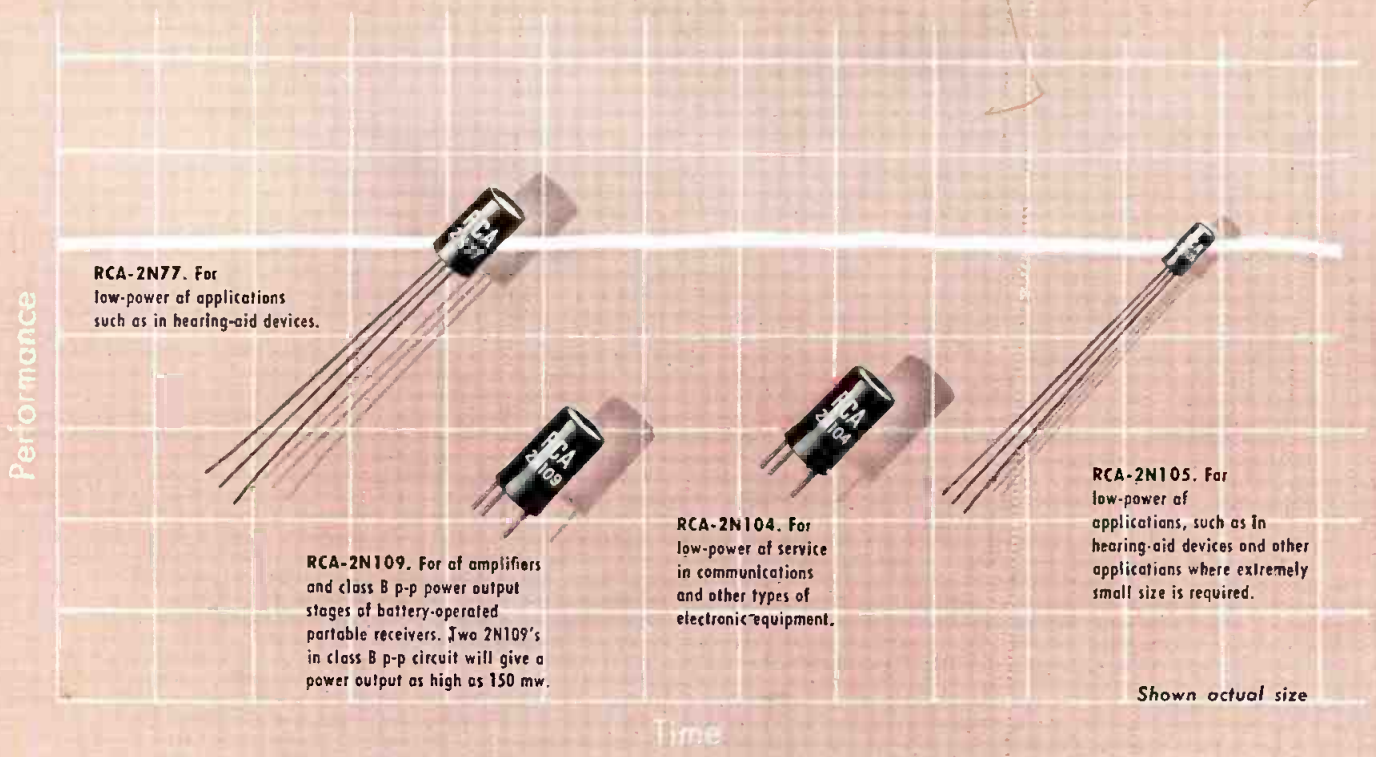
Catalog on request. Write (on your company letterhead) Dept. T-10 BOMAC Laboratories, Inc. Beverly, Mass., or phone Beverly 6000.



Exceptional Uniformity
Extreme Stability
—throughout life!

RCA HIGH-QUALITY TRANSISTORS

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.

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 af circuit, and maximum distortion at 10 percent

RADIO CORPORATION of AMERICA
ELECTRON TUBES
HARRISON, N.J.