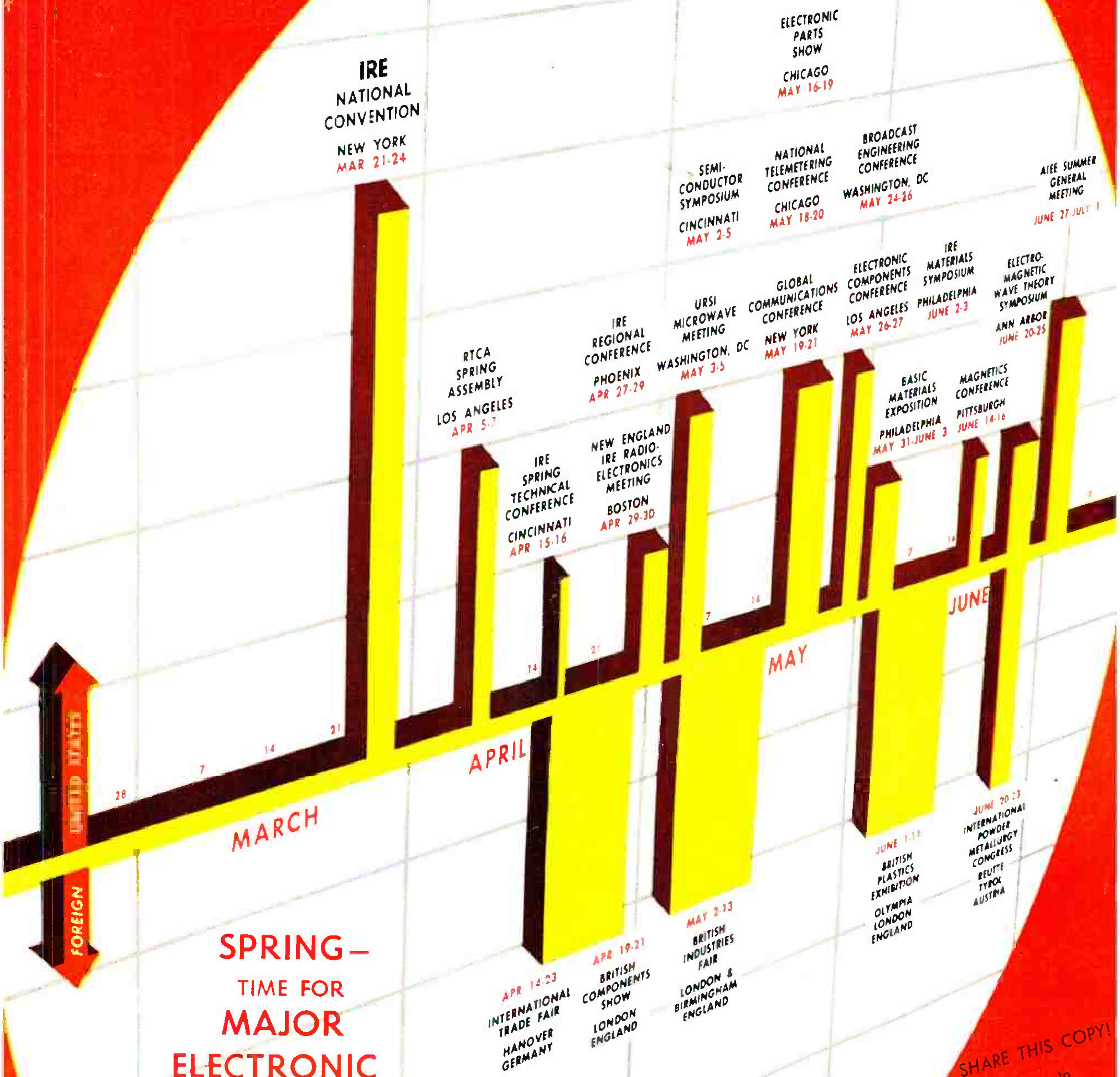
TELE-TECH
& Electronic Industries



SPRING—
TIME FOR
MAJOR
ELECTRONIC
EVENTS!

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Please Route to

April • 1955

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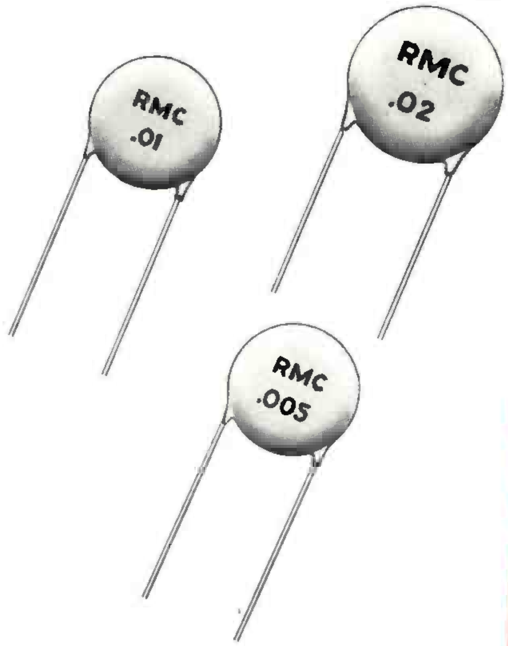
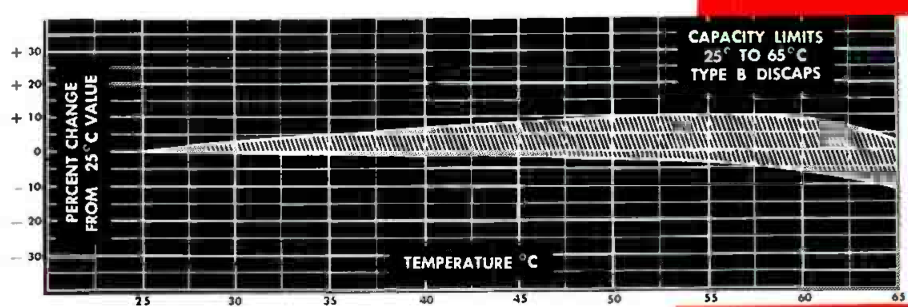
RMC BY-PASS DISCAPS

RMC Type B "Heavy Duty" DISCAPS are designed for all by-pass or filtering applications and meet or exceed RTMA REC-107-A specifications for type Z5Z capacitors

- Rated at 1000 working volts
- Available in any capacity between .00015 MFD and .04 MFD
- Minimum capacity change between +10°C and +65°C (See Curve)
- Heavy duty construction means greater dependability at no extra cost



PLUG-IN TYPES NOW AVAILABLE



RMC is now producing plug-in DISCAPS designed for printed circuit applications. Available in by-pass, temperature compensating, and stable capacity types, plug-in DISCAPS have the same high specifications featured in standard RMC capacitors. Leads are No. 20 tinned copper (.032 diameter) and are available up to 1½" in length. Popular range of sizes for all applications.

DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS CORPORATION

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

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Two RMC Plants Devoted Exclusively to Ceramic Capacitors

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TELE-TECH
& Electronic Industries

APRIL, 1955

FRONT COVER: SPRING—TIME FOR MAJOR ELECTRONIC EVENTS. An artistic portrayal of the many events of interest to electronic engineers which will take place in the immediate months ahead. Not shown, because of information received after press time, is the National Conference of Aeronautical Electronics, May 9-11, in Dayton, Ohio. In recent years there has been an undertone of objection throughout the industry because of the many conferences and exhibits taking place. Two or three overall regional meetings a year, similar to the annual IRE National Convention, are frequently mentioned as the ideal solution. For a list of events occurring during the April through Sept. period see page 28.

Section One:

Section Two: 1955 Roster of Associations Serving the Electronic Industries

DEPARTMENTS

TELE-TECH & ELECTRONIC INDUSTRIES*, Vol. 14, No. 4. Published monthly by Caldwell-Clements, Inc. 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. Copyright by Caldwell-Clements, Inc., 1955. Printed in U.S.A.

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KESTER SOLDER

COMPANY 4210 Wrightwood Avenue, Chicago 39, Illinois; Newark 5, N. J.; Brantford, Canada

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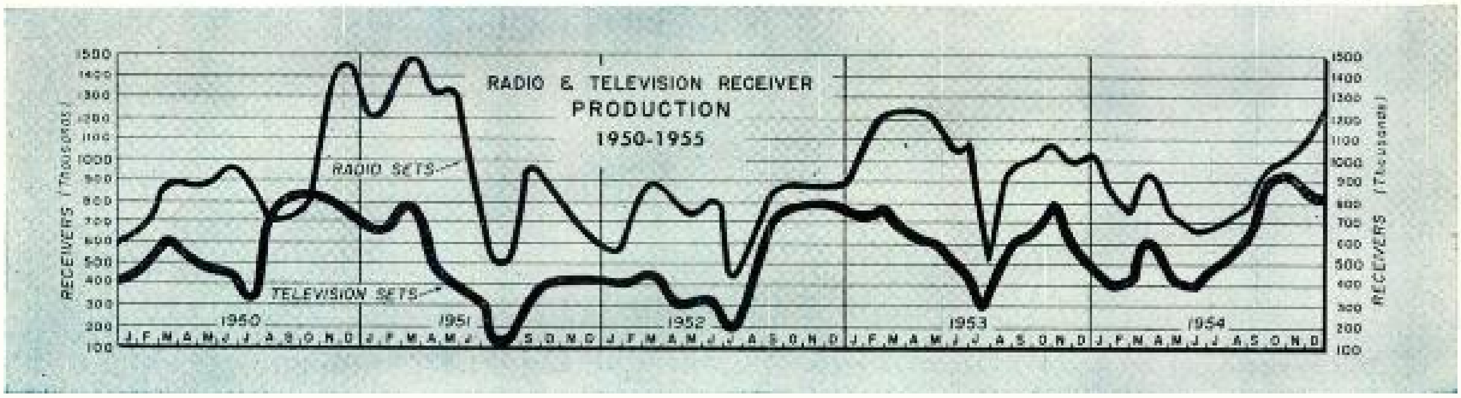
ELECTRONIC INDUSTRIES

TOTALS



1955 ENGINEERING GRADUATES

Following is a table of engineering graduates for 1955 by curricula and degree. The figures concern the 150 schools with accredited curricula.

	B.S.	M.S.	Ph.D.
Aeronautical	606	199	43
Agricultural	264	47	7
Architectural	381	12	0
Ceramic	113	34	16
Chemical	1,988	445	133
Civil	3,597	558	43
Electrical	4,076	960	111
Engrg. Mechanics	6	44	25
Engrg. Physics	219	74	18
General Engrg.	503	62	8
Geological	186	9	2
Industrial	1,103	367	6
Mechanical	4,827	698	72
Metallurgical	486	136	53
Mining	231	22	3
Naval Arch. & Marine	46	20	0
Petroleum	460	59	6
Sanitary	13	60	6
Textile	82	11	0
Unclassified	22	69	0
Other	498	145	38
TOTALS	19,707	4,031	590

Non-accredited schools will award about 2,529 Bachelor's Degrees and 47 Master's Degrees. There is no curricula breakdown available.

EDUCATIONAL ARITHMETIC

Ronald B. Thompson, Ohio State U., has prepared "A Supplement to College Age Population Trends, 1945-1970" for the American Assn. of Collegiate Registrars and Admissions Officers. Some of the figures compiled tell a story without words about the predicament of elementary schools and the impending problem in high schools and colleges.

Year	Number of Children: Age 6-11	Age 12-17	Age 18-21
1933	13,704,709		
1939	12,713,765	13,653,324	8,455,935
1943	12,205,137	13,173,495	9,060,592
1949	14,317,912	12,138,288	8,584,336
1954	17,921,998	13,552,629	7,967,556
1959	20,891,600	17,142,295	8,785,930
1964		20,494,660	10,955,207
1970			13,609,830

Obviously, our gross educational product must occupy as much of our thought and attention as our gross national product for some years to come.

Above figures from the Engineering Manpower Commission, 33 West 39 St., New York City and the Scientific Manpower Commission, 1530 P St. N.W., Washington, D.C.

Broadcast Stations in U.S.

	AM	FM	TV	
Stations on Air	2669	529	303 VHF 111 UHF	Comml.
			8 VHF 3 UHF	Educ.
Under Construction (CPs)	125	54	50 VHF 105 UHF	Comml.
			9 VHF 15 UHF	Educ.
Applications	170	11	155 VHF 17 UHF	Comml.

TV IN ENGLAND

Licensed television receivers as of Dec. 31, 1954 include:

England and Wales	3,920,897
Scotland	215,225
Northern Ireland	19,867
Total	4,155,989

Estimated Annual Production of Selected Electronic Parts

Product	Units	Value
Sockets	225,000,000	$ 25,000,000
Switches	35,000,000	10,000,000
Connectors, terminals	50,000,000	15,000,000
Coils, transformers	375,000,000	200,000,000
Hardware	1,500,000,000	30,000,000

GOVERNMENT ELECTRONIC CONTRACT AWARDS

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

Adapters, headset	200,000
Amplifiers, interphone	34,843
Amplifiers, klystron	179,600
Amplifier Units	2,255,770
Apparatus, X-Ray diffraction	29,782
Batteries, dry	80,225
Battery Jars	32,678
Cable and Boots	33,815
Cable, electric	156,082
Cable, watertight	83,397
Cavities	41,675
Connectors, plug	112,069
Connectors, receptacle	30,672
Controls, constant frequency	2,115
Control Equipments, auto degaussing	604,902
Converters, static	79,695
Crystal Units	89,670
Cubicles, power control	131,535
Disconnects, junction box	57,610
Electrodes, welding	525,200
Film, X-Ray	64,990
Generators, ac	299,759
Generators and Alternator Drives	62,308
Generator Sets	99,989
Gyros, rate	57,695
Handsets-Headsets	144,545
Indicators	122,926
Indicators, airspeed	536,883
Indicators, tachometer	438,913
Indicators, temperature	27,748
Inverters	82,331
Kits, cable splicing	112,531
Machmeters	476,393
Microphones	50,207
Microphone Stations	58,078
Mine Detector Sets	1,561,069
Motor Assys	103,115
Oscilloscopes	51,792
Panels, modification	35,505
Radar Sets	387,983
Radio Receivers	43,602
Radiographic Papers	127,668
Receivers, Transmitters, etc.	2,696,487
Recorder-Reproducer	52,395
Regulators, voltage	49,166
Relays	33,672
Servos, range recorder	44,555
Signals, air-to-water	34,500
Signal Generators	328,829
Simulators, flight	440,000
Simulators, radar signal	302,510
Solder, lead and rosin	26,636
Station Equipments, ship-shore	159,583
Switch Assys, motor control	32,209
Switches, flame detector	33,557
Switches, toggle	35,640
Systems, fire control	127,463
Telephone Sets	163,243
Test Sets	48,960
Test Sets, radar	516,921
Transformers	602,375
Transmitters, pressure	416,878
Tubes, electron	7,107,484
Tubes, klystron	48,000
Viewers, comparator measuring	25,226
Wire, electrical	25,153
Wobbulators	36,226

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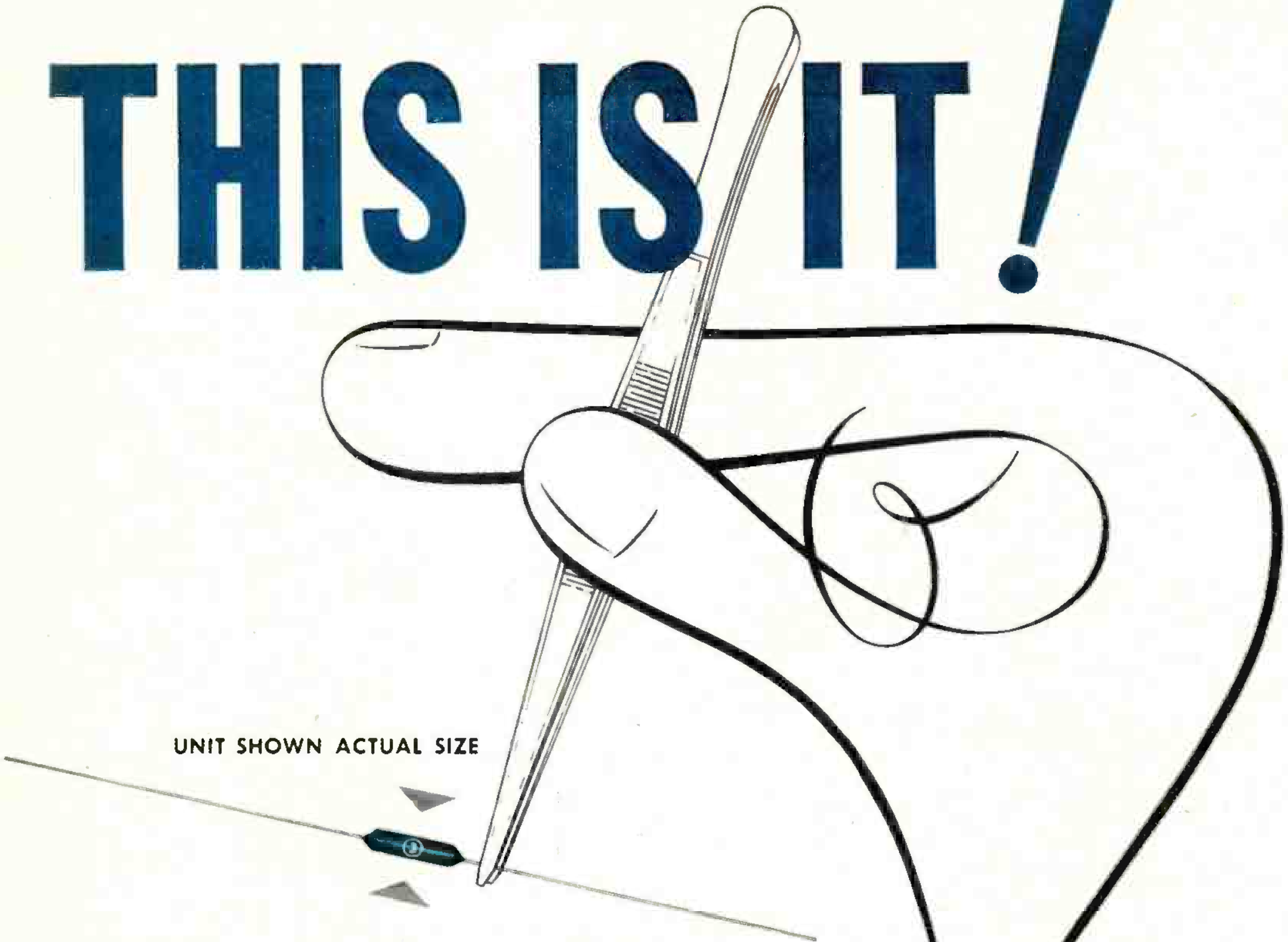
THIS IS IT!



NEW 3-WATT *Blue Jacket*®

miniaturized axial-lead wire wound resistor

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

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

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

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

Standard Resistance Tolerance: ±5%

SPRAGUE

WRITE FOR ENGINEERING BULLETIN NO. 111B

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

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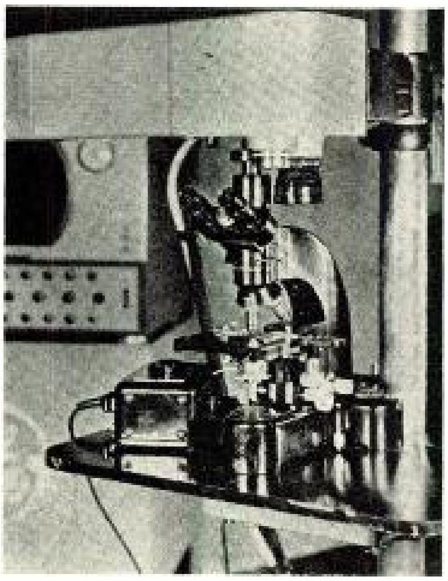
As We Go To Press...

Medical Color TV

A new technique of magnifying the microscopic details of pathological tissue, and projecting their images, in full color, onto a six foot screen, has been demonstrated by General Electric for the American Medical Association national conference on postgraduate medical TV education. The magnifying system, which features the use of closed circuit color TV, can magnify microscopic specimen, live or dead, up to 15,000 times.



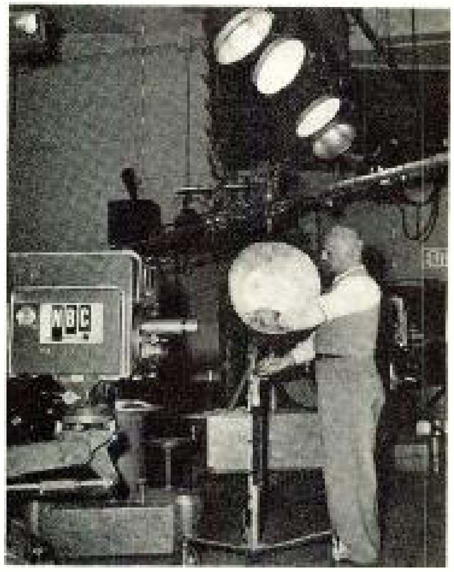
Closed circuit color TV Camera-microscope, which was demonstrated to the M.A. on post graduate medical TV education in Chicago. In the background is the color TV control monitor.

Ten different specimens of both healthy and diseased tissues, prepared with different staining techniques, were used to show the color fidelity possible with the color television-microscope projection system.

The color television-microscopy system was demonstrated at the conference in conjunction with a talk by Ralph S. Yeandle, of G. E. who said, "The system could be used for teaching large medical audiences in the classroom and at great distances. Information, both vocal and visual, on the latest developments and discoveries in pathology could be distributed to many points throughout the nation at the same time. In this manner, rapid mass diagnosis of epidemics could be accomplished in a minimum of time. The diagnostic abilities of the leading pathologists also would be available to all sections of the country when needed rapidly, or for instruction," Yeandle said.

In the demonstration, specimen of pathological tissue, mounted on slides, were placed in view of a specially adapted TV camera-microscope. The full color image, picked up by the TV camera-microscope, was, transmitted via coaxial cables to a projector, and magnified further.

TV WHITE LIGHT



NBC's TV studio at Radio City, N. Y., now boasts a self-diffusing incandenscent lamp that eliminates the need for a spun-glass diffusing "scrim" in producing a soft, white light. Developed by Westinghouse, the new 1000-watt lamp is shown being installed in a "scoop" fixture. Secret of the self-diffusing lamp bulb is an inner, baked-on coating of silica powder that absorbs a negligible amount of light. The fine white silica particles break up the beams reducing glare.

A. F. Runs Arctic Tests

Tests in actual Arctic winter weather have been successfully conducted for the Air Force at Ladd Field, Alaska, on SPAR, portable Ground Control Approach system for landing aircraft under poor visibility conditions. The tests, conducted by the Air Proving Ground Command, complete Air Force evaluation of the SPAR system.

SPAR is manufactured by Laboratory For Electronics, Inc., Boston, Mass., It was developed as a new type, low-cost, portable GCA radar landing system, suitable for both military purposes and small commercial airfields. Its performance to date in tests has been rated as highly satisfactory.

TV camera records and projects details of delicate ear "fenestration" operation to medical observers one floor away from surgery at Eye and Ear Hospital of Pittsburgh, Pa. Demonstration showed effectiveness of closed-circuit TV as medium for teaching surgical practices

'TV Eye' Sees Operations

In another important demonstration of its effectiveness as a medium for teaching surgical practices, closed-circuit TV system has been used successfully to project intimate details of delicate eye and ear operations to medical observers outside of the operating room.

The demonstration was held at the Eye and Ear Hospital of Pittsburgh, Pa., as a highlight of the recent joint meeting of the Pennsylvania Academy of Ophthalmology and Otolaryngology and the hospital's Annual Mid-Winter Clinical. The compact RCA "TV Eye" camera, which weighs less than five pounds, was mounted in the operating room and connected by closed-circuit to standard home TV receivers in the hospital auditorium, one floor away. A special sound system enabled the surgeons to provide a running commentary with the televised operations, which were seen and heard by approximately 100 doctors.

MORE NEWS on page 8

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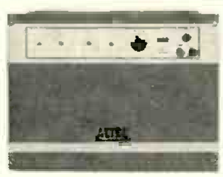
"TAKE THE ALTEC 1500 SERIES . . . FLAT . . . PERFECT FOR P.A."

Sound engineers will always agree that for superlative performance in commercial sound systems, Altec Lansing Amplifiers can't be beat. In addition to the superior design and precision craftsmanship, Altec engineers have built many outstanding features into the 1500 Series Amplifiers to make them ideal for every public address installation. Preamplifiers and controls can be mounted on power amplifier chassis. Simple circuitry makes for easy, simple maintenance. The "building block" design makes for flexibility of use, with performance specifications that meet broadcast requirements. This group is comprised of the 1520A and 1530A Amplifiers, the 1510A and 1511A Preamplifiers, 1540A two-stage line Amplifier, 1550A Matching Unit line to grid transformer and the 530A Power Supply. Two types of mounting assemblies are available or if desired, the 1560A Console will house a complete 1500 amplifier sound system and allow for operation on a desk or table top.

1520A Amplifier

Gain:	75 db.
Freq. Response:	± 1 db., 20-20,000 cycles. ± 2 db., 10-20,000 cycles.
Power Output:	35 watts nominal at 2% T.H.D.
Noise Level:	—43 dbm.
Input Impedance:	100,000 ohm Vol. Control.
Output Imp.:	Less than 20% of nominal load impedance.
Load Impedance:	4, 8, 16 ohms and 70 V. line (140 ohms).
Power Supply:	105-125 VAC, 60 cycles, 230 watts



1530A Amplifier

Gain:	75 db.
Freq. Response:	± 1 db., 20-20,000 cycles. ± 2 db., 10-20,000 cycles.
Power Output:	70 watts nominal at 2% T.H.D.
Noise Level:	—43 dbm.
Input Impedance:	100,000 ohm Vol. Control.
Output Imp.:	Less than 20% of nominal load impedance.
Load Impedance:	4, 8, 16 ohms and 70 V. line (70 ohms).
Power Supply:	105-125 VAC, 60 cycles, 280 watts.

For an exceptionally versatile amplifying and mixing control group for voice and music reinforcement for industry and entertainment and all public address applications, see the Altec Lansing 1500 Series Amplifiers at your dealer's. Or write Department 5AP for illustrated folder.

A SOUND REPUTATION SECOND TO NONE!

ALTEC LANSING CORPORATION

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161 Sixth Avenue, New York 13, N.Y.

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CIRCULATION NOW 27,000

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

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

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

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

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

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

THE ELECTRONIC INDUSTRIES DIRECTORY

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

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Savings that come from tough little Arches of Steel

This is a familiar sight on assembly lines today . . . a Tinnerman SPEED NUT being pulled down tight on its screw, never to shake loose from vibration. Yet easy to loosen at the proper time without worry about rust-frozen screw threads.

The secret lies in the arched base and prongs of the SPEED NUT. As the screw is tightened, the flexible SPEED NUT flattens, setting in action two distinct forces that lock for keeps. Yet a firm twist of the screwdriver is all that is needed to relieve those forces and loosen the fastener.

Savings in unit cost, in man-hours of application, in parts handling, are the important reasons why SPEED NUT brand fasteners are in service on your automobile, television set, home appliances and other assembled products. Write for "SPEED NUT Savings Stories", actual case histories of short cuts to assembly and production savings.

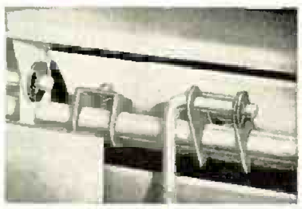
TINNERMAN PRODUCTS, INC. • BOX 6688, DEPT. 12, CLEVELAND 1, OHIO

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

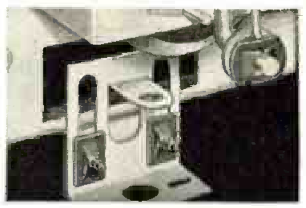
TINNERMAN Speed Nuts®
FASTEST THING IN FASTENINGS®

TYPICAL USES

Total cost of control-equipment enclosure reduced by 30% with "J" type SPEED NUTS!



Specially developed SPEED NUTS cut assembly costs of adjustable awning by 63%!



SPEED NUTS lower assembly costs 40% on casement-window air conditioner!

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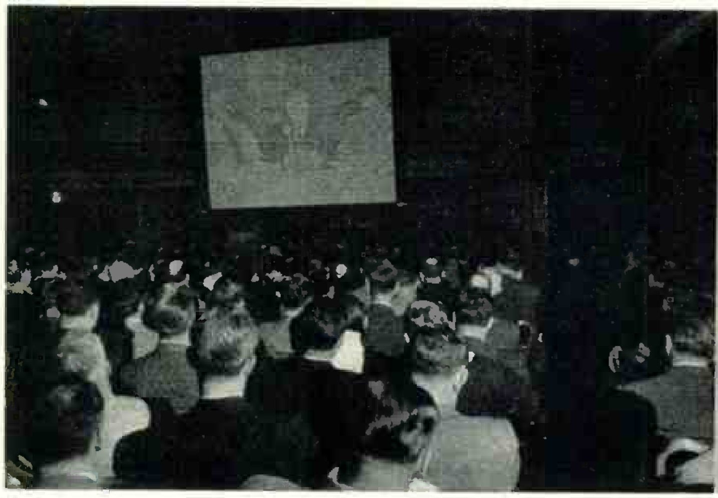
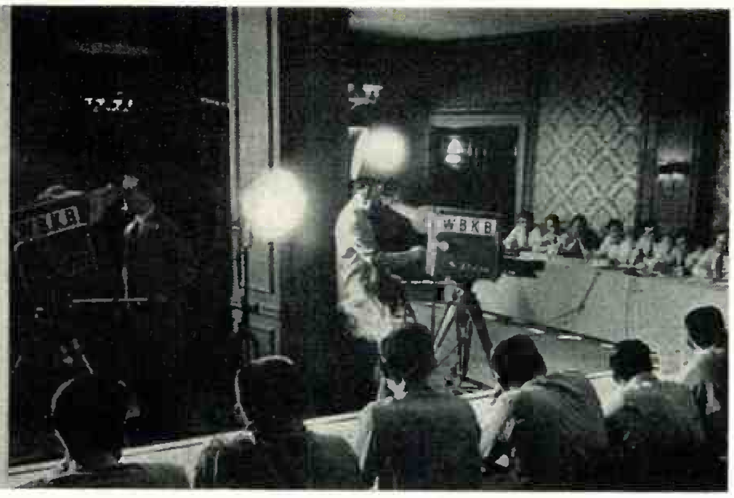




Registrants at the Mid-winter Personnel Conference of the American Management Assoc. held recently at the Palmer House, Chicago, witnessed one of the unique "firsts" of American industry; the televising via closed-circuit TV of the bargaining session between the officials of the Rogers Corp., Rogers, Conn. and the International Brotherhood of Paper Makers (AFL). The talks, which were held in the upstairs room of the hotel, were simultaneously viewed by close to 2,000 personnel and labor relations executives assembled in the Grand Ballroom below. Credit for the arrangement of the televised conference goes to the A.M.A., and, specifically, to James M. Black, personnel division manager. The technical arrangements were handled by Box Office Television Inc., New York.

Computers in Industry Theme of Conference

The first of a series of annual conferences designed to familiarize management personnel with the commercial applications of general purpose electronic computers was held recently at the Hotel Statler, N.Y.C. under the auspices of the American Management Assoc. The talks delivered during the two-and-a-half day conference treated a variety of aspects of computer use, from the preliminary survey to determine the need for computers, to the application of larger, more elaborate computers.

The meeting was under the chairmanship of Gordon G. Hoit, exec. vice-pres. of Stromberg-Carlson Co. The opening address, an overall appraisal of the status and future of the electronics industry, was delivered by Don G. Mitchell, chairman of the board, Sylvania Electric Products Inc.

TRADIC, a new digital computer, contains nearly 800 transistors which enable the machine to operate on less than 100 watts. J. H. Felker (l) gives instructions to the computer by means of a plug-in unit while J. R. Harris (r) places numbers into the machine.

TRADIC Computer

A miniature electronic device that opens a new era in computers, and that can operate flawlessly in planes flying at supersonic speed has been developed for the U. S. Air Force by Bell Telephone Labs.

The digital computer eliminates vacuum tube failure and heat, jet aircraft's greatest electronic problems, by the use of transistors. It contains nearly 800 of these, and is believed to be the first all-transistor computor designed for aircraft.

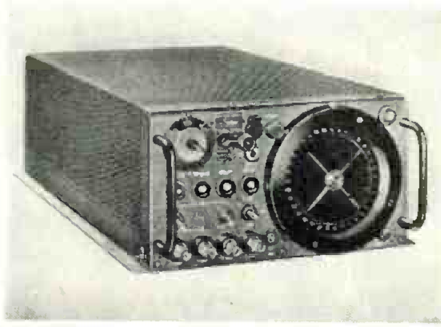
The new computer, known as TRADIC (TRansistor-DIgital-Computer), requires less than 100 watts to operate. This is one-twentieth of the power needed by comparable vacuum tube computers. Early computers used as many as 18,000 vacuum tubes and frequently required thousands of watts to operate. It contains, in addition to transistors, nearly 11,000 germanium diodes. When design work has been completed, the computer will probably occupy less than three cubic feet of the critical space in modern military aircraft.

Mathematical instructions are placed into Tradic by means of a "plug-in" unit resembling a small breadboard. Plug-in units are set up beforehand with interconnecting wires to represent problems at hand. Numbers to be processed are put into the machine by means of simple switches. The laboratory model of Tradic provides answers to trigonometric problems with a series of "dots" on an oscilloscope. These dots draw geometric diagrams on the scope.

Low Cost Automatic DF Announced by Olympic

Designed for the smaller airport normally unable to afford direction finding equipment, the new Model AS-111 VHF automatic direction finder being introduced at the IRE show by Olympic Radio & TV Inc., Long Island City, N.Y. offers high sensitivity and accuracy in a small package.

The sensitivity of the unit is 1.5 µv, providing bearing indications on signals 20 db below the noise level.



Indicator receiver accuracy is within 1°, with the overall system accuracy slightly lower. The bearing indicator, which is directly driven by a servo motor, has a response time of 1.5 secs for a 180° deflection. An auxiliary indicator, ganged to the main pointer, allows for magnetic or similar deviations.

Frequency range of the unit is 118-148 mc.

Olympic spokesmen set the price of the unit—complete with Adcock antenna and connecting cables—at approximately $3,500.

MORE NEWS on page 26

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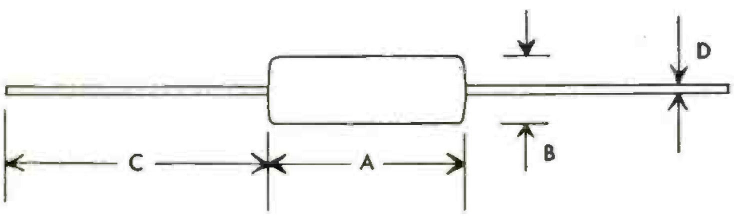
NOW

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"	.032"
MDB — MBB	BW½	5/8"	3/16"	1½"	.032"
MDC — MBC	BTA	23/32"	1/4"	1½"	.040"

MOLDED DEPOSITED CARBON PRECISTORS

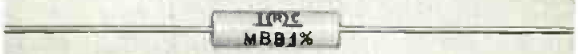

Type MDA — 1/8 Watt


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

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Send me data on:

☐ Molded Deposited Carbon Precistors

☐ Molded Boron Carbon Precistors

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Address____________________

City____________________ State__________

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NOW

IRC *encapsulated* precision resistors

The presence of extreme climatic conditions, unusual ambient temperatures or salt water are offset by a new IRC encapsulating technique. This IRC development uses an epoxy resin compound for both the winding form and the seal. A special molding process avoids air pockets and assures even, complete distribution of the resin. Designed to operate at 125° C. and to meet the military requirements of salt water immersion, these units exceed MIL-R-93A specifications in 1%, 0.5%, 0.25% and 0.1% tolerances.

Type WW15M—MIL-R-93A Style RB15

Type WW16M—MIL-R-93A Style RB16

Type WW17M—MIL-R-93A Style RB17

Type WW18M—MIL-R-93A Style RB18

Type WW19M—MIL-R-93A Style RB19

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Also available for precision applications . . .

IRC TYPE WWJ Precision Wire Wounds

In 6 standard sizes, plus miniature type WW10J, IRC Precision Wire Wound Resistors offer full coverage of requirements for exacting accuracy in critical applications. IRC's superior winding skill and care is the result of over 25 years experience.

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Send Technical Bulletin ☐ D-3 Encapsulated Precisions
☐ D-1 Type WWJ Precisions

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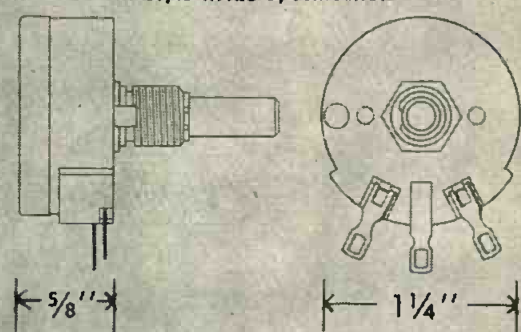
NOW

a *new* wire wound potentiometer

The mechanical and electrical features of Type 2W Rheostat-Potentiometer are designed for current and future electronic circuits. This modern, 2 watt unit offers maximum application adaptability plus typical IRC superior performance. Electrical operation is improved by one-piece center terminal and collector ring, and direct contact between collector ring and contactor. Advanced mechanical design anchors winding securely to strip, locks element into position, and assures accurate location of terminals.

Equivalent To JAN-R-19 Style RA20 Specification



New IRC Design Smaller and More Compact

IMPROVED DESIGN FEATURES

- **Better Heat Dissipation**
- **Greater Dust Protection**
- **Increased Mechanical Rotation**
- **Increased Electrical Rotation**
- **More Resistance Values**
- **Double and Single Taps Available**

2 Watt Power Rating Based On 60°C. Rise Above 40°C. Ambient

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Send Bulletin describing Type 2W Potentiometers:

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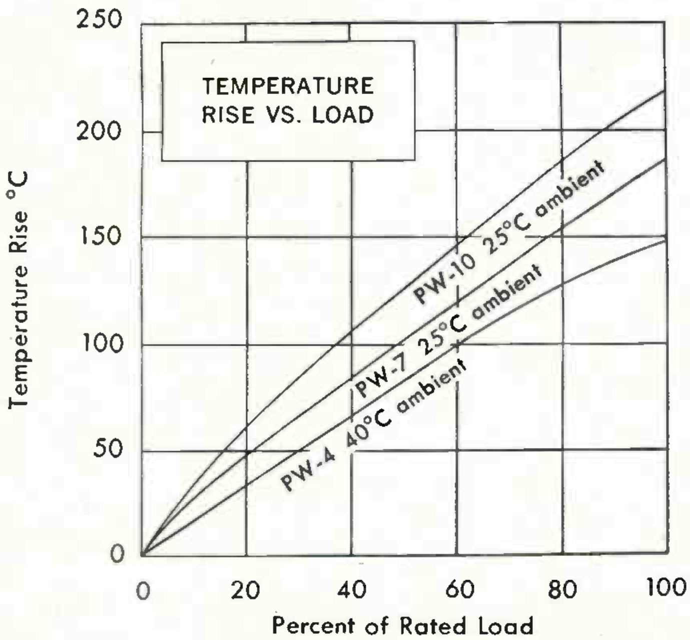
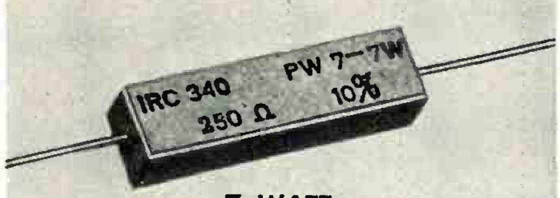
3 *new* wire wound resistors

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.



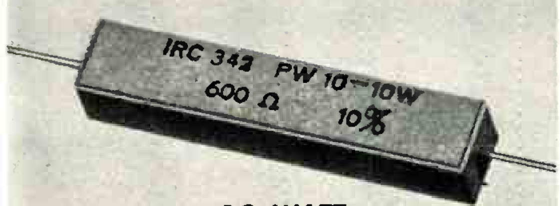
4 WATT

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.

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

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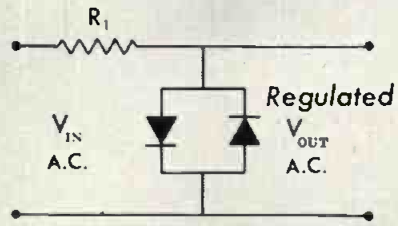
IRC Miniature MICROSTAK Selenium Rectifiers are available in a variety of types for many standard and special applications, in sizes as small as .060″ diameter. IRC's processing technique makes possible uniform, high grade, long-life, low capacitance cells with performance characteristics not available elsewhere.

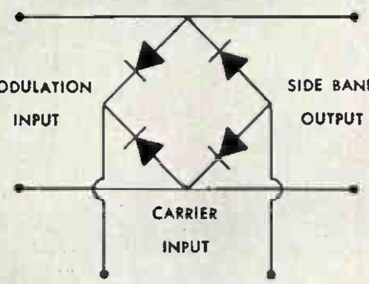
Cell thickness to ± .001. Less than 1% unbalanced voltage on bridge circuits. Hermetically sealed types available.

TYPICAL ADVANCED APPLICATIONS

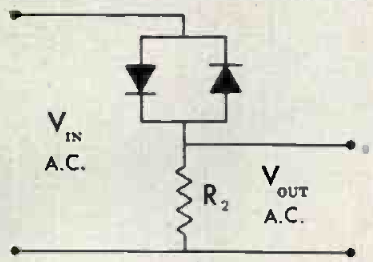
VOLTAGE REGULATION



BALANCED MODULATOR



LOGARITHMIC CONVERTERS



SEND COUPON FOR BULLETIN SHOWING CHARACTERISTICS, SPECIFICATIONS AND TYPICAL APPLICATIONS.

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Please send Technical Bulletin describing MICROSTAK Selenium Rectifiers.

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NEW

low cost insulated chokes

New sizes of IRC Insulated Chokes now provide 4 types — CL½, CLA, CL1 and CL2. The wide range of size and characteristic combinations available with these 4 types permit accurate specifications to space and electrical requirements. Insulated housing guards coil from physical damage and prevents shorting.

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Wherever the Circuit Says -ᴧᴧᴧ-

NEW

high frequency resistors

IRC Type HFR high frequency resistors are miniature, axial lead units that exceed all requirements of specification MIL-R-10683A. They are recommended for use in circuits requiring excellent frequency response over a wide band of frequencies, for high frequency circuits, and for applications where low shunt capacity is desirable. Type HFR has 9/16" body length with 3/32" diameter; ¼ watt power rating; resistance values from 20 ohms to 1.0 megohm.

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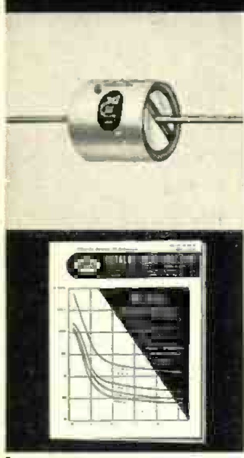
Wherever the Circuit Says -ᴧᴧᴧ-

NEW

non-linear resistors



New IRC VARISTORS are voltage sensitive and provide sharp variation of resistance with applied voltage. Designed to meet most needs for non-linear resistors, they are available in 5 convenient cell sizes, and a complete choice of enclosures including hermetic seals.

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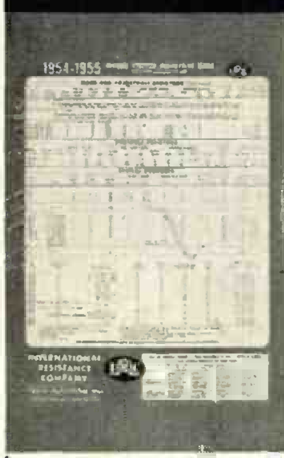
NEW

resistor engineering guide



New IRC 1954-55 RESISTOR ENGINEERING GUIDE gives digested specifications and approximate prices for 138 different resistor types including 56 JAN or MIL equivalents. Data on Insulated Chokes, Selenium Rectifiers, Germanium Diodes and Feed-Thru Terminals also included. Widest coverage of condensed resistor information available.

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NOW
IRC resistance strips and discs

IRC Resistance Strips and Concentric Disc Resistors offer unusual adaptability to special requirements. They consist of a high grade paper-base phenolic sheet to which IRC resistance material is permanently bonded.

Resistance strips can be used as supplied by IRC, with either side or end termination, or they can be further processed by the user to form particular shapes for individual requirements. Use coupon for detailed data on specifications and characteristics.

TYPICAL APPLICATIONS

IRC RESISTANCE STRIPS

IRC RESISTANCE STRIPS ARE USED EXTENSIVELY IN:

- Strain Gauges
- Servo-Mechanisms
- UHF Attenuators
- Telemetering Equipment
- In conjunction with Wave Guides

IRC CONCENTRIC DISC RESISTORS

THESE ARE PUNCHED FROM RESISTANCE STRIPS AND PREPARED BY IRC FOR USE IN APPLICATIONS SUCH AS:

- Terminating Resistors for line matching stubs.
- Concentric Line Terminations of low power requirements.
- Matching Resistors in measuring equipment—high frequency vacuum tube voltmeters, signal generators, etc.

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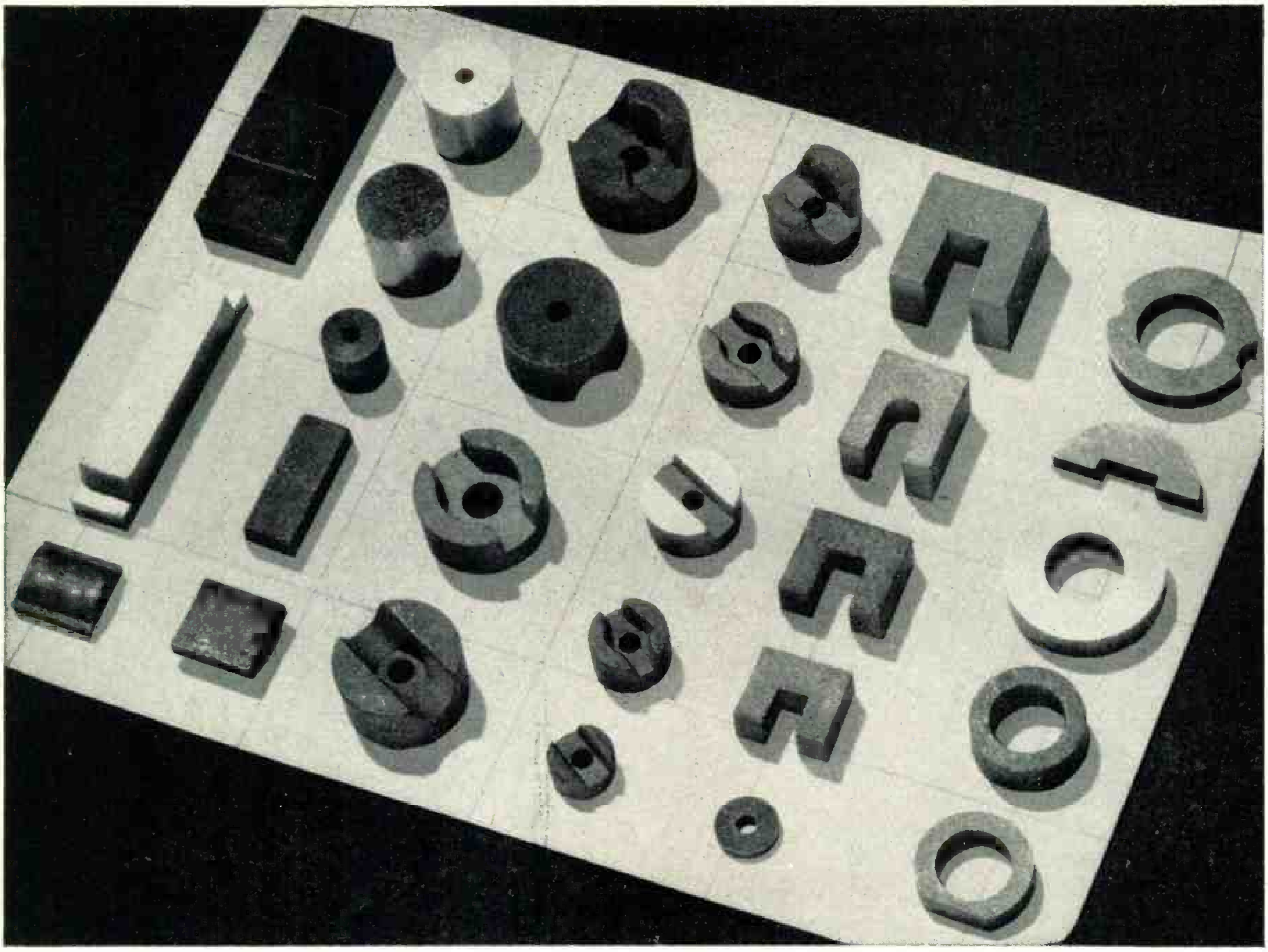

Page-full of ideas for you on *Sintered Magnets*

"MAGNETIC MATERIALS CATALOG"

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Contains handy data on various types of Alnico Magnets, partial lists of stock items, and information on other permanent magnet materials. Also includes valuable technical data on Arnold tape-wound cores, powder cores, and types "C" and "E" split cores in various tape gauges and core sizes.

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Magnets of sintered Alnico offer endless opportunities to designers who need their useful combination of self-contained power and small bulk. A wide range of sintered Alnico shapes are carried in stock for quick shipment. Special shapes to meet an individual design need can be developed, where the quantity required is large enough to justify the tooling costs. Arnold sintered permanent magnets are fully quality-controlled and accurately held to specified tolerances. ● *We'll welcome your inquiries.*

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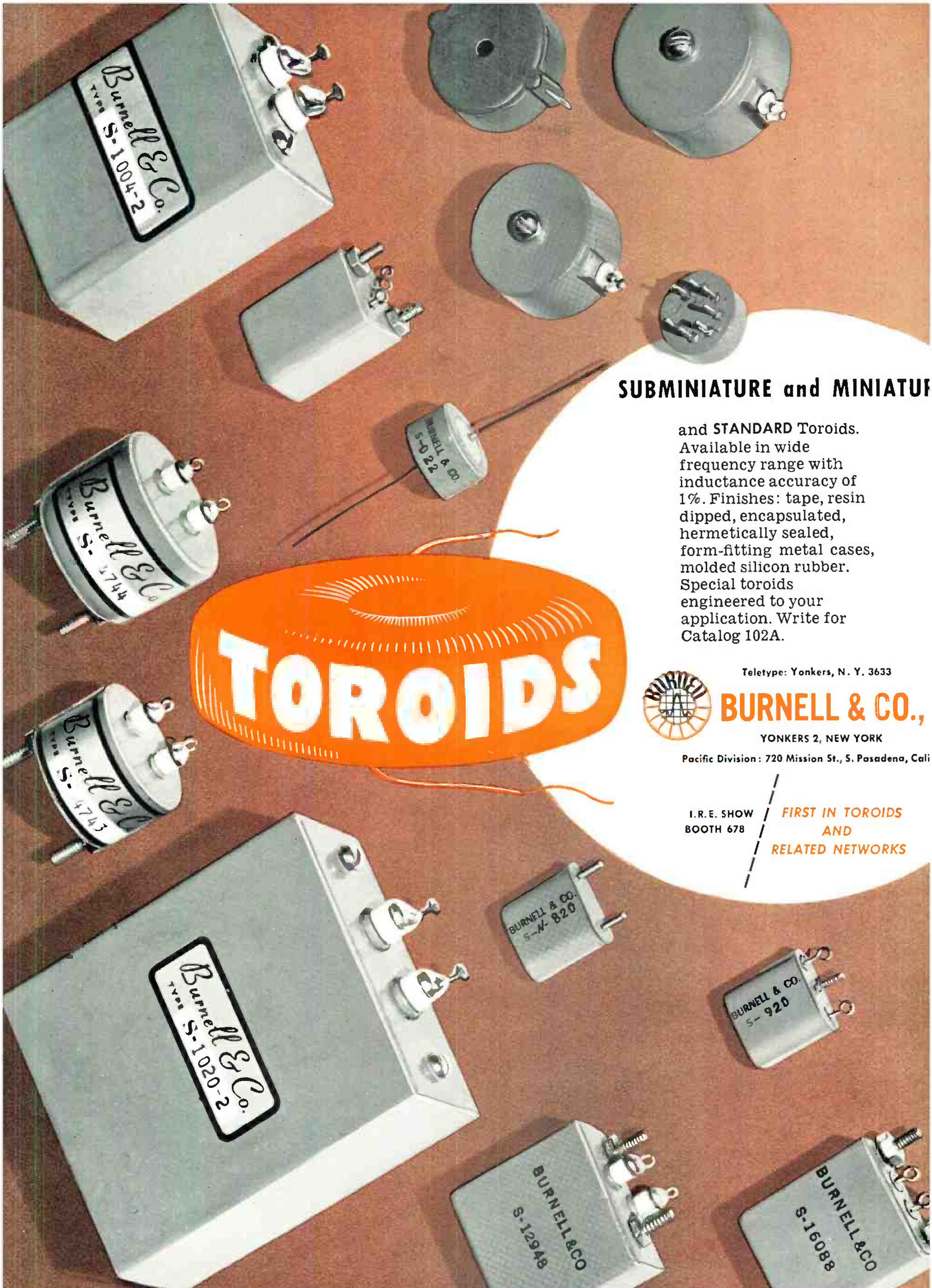

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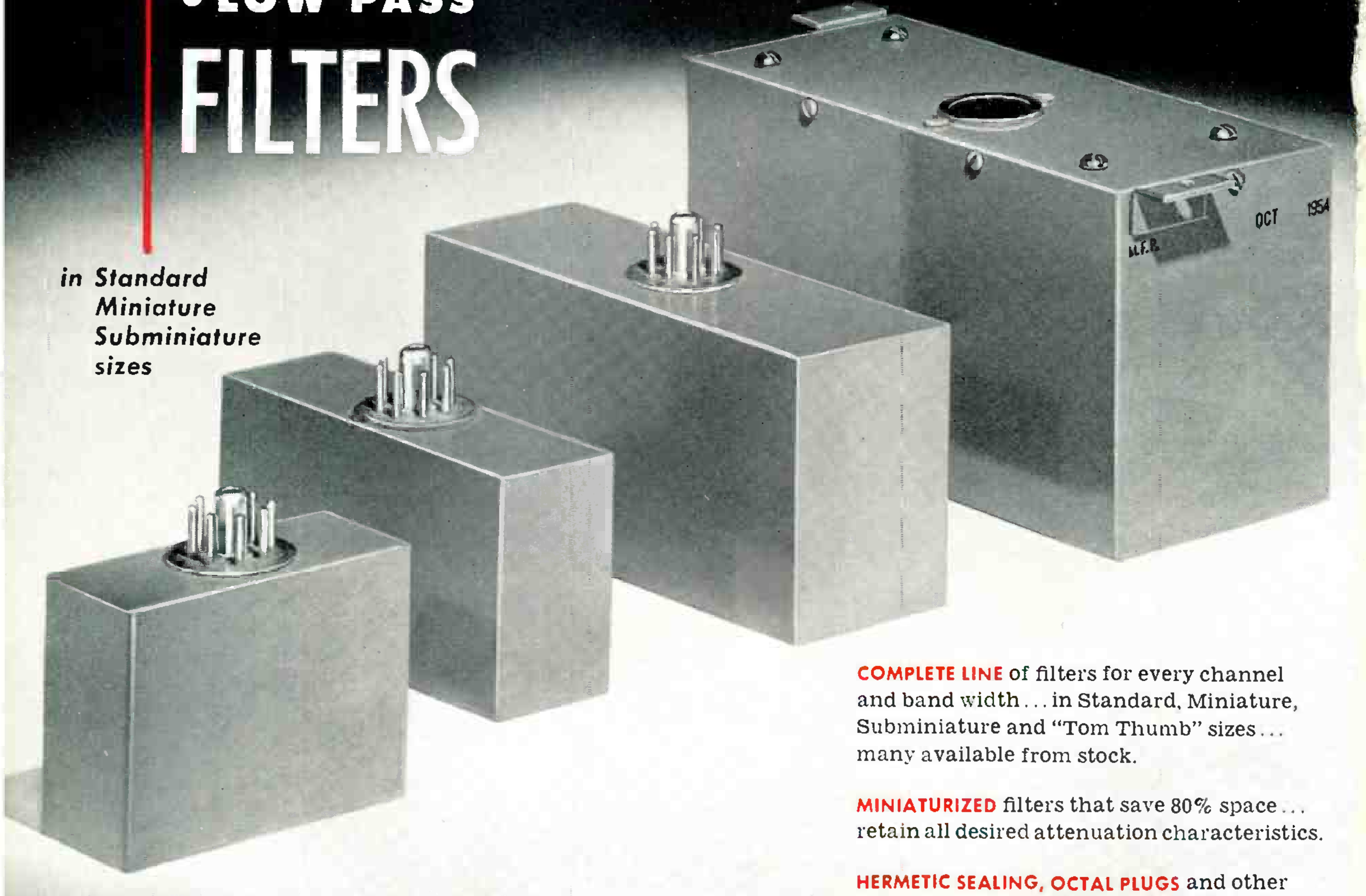
TELEMETERING

• BAND PASS
• LOW PASS

FILTERS

in Standard
Miniature
Subminiature
sizes



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

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

HERMETIC SEALING, OCTAL PLUGS and other new features.

only Burnell offers you . . .

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

OPTIMUM OPERATING IMPEDANCES	SOCKET TERMINAL CONNECTIONS
INPUT	OUTPUT
Terminals 1 & 2 — 500 ohms	Terminals 1 & 6 — 500 ohms
Terminals 1 & 3 — 10000 ohms	Terminals 1 & 7 — 50000 ohms

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

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

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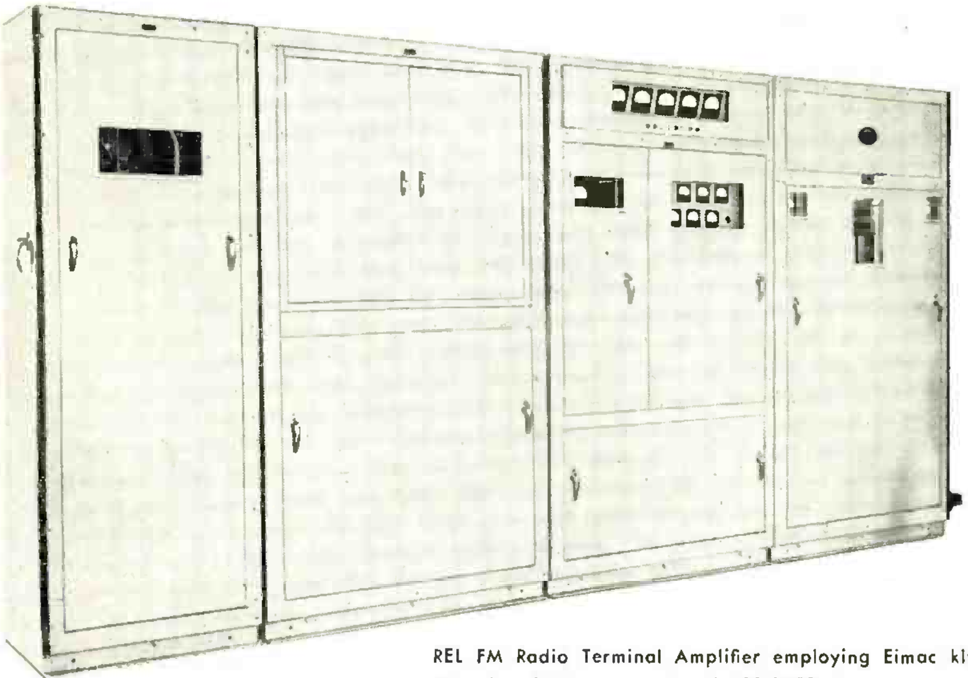
Radio Engineering Laboratories uses Eimac klystrons in high power, beyond-the-horizon communication equipment

Eimac 3K50,000L klystron in klystron section of REL 10kw power amplifier.

EXTENDED RANGE COVERAGE at frequencies previously limited to low power has been achieved in a new high power beyond-the-horizon UHF communication system. Radio Engineering Laboratories designed and manufactured 30 REL type 826 FM radio terminal equipments for a special system employing Eimac high power klystrons in the final amplifier stage. Eimac klystrons were selected not only because of reliability and high power, 10kw/CW power output with a minimum gain of 26 db, but also for their practical design which permits economical transmitter construction and minimizes replacement problems. Completion of this revolutionary communication system which is now in operation confirms that 1) high power, extended range UHF and microwave coverage is practical, and 2) Eimac klystrons are the most efficient, powerful and reliable tubes for the job.



REL FM Radio Terminal Amplifier employing Eimac klystron has frequency range of 400-1050mc.

See Eimac high power amplifier klystrons, booths 549-551, at the I. R. E. show, New York, March 21-24.

Eimac

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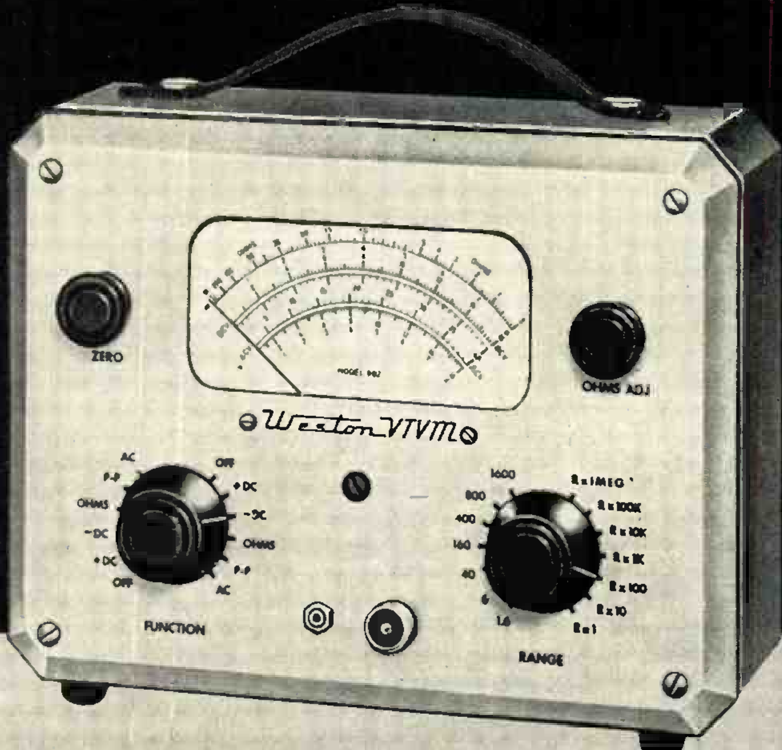
peak to peak measurement with input impedance of 10 megohms shunted by a capacitance of only *15 micromicrofarads!*



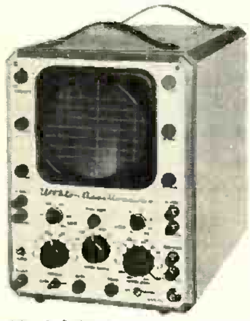
the 980 line VACUUM TUBE VOLTMETER

Model 982

Other 980 Line Instruments

Model 981 Tubechecker

Model 980 Analyzer



Model 983 Oscilloscope

Model 985 Calibrator

Model 984 Sweep Generator

Here is the most convenient, most versatile and portable VTVM available. Battery operated, it is completely isolated from spurious response due to stray a-c fields and circulating ground currents. Accuracy is ±3% d-c, ±5% a-c RMS, sinusoidal wave form. Impedance 10 megohms d-c; 2.8 megs a-c RMS; peak to peak voltage, 1 megohm input resistance; 60 mmf input capacitance.

RANGES:

D-C and Peak to Peak Volts	1.6	8	40	160	400	800	1600
A-C Volts	1.6	8	40	160	400	800	1200
Low-C Peak to Peak Volts	16	80	400	1600			
Ohms	X1Meg	X100K	X10K	X1K	X100	X10	X1
							(10 ohms center)

Frequency Response—to 300 KC on peak to peak; to 2 KC on AC rms; to 300 MC with RF probe, (available as accessory).

Battery Life—Battery A, Approx. 90 days, 8 hours, easily replaceable. Battery B, Approx. 1 year, 8 hours per day.

For complete details see your distributor, or write for literature . . . WESTON Electrical Instrument Corp., 614 Frelinghuysen Avenue, Newark 5, New Jersey.

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test equipment

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modern genie in a bottle!

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RADIO RECEPTOR

subminiature, hermetically sealed

GLASS DIODES

Radio Receptor engineers have rivaled the Arabian Nights with these new diodes hermetically sealed in tiny glass envelopes. Like the fabled genie who lived in a bottle, RRco. glass diodes are long lived, efficient and capable of performing amazing feats with remarkable endurance.

Here are some of the important features we've built into these subminiature glass units:

Actual size

DIMENSIONS

Diameter .... .098" max.
Length .... .265" max.
Lead diameter.. .021"–.019"
Lead length ......1.125" min.

GOLD BONDED GERMANIUM TYPES	SILICON ALLOYED JUNCTION TYPES
A few of these numbers include every registered RETMA type and many more. This will simplify engineering, purchasing and stock-keeping.	. . . with almost unbelievable specifications.
200 MA at + 1 volt.	500 MA at + 1 volt.
Reverse leakage in microamperes.	Reverse leakage — .01 microamperes at 25° C.
150 volt peak inverse.	Operation to 200° C.
Excellent recovery time.	Reverse breakdown — 300 volts, abrupt characteristic rising slightly with temperature.
Others with specified characteristics at high temperatures.	

OTHER PRODUCTS OF RADIO RECEPTOR:
Selenium Rectifiers, Germanium Transistors, Dielectric Heating Generators and Presses, Communication, Radar and Navigation Equipment.

Radio Receptor's line of glass diodes is constantly expanding and new numbers are added all the time. For latest news of these and other RRco. semi-conductor products write today to Department T-5.

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NEW SYMBOL FOR SEMICONDUCTOR LEADERSHIP

new designs

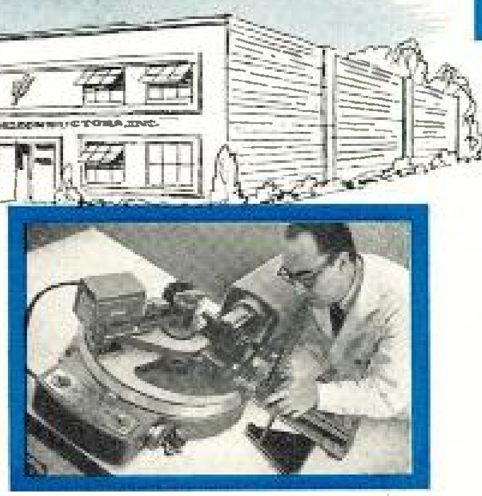
now...from Pacific Semiconductors

new techniques

new performance

Back of Pacific Semiconductors' new diode design is a fresh approach based on experience . . . over 145 man-years professional experience in the field of semiconductor electronics. Starting where others have left off, these pioneers in one of the decade's most promising electronic fields have developed a series of truly *new* semiconductor devices uniquely suited to the demands of today's airborne and computer circuitry. Experienced personnel and a thorough, continuing research and development program are your assurance of the most advanced design, combined with *proven* performance at levels heretofore unobtainable. Pioneering at PSI is not mere guesswork; it is based on thorough knowledge of each product and of the conditions under which that product is used. In the months and years to come, look to PSI . . . Pacific Semiconductors, Inc. . . . for your requirements of gold bonded germanium diodes, silicon junction diodes and other important semiconductor devices. Inquiries are invited for both standard units and for the special characteristics constantly called for by advances in electronic design.

High-purity silicon crystals are drawn in PSI's high frequency induction furnaces.



X-ray diffraction orients crystals prior to slicing wafer for silicon junction diodes.

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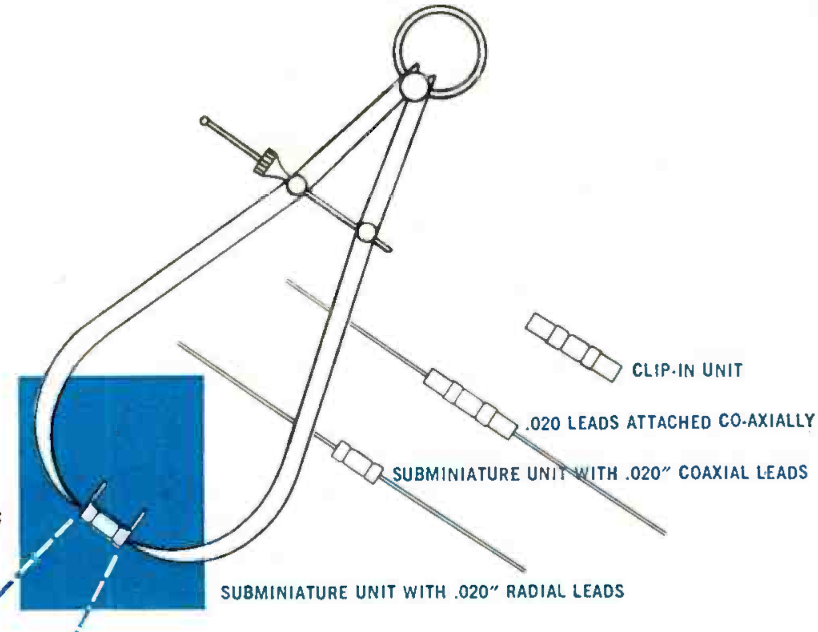
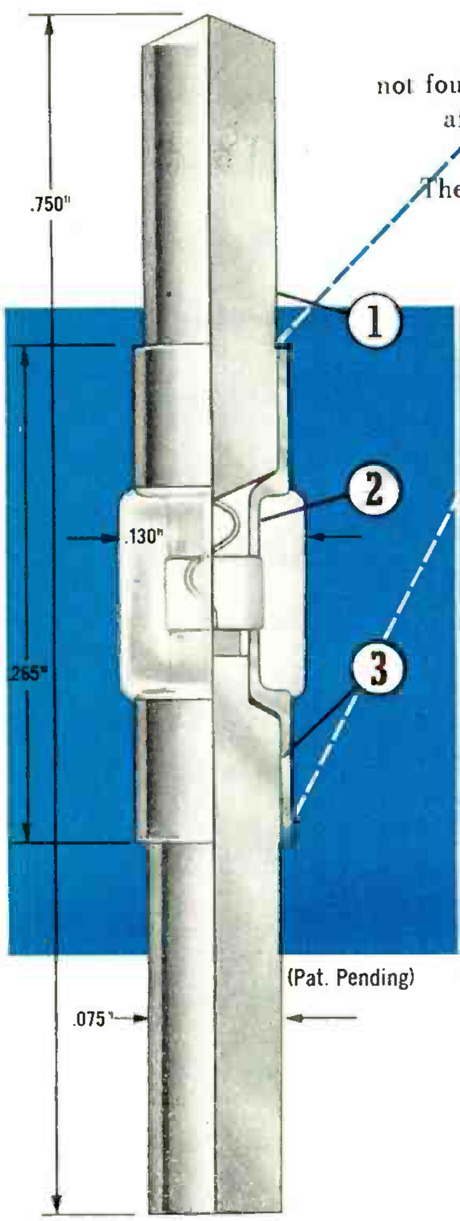
NOW AVAILABLE

- **GERMANIUM GOLD BONDED DIODES**
- **SILICON JUNCTION DIODES**

in the new ***PSI diode package . . .***
designed around user requirements



PSI's revolutionary new package, with advantages not found in any other commercially available diodes, was designed only after an exhaustive survey of user requirements. Space limitations, environmental demands, even assembly procedures became factors in the final design. The result: diodes with demonstrably superior performance, greater versatility, top all-around utility.



(Pat. Pending)

*CHECK THESE BENEFITS . . .

1. VERSATILE LEAD ARRANGEMENT . . . for maximum adaptability, diodes may be obtained in a variety of configurations.

2. GLASS-TO-METAL SEAL . . . for positive moisture resistance, PSI uses a true fusion seal.

3. WELDED CONSTRUCTION . . . for greater strength and freedom from contamination; no low melting point solders are used.

and your net benefit from all these features . . .

NEW STANDARDS OF RELIABILITY AND STABILITY

Typical PSI Gold Bonded Diode Characteristics @ 25°C

Forward Current @ 1v (ma)	Inverse Current (μa)	Inverse Working Voltage (volts)
100	100 (−20v)	35
35	10 (−50v)	80
15	25 (−50v) 200 (−200v)	220

Typical PSI Silicon Junction Diode Characteristics

E_s/E_t (volts)	Forward Current @ 1v (ma)	Back Current	
		at 25°C	at 150°C
30/29	80	$.01\mu a$ (−15v)	$5\mu a$ (−15v)
55/53	40	$.01\mu a$ (−30v)	$5\mu a$ (−30v)
150/145	15	$.01\mu a$ (−75v)	$5\mu a$ (−75v)
300/290	5	$.01\mu a$ (−150v)	$5\mu a$ (−150v)

a: The saturation voltage (E_s) is measured at $500\mu a$; the transition voltage (E_t) is measured at $20\mu a$.
b: Recovery time: after switching from 5ma forward current to −40v for all these types, back resistance reaches or exceeds 50K in $1\mu sec$.

For complete product specifications, address inquiries to Dept. S-5

PACIFIC SEMICONDUCTORS, INC.
10451 WEST JEFFERSON BOULEVARD
CULVER CITY, CALIFORNIA

For product information, use inquiry card on last page.

www.americanradiohistory.com

Why Ace Shielded Enclosures are your

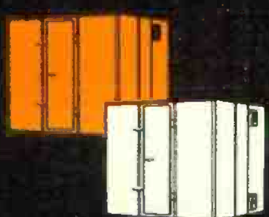
Best Buy

- ... ACE offers the *highest* attenuation over the *widest* frequency range, proved by independent testing laboratories.
- ... ACE takes the guesswork out of shielded enclosure buying. You get all the facts on which to base sound decisions, backed by *guaranteed* test data.
- ... ACE and only Ace, offers a truly interchangeable-panel enclosure, with bolting interior to the room but external to the shielding medium.
- ... ACE provides full engineering assistance—assurance that your specific enclosure needs will be met.
- ... ACE is first and foremost in the design and manufacture of every type of shielded enclosure for electronics, military, and general industry.

...ACE "CELL-TYPE" SCREENED ENCLOSURES

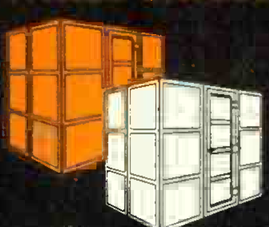
Here's the maximum in screen room performance. A must for laboratories and electrical manufacturers performing tests with highly sensitive equipment. 108db from 14kc to 1000mc; 103db at 3000mc (MIL-S-4957 measurements).

...ACE SOLID SHEET METAL (RFI DESIGN) ENCLOSURES



These enclosures employ the rugged Lindsay Structure, available in either sheet copper or galvanized. They can be transported completely assembled or disassembled; may be used indoors or out. Copper: 100db from 150kc to 1000mc; 70db at 15kc (Uniform-Field measurements). Galvanized: 110db from 14kc to 1000mc; 9db at 60cps; 37db at 1000cps for magnetic fields (MIL-S-4957 measurements).

...ACE SINGLE-SHIELD SCREENED ENCLOSURES



An economical enclosure, available in copper or galvanized wire cloth, that meets basic requirements for suppressing r-f radiations of industrial or laboratory equipment. Copper Screen: 70db from 100kc to 1000mc, 40db at 14kc. Galvanized Screen: 40db from 15kc to 400mc (Uniform-Field measurements).

Write for Catalog and Free Technical Data.

ACE

ACE ENGINEERING & MACHINE CO., INC.

3644 N. Lawrence Street • Philadelphia 40, Pa.

Telephone: REgent 9-1019 • REgent 9-2537 • GArfield 5-1160

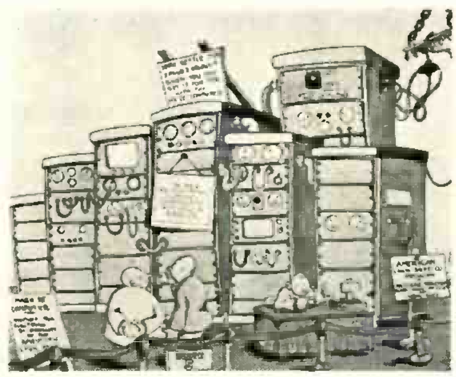
See Us at the I.R.E. Show—501, 600 and 601 Production Road

TELE-TIPS

FEDERAL TAX burden on the residents of the various states has been broken down by the Tax Foundation. Highest per capita of $553.93 is for Nevada, while the lowest of $185.87 is for Mississippi. Fiscal 1956 per capita taxes for some other states are: Calif., $492.92; Ill., $493.01; Mass., $419.52; N.J., $459.94; N.Y., $520.63; Penna., $420.41; and Texas, $366.86.

ATOMIC CLOCK, called the Cesium Atomic Frequency Standard, has been announced by MIT's Lab. for Nuclear Science. The unit is claimed to be so precise, that if it had been ticking away since the time of Christ it would now be only one-half second "wrong." Time keeping is controlled by the oscillation of electrons in the cesium atom at a frequency of about 9192.632 MC. Applications envisioned are a test of Einstein's General Theory of Relativity, communications synchronization and geophysical measurement of the earth's rigidity.

LAMPOON of industry by Bill Eddy's satirical cartoons on Brown Instruments' 1955 calendar is worth a few chuckles. The drawing shows



the "Mark IV Computer with built-in abacus, another all electronic by-product of the American Lawn Seed Co., specialists in nuclear reactors, ultra-sonic whistles, and grass seed."

NO STICKY FINGERS in the till is the object of one closed-circuit TV plan. According to a letter received by the editors, "We have a client who is interested in a closed circuit camera to be used between the cash register system and the main office in a supermarket."

(*Continued on page* 58)

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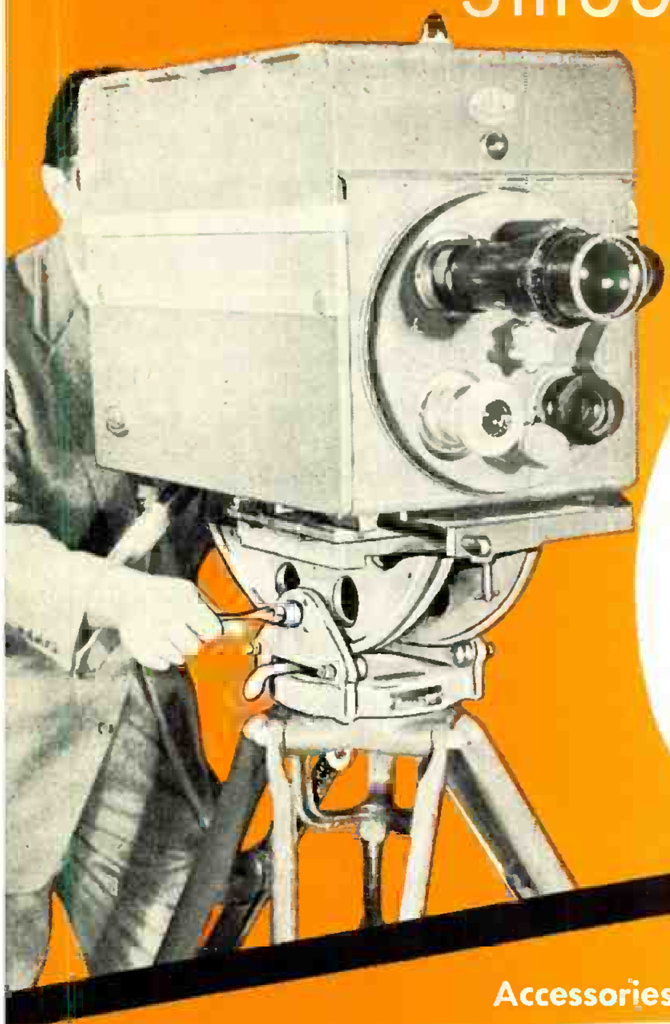
Smooth, Smoother, S-m-o-o-t-h-e-s-t



TV camera action ever known wit

CAMERA EQUIPMEN

GRAVITY BALANCED ROCKER TYPE PAN AND TILT HEA

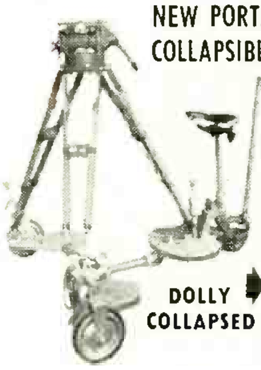
You'll know what we're talking about the instant you try it! C new ROCKER Head has almost gyroscopic action, smooth, effortle No longer do you have to fight spring balance to make your til

You establish absolute balance by positioning camera ROCKER head platform and adjusting center of gravity with verni control. Long and short lenses are compensated for wi vernier adjustment. Prompting device may be added and balanc easily. Convenient brake handles and locking devi for pan and tilt tension. Fits standard tripod and dolli Lighter in weight—and more economical in pri See it—test it—it's a "must

Accessories that SURPASS accepted standards— for Studio, Mobil and Micro-Relay Equipmen

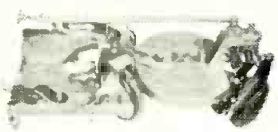
New Model C BALANCED TV Head provides correct center of gravity in a FLASH— without groping. No matter what focal length lens is used on the turret, the camera may be balanced by the positioning handle without loosening the camera tie-down screw. Something every camera-man has always desired.

NEW PORTABLE 3-WHEEL COLLAPSIBLE DOLLY



Dolly folds to fit into carrying case—18"x12" x36". Weighs only 60 lbs. Has wheel in rear for steering, which may be locked for straight dollying.

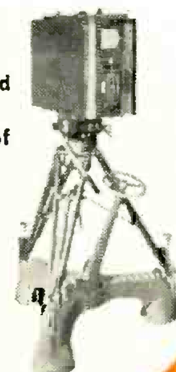
DOLLY COLLAPSED



MICRO RELAY

Micro wave relay beam reflector head, also metal tripod. Head is perfect for parabolas up to 6 ft. diameter, withstands torque spec's environmental treated. Tripod legs work in unison, one lock knob, spurs and rubber foot pads included.

Famous BALANCED TV Head supporting a TV camera. Both are mounted on one of our all-metal tripods, which in turn is mounted on a Ceco Spider Dolly. Here is a "team" outstanding for versatility and maneuverability in studio or on location.



WRITE FOR COMPLETE ILLUSTRATED BROCHURE

FRANK C. ZUCKER

CAMERA EQUIPMENT CO.

Dept. T-2-15 • 1600 Broadway • New York City

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Varian Magnetometer to Be Used by Hycon for Magnetic Surveys

Exclusive world-wide rights for the Varian Earth's-Field Magnetometer have been granted to Hycon Aerial Surveys of Pasadena, Calif. With this contract, Hycon Aerial Surveys becomes a separate corporation in which both Hycon Mfg. Company and Varian Associates hold ownership interest.

In the Varian magnetometer a simple bottle of water greatly speeds exploration of what lies beneath the earth's surface. It uses the inherent properties of hydrogen nuclei, contained in any sample of tap water, to detect and measure minute changes in the earth's magnetic field. By the alternate application and removal of a strong d-c magnetic field, the hydrogen nuclei are made to precess. The frequency of precession is measurable and is in direct relation to the intensity of the earth's magnetic field. Mineral or ore deposits, or for that matter any large ferrous structure capable of distorting the earth's field will be indicated. An outstanding advantage of this type magnetometer is that it measures the earth's magnetic field directly, and does not involve such determination through horizontal and vertical components. Another important feature lies in the fact that the instantaneous field information

Alden E. Acker (l) and Dr. Russell Varian (r) with a model of the Varian Earth's Field Magnetometer pickup. Mr. Acker is President of Hycon Aerial Surveys and Dr. Varian is Vice President in charge of research.

can be telemetered back to a central control point. This makes for a minimum of equipment on board the survey plane and permits a more immediate thorough analysis of readings obtained. Surveys are flown on, nominally, 1 mile grid coordinates. This figure however is expanded or reduced depending on the amount of earth's field information required from a given area.

The "bird" as the magnetometer is called, is trailed behind the survey airplane and is little more than a jar of water with a coil wrapped around it housed in a streamlined cone. Relatively inexpensive to build, there is negligible loss if the pilot comes too close to the ground and smashes the jar of water and coil.

Automatic Broadcast System

Automation in the broadcast industry has been advanced with the Ampex Corp. announcement of the successful completion of a six-weeks' field test of its automatic programming equipment at KEEN in San Jose, Calif. The system can broadcast a better than ten-hour schedule without the need for human assistance of any kind.

Automatic tape recorder broadcast system plays 10-hour schedule without human aid

Basically it consists of two electronically interlocked tape playback units, one capable of playing eight hours of recorded material from a single tape, and the other, up to four hours. On the first unit is placed program material, either from a library built up by the station over a period of time or from a network or commercial transcription service. Spot announcements, local programs and station breaks are recorded daily in the station's own studio and placed on the second machine.

After each segment of program material and after each local announcement, a sub-audible tone is recorded. At the end of a program segment, the device hears this tone and starts the announcement machine. After the announcement, another tone starts the program. This see-saw action continues until, at each half-hour, a timing device corrects for any slight time deviation in the system and inserts a station break.

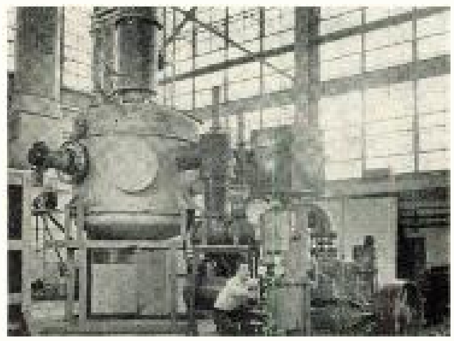
It is through more efficient use of personnel that the system is expected to be a big boon to station operators. An announcer can record enough announcements for a regular eight-hour shift in an hour or two, since he does not have to wait through the actual playing of the program material.

High-Vacuum Furnace

Consolidated Vacuum Corp. has shipped to the Metallurgical Development Lab. of Westinghouse Electric Co. in Blairsville, Pa., its first, modular type, 1000-pound capacity high-vacuum furnace.

This is claimed to be the first application of CVC's new technique of using modules or "building blocks" in the design and construction of high-vacuum furnaces. The modular type furnace offers maximum flexibility in operational technique and provides economical expansion to larger capacities.

Initially the Westinghouse people will melt a 350 pound charge in the CVC furnace and pour a single ingot. By interchanging the crucible-coil assembly and furnace bottom, by adding vacuum interlocks and a second large capacity vacuum pump; this same 350-pound furnace can be expanded to 1000-pound capacity for semi-continuous operation and permit the pouring of single, multiple, or centrifugal cast ingots. All alterations to the furnace can be made in the field without disturbing the basic installation.



Undergoing final tests is the modular type 1000-pound high-vacuum furnace.

Vacuum melted metals are currently used by aircraft manufacturers in building jet engines and planes capable of withstanding high-temperatures and high-pressures, by the chemical industry to produce porous-free metal so essential in large rollers and presses, and by industry in general to produce metals having physical characteristics heretofore impossible by other methods.

MORE NEWS on page 28

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2J32 MAGNETRON

2K28 KLYSTRON

HELPING ESTABLISH RELIABILITY RECORDS

Raytheon Magnetrons and Klystrons in proved Gilfillan ASR-1 Radar

Civil Aeronautics Administration reports record-breaking reliability of Gilfillan airport surveillance radar. Boston International Airport had 8,760 hours continuous performance with only 7⅓ hours involuntary outage—less than 1/10 of 1%—from their Gilfillan installation.

Condensed Typical Operating Data

	Power Output	Frequency Range, mc	Reflector Voltage	Resonator Voltage	Maximum Temp. Coef.	Tuning	Cavity
2K28	140 mw	1200-3750	—140 v. to —300 v.	300 v.	±.15	Mech. Inductive	Ext.
	Power Output	**Frequency Range, mc**	**Anode kv**	**Anode Amps.**	**Pulse Width**	**P.R.R.**	
2J32	285 kw min.	2780-2820 Fixed freq.	20	30	1 μsec	1,000	

Check these performance records of Raytheon tubes in the Gilfillan ASR-1. Average life, 2J32 Magnetron: 4,000 hours. Average life, 2K28 Klystron: 2,500 hours.

Your microwave and radar equipment offers extra reliability when you specify Raytheon Magnetrons and Klystrons. Use these rugged, reliable tubes in your present and proposed systems. Contact Power Tube Sales to take advantage of Raytheon's Application Engineer Service, without obligation. Write for free Tube Data Booklets.

RAYTHEON *Excellence in Electronics*

RAYTHEON MANUFACTURING COMPANY, Microwave and Power Tube Operations, Section PL00, Waltham 54, Massachusetts

For product information, use inquiry card on last page.

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Coming Events

A listing of meetings, conferences, shows, etc., occurring during the period April through September 1955 that are of special interest to electronic engineers

Apr. 4-5—Atomic Industry Conference, sponsored by Atomic Industrial Forum and Stanford Res. Inst., Mark Hopkins Hotel, San Francisco, Calif.

Apr. 5-7—RTCA Spring Assembly Meeting, sponsored jointly by RTCA and Los Angeles Section of IRE, Los Angeles, Calif.

April 6-10—World Plastics Fair and Trade Exposition, National Guard Armory, Los Angeles, Calif.

April 12-14—RETMA Spring Conference, Roosevelt Hotel, New York, N.Y.

Apr. 13-15—AIEE District #4 Meeting, Soreno Hotel, St. Petersburg, Florida

April 13-15—International Symposium on Modern Network Synthesis, II, sponsored by the Polytechnic Institute of Brooklyn, Engineering Societies Building, New York, N.Y.

Apr. 14-23—International Trade Fair, Hanover, Germany.

Apr. 15-16—9th Annual Spring Technical Conference, sponsored by Cincinnati Section of IRE, Engineering Soc. of Cincinnati Bldg., Cincinnati, Ohio.

Apr. 18-21—24th National Packaging Exposition, sponsored by American Management Association, International Amphitheatre, Chicago, Ill.

Apr. 18-22—National Convention of Dept. of Audio-Visual Instruction of Nat'l. Education Assn., Hotel Biltmore, Los Angeles, Calif.

April 18-22—77th Semi-Annual Convention of the Society of Motion Picture and Television Engineers, The Drake, Chicago, Illinois.

April 19-21—12th British Radio Components Show, Grosvenor House, London, England.

April 20-22—27th Annual Conference and Exhibition, sponsored by Petroleum Ind. Elect. Assoc. and Petroleum Electric Supply Assoc., Shamrock Hotel, Houston, Texas.

April 25-27—8th Annual Conference for Protective Relay Engineers, A.&M. College of Texas, College Station, Texas.

April 27-29—7th Regional Conference and Show, sponsored by IRE, Hotel Westward Ho, Phoenix, Ariz.

April 29-30—New England Radio-Electronics Meeting, sponsored by Boston and Connecticut Valley Sections of IRE, Sheraton Plaza Hotel, Boston, Mass.

May 2-5—3rd Annual Semiconductor Symposium of Electrochemical Soc., Cincinnati, Ohio.

May 2-13—British Industries Fair, London and Birmingham, England.

May 3-5—URSI Spring Meeting, sponsored by the IRE Professional Group on Antennas and Propagation, Microwave Theory and Techniques and Circuit Theory, National Bureau of Standards, Washington, D. C.

May 4-6—4th Int'l Aviation Trade Show, 69th Regiment Armory, N.Y.

May 4-6—AIEE District #2 Meeting, Deshler-Hilton Hotel, Columbus, Ohio

May 6—American Assoc. of Spectrographers 6th Annual Conference, Chicago, Ill.

May 9-11—1955 National Conference of Aeronautical Electronics, sponsored by IRE Dayton Section on Airborne Electronics, Biltmore Hotel, Dayton, Ohio.

May 10-12—Metal Powder Show sponsored by Metal Powder Assn., Bellevue-Stratford Hotel, Philadelphia, Pa.

May 16-19—Electronic Parts Distributors Show, Conrad Hilton Hotel, Chicago, Ill.

May 16-20—National Materials Handling Exposition, International Amphitheatre, Chicago, Ill.

May 18-20—Nat'l Telemetering Conference and Exhibit, sponsored by IRE, AIEE, IAS, ISA, Hotel Morrison, Chicago, Ill.

May 19-21—Global Communications Conference, sponsored by Armed Forces Communications Assn., Hotel Commodore, New York, N. Y.

May 23-25—9th Annual Convention of the American Society for Quality Control, Hotel Statler and Hotel New Yorker, New York City, N. Y.

May 24-26—9th Annual Broadcast Engineering Conference, sponsored by NARTB, Shoreham and Sheraton Park Hotels, Washington, D.C.

May 26-27—Electronic Components Conference, Los Angeles, Calif.

June 1-11—British Plastics Exhibition, Olympia, London, England.

June 2-5—ARRL Hudson Div. Convention and Amateur Radio Equipment Show, Hotel Adelon, Long Beach, N.Y.

June 2-3—IRE Materials Symposium, sponsored by the Philadelphia section of the Professional Group on Components, Convention Hall, Philadelphia, Pa.

June 6-8—National Community Television Assn. Convention—Park Sheraton Hotel, New York, N. Y.

June 7-10—National Spring Meeting of the American Welding Society, Hotel Muehlebach, Kansas City, Mo.

June 14-16—Conference and Exhibit on Magnetics, sponsored by the AIEE, in cooperation with the APS and the AIMME, William Penn Hotel, Pittsburgh, Pa.

June 20-23—2nd International Powder Metallurgy Congress, Reutte, Tyrol, Austria.

June 20-25—Symposium on Electromagnetic Wave Theory, sponsored by Commission VI of URSI and Univ. of Mich., University of Mich., Ann Arbor, Mich.

June 25-July 1—58th Annual Meeting ASTM, Atlantic City, N. J.

June 27-July 1—AIEE Summer Meeting, New Ocean House, Swampscott, Mass.

July 12-14—2nd Western Plant Maintenance Show, Pan Pacific Auditorium, Los Angeles, Calif.

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

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

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

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

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

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

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

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

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

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

Abbreviations:

ACM: Assoc. for Computing Machines.
AES: Audio Engineering Society.
AIEE: American Institute of Electrical Engineers.
AIMME—American Institute of Mining & Metallurgical Engineers
APS—American Physical Society
ASTM: American Society for Testing Materials.
IRE: Institute of Radio Engineers.
IAS: Institute of Aeronautical Sciences.
ISA: Instrument Society of America.
NACE: National Assoc. Corrosion Engineers.
NARTB: National Assoc. of Radio and TV Broadcasters.
RETMA: Radio-Electronics-TV Manufacturers Assoc.
RTCA: Radio Technical Commission for Aeronautics.
RTCM: Radio Technical Commission for Marine Services.
URSI: International Scientific Radio Union.

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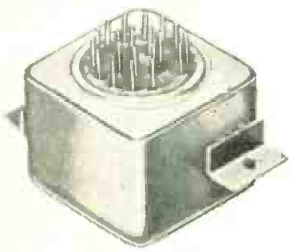
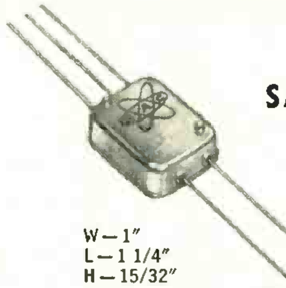


Depicted—6KC 100 Watt Unit
Less than 1.65 cubic inches

POWER TRANSFORMERS

Range—400-6000 cps
Efficiency—up to 95%
Wattage—6mw-200 watts
Temperature—-55 to +155° C.



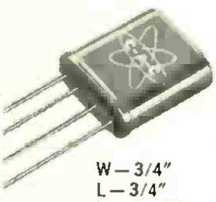
W—1"
L—1 1/4"
H—15/32"

SATURABLE REACTORS

Applications

- Servo Systems
- Data Telemetering
- Remote Frequency Control

Illustrated—High Frequency Reactor Tuned by Varying D. C. Current

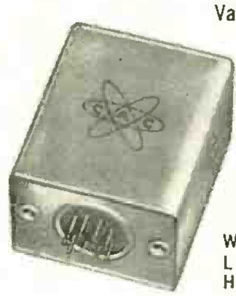


W—3/4"
L—3/4"
H—5/16"

PULSE TRANSFORMERS

Pulse Width—.2-50 microseconds
Rise Time—from .03 microseconds

- Blocking oscillator
- Pulse coupling
- Toroidal construction

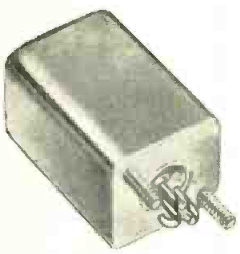


MAGNETIC AMPLIFIERS

Wattage (output) .5-200 watts
Response—1 cycle up

W—1 1/4"
L—1 3/4"
H—2 5/32"

Illustrated—Auto Pilot Application for Printed Circuit Mounting



W—23/32"
L—23/32"
H—11/16"

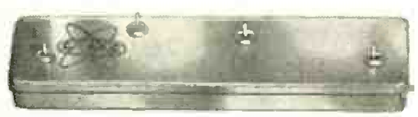
Illustrated
4KC
Band Pass

SUB-MINIATURE FILTERS

For Chassis Mount

Frequency—2.3-35Kc
Impedance in—600-10K Ohms
Impedance out—Grid

- Hermetic Sealed
- Temperature Compensated
- Internal D.C. Isolation
- Balanced or Unbalanced
- Military Specifications



SUB-MINIATURE TUNED CIRCUITS

For Printed Circuit Applications

- Multiple Tuned Transformers
- Delay Lines
- Tuned Circuits

W—1"
L—4 1/4"
H—7/16"

FOR ADDITIONAL INFORMATION CONTACT

COMMUNICATION ACCESSORIES COMPANY

3-55/1.0

HICKMAN MILLS, MISSOURI • PHONE KANSAS CITY, SOUTH 5528

For product information, use inquiry card on last page.

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Standard Electronics . . .

PROOF OF ECONOMY

SAVE with S-E TV Transmitting Equipment!

1 **A RECENT COMPARISON** of transmitter equipment manufactured by Standard Electronics and by Manufacturer "B" showed that if you bought S-E high power VHF transmitting equipment your savings in initial cost and operating expenses over 10 years would amount to:

total savings approx. $293,000.00

SAVINGS with S-E 50 KW Transmitter compared to competitive 50 KW Transmitter "B" (10 YEARS)

	OPERATING TUBE COSTS	POWER COSTS	INITIAL INVESTMENT	TOTAL COSTS
Transmitter "B"	$312,000	$144,360	$224,000	$680,360
S-E	$ 57,600	$108,360	$221,000	$386,960
Savings with S-E	$254,400	$ 36,000	$ 3,000	$293,400

NOW . . . Operating information is available to compare S-E equipment with manufacturer "C's". Examine the detailed "proof of economy" presented here.

2 **AGAIN,** S-E can show substantial savings! The chart at right illustrates the overall savings you can realize in 10 years when you buy S-E, as compared to operating costs of equipment by Manufacturer"C".

total savings approx. $169,000.00

SAVINGS with S-E 25 KW Transmitter compared to Transmitter "C" with only 20 KW (10 YEARS)

	OPERATING TUBE COSTS	POWER COSTS	TOTAL COSTS
Transmitter "C"	$167,400	$83,520	$250,920
S-E	$ 22,200	$59,520	$ 81,720
Savings with S-E	$145,200	$24,000	$169,200

3 **AND** to further accentuate this saving, note that Manufacturer "C" rates his high band transmitter at 20 KW compared to S-E's rating of 25 KW.

you get 25% additional transmitter power output... AND FOR LESS MONEY, TOO!

VHF Output Power Rating

Transmitter "C"	20 KW
S-E	25 KW
Percent Extra Power with S-E	25%

4 **FOR INSTANCE, TUBE COSTS:** The chart at the right is a tabulation of all tubes having a list price of over $100.00 each, used in Transmitter "C" and in the S-E transmitter.

The total list price of these tubes is shown in the chart to the right. It is evident that the *replacement cost* of the high priced tubes is almost 200% greater for Transmitter "C" than for S-E . . . resultant

savings of approx. $5,000.00

Tube Tabulation

	DRIVER	AMPLIFIER
S-E	4—4X500 2—AX9904R	8—AX9904R
Transmitter "C"	2—3X2500A3 8—5513 4—5588	4—6166 6—869B

Tube List Prices

	DRIVER	AMPLIFIER	TOTAL
Transmitter "C"	$3076	$4448	$7524
S-E	$ 904	$1680	$2584
Savings with S-E	$2172	$2768	$4940

All the figures used in this presentation are based on the latest available information for *High Band VHF Transmitting Equipment.*

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5 **THIS MEANS** your operating cost for tubes alone, based on 6,000 hours per year with an S-E 25 KW transmitter will SAVE YOU (compared to Transmitter "C") a 10 year total

savings of approx. $145,000.00

6 **IN ADDITION** substantial savings in your power bill are yours when you purchase S-E transmitting equipment. A comparison of published data for an S-E 25 KW and for Manufacturer C's 20 KW transmitter operated at black level with a 90% power factor, indicates a 10 year

savings of approx. $24,000.00

7 **SUMMARY:** From this information, savings in operating costs over a period of 10 years would indicate that YOU can

SAVE APPROX. $169,000.00

with economical, dependable S-E Transmitters!

Operating Tube Cost

	HOURLY COST TRANSMITTER "C"	HOURLY COST S-E	HOURLY SAVINGS WITH S-E	10 YEAR SAVINGS WITH S-E
Driver	$1.28	$0.15	$1.13	$67,800
Amplifier	$1.51	$0.22	$1.29	$77,400
Total Transmitter	$2.79	$0.37	$2.42	$145,200

Power Cost

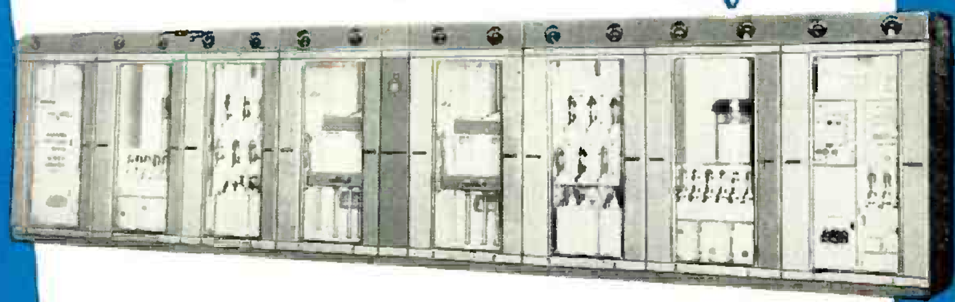
	DRIVER KW	AMPLIFIER KW	TOTAL TRANSMITTER KW	YEARLY DEMAND CHARGE @ $3 PER KW	YEARLY POWER COST @ 1c PER KWH	TOTAL
Transmitter "C"	22	65	87	$3,132	$ 5,220	$8,352
S-E	15	47	62	$2,232	$ 3,720	$5,952
Savings with S-E	7	18	25	$ 900	$ 1,500	$ 2,400
10 Year Savings				$9,000	$15,000	$24,000

Savings in Operating Costs (10 Years)

TUBE SAVINGS	$145,200
POWER SAVINGS	$ 24,000
TOTAL	$169,200

PROOF once again that with S-E TV Transmitting equipment you SAVE IN EVERY WAY!

Standard Electronics high band 25 KW transmitter gives you these extra ECONOMY PLUS features . . . economical installation . . . less floor space . . . integral air cooling . . . no complex plumbing and water pumps . . . "Add-A-Unit" permits expansion to higher power with no obsolescence of present equipment . . . ability to handle color is engineered into every S-E transmitter.



Compare S-E with any other make of transmitter for ECONOMY...QUALITY...PERFORMANCE!

For specifications and a copy of the "PROOF OF ECONOMY REPORT" write, wire, or phone Standard Electronics.

STANDARD SE ELECTRONICS

standard electronics corporation

A SUBSIDIARY OF CLAUDE NEON, INC.

255-289 EMMETT ST. • NEWARK 5, N. J. • BIgelow 3-5540

Operating costs are determined on the basis of 6000 hours of operation per year. Detailed comparison available on request.

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Electronic Industries News Briefs

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

ALTEC SERVICE CORP., New York, N. Y. recently announced the consummation of a contract for a public address system in the First Methodist Church, Mason City, Ia. This is the second sound engineering contract awarded to Altec within a brief period. The first installation was awarded in behalf of the Connie Mack Stadium, Philadelphia, Pa.

AMPEX CORP., Redwood City, Calif. states that its engineers are progressing in the development of such new products as an automatic programming system for radio stations, stereophonic sound reproducers for the high fidelity market and airborne instrumentation recorders for flight testing aircraft and missiles.

AMERICAN MACHINE & FOUNDRY CO. has leased land and awarded a contract for the erection of two radar-testing elevated platforms at Shelton and Seymour, Conn., on the banks of the Housatonic River. The range, with mile-apart towers, will be used for testing in microwave analysis and radar antenna design.

ASSEMBLY PRODUCTS, INC. recently moved to a larger plant in Chesterland, O. without noticeable loss of production. The new plant has twice the former floor space and better production line layouts to maintain prompt delivery.

BENDIX AVIATION CORP., INTERNATIONAL DIV., announced that over $2,000,000 worth of Bendix aircraft accessories and components was purchased for 90 turbo-prop "Viscounts" made by England's Vickers Armstrong, Ltd., ordered by a group of foreign air lines.

DALMO VICTOR CO., San Carlos, Calif., will appoint one microwave specialist, one servomechanism engineer, one mechanical engineer, and one industrial engineer during its first year of participation in the five-year Honors Cooperative Program of the School of Engineering of Stanford University.

THE BARRY CORPORATION, Watertown, Mass., has changed its name to a more accurately descriptive title, **BARRY CONTROLS, Inc.**

BOGUE ELECTRIC MANUFACTURING CO., Paterson, N. J. has announced the availability of general purpose N-P-N grown junction transistors in quantity.

CORNELL-DUBILIER ELECTRIC CORP., S. Plainfield, N. J. announces the opening of the new Los Angeles Div. plant situated on the west side. It is equipped to handle all phases of engineering, design, and sample production of capacitors and filters.

DAGE TELEVISION, THOMPSON PRODUCTS, INC., Cleveland, O., recommended more TV stations to reach more people to the FCC, particularly in places with less than 50,000 population. Approval of low-power transmitting stations could bring TV to such "black-out" areas for the first time, it was reported.

ELECTRODATA CORP. Pasadena, Calif. announced its second annual University Scholarship Program in computers to be held June 7 through September 2, 1955. Financially aided students selected from leading universities will take a 10-week course at Electrodata headquarters.

ELECTRODATA CORP., affiliate of **CONSOLIDATED ENGINEERING CORP.**, plans a new 40,000 sq. ft., $750,000 plant in Pasadena that will double capacity.

FAIRCHILD ENGINE AND AIRPLANE CORP., Wyandanch, L. I., N. Y., has appointed **DYNAMIC SALES ENTERPRISES, INC.**, 103 Park Ave., New York sales representative for electronic laboratory equipment and other industrial devices.

GENERAL ELECTRIC CO., Syracuse, N. Y. has taken a further step in the consolidation of GE's Heavy Military Equipment Dept. by planning the erection of a 69,000 sq. ft. structure in the "Systems Center" this year that will house the marketing section and engineering laboratories.

GENERAL ELECTRIC CO., Schenectady, N. Y. was requested to repair a 33-year-old mercury arc rectifier tube which charges the batteries of a 1922 Detroit Electric Car still giving good service to a Long Island family—the tube had partially lost its vacuum and become "gassy."

GORDON ENTERPRISES, North Hollywood, Calif., announced the completion of an electronic test panel to check out and test the most complex of the new electrical camera devices.

GULTON MFG. CORP. Metuchen, N. J. has been granted an exclusive license to produce and market a new series of subminiature variable reluctance accelerometers developed by Boeing Airplane Co.

HEWSON CO., INC., Newark, N. J. announces that electronic controls prevent loading of inflammable liquids if equipment is not properly grounded and thus reduce exposure to fires.

HOFFMAN ELECTRONICS CORP., Los Angeles, Calif., has purchased the assets, and leased the premises of E. M. Kemp Co., and has been operating its own sales organization in the Sacramento area since March 1.

IRON FIREMAN ELECTRONICS DIVISION, Portland, Ore., recently announced that miniature slip ring and brush assemblies matched to specific project requirements are now being manufactured.

KAY LAB, San Diego, Calif. has developed and installed a TV camera system in the TV controlled equipment used for the treatment of deep-seated cancer at the Cedars of Lebanon Hospital, Los Angeles, Calif. The TV camera replaces the eyes of the radiologist when a cobalt "bomb" is centered on the tumor site.

GRAND RAPIDS DIV. of LEAR, INC., Santa Monica, Calif., has been awarded contracts totaling over $15,000,000 for instruments during the first two months of 1955.

LYNCH CARRIER SYSTEMS, INC., San Francisco, Calif., opened a midwest sales and engineering office in the Graybar building, 850 Jackson Blvd., Chicago, Ill. under the direction of Herbert E. Reynolds.

MAGNAVOX CO., Fort Wayne, Indiana, is undertaking a program of expansion at their Research Laboratories in West Los Angeles. Dr. Ragnar Thorensen has been appointed director of research. Dr. John Salzer is now assistant director.

MACK TRUCKS, INC., New York, N. Y. has acquired **WHITE INDUSTRIES, INC** and **RADIO SONIC CORP.**, New York, N. Y. as a first major step in a long range product diversification program.

MINNEAPOLIS-HONEYWELL'S Industrial Division Training School, Philadelphia, Pa., graduated some 315 employees representing 204 companies in 33 states and 9 foreign nations according to M. J. Ladden, director.

MONSANTO CHEMICAL CO., St. Louis, Mo., recently received delivery of the first **INTERNATIONAL BUSINESS MACHINE** Type 702 electronic data processing machine —the largest of the so-called electronic brains made by IBM and the first installed outside that company's own offices. The 702 consists of 23 units electronically connected by cables.

NATIONAL UNION ELECTRIC CORP., Orange, N. J., announces that its research and transistor divisions have been awarded government contracts totalling nearly $1,000,000 for work in the electronic field.

OLYMPIC METAL PRODUCTS CO., has completed a 100% expansion in plant facilities at Alpha, N. J. to be used almost exclusively in producing deep-drawn, fine-metal, seamless housings.

PHILAMON LABORATORIES INC., formerly of Brooklyn, N. Y., have acquired a modern 15,000 sq. ft. plant at 90 Hopper St., Westbury, N. Y.

RADIO CONDENSER CO., Camden, N. J., has organized a new automation division for design and engineering connected with the manufacture of electro-mechanical assemblies.

RADIO CORPORATION OF AMERICA, New York, N. Y., established it new Aviation Systems Engineering Laboratory in Waltham, Mass. because of New England's increasingly important role as a center for the advancement of electronic science,according to the statement of Theodore A. Smith, vice president and general manager of RCA Engineering Products Div.

RAYTHEON MANUFACTURING CO., Waltham, Mass., has developed a new automatic radio direction finder, said to be the first specifically designed for marine use to determine exact positions in offshore waterways.

RETMA recently announced its sponsorship of the attendance of 29 manufacturers of electronics equipment and parts, with FCDA, at an atomic test this spring at the Nevada site as an aid to the electronics industry, and the FCDA, in evaluating the effects of nuclear explosion on typical civilian communications equipment.

ROBERTSHAW-FULTON CONTROLS CO., THERMOSTAT DIV., Bridgeport, Conn., $2,000,000 plant has its steel work completed. The building is up to construction schedule and will be ready in July. The entire personnel of the existing Bridgeport plant is expected to move into the new quarters.

ROBINSON AVIATION, INC., Teterboro, N. J., has signed a twenty year lease agreement with the Port of New York Authority for construction of a new 42,000 sq. ft. factory to handle Robinson production. To cost $425,000, exclusively to land value, the building will be located on Teterboro airport's northeast corner.

ROLLER-SMITH CORP., INSTRUMENT DIV., Bethlehem, Pa., has appointed **QUALITY ELECTRIC CO.**, 2212 S. Hill St., Los Angeles, Calif., as its West Coast repair station to service and repair meters for customers in the western section of the country.

SMPTE and the **U. S. NAVY** have developed a short inexpensive test film for rapidly checking and demonstrating 16mm projector system performance. Checks 135 feet of film in four minutes.

TERMINAL RADIO INTERNATIONAL, LTD., New York, N. Y., has issued a 4-page folder describing the firms facilities, special services, and products. Gives brief information on export-import procedure, etc.

THOMPSON PRODUCTS, INC., Cleveland, O., received the American Legion's annual award for personnel practices which have made it Ohio's outstanding employer of physically handicapped veterans.

TRAV-LER RADIO CORP., Chicago, Ill., has officially assumed full control of the entire stock of the Hallicrafters Co. wholly owned Canadian subsidiary, Hallicrafters Canada, Ltd. in accordance with an agreement signed January 17, 1955.

MORE NEWS on page 36

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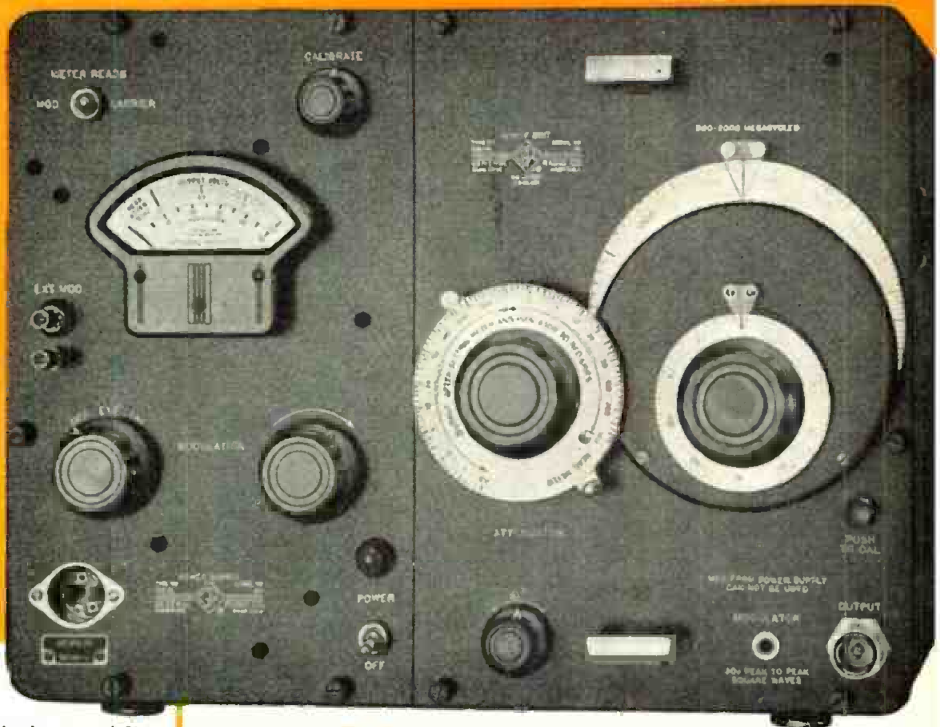
Standard-Signal Generator

40 to 2000 Mc



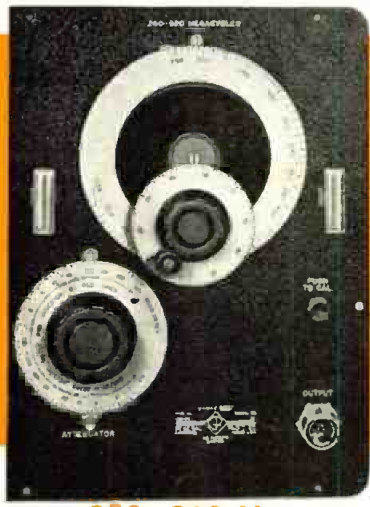
The range of the popular Type 1021-A Standard-Signal Generator has been extended to 2,000 Mc with the addition of a third oscillator unit, and downward to 40 Mc with the added 40-50 Mc range of the low-frequency oscillator unit. Now, the complete frequency range from 40 to 2,000 Mc is covered by one power supply and three oscillator units with frequency ranges of 40-250, 250-920, and 900-2,000 Mc, respectively.

The new Type 1021-P4 900-2,000 Mc Unit is a grid separation triode oscillator using a Type 5675 uhf pencil tube. It delivers relatively high output at uhf . . . is stable and well shielded . . . has provision for square-wave modulation . . . and is low in cost for a high-performance signal source. Line sections with sliding contacts are used to tune plate and cathode— tuning is exceptionally smooth. The instrument is remarkably free of noise modulation caused by microphonics and vibrations.

Additional Oscillator Units

40 - 250 Mc

Type 1021-P3B now has added 40-50 Mc range for television i-f measurements, v-h-f receiver and amplifier development.



250 - 920 Mc

Type 1021-P2 is a convenient, well-shielded source of power for bridge and slotted line measurements and u-h-f television work.

NEW

Type 1021-P4 Oscillator Unit

SPECIFICATIONS

Frequency Range 900-2000 Mc

Frequency Calibration Accuracy Large direct-reading dial with slow motion drive calibrated to 1% over 200°

Incremental Frequency Control Variable resistor in grid circuit provides small frequency adjustments.

Frequency Drift Under 0.1% per day

Output Voltage Continuously adjustable from 0.5 μv to 1.0 volt open circuit.

Output Impedance 50 ohms $\pm$10%

Output Meter Output voltage indications accurate to better than 20% — meter circuit can be calibrated in terms of accurately known 60-Cycle voltage.

Modulation Provision Square-wave modulation from 100-5,000 cycles from external modulator.

Leakage Stray fields and residual output voltage cannot be detected with receiver having 2 μv sensitivity.

Heater Voltage Rectified To reduce modulation by power frequency.

Inexpensive Tube Replacement Only $15.20

Frequency	Standard-Signal Geneerator		Oscillator Unit	Power Supply
40— 250 Mc	1021—AV, $595		1021—P3B, $400	
250— 920 Mc	1021—AU, $615	. . . . . consists of	1021—P2, $420	and 1021—P1, $195
900—2000 Mc	1021—AW, $845		1021—P4, $650	

GENERAL RADIO Company

1915-1955
40 Years of Pioneering in Electronics

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

90 West Street NEW YORK 6
8055 13th St., Silver Spring, Md. WASHINGTON, D. C.
920 S. Michigan Avenue CHICAGO 5
1000 N. Seward Street LOS ANGELES 38

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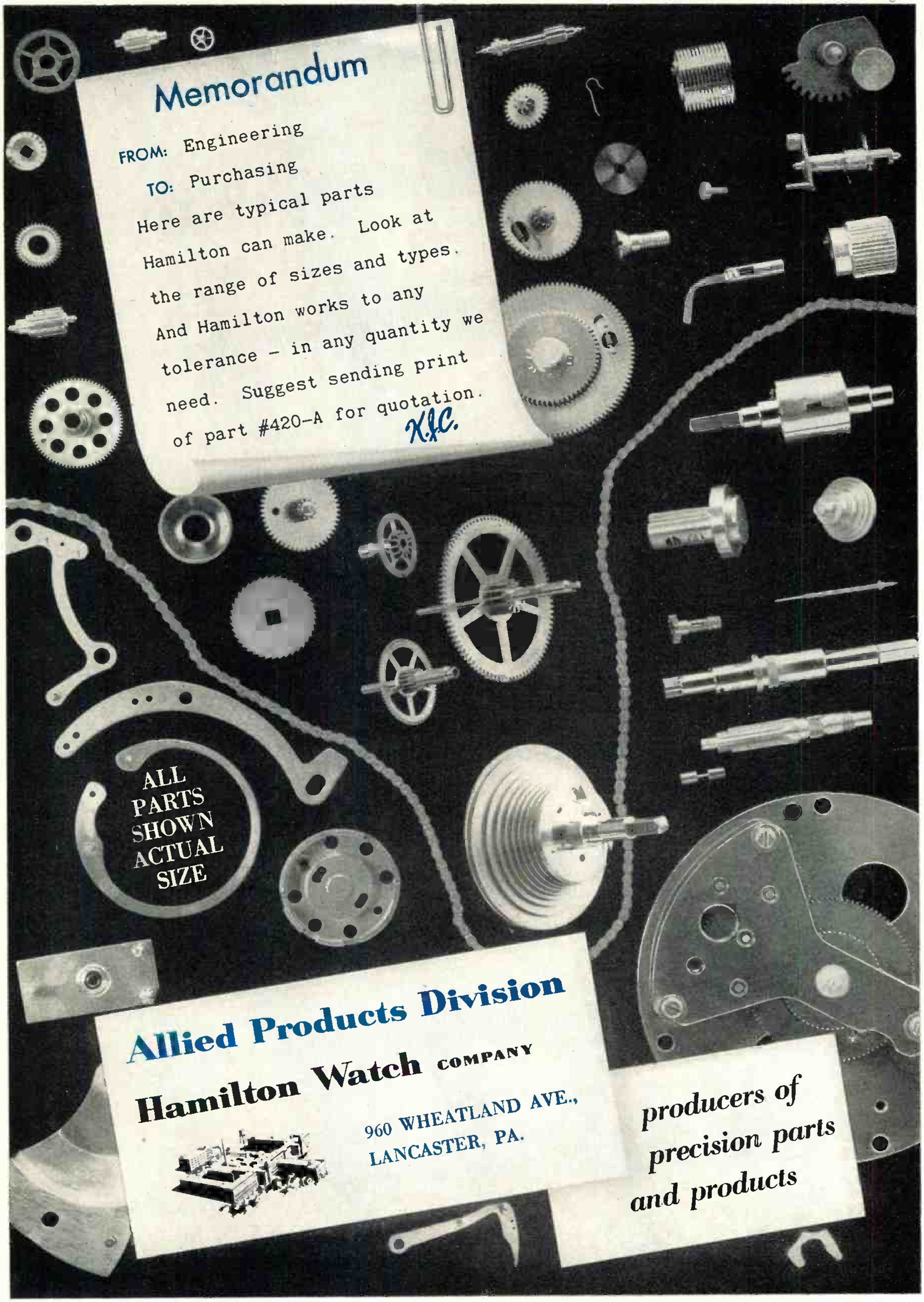

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Never before!

NOT 2: motor + gear train BUT ONE homogeneous unit

New Power Motor–Gear–Train

1. Unique: *Not* 2 separate units but a single entity. An entirely new principle—another OSTER "first."
2. More Versatile: Any output speed from 10,000 to .3 RPM.
3. Extremely High Torque Capacity: e.g., 100 #-in. at 523:1 and 1600 #-in. at 10,500:1.
4. Lighter-Smaller: e.g., 10-1/2 oz., 1-1/2" dia., 3-1/2" long at 523:1 ratio.
5. Available in 28 V and 115 V DC or in 28 V and 115 V 400 cycle AC
6. 1.50" dia. (Type 3094) illustrated. Variations include 1.25" dia. (Type 3101), 1.062"* dia. (Type 3200) and 1.75"* dia. (Type 2487).

*Available soon.

For a precision speed reducer with low backlash and low composite error at a moderate price specify an OSTER Power Motor-Gear-Train adapted to your individual application. Write for further information TODAY.

Actual Size
1.50" dia. (Type 3094)

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JOHN OSTER MANUFACTURING CO.
AVIONIC DIVISION
RACINE, WISCONSIN

Your Rotating Equipment Specialist

Other products include Actuators, AC Drive Motors, DC Motors for Special Applications, Fast Response Resolvers, Servo Torque Units, Low Inertia Servo Motors, Synchro Differentials, Two-Phase Reference Generators, Tachometer Generators and Motor Driven Blower and Fan Assemblies.

For product information, use inquiry card on last page.

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New Tech Data for Engineers

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

Vacuum Pumps

New 48-page catalog issued by W. M. Welch Scientific Co., 1515 Sedgwick St., Chicago, Ill., describes the performance of Welch Duo-Seal vacuum pumps ranging from 21 to 375 liters per minute. Also contains a greatly enlarged listing of diffusion pumps, vacuum gauges and accessories. (Ask for B-4-1)

Test Equipment

The 135-page catalog, "PRD Test Equipment," issued by Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N.Y. illustrates and presents the theory, technical data, and applications related to the company's products in 9 major sections. Beginning each section, a table gives type numbers, specifications, and page references. Covers attenuators and terminations, impedance measurement and transformation, transmission line components, frequency measuring devices, detection and power measurement, signal sources and receivers, VHF-UHF test equipment, millimeter test equipment, and ridged waveguide equipment. (Ask for B-4-3)

Networks

Bulletin R-5501, prepared by I-T-E Circuit Breaker Co., Resistor Div., 19th and Hamilton Sts., Philadelphia 30, Pa., presents a new potted resistor networks construction technique and the characteristics and performance results it produces in resistance circuitry. (Ask for B-4-4)

Magnetic Cores

General Ceramics Corp., Keasbey, N.J. have prepared a 4-page folder that presents specifications and curve data on "Ferramic 'Q'" magnetic properties and core and rod comparisons with J and N "Ferramic" materials. (Ask for B-4-5)

Camera Mechanism

Catalog E. 54, released by Radio Corp. of America, Engineering Products Div., Building 15-1, Camden 2, N.J. describes the camera pan and tilt mechanism developed for use with RCA industrial TV (Ask for B-4-6)

Microwave-Radio Systems

B-6393, an 8-page booklet prepared by Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa., completely describes 2,000 MC microwave-radio systems and discusses the importance of Type-FR microwave radio and Type-FJ multiplexing equipment. (Ask for B-4-7)

Antenna Systems

"'Job-Packaged' Antenna Systems," an article reprinted by Prodelin Inc., Kearny, N.J. presents the development and accomplishments of that organization. (Ask for B-4-9)

Electronic Equipment

Latest developments in materials research, electronic equipment and precision instruments pioneered by affiliates of Gulton Industries, Metuchen, N.J. are described in "Products for Industry and Science" released by the company. (Ask for B-4-8)

Servo

"An Introduction to the 'A' Series Range Servo," released by Servomechanisms, Inc., 500 Franklin Ave., Garden City, N.Y., is a 32-page bulletin that humorously describes the applications resulting from "functional packaging" techniques. (Ask for B-4-10)

Variable Resistance Units

Data sheet 54-86 describes "Helipot" Series T-10-A precision variable resistance units for instantaneous setting. Laboratory models are described and illustrated in detail, including specifi tions and coil characteristics. Helipot C rp., 916 Meridian Ave., S. Pasadena, Calif. (Ask for B-4-11)

Resistors

Engineering Bulletin L-35, published by Shallcross Mfg. Co., Collingdale, Pa., describes and lists 0.10-2.0 w. "Akra-Ohm" ceramic-bobbin precision wirewound resistors from 0.1 ohm to 1,000 megohms, 75 to 2,000 v. (Ask for B-4-12)

Radioisotope Instruments

A 28-page catalog covering radiation instruments has been released by NRD Instrument Co., 6425 Etzel Ave., St. Louis 14, Mo. describes scintillation counters, scalers, other circuits, and radioactivity counting accessories. (Ask for B-4-13)

Tubing

Bulletin 40 is an 8-page catalog that contains information needed for the selection and application of 46 principal analyses of tubing in five classifications; stainless steel, nickel and nickel alloys, carbon and alloy steels, beryllium copper, and titanium, issued by Superior Tube Co., 1614 Germantown Pike, Norristown, Pa. (Ask for B-4-14)

Ferrite Cores

An engineering bulletin released by Ferroxcube Corp. of America, 233 E. Bridge St., Saugerties, N.Y. contains complete technical information on the advantages of ferrite cores in low-frequency power carrying coils. (Ask for B-4-15)

High Frequency Insulators

Bulletin No. 546, "AlSiMag L-5 High Frequency Electrical Insulators," presents all requirements for JAN-1-8 type insulators, identified by code, that can be obtained as stock items from American Lava Corp., subsidiary of Minnesota Mining and Mfg. Co., Cherokee Blvd. & Mfgrs. Rd., Chattanooga 5, Tenn. (Ask for B-4-16)

Motors

Catalog F 4344-1, describing the permanent magnet dc current motors with outputs to 1/10 h.p. is available at Barber-Colman Co., Aircraft Controls Div., Rockford, Ill. Contains data sheets on motors from 6 v to 115 v. dc. (Ask for B-4-17)

Guide

Prepared by the RETMA Jobber Relations Committee, the 8-page report, "Unit Territory Plan . . . to Serve the Jobber Better," presents the results of an 18-month study of electronic parts distribution in the form of an introduction, a discussion of the problem, a recommended solution and conclusion. 777-14th St., N.W., Washington 5, D.C. (Ask for B-4-18)

Tubeless Power Supplies

A catalog sheet covering new additions to the line of Electronic Research Associates, Inc., 67-69 E. Centre St., Nutley, N.J. includes a combined dc/ac medium voltage supply, a portable, variable low-voltage, high current dc/ac supply, and a dual transistor supply. (Ask for B-4-19)

Double Ridge Waveguide System

A catalog series released by Airtron, Inc., 1103 W. Elizabeth Ave., Dept. A, Linden, N.J. provides the aircraft and radar designer with theory, construction, dimensional, electrical and mechanical data, etc. (Ask for B-4-20)

Pressure Transducer

A new brochure released by Technology Instrument Corp., 531 Main St., Acton, Mass., describes a dual element pressure transducer that translates static and dynamic air pressures to equivalent voltages. (Ask for B-4-21)

TV Console

Bulletin TR-811 illustrates and describes the type AS70 C TV console section and the TV console end bell set, Type AS70 EB, produced by TV Transmitter Dept., Allen B. Du Mont Labs., Inc., Clifton, N.J. (Ask for B-4-22)

Calorimeter

A technical folder released by Chemalloy Electronics, Inc., Gillespie Airport, Santee, Calif. describes and illustrates the Model SME Chemalloy-Kahl calorimeter, its functions and capabilities. Gives formulae and data. (Ask for B-4-23)

Program Equalizers

The models EQH, EQH-2, EQH-3, and EQP-1 program equalizers are presented with illustrations, characteristics, and specifications on two data sheets released by Pulse Techniques, Inc., 1411 Palisade Ave., W. Englewood, N.J. (Ask for B-4-21)

Coaxial Cable

Bulletin CT, issued by Phelps Dodge Copper Products Corp., 40 Wall St., New York 5, describes and presents engineering data covering "Spirafil" semi-flexible, aluminum-sheathed coaxial cable for broadcast, communications, microwave, and community antenna. (Ask for B-4-25)

Unitized Equipment

A 4-page folder released by Burroughs Corp., Electronic Instruments Div., 1209 Vine St., Philadelphia 7, Pa., titled, "The Unitized Approach," describes the use of individually packaged units that are an integral set of design concepts that place at the disposal of the engineer all elements necessary to planning and constructing an entire digital pulse system. Also, it presents characteristics and performance data covering the pulse and dc output units discussed. (Ask for B-4-2)

Spectrometer

Bulletin 1800C, covering the Type 21-103C mass spectrometer, made by Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif., illustrates the instrument diagrammatically, and describes its applications and engineering features. (Ask for B-4-27)

Electronic Equipment

Collins Radio Co., Cedar Rapids, Ia., have released their general catalog presenting the company's staff, plant and equipment and its wide variety of electronic equipment made for the aviation, communication, broadcast, and industrial fields. (Ask for B-4-28)

Racks and Panel Connectors

Bulletin DP9, a new 64-page is a complete compendium of technical information on the various DP lines, plus the RTC, all rack, panel/chassis designs produced by Cannon Electric Co., 420 West Ave. 33, Los Angeles 31, Calif. Adds a new descriptive index and more illustrations and technical data. (Ask for B-4-29)

Rotary Switches

Catalog No. 854, a 10-page booklet issued by Communication Products Co., Marlboro, N.J., illustrates and presents dimensional drawings and performance data covering the company's r-f and power steatite insulated rotary switches. (Ask for B-4-30)

Test Unit

"Norelco Portaflux—New Portable Magnetic Particle Test Unit," an 8-page booklet released by Research & Control Instruments Div., North American Philips Co., Inc., 750 S. Fulton Ave., Mount Vernon, N.Y. describes the latest and most economical method for checking ferrous metal objects for surface discontinuities (Ask for B-4-31)

Magnetic Tape

"Extra Play 190," an 8-page booklet issued by Minnesota Mining and Manufacturing Co., Dept. M5-2, 900 Facquier St., St. Paul 6, Minn., answers seven questions most often asked by engineers concerning "Scotch" brand "Extra Play" magnetic tape No. 190. (Ask for B-4-39)

Connectors

A 6-page folder, released by American Phenolic Corp., Chicago 50, Ill., presents "Subminax" r-f connectors, Series 27 with cable and connector type matching table and 50 and 75 ohm mating components diagrams. (Ask for B-4-40)

OBTAIN THESE BULLETINS

described here by writing on company letterhead to Bulletins Editor, TELE-TECH & ELECTRONIC INDUSTRIES, 480 Lexington Ave., New York 17, N.Y., listing numbers given at end of each item of interest. Please mention title of position held.

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Here's the New

PHILCO SB

(Surface Barrier)

TRANSISTOR

Industry's First High Frequency Transistor

...Available Now!

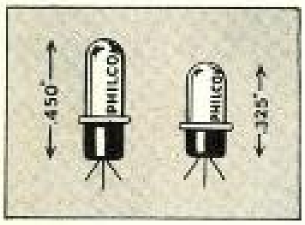
See Next Page For Details

www.americanradiohistory.com

For the First Time...

High Frequency Circuits Can Be

COMPLETELY TRANSISTORIZED



Philco SB Transistors are available in the sizes shown here—standard and miniature.

Today, Philco's new SB Transistor opens up a completely new field of commercial, industrial and military applications for the electronics design engineer. With vastly superior performance assured to 50mc and above, many basic circuits can now be *completely transistorized.* Video bandpass amplifiers, wide band low-pass amplifiers, high frequency oscillators and high speed switching are only a few of the innumerable circuits which the design engineer can produce quickly, easily, efficiently with the revolutionary new SB Transistor.

UP TO 10 TIMES BATTERY LIFE

The Philco Surface Barrier Transistor operates efficiently with power consumption of less than *one* milliwatt! This extremely low power drain results in up to *ten* times the battery life obtainable with junction transistors, vastly reducing operating costs. Hermetically sealed, the SB Transistor has greater inherent characteristics of stability, longer life and higher efficiency than any other type of transistor

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For complete technical information on the PHILCO SB Transistor write Dept. T

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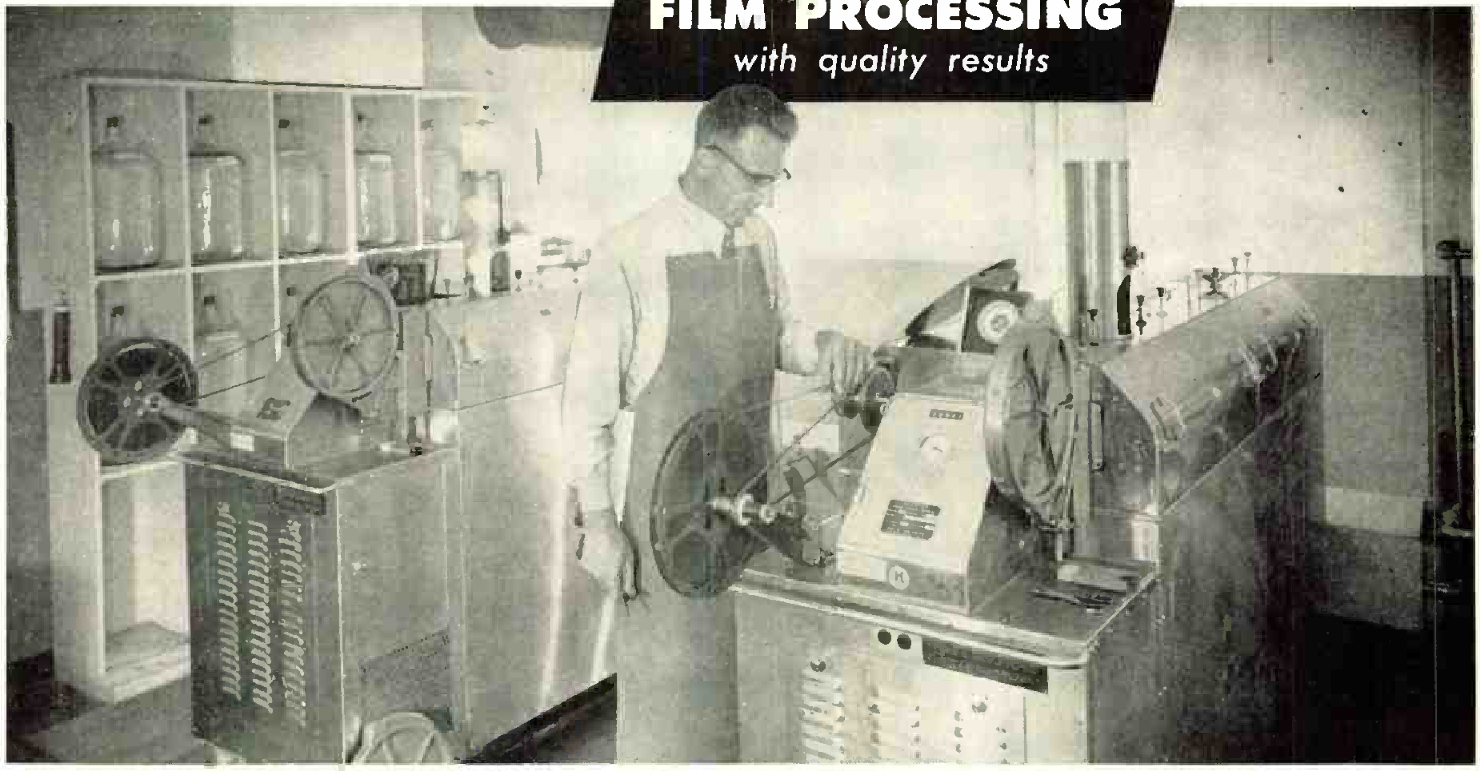

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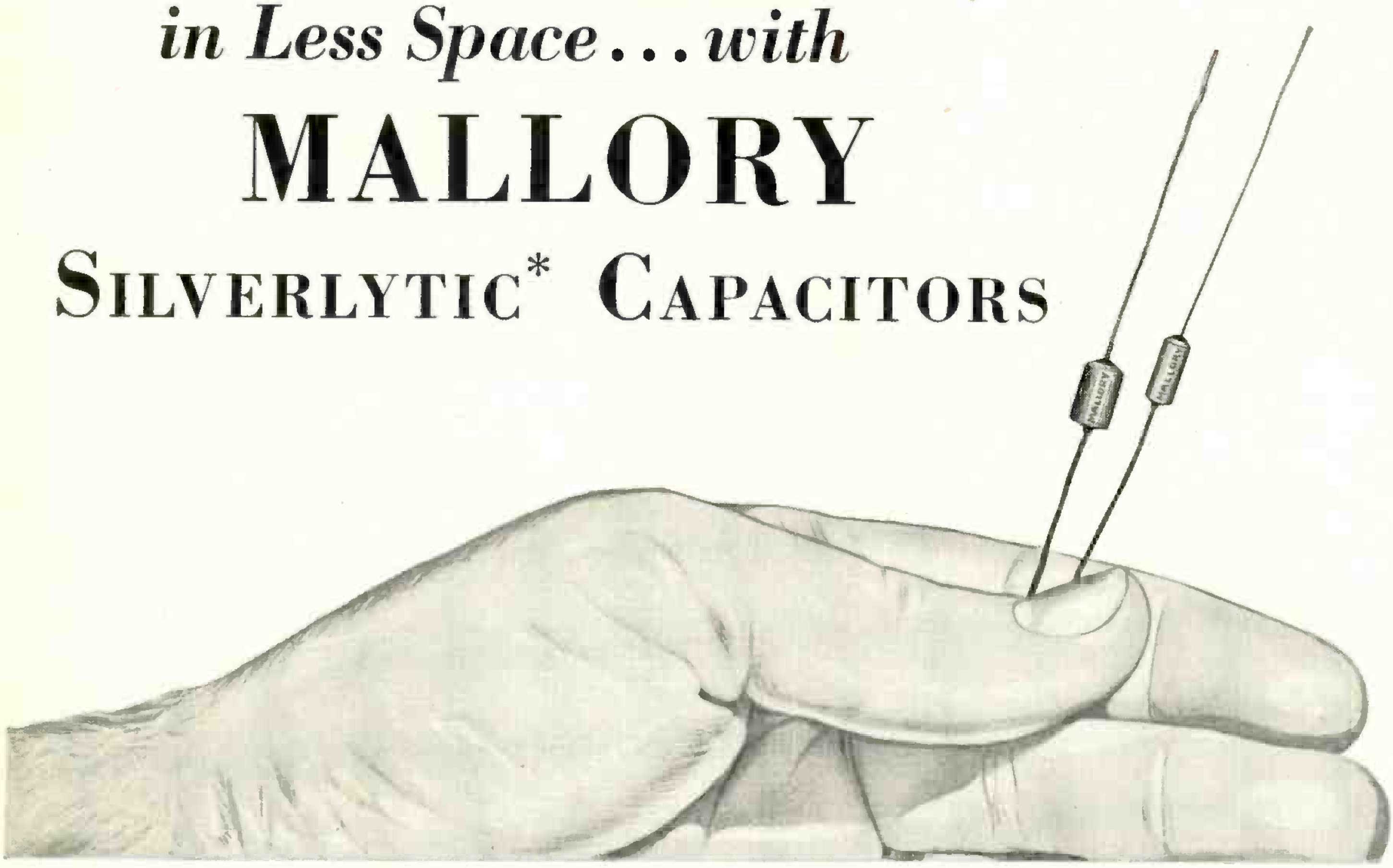

For transistor circuits and other miniaturized electronic equipment, Silverlytic capacitors will simplify your problem of getting maximum capacitance into minimum space. These subminiature electrolytics offer the highest available ratio of capacitance and voltage to case size.

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Type TAP Silverlytics are rated for temperatures from −55 to +85° C. Their case measures only $\frac{7}{32}$″ in diameter by $\frac{3}{8}$″ long. They are supplied in values from 2 mfd at 100 volts to 30 mfd at 6 volts.

Type TAW Silverlytics are available in a case only 0.145″ in diameter by $\frac{3}{8}$″ maximum length. They are supplied in two standard ratings of 4 mfd at 4 volts and 6 mfd at 4 volts, for temperatures from −55 to +65° C.

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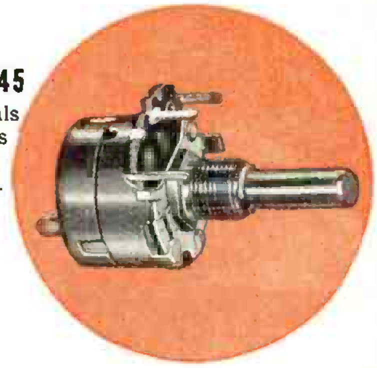
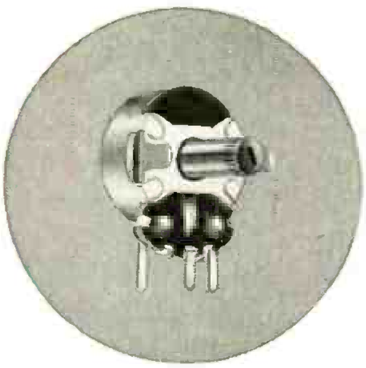
Type UPM-45
For TV preset control applications. Control mounts directly on printed circuit panel with no shaft extension through panel. Recessed screwdriver slot in front of control and 3/8" knurled shaft extension out back of control for finger adjustment. Terminals extend perpendicularly 7/32" from control's mounting surface.

Type GC-U45
Threaded bushing mounting. Terminals extend perpendicularly 7/32" from control's mounting surface. Available with or without associated switches.



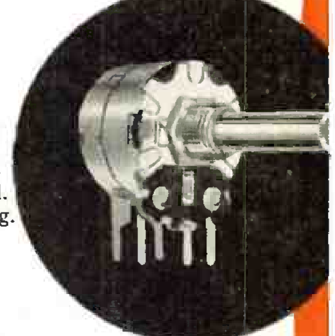
Type U70 (Miniaturized)
Threaded bushing mounting. Terminals extend perpendicularly 5/32" from control's mounting surface.

Type YGC-B45
Self-supporting snap-in bracket mounted control. Shaft center spaced 29/32" above printed circuit panel. Terminals extend 1-1/32" from control center.

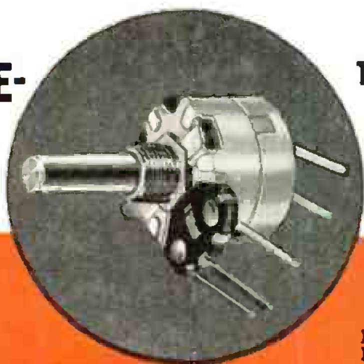


Type XP-45
For TV preset control applications. Control mounts on chassis or supporting bracket by twisting two ears. Available in numerous shaft lengths and types.

Type XGC-45
For applications using a mounting chassis to support printed circuit panel. Threaded bushing mounting.



VARIABLE RESISTORS FOR SOLDERLESS "WIRE-WRAP" CONNECTIONS



Type WGC-45
Designed for solderless wire-wrapped connections with the use of present wire-wrapping tools. Available with or without switch and in single or dual construction.

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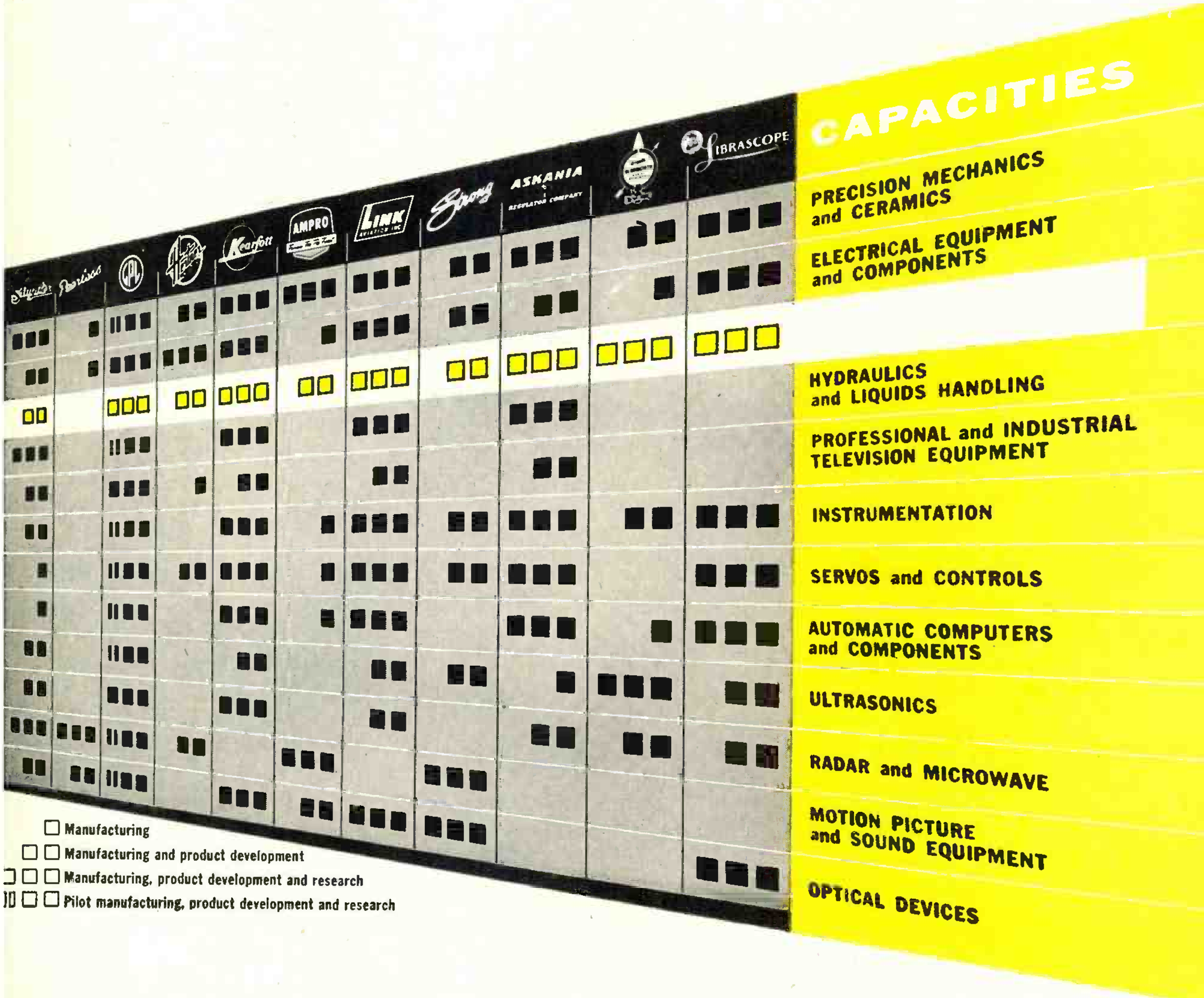

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how the producing companies of
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are contributing to America's progress.

precision technology

GPE Coordinated Precision Technology is the basic GPE operating policy which inter-relates the research, development and manufacturing facilities, techniques and capabilities of the producing companies of General Precision Equipment Corporation. Thus each company's specialization in its particular areas of competence is supplemented by the application of the resources of the other companies, wherever relevant. A diversified line of advanced precision equipment of superior design and performance has resulted from this application of the newest and most advanced techniques possessed among the companies in every technical capacity.

e.g. in ELECTRONICS

Ten of the GPE Producing Companies work in this important field. These companies were "born in electronics" and pioneered in its development before the word was coined. Their work covers every phase of electronics and GPE coordination relates each new electronic problem to the specialized knowledge and experience which is most valuable. This secures the optimum solution for the customer with minimum expenditure of time and money.

GPE Producing Companies have been responsible for the research, development and manufacture of a wide range of electronic precision components, equipment and systems, including Theatre Sound Systems, Sonar Equipments, Flight Simulators, Industrial Control Systems, Analogue Computers, Digital Computers and Components, Industrial and Studio Television, Navigation Systems—both airborne and marine. GPE systems, in most instances, are advanced concepts, often employing components specifically developed for the purpose by one of the GPE companies. Of the great number, two are shown.

Kearfott X-band Test Set, frequency range 8,500 to 10,000 MC; a unique all-purpose portable radar test set, comprising a power monitor, spectrum analyzer, wavemeter and signal generator which supplies an accurately calibrated signal of known level with variable amplitude and pulse-width combinations. Also provides FM, square wave and CW output.

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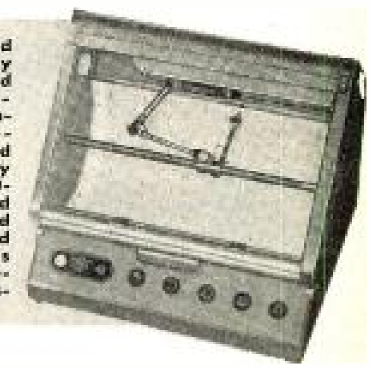

Most advanced technological products which utilize electronics also call for other advanced technological skills. Though space allows only for an outline of GPE's work in electronics, both the capacities chart on the facing page and most of the products mentioned above serve to suggest the broad coordination of technical capacities in all fields which exists as a result of GPE Coordinated Precision Technology.

Address inquiries to: **GENERAL PRECISION EQUIPMENT CORPORATION**

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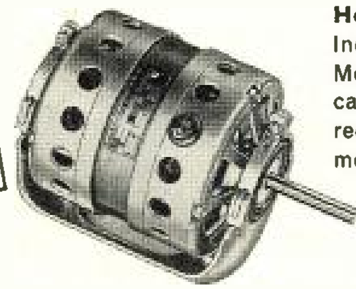

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Movie projectors, TV cameras, tape recorders—Resilient mounted.

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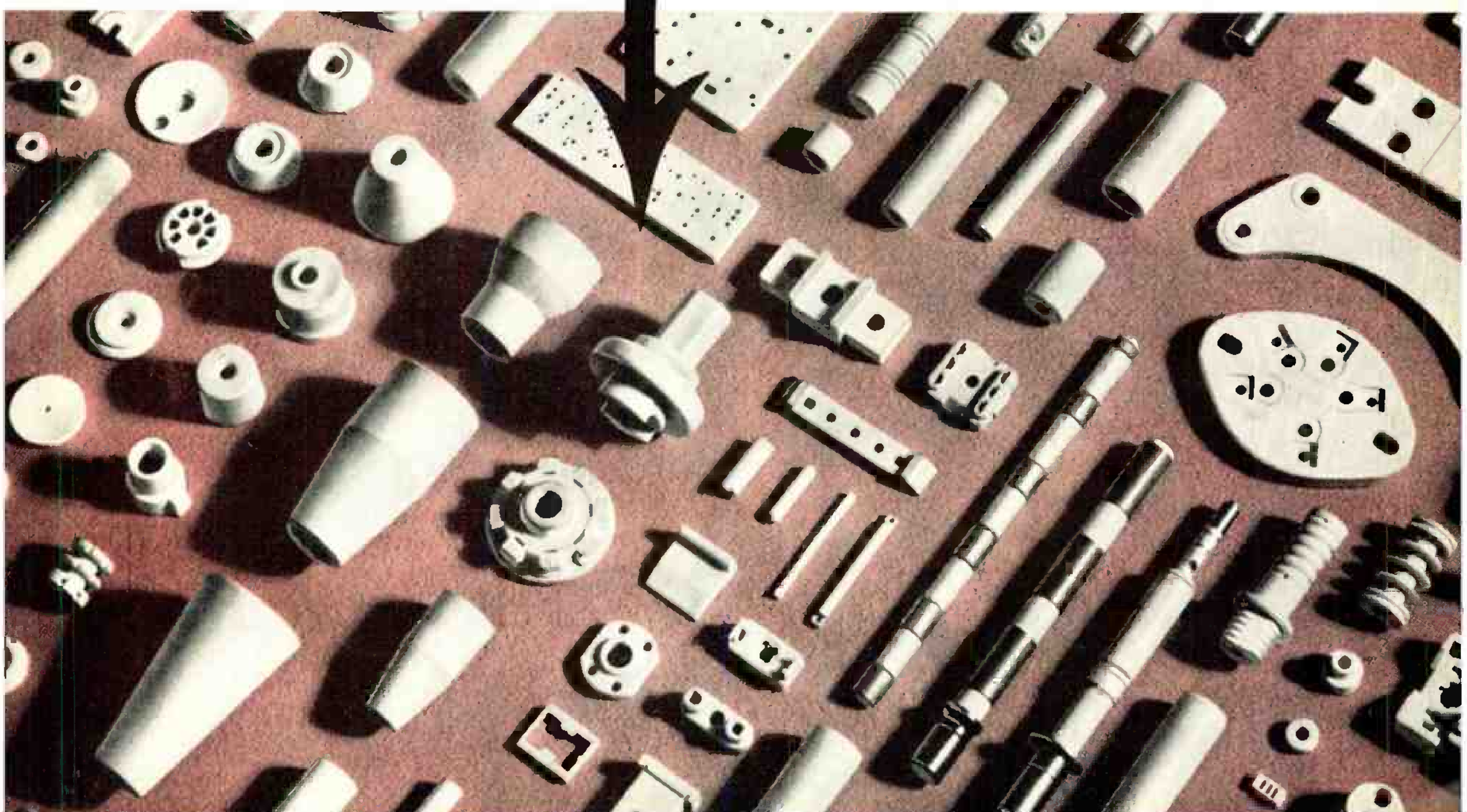

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- All purpose AM, FM, Pulse

The new Polarad Model R Receiver is a fully integrated unit which combines reliability, ruggedness and simplicity of operation. Characterized by high sensitivity, low noise figure and excellent gain stability, this versatile instrument is ideal for communications, laboratory measurements, field intensity measurements, production testing, and automatic monitoring.

Range 950 to 11,260 mc with four (4) interchangeable, plug-in RF tuning units featuring direct reading UNI-DIAL control.

Low noise figure.

Excellent gain stability.

Automatic frequency control.

Direct reading output in db with provision for external metering and recording.

Separate audio and video channels.

Connectors for external IF attenuators.

High sensitivity and broadband tuning achieved with double tuned cavity preselector which tracks automatically with the local oscillator.

External type cavity klystron with non-contacting chokes. Klystron voltages regulated and automatically tracked with the oscillator.

SPECIFICATIONS:

Basic Receiver: Model R-B

Tuning Unit Frequency Ranges:

Model RL-T:	950 to 2,040 mc
Model RS-T:	1,890 to 4,320 mc
Model RM-T:	4,190 to 7,720 mc
Model RX-T:	7,260 to 11,260 mc

Signal Capabilities:
CW, AM, FM, Pulse

Sensitivity:
−80 dbm or better throughout range on all models

Frequency Accuracy:
1%

IF Bandwidth:
3 mc

Image Rejection:
Greater than 60 db

Gain Stability with AFC:
2 db for 24 hour period

Automatic Frequency Control:
Pull-out range 10 mc off center

Recorder output:
1 ma full scale

Trigger output:
10 v. pulse across 100 ohms

Audio output:
5 v. undistorted across 500 ohms

FM Discriminator Deviation Sensitivity:
.7 volts/mc

Skirt Selectivity:
60 db to 6 db bandwidth ratio less than 5:1

IF Rejection:
50 db

Input AC Power:
105 to 125 v., 60 cps., 460 watts

Input Impedance: (ANT)
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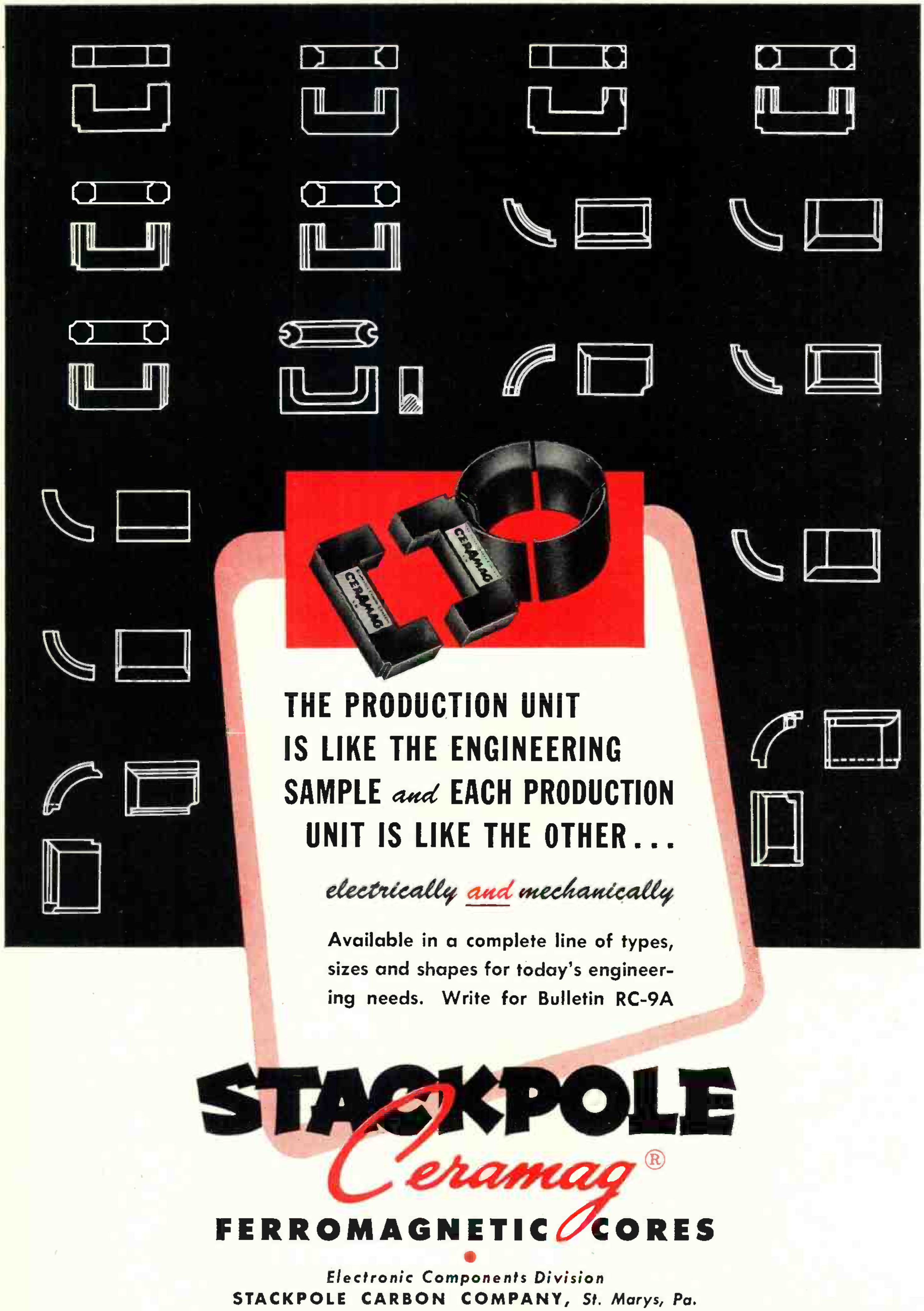

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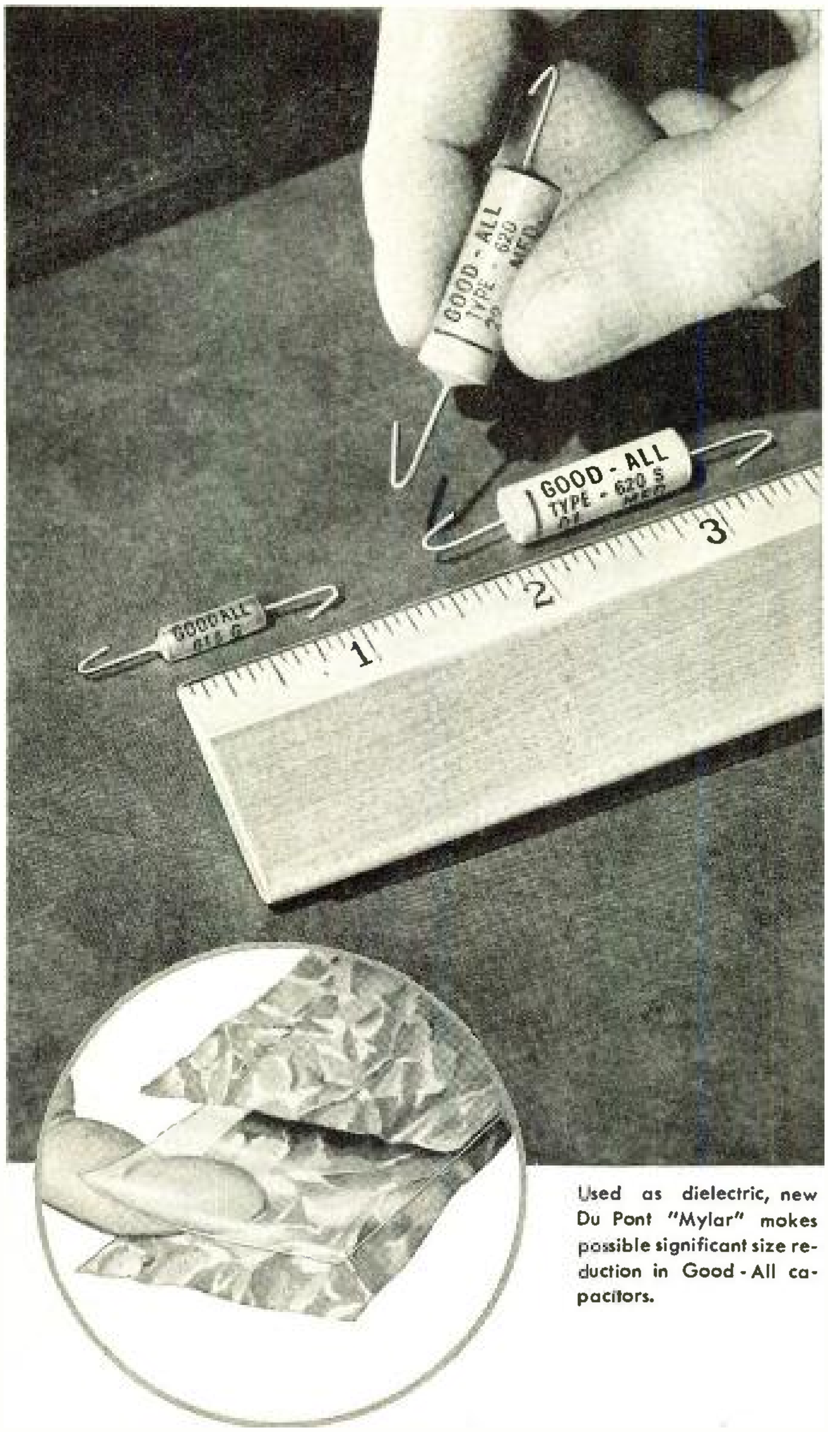

Used as dielectric, new Du Pont "Mylar" makes possible significant size reduction in Good-All capacitors.

"We have met specifications that would have been impossible without 'Mylar,'

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Mr. Q. T. Wiles, President
GOOD-ALL ELECTRIC MFG. CO.
Ogallala, Nebraska

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Film Department, Room TT, Nemours Bldg.
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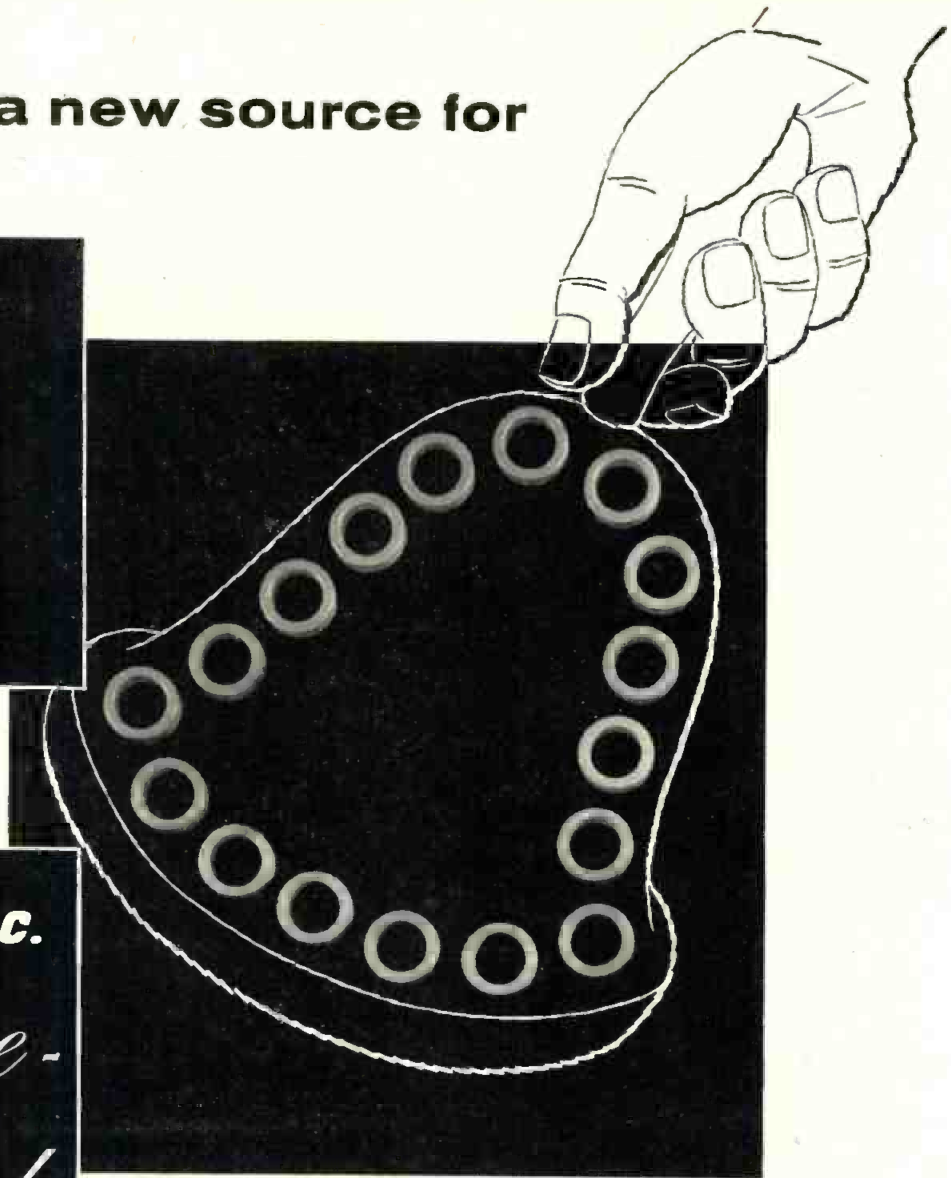

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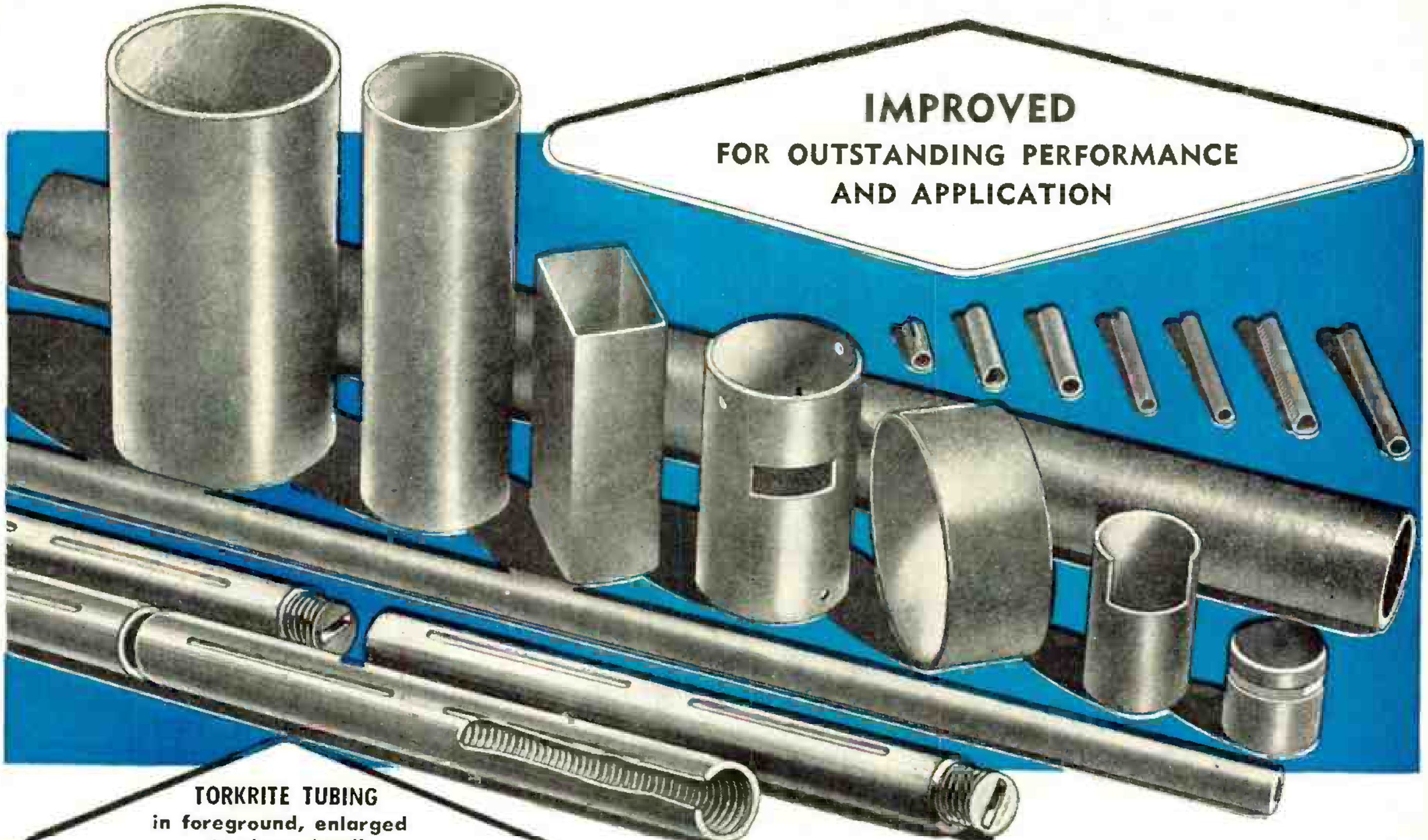

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Improved new Torkrite is now available in various diameter tubes. Lengths from 3/4" to 3-1/8" are made to fit 8-32, 10-32, 1/4-28 and 5/16-24 cores.

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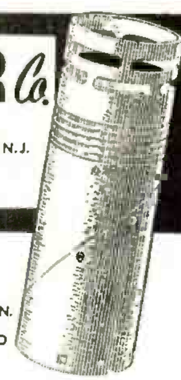

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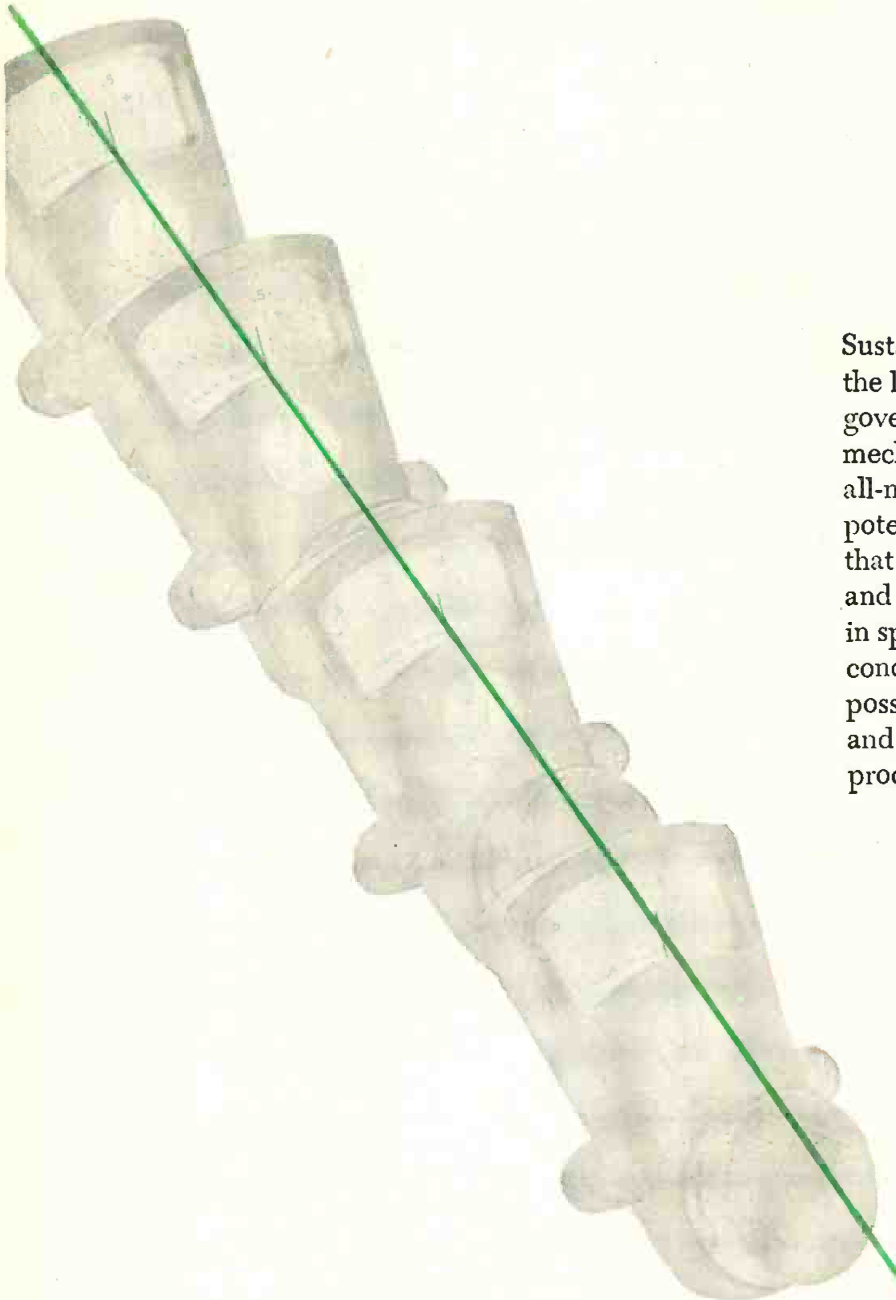

Sustained electrical accuracy throughout the life of a potentiometer is largely governed by the unit's ability to resist mechanical dimensional changes. The all-metal-case construction of Fairchild potentiometers assures mechanical rigidity that maintains superior initial accuracies and tolerances throughout a long life cycle—in spite of severe changes in environmental conditions. This is another advance made possible by Fairchild's continuous research and quality control program on materials, processes and manufacturing.

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Now for the first time Fairchild brings you the sustained accuracy of all-metal-case construction in a 10-turn potentiometer. This unit has only ½ the diameter and ⅓ the weight of usual standards. It is the Fairchild Standard Type 920. Its 24½" coil length assures linearities of ±0.25% in a resistance range of 1,000 to 200,000 ohms, with ±0.1% available for special applications. Your choice of servo, threaded bushing or three-hole pilot bushing mountings.

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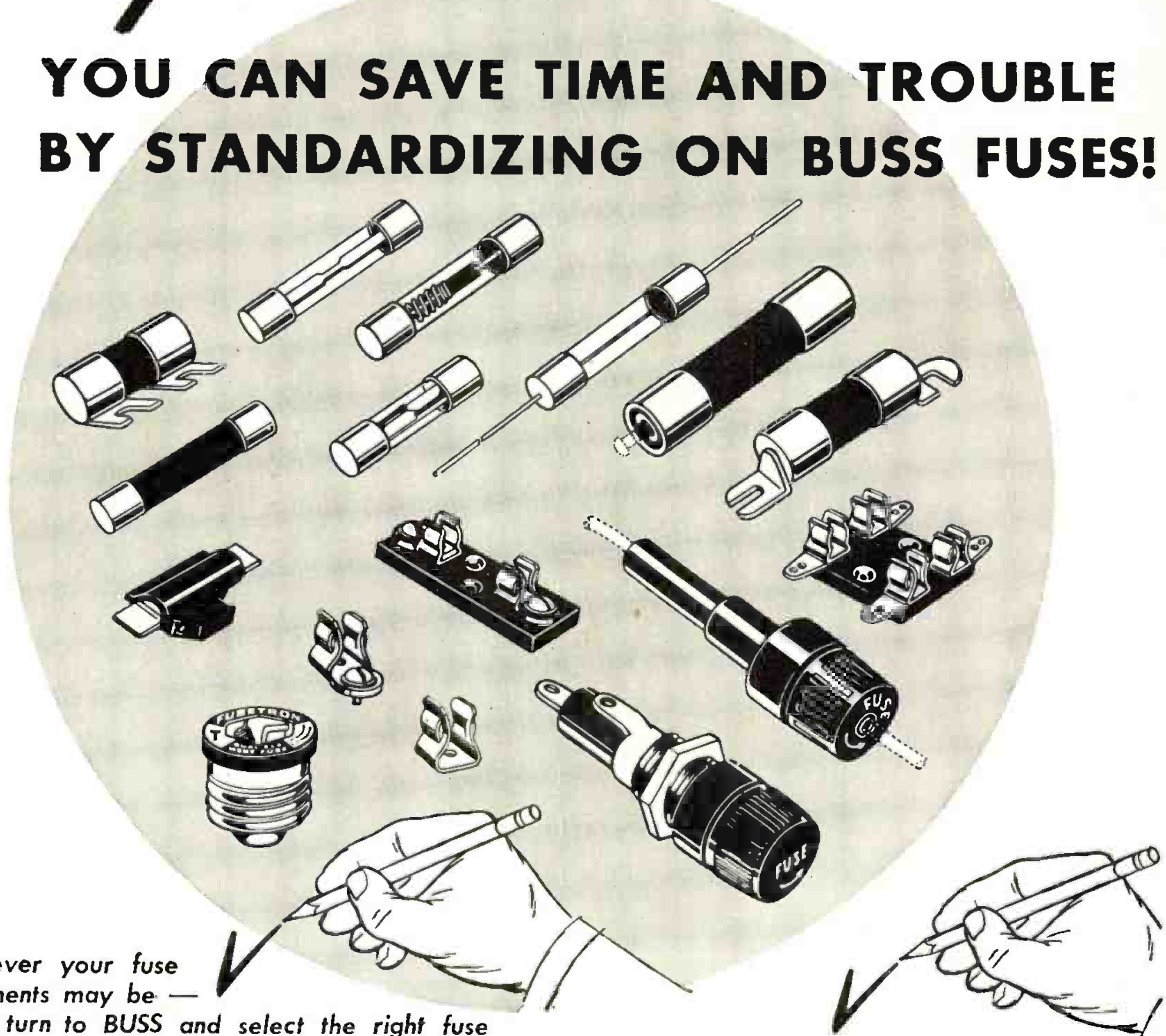

Whatever your fuse requirements may be — you can turn to BUSS and select the right fuse for the job.

The complete BUSS line includes fuses in any size from 1/500 up, plus a companion line of fuse clips, blocks and holders.

You'll find that relying on this one, dependable source for fuses helps to simplify your buying, stock handling and records — and results in profit-saving efficiency.

Every BUSS fuse is electronically tested to assure "trouble-free" protection.

To make sure that BUSS fuses will operate properly under all service conditions — every BUSS fuse normally used by the Electronic Industries is electronically tested. A sensitive device automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

If you should have a special problem in electrical protection . . . the world's largest fuse research laboratory and its staff of engineers are at your service — backed by over 40 years of experience. Whenever possible, the fuse selected will be available in local wholesalers' stocks, so that your device can be easily serviced.

For more information on BUSS and Fusetron small dimension fuses and fuse holders . . . Write for bulletin SFB.

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

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

BUSSMANN MFG. CO. *(Div of McGraw Electric Co.)*
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455

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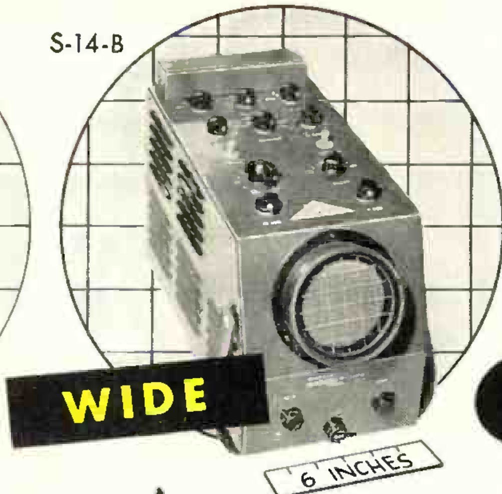
Waterman POCKETSCOPE

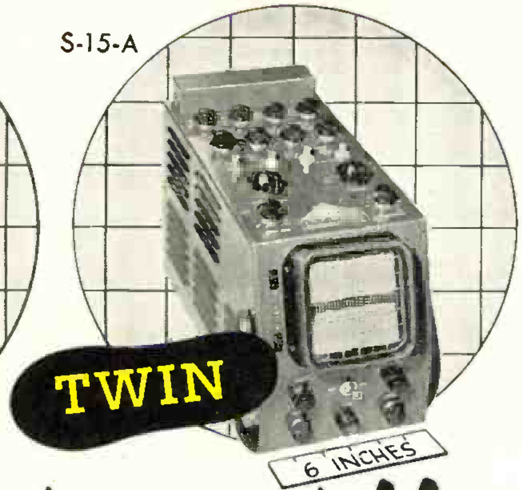
The Pocket-Size Oscilloscope

S-14-A

S-14-B



S-15-A

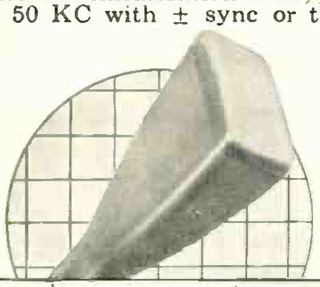


...light... compact... accurate... portable

Featuring small size, light weight and outstanding performance the HIGH, WIDE and TWIN POCKETSCOPES have become the "triple threat" of the oscilloscope field. Their incomparable versatility, reliability and accuracy have skyrocketed this team of truly portable instruments into unparalleled demand. Each oscilloscope features DC coupled amplifiers in both vertical and horizontal channels.

HIGH

The S-14-A HI-GAIN POCKETSCOPE provides the optimum in oscilloscope flexibility for analysis of low-level electrical impulses. Extremely light weight (12¾ lbs.), compact in size (12 x 5¾ x 7 in.), dependable and accurate in performance. Vertical and horizontal channels: 10mv rms/inch with response within 2DB from DC to 200 KC and pulse rise of 1.8 μs . . . non-frequency discriminating attenuators and gain controls with internal calibration of trace amplitude . . . repetitive or trigger time base with linearization from ½ cycle to 50 KC with ± sync or trigger.



WIDE

The S-14-B WIDE BAND POCKETSCOPE is ideal for investigations of transient signals, DC signals, aperiodic pulses or recurrent waveforms. Vertical channel: 50 mv rms/in. within —2DB from DC to 700 KC . . . pulse rise time of 0.35 μs. Horizontal channel: 0.15v rms/in. within —2DB from DC to 200 KC . . . pulse rise of 1.8 μs. Attenuators and gain controls are non-frequency discriminating . . . trace amplitude calibration . . . repetitive or triggered time base from ½ cycle to 50 KC . . . ± sync or trigger . . . trace expansion, filter graph screen and many other features . . . 14 lbs. . . . 12 x 6 x 7 inches.

TWIN

The S-15-A POCKETSCOPE is a portable, twin tube, high sensitivity oscilloscope with two independent vertical as well as horizontal channels. It is indispensable for investigation of electronic circuits in industry, school and laboratory. Vertical channels 10 mv rms/in. with response within—2DB from DC to 200 KC and pulse rise time of 1.8 μs . . . horizontal channels 1v rms/in. within —2DB from DC to 150 KC . . . non-frequency discriminating controls . . . internal signal amplitude calibration . . . linear time base from ½ cycle to 50 KC, triggered or repetitive, for both horizontal channels.

S-11-A

The S-11-A INDUSTRIAL POCKETSCOPE is a small, compact (5x7x11 inches), and lightweight (8¾ lbs.) instrument for observing electrical circuit phenomena. The flexibility of the POCKETSCOPE permits its use for AC measurements as well as for DC. The vertical and horizontal amplifiers are capable of reproducing within —2DB from DC to 200 KC with a sensitivity of 0.1v rms/in. . . . repetitive time base from 3 cycles to 50 KC continuously variable throughout its range . . . variations of input impedance, line voltage or controls do not "bounce" the signal—the scope stabilizes immediately.

RAYONIC CATHODE RAY TUBES BY WATERMAN

TUBE	PHYSICAL DATA		STATIC VOLTAGE		DEFLECTION*		LIGHT OUTPUT**
	FACE	LENGTH	A3	A2	VERT	HOR	
3JP1	3"	10"	3000	1500	111	150	352
3MP1	3"	8"		750	99	104	33
3RP1	3"	9.12"		1000	61	86	44
3SP1	1.5x3"	9.12"		1000	61	86	44
3XP1	1.5x3"	8.875"		2000	33	80	218

*Deflection in volts per inch.

The basic properties of the cathode ray tube that concern the designer or the user are: deflection sensitivity, unit line brightness, line width, static voltage requirements and physical size. A comparison between cathode ray tubes manufactured by Waterman Products Company is shown in the table adjoining. These tubes are available in P1, P2, P7 and P11 phosphors. 3JP1, 3JP7, 3SP1 and 3XP1 are available as JAN tubes.

Write for your complimentary copy of "POCKETSCOOP" • Official Waterman publication.

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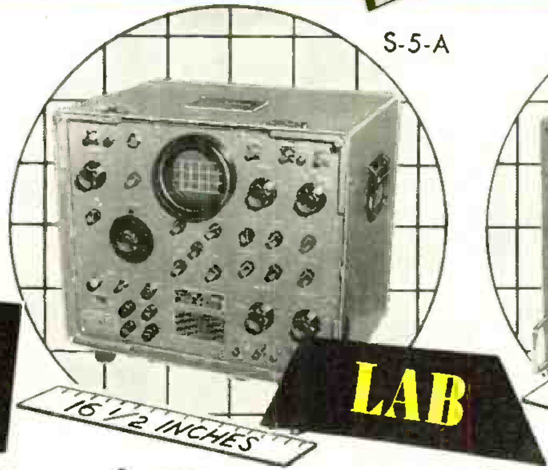
PULSESCOPE by Waterman

The Oscilloscope that Portrays the Pulse



Classic Examples of Precision Engineering...

The PULSESCOPES are cathode ray tube oscilloscopes that portray the attributes of the pulse: shape, amplitude, duration and time displacement. All PULSESCOPES have internally generated markers with the basic difference that in the SAR PULSESCOPE the markers initiate the sweep while in the others the sweep starts the markers.

BROAD The S-6-A BROAD BAND Scope is a PULSESCOPE in performance, POCKETSCOPE in size. The instrument measures DC as well as AC signals. Unique DC calibration methods permit rapid measurements of either positive or negative, AC or DC signals. Vertical amplifier sensitivity of 0.2v rms/inch, and response to 5 mc within 3DB . . . pulse rise time of 0.1 μs . . . internal markers from 1 to 1000 μs . . . repetitive or trigger sweep from 5 cycles to 500 KC with 5X sweep expansion . . . sweep, marker and DC calibrating voltage available externally. Size 8½ x 6¾ x 13¾ in. Weight 22 lbs. Operates from 50 to 400 cycles at 115 volts AC.

LAB The S-5-A LAB PULSESCOPE is a JANized (Gov't Model No. OS-26) portable, AC, wide band-pass, laboratory oscilloscope ideal for pulse as well as general purpose measurements. Internal delay of 0.55 μs permits observation of pulse leading edge. Includes precision amplitude calibration, 10X sweep expansion, internal trace intensity time markers, internal trigger generators and many other features. Video amplifier 0.1v p to p/inch . . . pulse rise time of .035 μs or response to 11 mc. 1.25 to 125,000 μs triggered or repetitive sweep . . . internally generated markers from 0.2 to 500 μs . . . trigger generator from 50 to 5000 pps. for internal and external triggering. Operates from 50 to 400 cycles at 115 volts AC.

SAR The S-4-C SAR PULSESCOPE is a JANized (Gov't Model No. OS-4) portable instrument (31.5 lbs.) for precision pulse measurements for radar, TV and all electronic measurements. Portrays all attributes of the pulse . . . internal crystal controlled markers of 10 and 50 μs available for self-calibration . . . in R operation a small segment of the A sweep is expandable for detailed observation with a direct-reading calibrated dial accurate to 0.1%. Video amplifier band-pass up to 11 mc . . . optional video delay 0.55 μs . . . pulse rise and fall time better than 0.07 μs . . . R pedestal (sweep) 2.4 to 24 μs . . . video sensitivity of 0.5v. p to p/inch. Easily convertible from μs to yards. Operates from 50 to 400 cycles at 115 volts AC.

RAKSCOPE Because the panel is only 7" high and fits any standard rack, the S-12-B RAKSCOPE admirably fills the need for a small oscilloscope of wide versatility. With all the features of the S-11-A POCKETSCOPE, the RAKSCOPE is JANized (Gov't Model No. OS-11), and has many additional advantages; the sweep, from 5 cycles to 50 KC, is either repetitive or triggered . . . vertical and horizontal amplifiers are 50 mv rms/inch with band-pass from 0 to 200 KC . . . special phasing circuitry for frequency comparison.

WATERMAN PRODUCTS CO., INC.

WATERMAN PRODUCTS

PHILADELPHIA 25, PENNA., U.S.A.

CABLE ADDRESS, POKETSCOPE, PHILA.

Manufacturers of POCKETSCOPES® • RAKSCOPES® • PULSESCOPES® and RAYONIC® TUBES

For product information, use inquiry card on last page.

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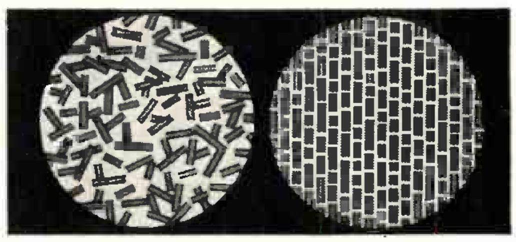
Now...record the whole performance...

without a break!

Got a favorite concert or opera program you'd like to preserve on tape? Symphony or dramatic production? Now, *record it all* using new "Scotch" Brand Extra Play Magnetic Tape. With 50% more tape wound on each reel, Extra Play Tape gives you as much recording time as 1½ reels of standard tape, plus strength to spare. This means annoying interruptions for reel change are sharply reduced to offer more perfect recording results.

You'll notice a crisper tone and higher fidelity, too—the result of "Scotch" Brand's exclusive oxide dispersion process. By packing minute, fine-grain oxide particles into a neater, thinner pattern, "Scotch" Brand has been able to produce a super-sensitive, high-potency magnetic recording surface. Hear the difference yourself. Try new "Scotch" Brand Extra Play Tape on your own machine.



Electron Photo Microscope Shows the Difference!

At left, artist's conception of magnified view of old-fashioned oxide coating still used by most ordinary long play tapes. At right, "Scotch" Brand's new dispersion method lays fine-grain particles in an orderly pattern to give a super-sensitive recording surface that contains as much oxide as conventional tapes, yet is 50% thinner.

New! REG. U.S. PAT. OFF. **SCOTCH** BRAND

Extra Play Magnetic Tape 190

The term "SCOTCH" and the plaid design are registered trademarks for Magnetic Tape made in U.S.A. by MINNESOTA MINING AND MFG. CO., St. Paul 6, Minn. Export Sales Office: 99 Park Avenue, New York 16, N.Y. In Canada: Minnesota Mining and Manufacturing Co. of Canada, Ltd., P.O. Box 757, London, Ontario.

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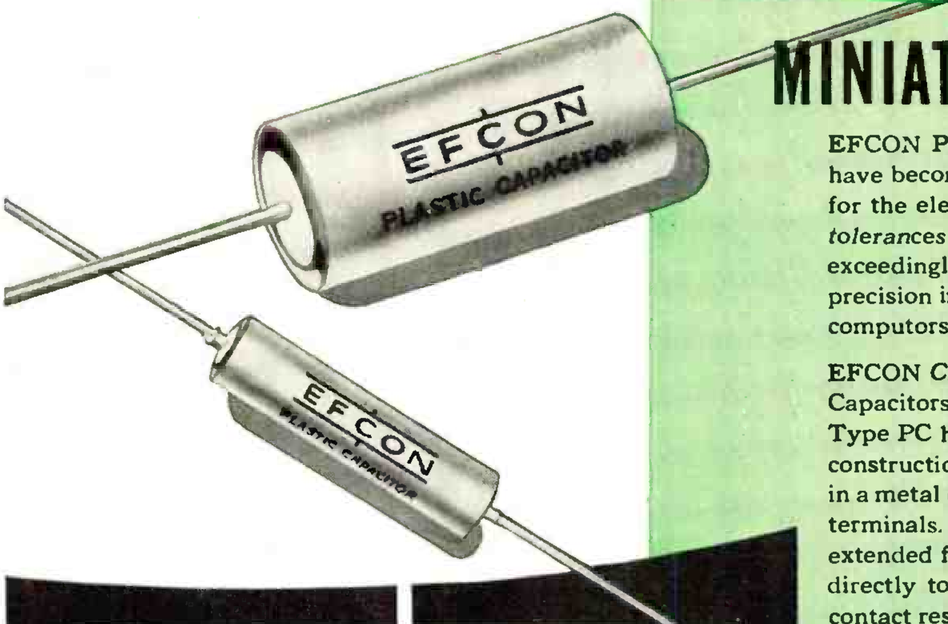
for economy...
for quality...
specify...

EFCON POLYSTYRENE

CLOSE TOLERANCE

MINIATURE CAPACITORS



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

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

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

EFCON

...where close tolerance is standard tolerance

PERFORMANCE DATA

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

OTHER EFCON CAPACITORS

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

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

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

Type S Molded Silver Mica Capacitors.

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

*DuPont Trademark

ELECTRONIC FABRICATORS, INC.
682 Broadway, New York 12, New York

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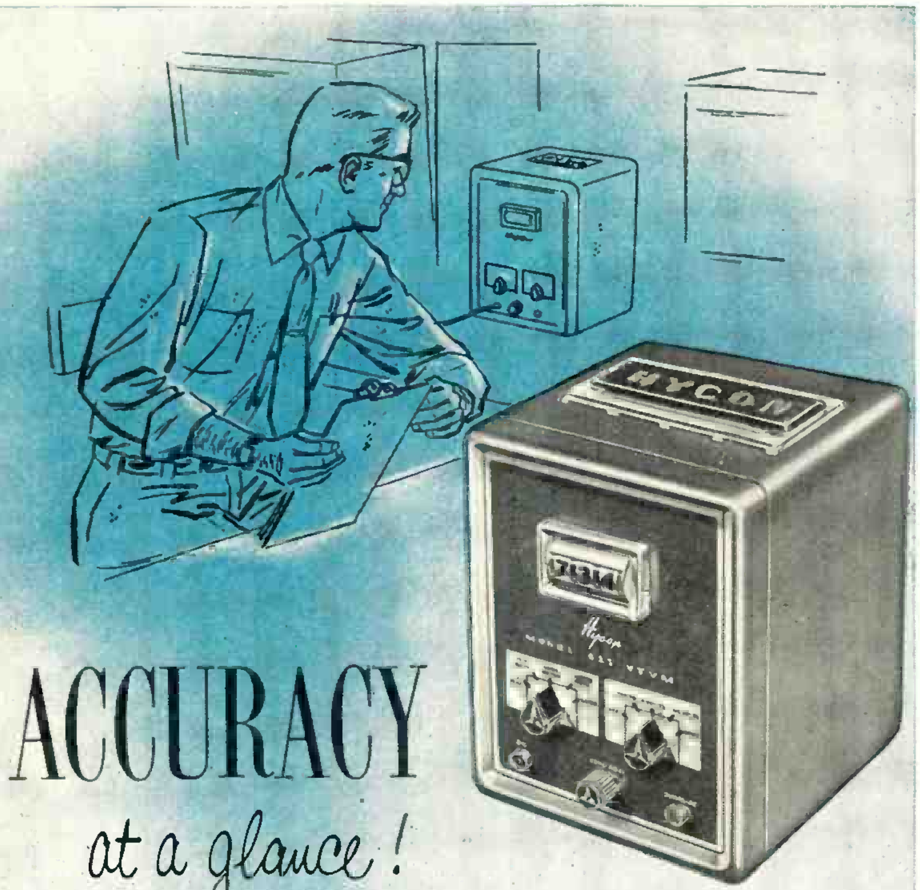

ACCURACY

at a glance!

Just select the range you want... Hycon's new Model 615 *Digital* VTVM does the rest... gives you a *direct* reading in numerical form, complete with decimal point and polarity sign. There's no interpolation, no chance of reading the wrong scale. Even inexperienced personnel find the Model 615 easy to use... you just *can't* read it incorrectly!

Ideal for both laboratory and production-line testing, here's what the Model 615 offers...
...1% accuracy on DC and ohms; 2% on AC
...12 ranges...0 to 1000 volts DC and AC; 0 to 10 megohms
...Illuminated 3-digit scale, with decimal point and polarity sign
...Response (with auxiliary probes) to 250 mc
...Shielded case; rugged, bench-stacking design; lightweight

Two more Hycon test instruments... designed for tomorrow's circuitry... *ready for color TV...*

MODEL 617 3" OSCILLOSCOPE...
Accurate enough for research, rugged enough for servicing. Features high deflection sensitivity (.01 v/in rms); 4.5 mc vertical bandpass, flat ±1 db; internal 5% calibrating voltage. **SPECIAL FLAT 3" CRT FOR UNDISTORTED TRACE FROM EDGE TO EDGE.**

MODEL 614 VTVM...
Maximum convenience combined with unprecedented low cost. Plus features include: 21 ranges (28 with p-p scales); 6½" meter; 3% accuracy on DC and ohms, 5% on AC; response (with auxiliary probe) to 250 mc. **TEST PROBES STOW IN CASE, READY TO USE.**

See these Hycon instruments ...all in matching, bench-stacking cases...at your local electronic jobber.

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2961 EAST COLORADO STREET
PASADENA 8, CALIFORNIA

"Where accuracy counts"

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ELECTRONIC TEST INSTRUMENTS • GO NO-GO MISSILE TEST SYSTEMS • AERIAL SURVEYS

TELE-TIPS

(Continued from page 24)

MILITARY weapons are becoming so complicated that in case of war there may not be enough enlisted men smart enough to operate and service them, reports a science and industry writer in American Mercury.

BROADCASTERS are wondering why the hue and cry about liquor advertising on the air. NARTB has found that only 2% of all radio programs are sponsored by beer and wine companies using an actual message time of 0.21%. For TV stations about 3% are sponsored by these advertisers, accounting for an actual message time of 0.31%.

TURBO-ENCABULATOR described in these columns this past February had us a bit puzzled. We asked for help and got it. According to a report from F. A. Swanlund, Chief Radio Engineer of the Colorado State Patrol, "I found utilization of parallel magnetostriction stasis to be directly dependent upon quasi-iestic wending, while hydrostatic activation of any deviation occurring in negative control could be directly attributed to atmospheric contrabulation. I hope, as a result of this further description it will now be possible to rely on the detractors for better unilateral phase discrimination." So there!

LIGHTNING kills 400 people each year and sparks 10% of our forest fires. Although the mechanics of the flash are fairly well understood, the mystery remains, "What causes the electricity in the first place?" Dr. Bernard Vonnegut, rainmaker and physicist at Arthur D. Little, Inc., believes that positively charged air from the earth rises to form positive clouds. Negative ions from the upper atmosphere are thus attracted and swept by downdrafts to the lower part of the cloud, which in turn attract fast positive ions from the earth. These positive ions become attached to fine particles, are carried to the upper part of the cloud, increasing the negative charging rate on the lower part, resulting in a "boot-strap" electrification process which builds up the charges large enough to produce lightning.

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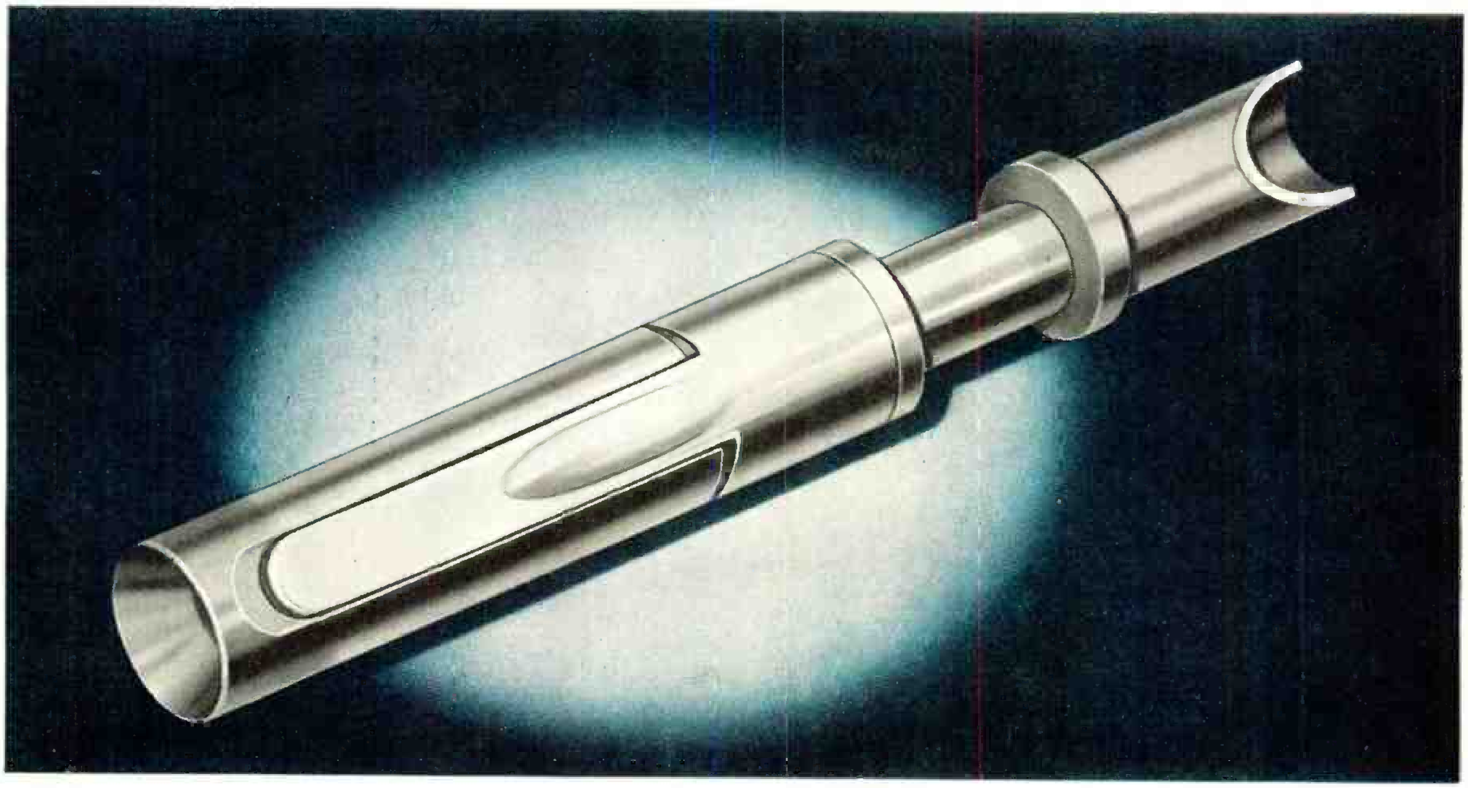

"CLIP-TYPE" closed entry socket contact now standard in

BENDIX-SCINFLEX

ELECTRICAL CONNECTORS

CANNOT be overstressed— eliminates intermittent circuit problems resulting from socket contact malfunction.

The heart of any electrical connector is the socket contact. This is why the Bendix-Scinflex* socket contacts have always been machined from bar stock. Stampings, with their required thin sections, can be easily overstressed.

Even with the machined sockets, industry has been plagued with overstressed spring leaves due principally to the misuse of test probes and lax tolerances on pin contacts. Bendix engineers have now provided the only socket contact on the market today which completely eliminates all these problems.

The "Clip-Type" socket will not accept any oversize probe or pin, nor can one be forced into it. Also, no amount of wrenching or twisting of an acceptable pin or probe can possibly distort the spring clip. This new socket is now standard in all Scinflex connectors including those using solderless, high-temperature and thermocouple contacts.

Our sales department will be glad to furnish complete information on request.

*TRADE-MARK

Bendix

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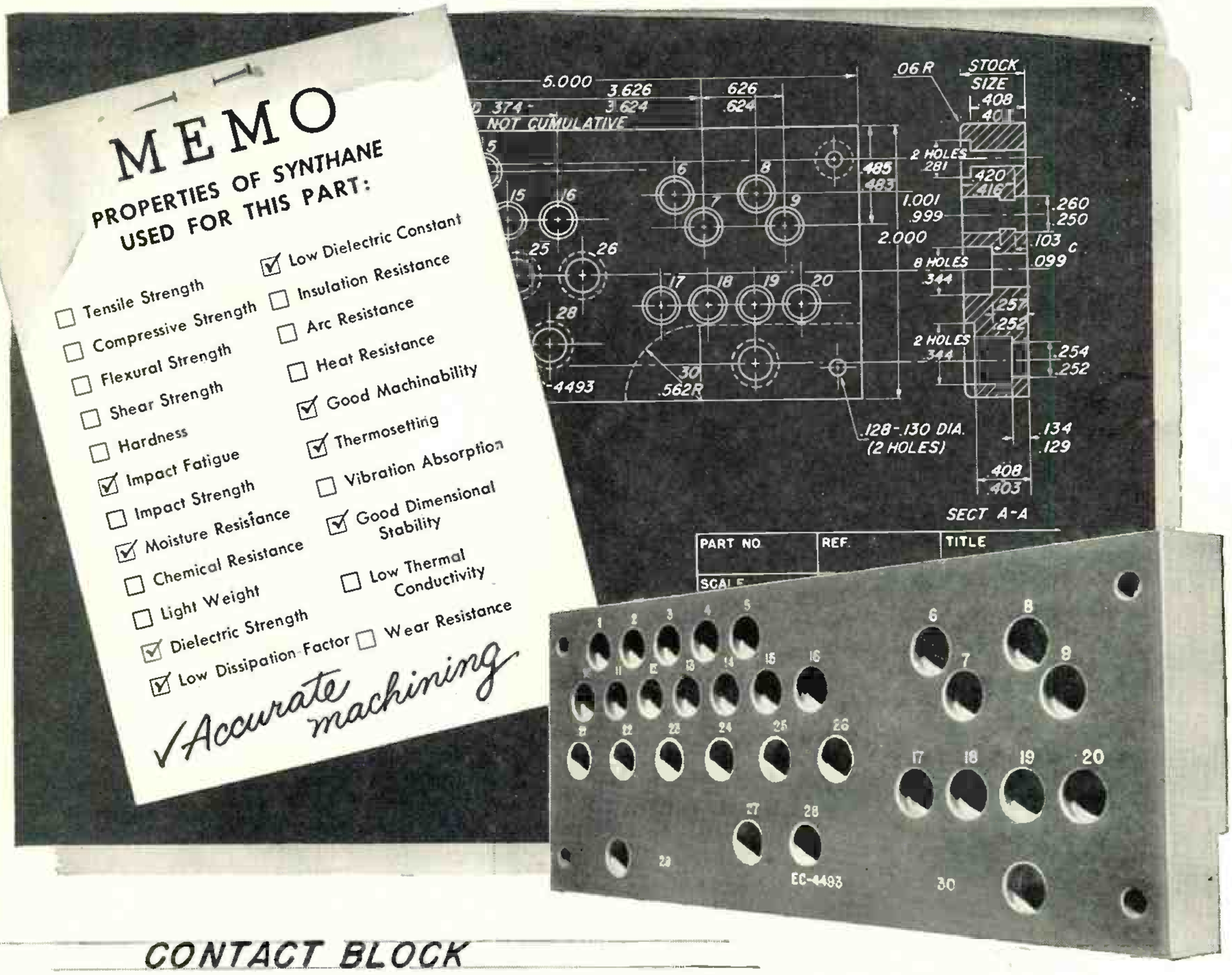
YOU FURNISH THE PRINT, WE'LL FURNISH THE PART



CONTACT BLOCK

OF SYNTHANE LAMINATED PLASTIC

MEETS MANY ELECTRICAL, MECHANICAL REQUIREMENTS

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

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

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

SYNTHANE CORPORATION, 11 River Road, Oaks, Pa.

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

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IT'S IN THE BAG!

the new audiotape

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that's 7-WAYS* BETTER than ever!

* **IMPROVED BALANCE** between high and low frequencies without sacrificing low-frequency output.

* **NEW MOISTURE-REPELLENT BINDER** with lower coefficient of friction. Absolutely eliminates tape squeal under hot, humid conditions. Runs well even on machines badly out of tension adjustment.

* **NEW ANTI-TACK AGENT** virtually eliminates possibility of sticking on hot erase and record heads. Especially important to owners of older type machines.

* **NEW DRIER-TYPE FORMULA** greatly reduces danger of oxide rub-off, even on dirty heads. Keeps clean heads clean.

* **IMPROVED HOT SLITTING** of standard plastic base. Edges of tape cleaner and smoother than ever, danger of tear or breakage greatly reduced.

* **NEW LOW BACKGROUND NOISE** through better dispersion of finer oxide particles. A feature of importance to all serious recordists.

* **NEW DUST-PROOF PACKAGING** in protective, re-usable polyethylene bag.

Audio Devices now offers you a new and vastly superior professional sound recording tape, at NO INCREASE IN PRICE

Here's a radically improved sound recording tape, perfected after long research in Audio Devices laboratories—a tape that sets completely new standards of performance.

Any *one* of the seven new and improved features listed here would be important news to the tape recordist. Collectively, they spell a degree of perfection heretofore unattainable in any magnetic recording tape!

Such a premium quality product could easily justify a premium price. But it has been made *standard* for *all Audiotape*, on plastic base or Mylar* polyester film—and is available at previous standard prices.

Try the new Audiotape—test it—compare it with any other product on the market. It will speak for itself!

* DuPont Trade Mark

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"they speak for themselves" **audiotape audiodiscs audiopoints audiofilm**

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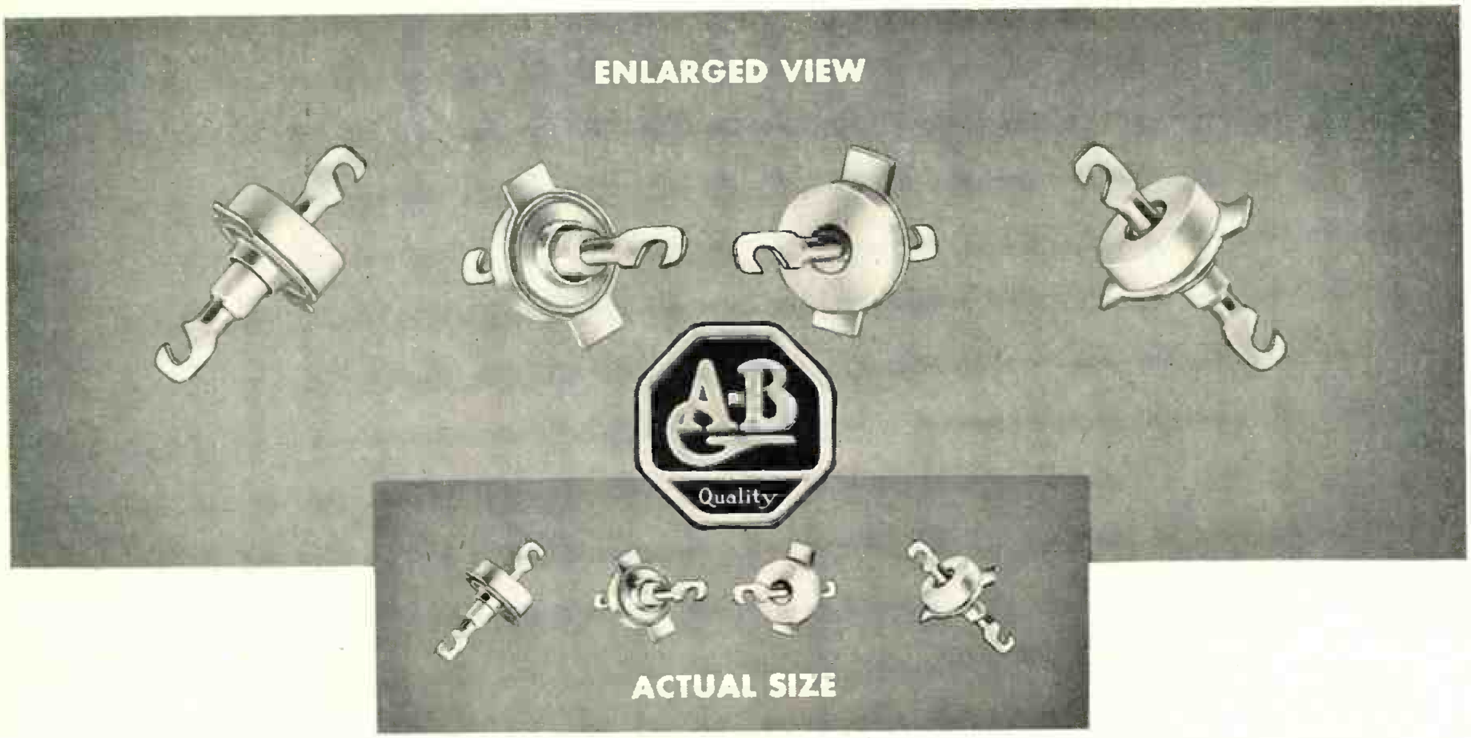
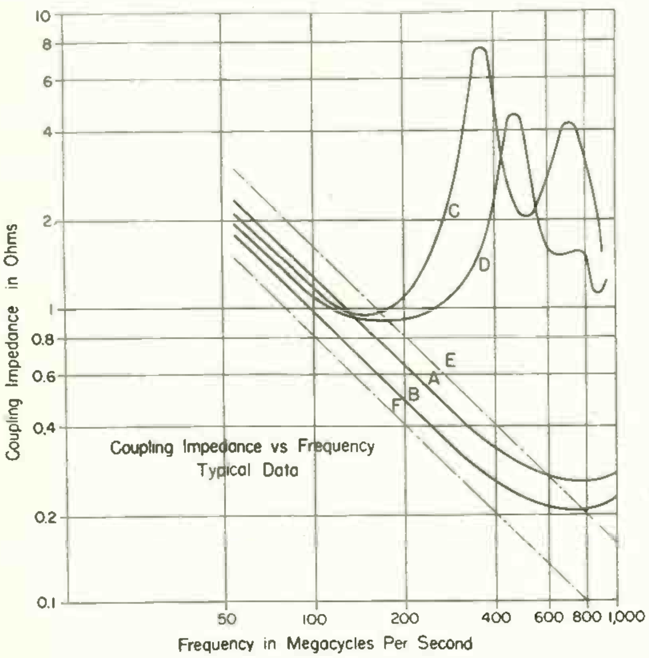


ANNOUNCING — An Improved UHF Discoidal Feed-thru Capacitor



Discoidal vs. Tubular Feed-thru Ceramic Capacitors

Allen-Bradley Discoidal Type	Curve A — 1300 MMF at 1 KC Actual Curve B — 1600 MMF at 1 KC Actual
Representative Tubular Type	Curve C — 1400 MMF at 1 KC Actual Curve D — 1500 MMF at 1 KC Actual
The "Ideal" Capacitor	Curve E — 1000 MMF at 1 KC Curve F — 2000 MMF at 1 KC

Feed-thru filtering . . . to prevent high frequency stray currents from passing from shielded areas over the power supply circuits . . . is a "must" in television receivers, radar, and other high frequency equipment.

The new Allen-Bradley discoidal feed-thru capacitors trap such stray currents by providing a low resistance path thru the shield for power currents and a low impedance coupling to the shield for diverting undesirable, high frequency currents.

Because these tiny discoidal capacitors (over-all length—23/32 in.) are so well constructed, you need not worry about breakage which might result from assembly line handling, contact with soldering irons, and thermal shock incurred in soldering operations.

In the frequency range between 100 megacycles and 1000 megacycles (VHF and UHF television), tubular type feed-thru capacitors have been found unsatisfactory because of parallel resonance effects resulting in high "coupling impedances." Allen-Bradley discoidal feed-thru capacitors do not exhibit such resonance effects at frequencies of 1000 megacycles or less.

The absence of these parallel resonance effects and the relatively high capacitance values with resultant low coupling impedances make Allen-Bradley discoidal feed-thru capacitors ideal for ultra high frequency television receiver applications. Measurements have shown improvement in filtering of more than 20 db through their use.

You should be interested! Write for Bulletin 5420 covering feed-thru and stand-off capacitors.

Allen-Bradley Co., 1342 S. Second St., Milwaukee 4, Wis. • In Canada—Allen-Bradley Canada Limited, Galt, Ont.

ALLEN-BRADLEY

RADIO, ELECTRONIC AND TELEVISION COMPONENTS

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NEW HIGH VOLTAGE SILICON JUNCTION DIODES

NEWLY EXPANDED TI LINE NOW INCLUDES 15 SINGLE CRYSTAL JUNCTION TYPES IN 20% VOLTAGE RANGES FROM 4.7 TO 470 VOLTS!

high temperature conditions call for silicon diodes from Texas Instruments — your most experienced source of supply for silicon semiconductor devices. The first commercial producer of silicon transistors, TI has produced for commercial and military use many thousands of silicon junction diodes and triodes. TI now introduces a completely new line of silicon diodes including many high voltage types, greatly increasing the application for these reliable devices. This new line features types with characteristics stable to 150°C.

600C

TI

low back current, another important characteristic of TI silicon junction diodes, opens up still more space and weight saving circuit design possibilities. With back current as low as 0.001 microamp at rated voltage for many types, these silicon junction diodes can be used in applications where high operating temperatures and low back current requirements make germanium diodes unsuitable.

100 per cent inspection and aging of every TI diode assures maximum reliability. Thoroughly tested at high temperatures, these uniformly high quality silicon diodes will increase electronic equipment dependability where heat, shock and vibration are problems. Every unit is hermetically sealed, providing maximum protection against ambient moisture.

TI Type	Max. Rev. Working Voltage	Min. Junct. Break-down Voltage	Minimum Forward Current 25° Ma.	Minimum Forward Current 25° Volts	Maximum Ratings at 25°C: Reverse Current Amperes*	Maximum Ratings at 25°C: Dissi-pation mw	Maximum Ratings at 25°C: Average Rectified Forward Current ma	Maximum Ratings at Elevated Temperatures: Ambi-ent Temp. °C	Maximum Ratings at Elevated Temperatures: Reverse Current Amperes*	Maximum Ratings at Elevated Temperatures: Dissi-pation mw	Maximum Ratings at Elevated Temperatures: Average Rectified Forward Current ma	Typical Capacity μμfd f=500 kc Temp.=25°C Rev. Volts −12V†
600C	—	30.0	3	1	$1 \cdot 10^{-6}$ @ −1V	100	25	100	$0.4 \cdot 10^{-4}$	40	15	2.5
601C	—	50.0	3	1	$1 \cdot 10^{-8}$ @ −1V	100	25	150	$0.5 \cdot 10^{-4}$	20	10	2.5
604C	4.7	5.5	60	1	$1 \cdot 10^{-7}$	150	100	150	$0.5 \cdot 10^{-4}$	40	40	20
606C	6.8	7.5	35	1	$1 \cdot 10^{-7}$	150	90	150	$0.5 \cdot 10^{-4}$	40	35	16
608C	10.0	11.0	25	1	$1 \cdot 10^{-7}$	125	75	150	$0.5 \cdot 10^{-4}$	20	25	12
610C	15.0	17.0	12	1	$1 \cdot 10^{-7}$	125	60	150	$0.5 \cdot 10^{-4}$	20	20	7
612C	22.0	25.0	7	1	$1 \cdot 10^{-7}$	125	50	150	$0.5 \cdot 10^{-4}$	20	20	5
614C	33.0	37.0	5	1	$1 \cdot 10^{-7}$	125	35	150	$0.5 \cdot 10^{-4}$	20	15	3.5
616C	47.0	52.0	3	1	$2 \cdot 10^{-7}$	100	30	125	$0.4 \cdot 10^{-4}$	20	15	2.5
618C	68.0	75.0	1.5	1	$2 \cdot 10^{-7}$	100	25	125	$0.4 \cdot 10^{-4}$	20	10	2.0
620C	100.0	110.0	0.9	1	$2 \cdot 10^{-7}$	100	20	125	$0.4 \cdot 10^{-4}$	20	8	1.4
622C	150.0	170.0	6.5	4	$2 \cdot 10^{-7}$	90	15	100	$0.3 \cdot 10^{-4}$	30	5	1.2
624C	220.0	250.0	3	4	$0.4 \cdot 10^{-6}$	80	10	71	$0.2 \cdot 10^{-4}$	40	5	1.0
626C	330.0	370.0	2	4	$1 \cdot 10^{-6}$	75	7	71	$0.2 \cdot 10^{-4}$	30	4	0.9
628C	470.0	520.0	1	4	$1 \cdot 10^{-6}$	70	5	71	$0.2 \cdot 10^{-4}$	20	3	0.7

* At maximum working voltage.

† On types 604C, 606C, and 608C reverse voltage was reduced below breakdown voltage.

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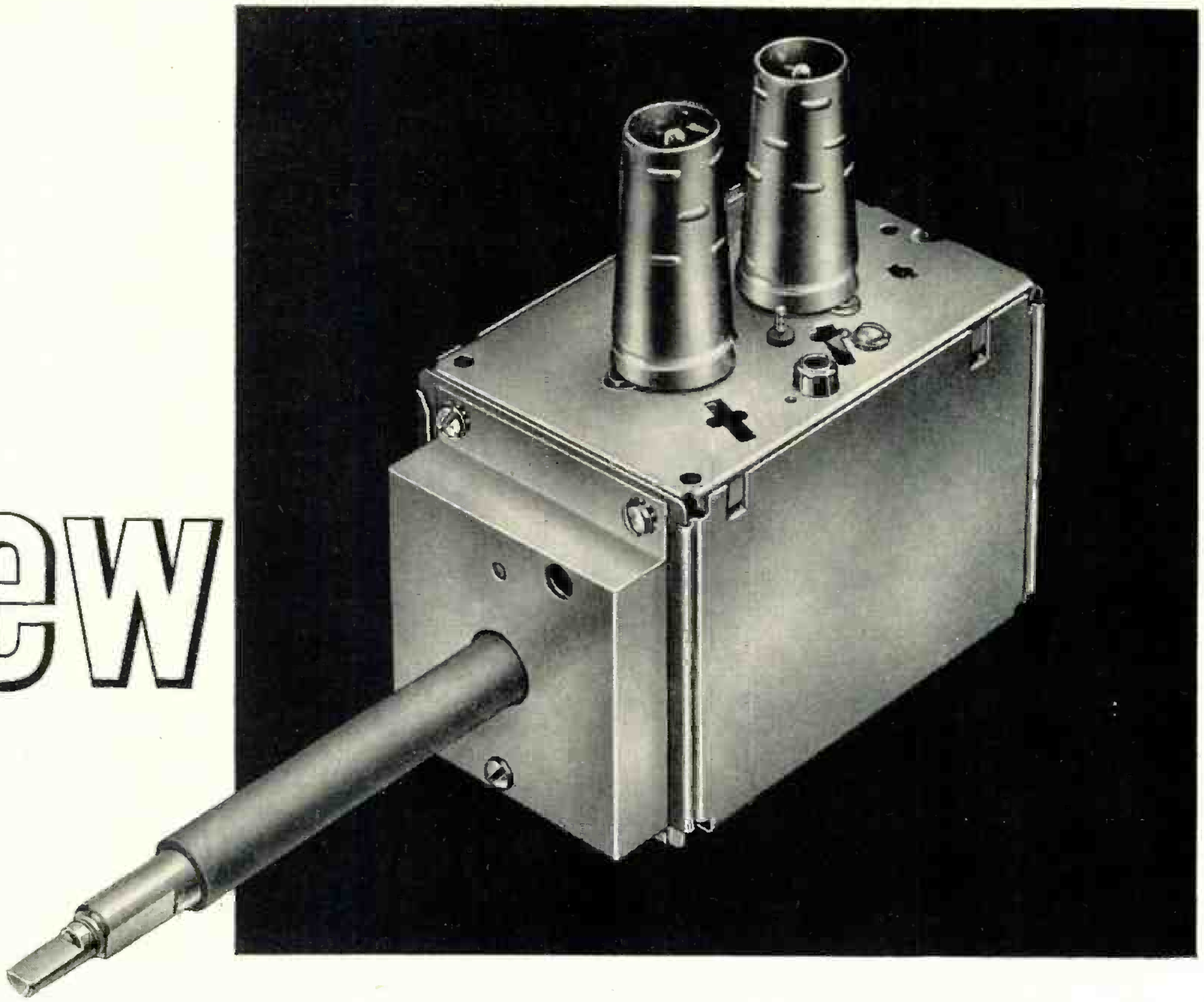

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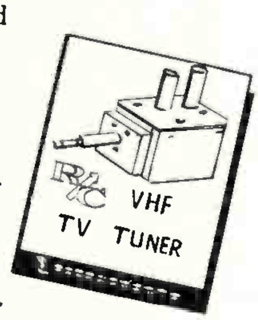

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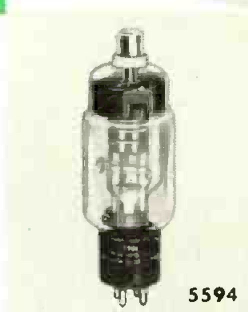
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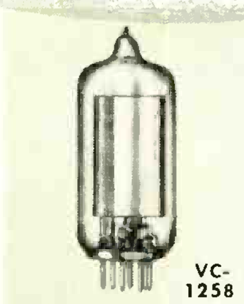
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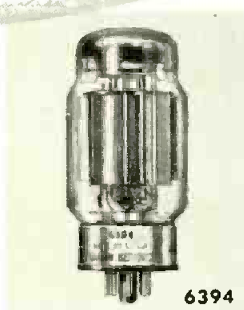
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ELECTRICAL CHARACTERISTICS OF SPRAGUE PULSE TRANSFORMERS

Type No.	Turns Ratio	Pulse Width μ seconds	Rise Time μ seconds	Primary Inductance	Leakage Inductance	Repetition Rate	Load and Output	Typical Applications
10Z1	5:1	0.1	0.04	200 μH	5 μH	1 to 2 MC	15 volts 100 ohms	Used in digital computer circuitry for impedance matching and inter-stage coupling. Pulses are of sine wave type.
10Z2	4:1	0.07	0.03	200 μH	20 μH	1 to 2 MC	20 volts 100 ohms	
10Z3	1:1	0.07	0.03	125 μH	12 μH	1 to 2 MC	20 volts 200 ohms	
10Z4	3:1	0.07	0.03	160 μH	15 μH	1 to 2 MC	20 volts 100 ohms	
10Z6	4:1	0.1	0.04	200 μH	6 μH	1 to 2 MC	17 volts 100 ohms	
10Z12	1:1	0.25	0.02	200 μH	2 μH	12KC	100 volts	Blocking Oscillator
10Z13	1:1	0.33	0.07	240 μH	2 μH	2KC	50 volts	Blocking Oscillator
10Z14	7:1:1	0.50	0.05	1.2 mH	20 μH	1MC	25 volts	Impedance Matching
15Z1	3:1	5.0	0.04	7.5 mH	22 μH	10 KC	10 volts 100 ohms	Impedance Matching and Pulse Inversion
15Z2	2:1	0.5	0.07	6 mH	15 μH		40 volts	Blocking Oscillator
15Z3	5:1	10.0	0.04	12 mH	70 μH	10 KC	10 volts	Impedance Matching
15Z4	1:1.4	6.0	0.1	16 mH	15 μH	0.4 KC	15 volts	Blocking Oscillator
20Z1	5:5:1 Push-Pull	1.5	0.25	4.0 mH	0.3 MH		5 volts 10 ohms	Memory Core Current Driver
20Z3	6:1	1 to 4	0.22	18 mH	0.8 MH	250 KC (max.)	21 volts 200 ohms	Current Driver
20Z4	6:1:1	1 to 7	0.25	55 mH	0.3 MH	50 KC (max.)	22 volts 400 ohms	Current Driver and Pulse Inversion
20Z5	3.3:3.3:1 Push-Pull	2.4	0.2	2.8 mH	0.2 MH		2.5 volts 6 ohms	Memory Core Current Driver
20Z6	11:1	6.0	0.2	90 mH	0.2 MH	50 KC (max.)	10 volts 75 ohms	Current Transformer
40Z1	7:1:1	0.50	0.05	1.2 mH	20 μH	1 MC	25 volts	Impedance Matching

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Engineers — Benchmen or Deskmen?

During our recent visits to electronic research and engineering laboratories, we came across two contradictory complaints. In some companies, the lament ran something like this: Engineers are becoming a group of pencil pushers. They draw up plans, pass them on to technicians to do the construction and eventually start to lose the physical feel of the very equipment they create. What a departure from the methods used by men like Edison!

In other laboratories the plaint is just the opposite: Engineers are becoming a group of well educated technicians, spending their time soldering chassis instead of doing analytical and conceptual work. What a waste of training and brainpower!

Strangely enough, both complainants may be right . . . in their own particular cases.

Since this problem of utilizing engineering time at the desk or bench is a very fundamental one to engineering management, it would be appropriate to examine why the problem exists and what criteria may be established to resolve it. Greater insight into the problem should provide a basis for each company to make an honestly critical self-evaluation of its own operation.

Engineers at the Bench

The history of scientific advancement shows us that most fundamental developments were made by men with creative minds and gadgeteering hands. Of course, there are exceptions such as Einstein and the atomic bomb, but for the most part pioneering theories have been rough hewn to start and the only check on the concept's validity was to make the device. In feedback fashion, empirical results would modify the theory, and the cycle would repeat.

In virgin fields precedents and established procedures are relatively non-existent. Therefore, the creative engineering work must be done "along the way" so to speak; that is, while the development is under construction. A routine-minded technician would not be qualified to engineer-fabricate the radically new item, so the task falls to the engineer with the gadgeteering hands.

Now we can extend this observation with something of a generalization which describes the primary pattern (but not necessarily each individual case) and provides a workable criterion: *Pioneer efforts in untried scientific areas generally require the engineer to do a considerable amount of bench work in proportion to desk work.*

Engineers at the Desk

Once the initial effort has been made, the monumental task of engineering improvement presents itself. Prototype testing, data analysis, product modifications and design technique refinement become prime interests. Here the essential tools are the slide rule, data sheets, blueprints, performance curves and mathematical equations, all used at the desk. There is little engineering knowledge required to make most of the physical constructions, so technicians can do the greater part of the manual work.

One other category should also be mentioned, the theoretician. Since a product is usually not an integral part of this work, the desk is his best work place.

So we come to our second generalization (once again, not necessarily applicable to each individual case): *Theoretical work and efforts in well-tried scientific areas generally require the engineer to do a considerable amount of desk work in proportion to bench work.*

How does *your* operation measure up to these two criteria?

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RADARSCOPE

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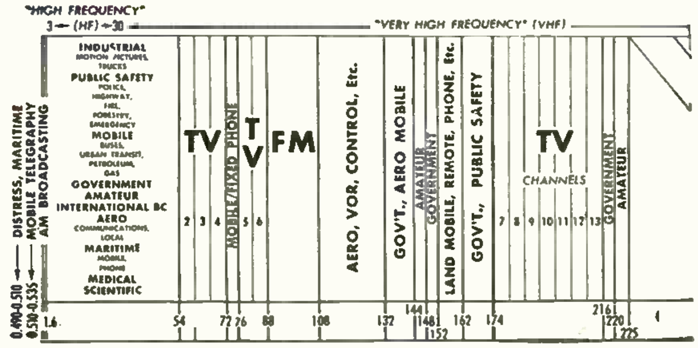

MAGNETIC TAPE market, which has been expanding rapidly during recent years, receives another boost with the establishment of the Recorded Tape of the Month Club, P.O. Box 195, Radio City Station, New York, N. Y. New organization furnishes "preview" tapes of monthly selections. Regular tapes on 7-in. reels sell for $5.95.

SELECTIVE DE-INTERMIXTURE of VHF and UHF channel allocations appears in the offing, reflecting sentiments of FCC Chairman McConnaughey and Senate Commerce Committee Chairman Magnuson. Such action is more than welcomed by many UHF broadcasters. Some industry leaders are recalling their comments of several years ago that mixture of VHF and UHF stations in same market would place serious burdens on UHF telecasters.

COLOR-TV

Photo showing what it takes for a 21-in. RCA compatible color-TV receiver. These 2076 parts are provided by more than 600 suppliers located in many different sections of the U. S. Industry leaders indicate that a more widespread production of color-TV receivers is expected this fall.

COLLECTIVE BARGAINING report, #75, has just been issued by the Bureau of Labor Statistics. The study lists individually 284 agreements involving more than 6 million workers, and includes the dates when wages may be adjusted.

COURT DECISION nullifying FCC fixed limitation on number of stations owned by one party may modify Commission policy on the subject unless it is taken to Supreme Court and reversed on appeal. However, court decision stated that hearings must be made on individual basis, with ultimate discretion of granting or not resting with FCC.

TAPPING TELEPHONES appears to be more widespread than many had ever imagined. Situation has been brought to light by headline scandal revealed in New York City. In addition to professional tappers, often paid by businessmen to get inside information on a company's activities, there are a host of tap cases involving police and private detectives.

UHF TRANSISTOR to be revealed in near future will cause quite a stir in the industry.

RETMA IMPORT policy has been revised, according to informed sources. A resolution adopted last fall, seeking the restoration of the 35% U.S. tariff on electronic imports from the present 12½% has been shelved. The new policy is to watch and wait. Plans are to take action against any unfair competition from foreign sources should it arise and grow sufficiently strong to threaten the domestic market.

SUBWAY communications system is being evaluated by New York City engineers. The r-f signal would be fed to a long cable running through the tunnel, and then radiated in a restricted area to a loop atop the subway car. Similarly, the trainman could transmit messages from the car to a central office.

INTERESTING experiment with radio broadcasting from overhead power lines is being conducted by consulting engineer William S. Halstead. It is intended to overcome static interference and extend the range of stations. In operation, an FM broadcast is picked up from a distant metropolis, converted to AM, and fed into the power line at 550 KC by a 10-watt transmitter. Any home or auto radio within 1 mile of the transmitter and 100 ft. of the power line can receive the rebroadcast. The technique, although new to commercial broadcasting, has been used by the Army and Air Force.

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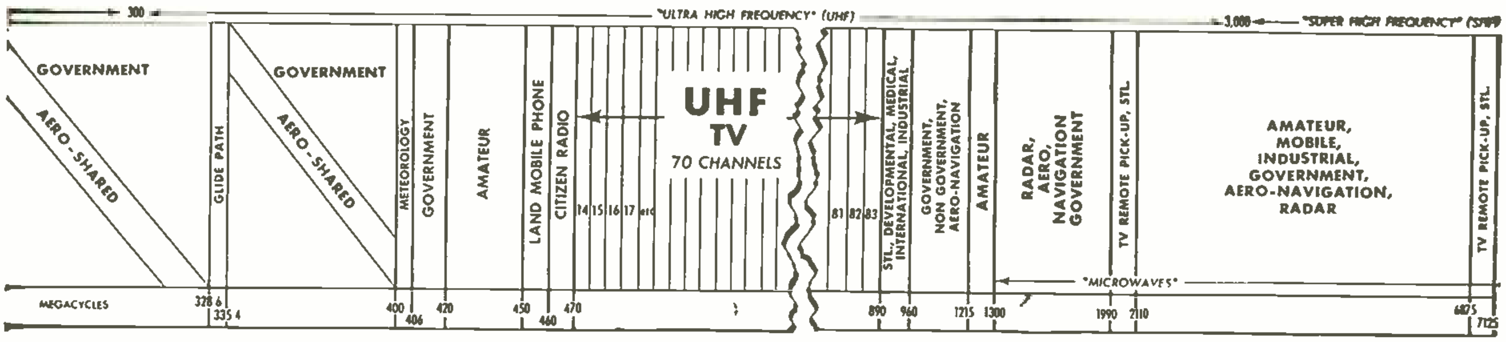

INDUSTRIAL TV is being used on board sea whalers, reports the British Information Services.

ENGINEERING MANPOWER

THE FOLLOWING statement of policy from leading engineering groups reflects the growing concern over the utilization of engineering manpower.

"In the interest of immediate as well as long range needs of our nation, it is the opinion of the Engineering Manpower Commission of Engineers Joint Council, the Scientific Manpower Commission, the Board of Directors of the American Chemical Society and the Technical Manpower Commission of the Armed Forces Chemical Association that every step should be taken:

"1. To assure maximum and uninterrupted growth of scientific and technological developments by promoting a strong educational system at all levels which will produce an adequate flow of specialized personnel of outstanding qualifications.

"2. To assure optimum utilization of specialized personnel through a system whereby both military and civilian needs will be fulfilled. This objective will require expert civilian and military judgment to determine where each person can contribute most to the national interest.

"These broad objectives are not being met today. Because they are not being met, it is our opinion . . . that those in Government having responsibility for the administration of the manpower program should seek:

"1. Modification of Public Law 51 (Universal Military Training and Service Act) and its administration, including a change in title, in order to guarantee the selectivity features of the law.

"2. Legislation to establish a National Manpower Board in the Office of the President composed of both civilian and military personnel whose duty it shall be to determine policy and implement and administration of matters relating to specialized personnel. This legislation shall also provide for proper organization at state and local levels to ensure adequate recognition of individual abilities and local situations which provide realistic proper utilization of each reservist.

"3. Legislation to provide an immediately callable reserve, under the control of the military, of such a size that it can be well organized, highly trained, and quickly mobilized to provide an effective striking force in the event of aggression, and also

"4. Legislation to provide a selectively callable reserve, whose members shall not be recalled to the military except on a selection basis under the direction of the National Manpower Board."

MILITARY COMMUNICATIONS

A NEW, PORTABLE, G. I. telephone system, which can handle three times as many conversations over a single cable as comparable Korea and World War II systems, has been developed for the U.S. Army Signal Corps by Bell Telephone Labs. Basic equipment for the new telephone system is contained in units about the size of large suitcases which can be handled by only one or two men. These units are designed so they can be stacked one on another. The "carrier" principle used for the new system allows 12 conversations to share the same cable by using a different frequency for each.

The system, providing for twelve simultaneous conversations, can be used for distances up to two-hundred miles. Another, a four-channel system, can be used for four simultaneous conversations at distances up to a hundred miles. Recently developed miniaturized parts can be credited with the sharp reduction in size and weight of the new equipment. The earlier, four-channel unit, for example, weighed 475 lbs. and occupied 20 cu. ft. of space. Complete with its power supply, the new four-channel terminal weighs 178 lbs. and occupies only 5.5 cu. ft.

Portable, G. I. telephone system designed by Bell Telephone Labs. for the Army Signal Corps can handle four conversations at a time over a single cable. The repeater shown here is used to amplify the conversations, which may be transmitted over a distance of a hundred miles. It weighs only 178 lbs., a real improvement over the earlier version.

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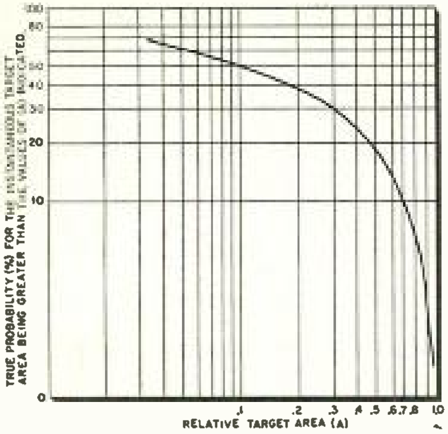

Fig. 1: Target area probability distribution

Cumulative Probability

Method presented for evaluating the figure of merit for radar performance, and optimum scan rate to be used when target relative velocity is known



By T. J. ROONEY *L. S. RIDER* *& B. H. RUDWICK*

*Advanced Electronics Center at Cornell Univ.
General Electric Co., Ithaca, N.Y.*

THE figure of merit for evaluating radar range performance is defined here as the probability of detecting a target on any two successive scans before it reaches a given range. It is considered a better measure of actual radar performance than merely using the probability of seeing a target return on any one scan, since noise may present a false target to the radar observer. Another use of this method of radar analysis is presented; that of determining the effect created by varying the radar scan rate, since the detection probability is a function of the number of times that the radar has "looked" at the target.

Many standards have been proposed and used for evaluating radar range performance. These standards include:

A. The radar range equation which commonly gives the range at which a discernible signal is obtained on 50% of the scans (the familiar 50% blip-scan range).

B. The single scan probability curve on which is plotted the probability of seeing a target above the average noise for each range.

C. The area under the single scan probability curve in which one figure of merit is derived from the curve and used as the figure of merit of the radar.

None of the above standards presents the entire radar system evaluation. The considerations involved in detecting a target should be examined so that a proper definition of target detection can be obtained, and a figure of merit for the radar performance evolved.

Since a radar operator sees peak noise pulses in addition to target pulses, he cannot be certain if the indication he sees on a single scan is a target or noise. However, since the noise has a random probability of appearing at any one spot on the display, its probability of appearing at a neighboring spot on the next scan is very small. This fact enables an operator to use scan-to-scan correlation in distinguishing a true target from noise. A good definition, therefore, of "target detection" is the appearance of a target return in the same region on each of two successive scans.

The figure of merit of the radar system can then be defined in either one of two ways.

A. The probability of detecting a target prior to some arbitrary range. The two-successive-scan criterion is the heart of the definition of detection and, even though not explicitly stated, is assumed when the term detection is used hereafter.

B. The range at which the detection probability is equal to some arbitrary value.

The first definition is the one which will be used in this report.

Calculation of Single Scan Detection Probability

The radar detection range, R, is given by the radar equation:

$$R = K\left[\frac{P_t\, G_o^2\, \lambda^2\, \tau\, F^{1/2}\, \theta^{1/2}_{HP}\, A_e}{\overline{NF}\, \omega^{1/2}}\right]^{1/4} \quad (1)$$

Fig. 1 gives the probability of the instantaneous effective target area, A_e, of a jet aircraft being greater than some fraction of the peak target area. This curve, theoretically derived, was taken from a confidential General Electric report, and can be used to relate range with the probability of detection on any single scan. For instance, the curve indicates that the instantaneous effective target area exceeds approximately one-tenth of the peak target area 50% of the time. Thus, if the peak target area is multiplied by 0.1 and this value substituted for A_e in the

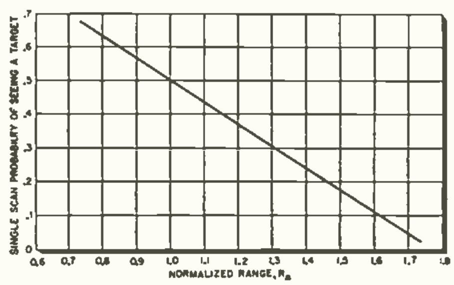

Fig. 2: Single scan probability distribution

radar range equation, the range for 50% probability of detection on any scan is obtained. Let this range now be defined as R_e, the Effective Range of the radar. Similarly, the range for other values of probability can be obtained. However, a curve constructed in this manner would be applicable to only one set of radar parameters, therefore, it is desirable to develop an expression which does not contain specific radar parameters, and thereby obtain a generalized curve.

For any particular radar set the radar range equation can be written as follows:

$$R = K\,(A_e)^{1/4} \quad (2)$$

and

$$A_e = (A)\,(A_m) \quad (3)$$

where

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# of Radar Detection

A_m = peak target area
A = ratio of instantaneous effective target area to peak target area (relative target area).

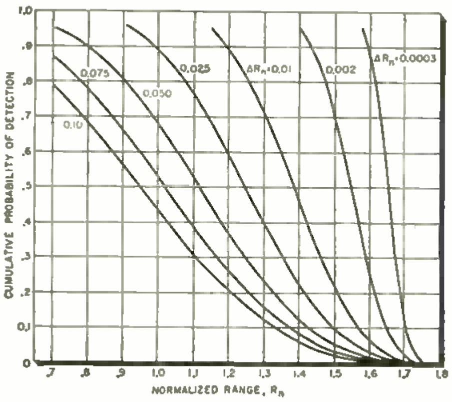


Fig. 3: Cumulative probability of detection as function of normalized range and scan interval

By definition

$$R_e = K\,(0.1\,A_m)^{1/4}. \qquad (4)$$

Let

$$R/R_e = R_n \qquad (5)$$

R_n being equal to Normalized Range.

Then

$$R_n = (10\,A)^{1/4}. \qquad (6)$$

From both Eq. (6) and Fig. 1, Fig. 2 can be derived; each value of A having associated with it a particular probability value. Thus for $A = 0.1$, R_n is 1 and the probability of seeing a target on a single scan at this range is 50%. In this manner a generalized curve is obtained which is independent of the actual effective radar range. Note that this curve is linear. The normalized scale can be converted to actual range for any particular set of radar parameters by calculating the effective radar range and multiplying the normalized scale by this factor.

Cumulative Probability of Detection

The probability that a target will be detected prior to reaching some arbitrary range is a function of the number of times the target has been scanned and the probabilities that the target is seen on each of these scans. Thus, the probability of detection accumulates or increases as the target approaches the radar. Table 1 indicates how the Cumulative Probability of Detection may be obtained as a function of the number of radar scans which have occurred, and the values of the single scan probabilities of seeing a target. All possible combinations of single scan success and failure are derived (discontinuing a chain once a detection success has been made since the detection of a given target may only be counted once).

Two tasks now remain to complete this discussion:

A. The general formula for the Cumulative Probability of Detection following the *i*th radar scan must be obtained.

B. The means of evaluating p_1, the single scan probability, and q_1, $1-p_1$, must be obtained.

The general formula for the Cumulative Probability of Detection is a function of the number of scans and the single scan probabilities p_1 and q_1, and may be expressed in terms of target range in the following manner:

1. Assume that the first target scan occurs at the lowest value of the single probability of seeing the target, shown in Fig. 2. This corresponds to $R_n = 1.755$. Tests have shown that the choice of the initial starting point introduces very small differences in the final accumulated probability value since the single scan probabilities of the first few scans are so very small for the average radar problem.

2. Successive target positions when illuminated by the radar may be obtained by calculating the distance the target travels between each successive scan. This distance, ΔR, is dependent upon the assumed target speed and the antenna rotation rate as follows:

$$\Delta R = V\Delta t = V/60\,\omega \qquad (7)$$

where
V = closing rate of the target in knots,
ω = scan rate of radar in rpm.

The target closing rate, V, should consider the fastest target to be encountered, and if the radar set is to be airborne, should include the motion of the radar platform.

Since Fig. 2 (which has been plotted in general, normalized coordinates) is to be used to obtain single scan probabilities, values of ΔR must be normalized by dividing by R_e. Thus

$$\Delta R_n = \frac{\Delta R}{R_e} = \frac{V}{60\omega R_e} \qquad (8)$$

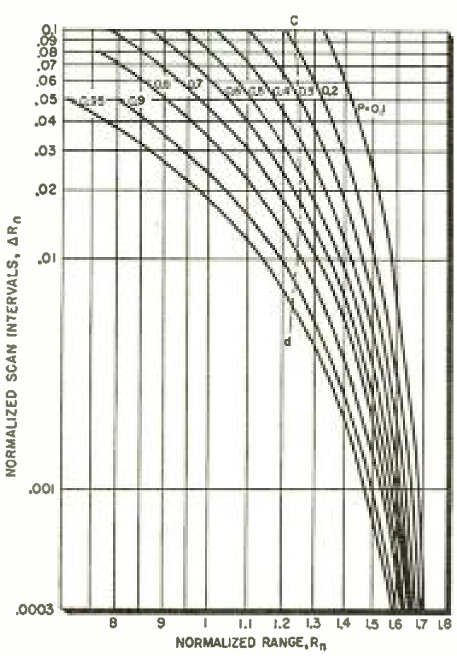
where R_e is again the effective range of the radar in nautical miles. Thus, for each value of ΔR_n, the probability of seeing (or not seeing) a target on each radar scan may be obtained and inserted into a detection probability formula to yield the probability of seeing a target on two successive scans by a given range. The results of this formula for different values of ΔR_n are shown in Fig. 3. To avoid cumbersome extrapolations for odd values of ΔR_n, the data in Fig. 3 has been plotted in different form, and on logarithmic scales, as shown in Fig. 4. This also affords greater ease in using the data.

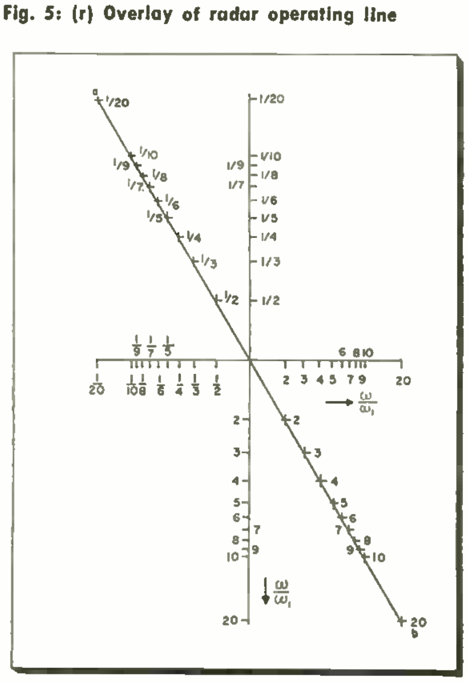
Example 1:

Assume a radar antenna rotation rate of 10 rpm., a target speed of 600 knots, and a calculated effective radar range of 80 nmi.:

(1) Calculate the Cumulative Probability of Detection at 90 nmi.

Fig. 4: (l) Detection probability distribution. Fig. 5: (r) Overlay of radar operating line





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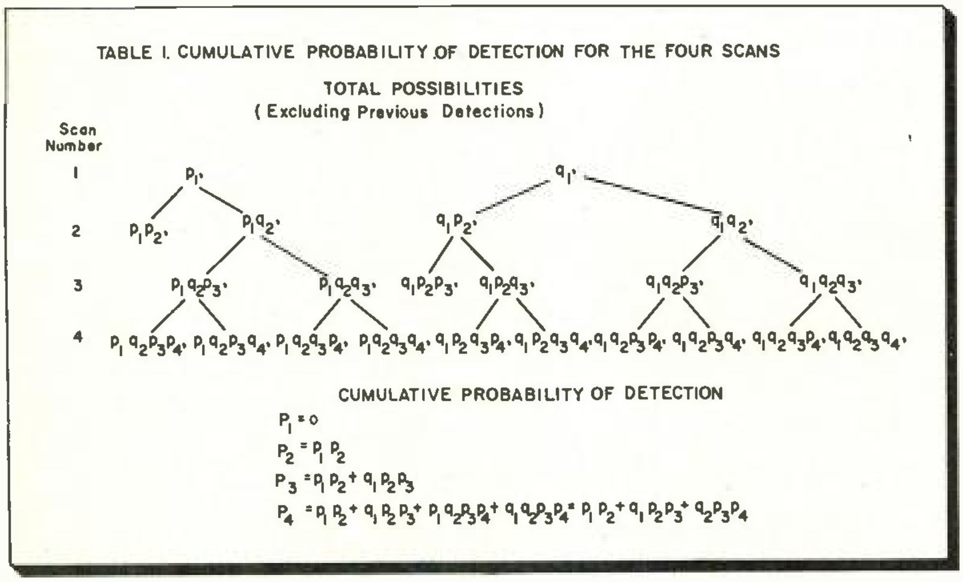

(2) At what range will there be a detection probability of 50%?

(1) $\Delta R_n = \frac{V}{60\omega R_e}$

$$= \frac{600 \text{ knots}}{(60)(10 \text{ rpm.})(80 \text{ nmi.})} = 0.0125.$$

$$R_n = \frac{R}{R_e} = \frac{90 \text{ nmi.}}{80 \text{ nmi.}} = 1.125.$$

Thus from Fig. 4, the Cumulative Probability of Detection at $\Delta R_n = 0.0125$ and $R_n = 1.125$ is 92%.

(2) Also from Fig. 4, if $\Delta R_n = 0.0125$ and $P = 50\%$, $R_n = 1.36$. Thus $R = R_e R_n = (80 \text{ nmi.})\ (1.36) = 109$ nmi.

This section illustrates how the curves of Fig. 4 may be used to obtain the optimum scanning speed, ω, for maximum cumulative detection probability by a given range.

The radar range equation indicates that the effective range of a radar varies inversely as the eighth root of the scan rate, ω. This implies that the slowest scan rate is the most desirable for early warning detection. However, as was seen previously, the faster the target closing rate, the fewer times the target is scanned, and the more incorrect the above assumption becomes. Each value of ω will determine its own value of ΔR_n and R_n, the coordinates of the "radar operating point" in Fig. 4, and this produces a unique value of detection probability. Thus, what is desired is a technique of automatically obtaining the new "operating point" for different values of ω. To obtain this, one must determine the relationships between R, R_n, ΔR_n and ω, where R is arbitrarily chosen. This relationship is then expanded about an arbitrary value of ω, as follows:

$$R_n = \frac{R}{R_e} = K_1 \omega^{1/8} \quad (9)$$

$$= K_1 \omega'^{1/8} (\omega/\omega')^{1/8} = K_2 (\omega/\omega')^{1/8} \quad (10)$$

where ω′ is the arbitrary value of ω.

(*Continued on page* 178)

"Mylar" Film as a Capacitor Dielectric

By J. A. RUBY
Film Department
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Wilmington, Del.

WITH the recent growth of "Mylar" polyester film production, increasing attention has been focused on the practical aspects of using this material in electronic circuit components, magnetic recording tape, laminates and insulation.

One of the most promising applications of the material in thin gauges (as thin as 0.00025 in.) is its use as a dielectric material in capacitor construction in place of regular tissue. This is indicated by the fact that all of the following companies are reported to be making capacitors using "Mylar" as a dielectric:

Aerovox Corp.
Astron Corp.
Bendix Aviation Corp.
Cornell-Dubilier Electric Corp.
Dumont Airplane & Marine Instr.
Electronic Fabricators, Inc.
J. E. Fast & Co.
General Electric Co.
Goodall Electric Mfg. Co.
Gudeman Co.
P. R. Mallory & Co.
New Haven Clock & Watch Co.
PCA Electronics Inc.
Plastic Capacitors Inc.
Sangamo Electric Co.
Southern Electronics
Sprague Electric Co.
Tobe-Deutschmann Corp.
Western Electric Co.

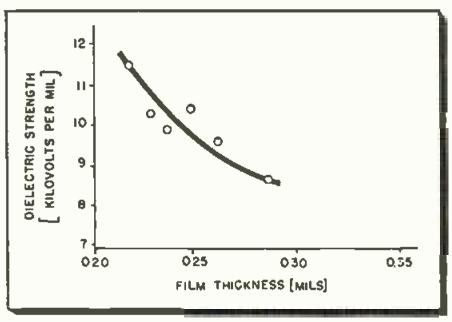


Fig. 1: Dielectric strength characteristic

Type C "Mylar" has these outstanding properties:

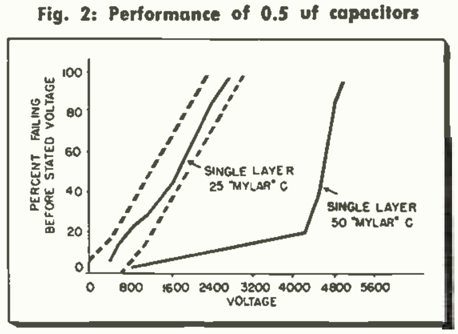
1. High dielectric strength
2. Good dielectric constant
3. Low power factor
4. Excellent high temperature insulation resistance
5. Physical strength

In order to develop quality tests for evaluation of "Mylar" polyester film as a capacitor dielectric, Du Pont has evaluated a large number of single-layer capacitors wound with 25 "Mylar" C. Results indicate that single-layer capacitors using this as a dielectric are feasible.

Short duration dielectric strength was obtained in air at 25°C, using 1-in. diameter painted silver electrodes on 25 "Mylar" C. These electrodes were used in preference to the discs of ASTM designation D-149-44 to insure freedom from surface defects. Since the dielectric strength of thin films depends on thickness, measurements were made

(*Continued on page* 114)

Fig. 2: Performance of 0.5 uf capacitors



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Wideband Ferrite-Core Transformer for High Frequencies

Construction techniques for low power units provide exceptionally good shielding. Transformers designed for use in 0.5 to 30 mc region

By *THOMAS R. O'MEARA,*
Univ. of Illinois, Urbana, Ill.

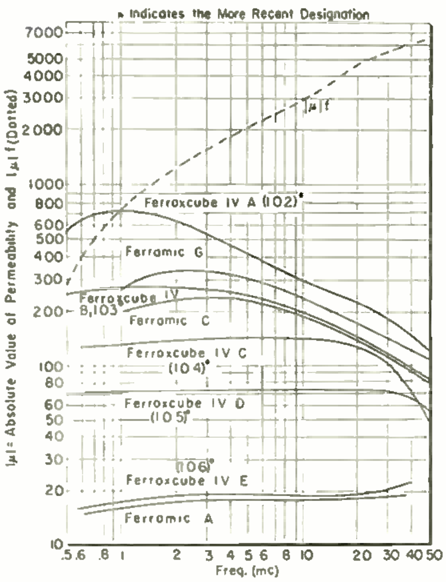


Fig. 1: Permeabilities of some commercially available ferrites. Number preceding asterisk (*) indicates the more recent designation

ABSTRACT

A discussion is given for a method of constructing wideband transformers for use in the 0.5 to 30 MC region for low power or instrument applications. The method of construction is suggested as offering exceptional shielding which contributes to the attainment of good balance-to-unbalance ratios. The frequency response of these units is compared to that of various other air-core and ferrite-cored units. Measurements on input impedance of various terminated transformers are given. Various practical applications are considered including the problem of coupling balanced transmission lines to vacuum tubes.

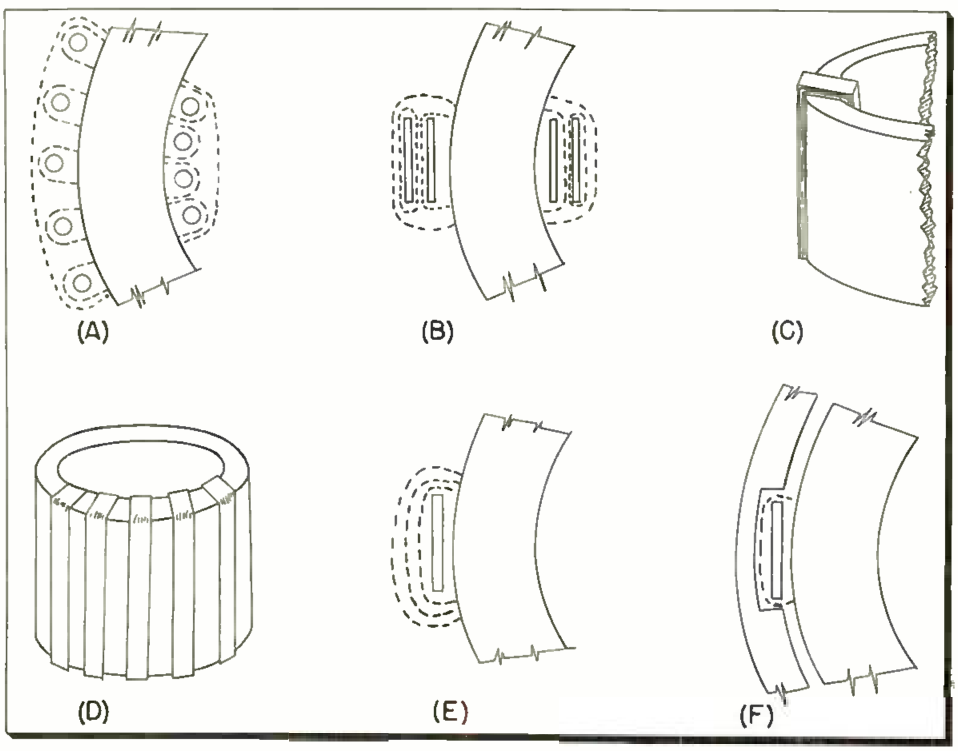
WELL known procedures used in low frequency transformer design may be extended to radio frequencies, as has been described by Maurice and Minns.[1] We are concerned here with constructing wideband transformers for use in the 0.5 to 30 MC region for low power or instrument use. A method of shielding is offered which contributes to good balance-to-unbalance ratios.

Although ferrite core units are discussed, it is not meant to imply that ferrites are intrinsically superior metal cores such as Mumetal or Permalloy, providing that the metal core laminations are sufficiently thin (about 0.001 or 0.002 in.)

Fig. 1 shows some curves of commercially available ferrite materials.

Fig. 2 shows the leakage flux paths and windings for various configurations. The type of transformer selected for development was of the so-called split screen variety. Figs. 2e and 2f illustrate a way in which the leakage reactance may be reduced by screening techniques. In this case principal concern is expressed over flux linkages which encircle the entire block of primary (or secondary) windings, shown in Figs. 2e and 2f. If the cross sectional area of the leakage flux path is reduced, then the reluctance of the path is increased; hence, the leakage flux and reactance are diminished. A principle can be used for this purpose which is applicable only to the r-f transformer. Specifically, since the high frequency field does not penetrate a good conductor to any great depth, encasing the block of turns in a tightly fitting conducting case or shield as shown in Fig. 2f will greatly restrict the leakage flux path (for the block of turns) in cross sectional area. It should be emphasized that this technique offers no theoretical advantage in leakage inductance over winding the primary turns block directly over or under the secondary block, if the leakage flux path cross sectional areas (and lengths) are the same in

Fig. 2: Leakage flux paths for (a) wire winding, (b) tape winding, (c) block or spiral tape winding, (d) distributed or helical tape winding, (e) tape without case, and (f) tape with case



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Wideband Transformer (Continued)

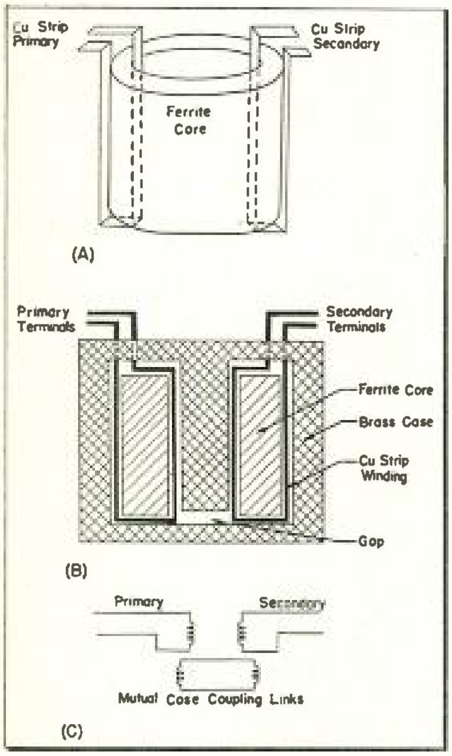


Fig. 3: (a) Copper strip windings on core. (b) Same as (a) in case. (c) Link coupling action

both instances. There is a theoretical advantage of the split screen technique in giving better shielding between primary and secondary where this is required. Experimental applications often call for later modification of either primary or secondary turns, and the advantage of physical separation of primary and secondary then becomes obvious. Fig. 3 gives a more detailed illustration of the construction adopted. Fig. 3a shows the turns and the ferrite core only, while Fig. 3b illustrates the conducting case in which the above units are imbedded. It should be noted that a gap must be introduced somewhere in the conducting case in order to prevent its acting as a shorted turn. It is this gap which gives rise to the term "split screen." Fig. 3c illustrates still another type of action which is present with the case construction of Fig. 3b. It is seen that the case can be considered as two single turn coils, each tightly coupled to primary and secondary respectively. This type of action is illustrated by the circuit of Fig 3c, and will subsequently be called link coupling action.

Construction Details

The photographs of Fig. 4 serve to give a better concept of the internal construction. The windings were constructed of 3/16 in. copper tape one mil thick (rolled down from five mil sheet). The insulation was two mil thick rice paper, 1/4 in. wide (later units used Teflon tape which has much superior mechanical characteristics). Obviously the voltage gradients and power levels to be handled were small in these units. Ferroxcube IV A (102) core material was used. Ferroxcube 101 has a higher $|\mu|$, but is more lossy. The slots for the windings were cut about 1/32 in. deep by 1/4 in. wide in the brass case.

Coupling Measurements

One of the most frequent low impedance problems is that of balance-to-unbalance coupling, but because more data on balance-to-unbalance measurements is available in later sections dealing with medium impedance secondaries, discussion of these results will be deferred. Another low impedance application occurs in the matching of transmission lines with unequal characteristic impedances. The number of turns in the unit to be described was selected for the purpose of matching a secondary to two 75 ohm transmission lines. As the high frequency response was initially uncertain and response below 2 MC was not particularly desired, the number of turns had been picked rather arbitrarily at four for the primary. The transformer construction is as already shown in Fig. 4.

Measurements were then made on leakage inductance, L, and terminal capacity, C, to determine the optimum terminating resistance via the low pass filter criteria. The leakage inductances were determined by

Type of Circuit ↓ / Type of Enclosure →	1 Complete Case	2 Insulated Case	3 No Case
(A)	L_{1A} = .110 μh	L_{2A} = .128 μh	L_{3A} = .49 μh
(B)	L_{1B} = .116 μh	L_{2B} = .132 μh	L_{3B} = .61 μh
(C)	L_{1C} = 2.37 μh	L_{2C} = 3.08 μh	L_{3C} = 13.3 μh
	L'_{1C} = .117 μh (Referred to Terminals 1 & 2)	L'_{2C} = .152 μh	L'_{3C} = .655 μh
(D)	L_{1D} = .32 μh	L_{2D} = .408 μh	L_{3D} = 2.29 μh
	L'_{1D} = .08 μh (Referred to Terminals 1 & 2)	L'_{2D} = .102 μh	L'_{3D} = .548 μh
(E)	L_{1E} = .17 μh		
	L'_{1E} = .042 μh		

Fig. 5: Leakage inductance measurements

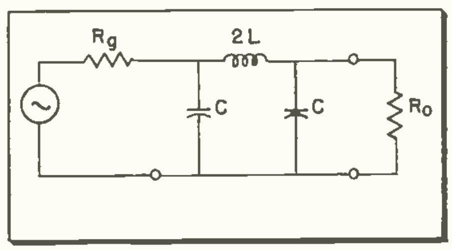
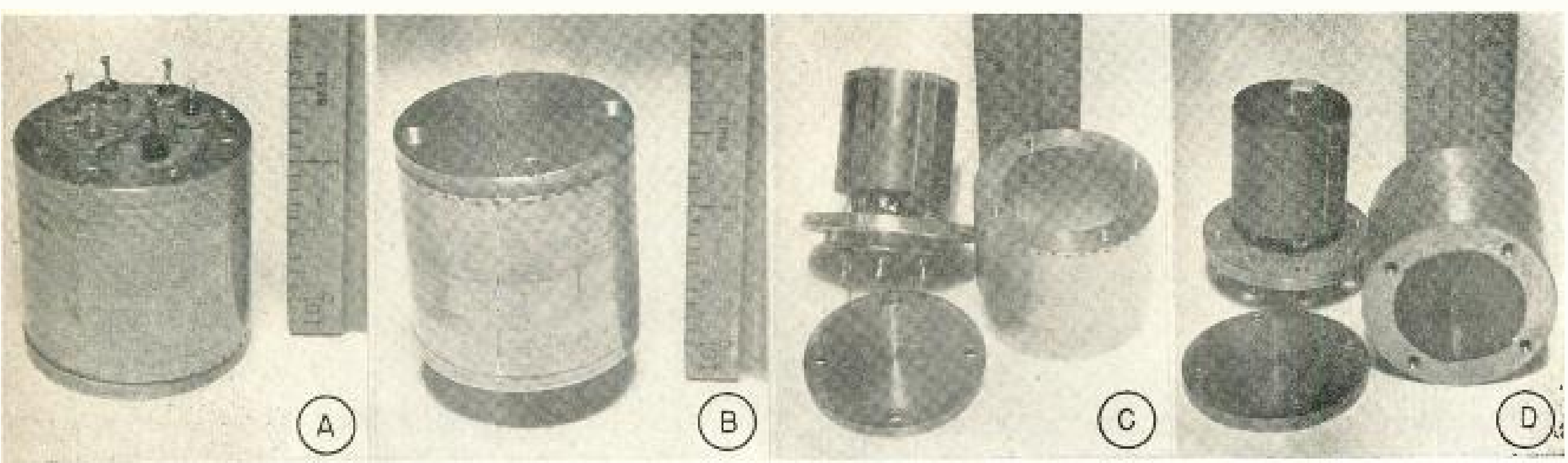


Fig. 6: High frequency equivalent circuit of 1:1 transformer with source and load connected

Fig. 4: Views of transformer. (a) Top and (b) bottom views of complete unit. (c) and (d) Exploded views showing core and windings



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short circuiting one set of terminals and measuring the inductance across another. These values were then corrected for lead inductance. The values obtained for various sets of terminals are shown in Fig. 5, together with the measurement circuits. Leakage inductance was relatively independent of frequency, at least in the 3 to 50 MC region. The measured values are shown unprimed and the values referred to the primary are given as primed values. The same measurements were made without the case in order to evaluate the action of the case in reducing leakage reactance. Data on the leakage reactance includes a secondary winding of 9 turns of No. 32 copper wire, although this winding represents a relatively high impedance level.

It is seen that in measurement of Fig. 5a the leakage inductance runs much higher than it should in comparison with the other measurements. This probably reflects the fact that the lengths of the various internal connecting leads and shorting leads are relatively more important for this circuit than the others (no individual connecting lead exceeded ½ in.) The improvement in leakage reactance of tape wound coils over wire wound secondaries is indicated by the measurements of Fig. 5a-3 and 5b-3 when the case is not present. When the case is present, the distinction is not so evident, being apparently small enough to be buried by the relative effect of the inductance of the internal connecting leads.

Leakage Flux

The middle column (2) of Fig. 5 illustrates an attempt to separate the relative effect of the function of the case in confining the leakage flux as compared to its function as a link coupling mechanism. The results are not conclusive as in spite of the breaks in the case in the axial direction the current paths can still be completed around the periphery of the case to give link coupling.

Next an attempt was made to measure terminal capacity, C (for the 2 turn primary-2 turn secondary transformer), using the circuit of Fig. 6. R_0 was open circuited and R_g was made 4700 ohms. A pronounced resonant peak was found at 110 MC with the case on and at 77 MC without the case. From this data, C with and without the case can be calculated as about 39 μμf (this value is needlessly high and was reduced to about 15 μμf in a subsequent unit by increasing the turns to core spacing) and 17.4 μμf

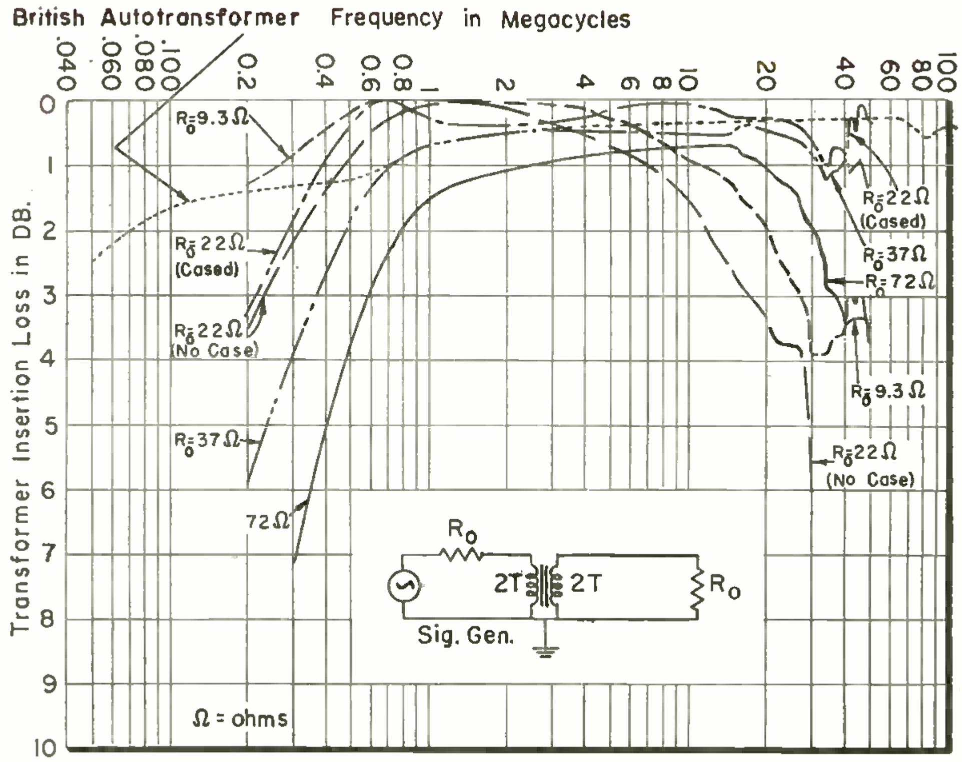


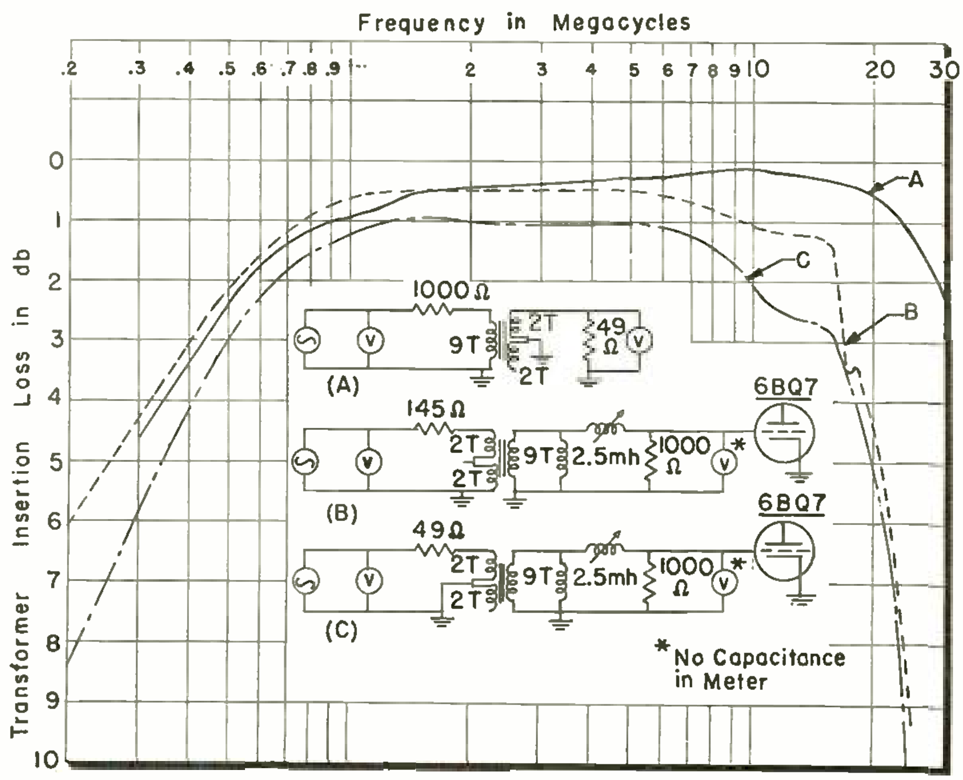
Fig. 7: Frequency response curves plotted as db insertion loss vs. megacycles

respectively, if 2L is taken as about 0.11 μh with the case and 0.49 μh without it. Similarly the optimum R_0 without the case is now calculated to be about 37 ohms for the cased unit.

A frequency response curve, plotted as insertion loss versus frequency, was taken for a 37 ohm matching circuit ($R_g = R_0 = 37$ ohms). The results are shown plotted in Fig. 7. It is seen that for some applications, at least, there is a usable frequency response (± 1 db) from 300 KC to at least 50 MC, although the fluctuations at the high frequency end are rather disturbing. Low pass filter theory indicates that the response should continue rather flat out to about f_2=110 MC and then drop off slowly to about 2 db down at 150 MC. The measurements indicated that the response did extend out to about 80 MC but the data is considered too unreliable to show

(*Continued on page* 164)

Fig. 8: Frequency response for various terminations. (a) Pure resistance. (b) Source across primary, nearly an impedance match. (c) Source across half of primary; theoretical source match to 1K



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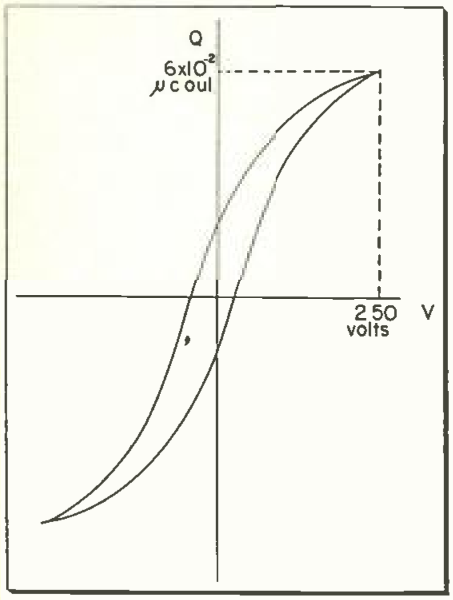

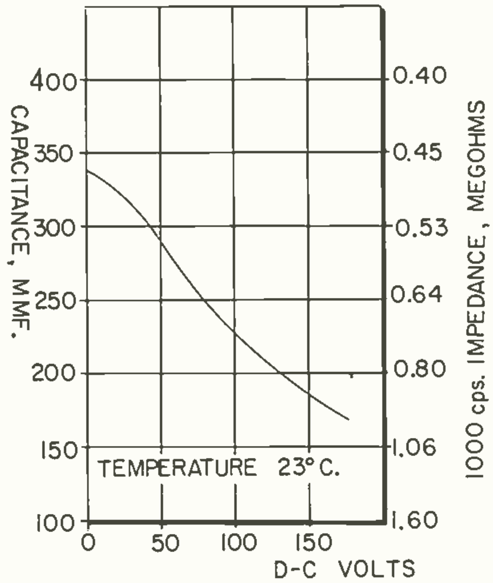

Fig. 1: (l) Hysteresis loop for ferromagnetic material. Fig. 2: (r) Capacitor impedance curve

Power Gain

Nonlinear capacitor measurements and amplifier performance clarify effect of r-f voltage in calculating input power

By STANLEY ZISK
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This article deals with a little-known phase of dielectric amplifier operation, the effect of r-f voltage in the calculation of input power. The effective impedance of a nonlinear condenser at audio frequencies when an r-f voltage is simultaneously applied is found to be a function of the r-f field strength. A series of measurements are made of the complex impedance of a commercially available nonlinear capacitor with a variable dc field as one independent parameter and a simultaneously-applied constant r-f field as another. From this data, the power gain of a nonlinear condenser in a typical dielectric amplifier circuit is calculated, and compared with the value obtained experimentally for an amplifier operating under the same conditions.

A DIELECTRIC amplifier is defined as "a device which, in order to obtain amplification or control, uses non-linear capacitors either alone or in combination with other circuit elements." The dielectric amplifier circuits which have so far been devised employ an r-f power source in the range from 1 to 5 MC and have a band-width exclusive of coupling networks extending from dc to about 10 KC.

The input to the amplifier usually is directly across 1 or 2 non-linear condensers of 400 to 1000 μμf. capacity, which therefore presents a high impedance at audio frequencies. The dissipation factor of these capacitors as measured on a bridge is as high as 8%, indicating that the power loss in the input circuit is not negligible. Although several analyses have been made of dielectric amplifier operation, no one to the author's knowledge has measured the input power, which would be an important factor in most dielectric amplifier design problems. Accordingly a project was undertaken to determine the actual power gain of a dielectric amplifier.

Presently available non-linear capacitors are made with a ceramic dielectric containing a large percentage of barium titanate, other compounds being added to modify the electrical and physical characteristics of pure titanate. Such capacitors exhibit a non-linear and usually multi-valued relationship between charge and applied voltage, similar to the hysteresis loop of a ferromagnetic material (Fig. 1). In the analysis of networks containing non-linear condensers, the term "capacity" is ambiguous. When voltages of different frequencies are applied to such a condenser, the capacity presented to the various voltage sources are not likely to be the same. "Incremental capacity," defined as

$$C_i = \frac{\Delta Q}{\Delta V}$$

is a more revealing quantity than capacity. When a dc voltage is applied in series with a small ac voltage and the resulting ac current is measured, the incremental impedance of the condenser is found to vary as a function of the dc voltage as in Fig. 2. There is seen to be a possibility of using the device as a value, analogous to the saturable reactor or the vacuum tube. One difference between the operation of the dielectric amplifier and that of a magnetic or vacuum tube amplifier arises from the difficulty of isolating on a single condenser different sets of terminals to be used as input and the output. In order to provide isolation between the r-f power input signal source and dc supply additional components must be added to the amplifier circuit, as in Fig. 4. The input signal is applied in series with a dc voltage of an appropriate value to obtain the maximum capacitance change per volt. The dc source is prevented by capacitor C_1 from being short-circuited by the r-f supply, which in turn is isolated by the inductor L. The output current vs. control voltage characteristic for such an amplifier is shown in Fig. 3.

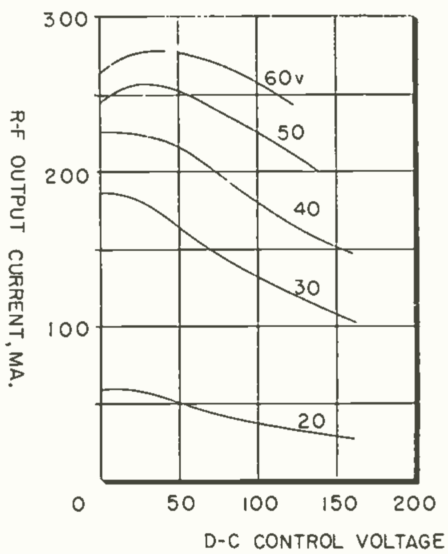

Fig. 3: Amplifier output characteristics

Hysteresis Loss

Unlike ferromagnetic core materials, the hysteresis loss of a nonlinear condenser is relatively low; consequently the latter can be incorporated in a resonant circuit without excessive heating. This fact allows the use of an ac signal to vary the resonant frequency of a tuned circuit, thus producing a much greater impedance change per unit

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# of Dielectric Amplifiers

input voltage than can be obtained with the condenser alone (Fig. 5). This so-called "resonant" amplifier circuit holds the greatest possibility for practical application, since voltage and power gains greater than unity can be obtained with the resonant amplifier as opposed to the non-resonant type which produces positive power gains, but voltage gains of the order of 0.3.

It is known that the remanent polarization of a non-linear dielectric will decay when a high-frequency field is applied. Even when there is a dc voltage on the non-linear condenser, an additional r-f field will cause the charge on the condenser to approach that value of charge which is given by the material's single-valued polarization curve ("virgin" polarization curve, analogous to the virgin magnetization curve of a ferromagnetic). The static hysteresis loop of a non-linear condenser will therefore approach a single-valued curve when an r-f voltage is applied. In dielectric amplifier operation, the frequency of the r-f power source is several orders of magnitude greater than that of the audio signal source; there are many cycles of r-f before the audio voltage has changed appreciably, and hence the audio hysteresis loop can be considered static as far as the r-f source is concerned. By following this line of reasoning, realizing that the major part of the dissipation in a non-linear condenser at audio frequencies is hysteresis loss, it was felt that the input power to a dielectric amplifier should be less, by some fraction of the hysteresis loss, than the power predicted on the basis of measurements of the dissipation factor of the non-linear condenser alone.

It was hoped that this theory would be sustained by the program of measurements which was to be carried out.

Measurements

Several methods of obtaining the signal power input to the dielectric amplifier were considered before the use of a capacitance bridge was decided on. To provide for the application of r-f and dc voltages while the measurements were being made, a circuit similar to the non-resonant dielectric amplifier was constructed. The terminals corresponding to the dielectric amplifier "input" terminals were connected to a General Radio 716 C bridge. The condenser on which most of the measurements were made was a Radiation Inc. type R2-226 500 mmf. "dielector" which had a Curie temperature of about 20°C. The intention was to obtain measurements of the capacitance and dissipation factor of the complete circuit and then subtract the capacity and resistance which was due to the isolating network in order to obtain these quantities for the non-linear condenser alone.

The temperature of the condenser was kept constant by an oil bath. The audio frequency voltage was maintained at a fixed value, as well as the frequency of both the a-f and r-f sources. The variables, therefore, would be the amplitudes of the d-c and the r-f sources. In this way, keeping the amplitude of the a-f voltage small, the incremental capacitance and the small-signal loss of the non-linear condenser are measured under conditions similar to dielectric amplifier operation. From this data, the power input and output of a theoretical resonant amplifier can be calculated and compared with these quantities measured for an actual amplifier.

Analysis

Figs. 6 and 7 show curves of the capacitance and dissipation factor of one sample of Radiation, Inc. type R2-226/500 mmf. "dielector" as a function of the dc voltage, for several values of r-f voltage. Note that the dissipation factor does decrease as the amplitude of the r-f voltage increases, according to the original supposition, at least until the dc voltage becomes large. The operation of a dielectric amplifier is impractical at the lower values of r-f voltage, since the output power from the amplifier is recovered from the modulated r-f power, and will therefore be low when the latter is low. When the r-f voltage is too large however, the decrease in capacitance change/volt results in a lower voltage and power gain. From Fig. 6 it is seen that the highest r-f voltage at which the condenser still possesses most of its original voltage sensitivity is 40 v. rms. across the two condensers in series, or 20 v. across each. In addition, at this voltage the dissipation factor has been decreased to a low, fairly constant value. Consequently, in the following analysis of a resonant amplifier, the curve for E_{rf} 40 v. will be used as the characteristic of the non-linear condenser, in order to obtain optimum performance.

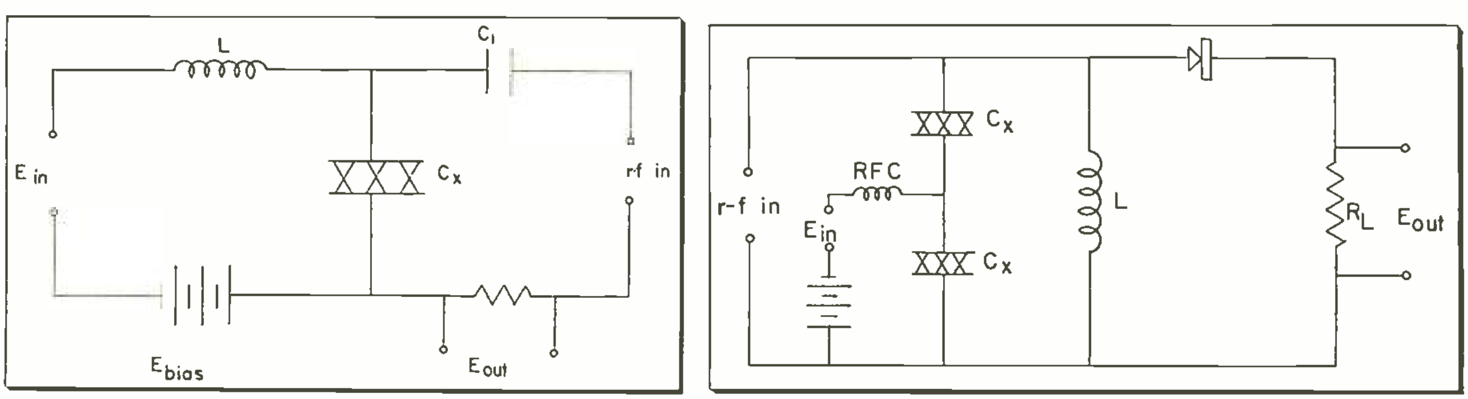
In the presentation below, the following assumptions will be made:

(1) $\frac{\Delta C}{\Delta E}$ will be taken from the curve of C vs. E_{dc} at E_{rf} 40 v. at the point of maximum slope which is obtained with a bias voltage of 100 vdc.

(2) The condensers, aside from the change of capacity produced by the input voltage, will behave linearly at the radio-frequency.

The second of these assumptions causes the most significant error in the calculation. We are assuming

Fig. 4: (l) Provision for circuit isolation between signal source and power supply. Fig. 5: (r) "Resonant" amplifier circuit



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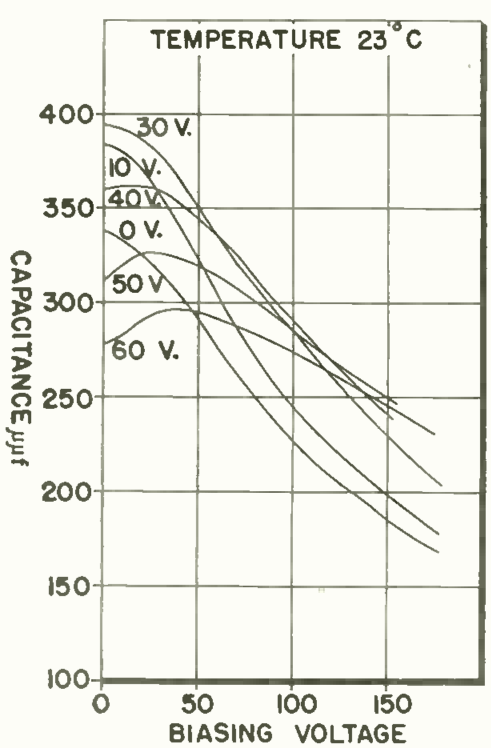
Dielectric Amplifiers (Continued)

that linear operation allows the use of standard resonance curves; however, when a resonant circuit contains a non-linear storage element, it is known that its resonance curve, instead of being symmetrical about a center frequency, has a steeper



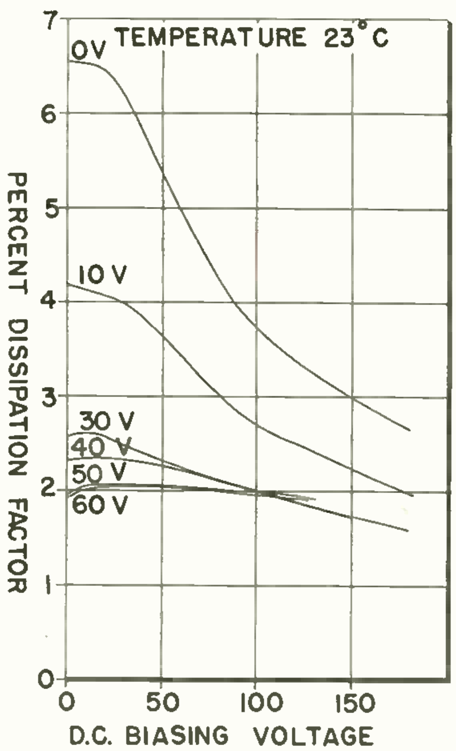


Fig. 6: (l) "Dielector" capacitance curves. Fig. 7: (r) "Dielector" dissipation curves

slope on the skirt than on the other. When either the r-f driving current or the degree of non-linearity becomes great enough, the slope of the steeper side becomes infinite and then reverses, resulting in a double-valued resonance over a restricted frequency band. In the case of the dielectric amplifier, the output so loads the tuned circuit that a single-valued resonance results; however, there is usually a larger gain with a more critical frequency adjustment on one side of the resonance curve, due to its assymetry, and the pseudo-linear analysis will give an approximate average of the two possible gains.

Once having made the above assumptions, the analysis proceeds as follows. Let the r-f power be supplied by a current source, for example, a pentode r-f amplifier or oscillator in the case of an experimental dielectric amplifier. E is the peak-to-peak r-f voltage across the parallel-tuned dielectric amplifier, and ω the angular frequency of the r-f source. The first step is calculation of the load resistance for maximum output power with a fixed input voltage. Given this load, the power output is calculated and compared with the input power, as obtained from the dissipation factor measurements, to give the power gain of the amplifier stage.

From the universal resonance curves for a parallel LRC circuit, the maximum rate of change of voltage with respect to frequency occurs at a frequency removed from the resonant frequency by

$$\Delta \omega = \frac{0.5\ \omega_o}{Q} \qquad (1)$$

where ω_o is the resonant frequency. At this point it is also seen from resonance curves that

$$\frac{\Delta E}{\Delta \omega} = \frac{0.7\ E_o Q}{\omega_o} \qquad (2)$$

E_o again being the voltage at resonance. For small changes of capacity, the resonant frequency of the tuned circuit changes an amount.

$$\Delta \omega = -\frac{\omega_o}{2C} \Delta C \qquad (3)$$

Combining (2) and (3),

$$\frac{\Delta E}{\Delta C} = -\frac{0.7\ E_o Q}{2C} \qquad (4)$$

The total resistance in the tuned circuit is a combination of the equivalent resistances of the coil and the non-linear condensers, plus the load resistance. Let the combined coil and condenser resistance equal R_i and the load resistance equal R. Then

$$Q = \omega_o C R_i \frac{R}{R + R_i} \qquad (5)$$

If the current input is kept constant, then the voltage at resonance is

$$E_o = I \frac{Q}{\omega_o C}$$

Substitute in (4)

$$\frac{\Delta E}{\Delta C} = -\frac{0.7\ I}{2\ \omega_o C^2} \times Q^2 \qquad (6)$$

Combine (5) and (6)

$$\frac{\Delta E}{\Delta C} = -\left(\frac{0.7\ I\ \omega_o R_i^2}{2}\right)\left(\frac{R^2}{[R+R_i]^2}\right)$$

If ΔC is constant,

$$\Delta E = K_1 \frac{R^2}{(R + R_i)^2} \qquad (7)$$

Assuming perfect rectification of the r-f, the output power will be

$$P_o = \frac{K_1^2 R^3}{(R + R_i)^4}$$

Maximize P_o with respect to R

$$0 = \frac{d P_o}{d R} = K_1^2 \left[\frac{3R^2 (R+R_i) - 4 R^3}{(R+R_i)^5}\right]$$

$$\therefore R = 3 R_i \qquad (8)$$

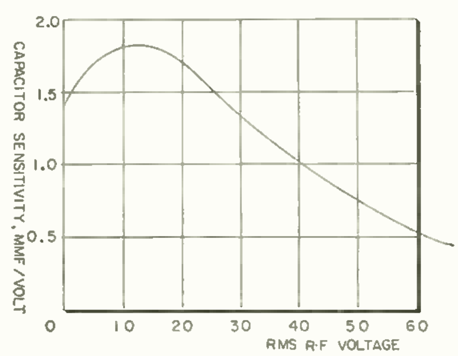


Fig. 8: Capacitor sensitivity characteristic

Thus, for maximum output power, the load resistance should equal 3 times the r-f resistance of the coil plus non-linear condensers. When this condition is fulfilled, the total Q equals 0.75 times the unloaded Q of the resonant circuit. From the graph of capacitance vs. bias voltage, the maximum rate of change of capacity is seen to be 1.1 mmf./v., at a bias of 110 v. The inductor used in one experimental model of a dielectric amplifier had a Q of 120 at a frequency of 2.5 MC., and the condensers a Q of about 35, giving an overall Q of 27. The equivalent resistance of this tuned circuit is 4,000 ohms, requiring a load resistance of 12,000

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Fuses for Electronic Equipment

Newly approved fuses and holders offer maximum fire and overload protection. Design aids equipment makers and discourages use of fuses with oversize ratings

By J. C. LEBENS
Chief Engineer
Bussmann Manufacturing Co.
St. Louis, Mo.

THE recent approval by the Underwriters' Laboratories Inc. of special fuse-holders submitted by us represented the culmination of a long development to provide positive electrical protection for electrical appliances such as television and radio receivers. The development was unusual in that it was encouraged by the manufacturers of television and radio receivers as well as by the Underwriters' Laboratories and was undertaken by two of the fuse suppliers, working together, pooling their engineering talents, to develop the best answer to a difficult problem. Now that the fuses and fuseholders are commercially available it should open a new vista in the field of electrical appliance protection so that truly safe devices can be furnished at a minimum cost.

When radio receivers were first introduced they were battery operated so that the current which could flow under fault conditions was limited by the capacity of the battery. Even though relatively high voltages were present, the powers were small because of the battery limitation. Hence, glass tube fuses, rated at 32 V. or less, were used where electrical protection was required even though the voltage exceeded the voltage rating of the fuse.

Voltage Rating

In the blowing of a fuse it is the current alone which causes it to melt. Once it melts the entire line voltage appears across the fuse and, before the circuit is cleared, the fuse must extinguish the arc established by this voltage. Obviously, the higher the voltage the greater the arc and the more difficult it is to clear the circuit. It is for this reason that the voltage rating of fuses always is given at "32 v. or less," "125 v. or less," or "250 v. or less," meaning that the maximum voltage is established and the fuse will per-

(*Continued on page* 118)

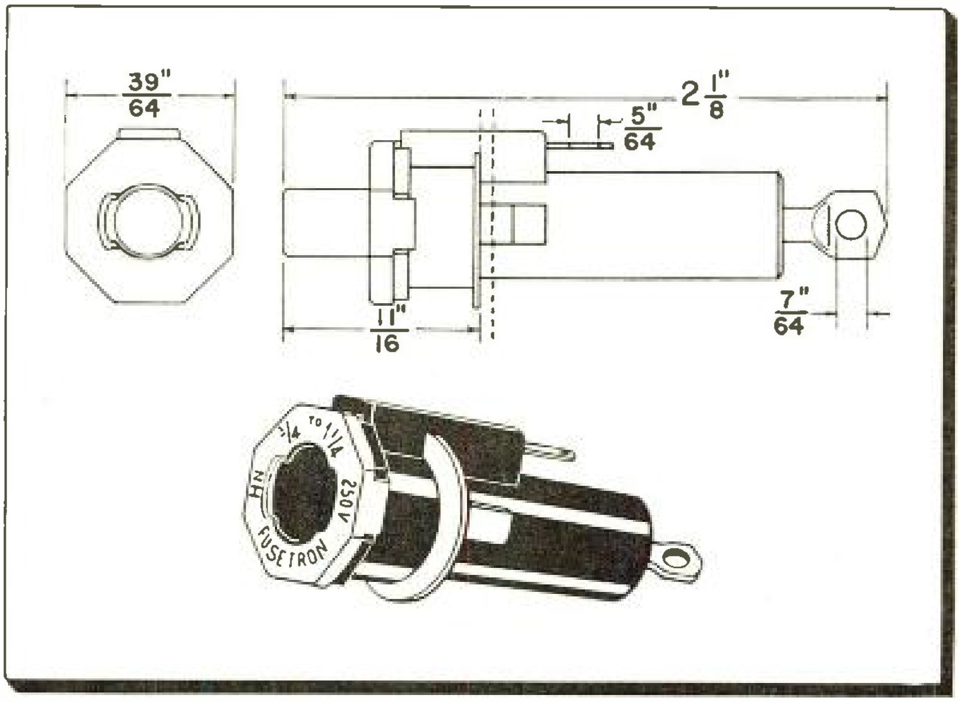

Fig. 1: Dimensional details of new holder designed for either fast acting or time-lag fuses. By using same type holder manufacturer does not have to change tooling to use either style

TABLE I—Standard Ratings of Fast-Acting and Time-Lag Fuses and Fuseholders.

Fast-Acting Fuses—Type C Symbol & Amps	*Fuseholder Type HC* Symbol	*Time-Lag Fuses Type N* Symbol & Amps	*Fuseholder Type HN* Symbol
C 1/32 C 1/16 C 1/8 C 3/16 C 1/4 C 3/10	HC 0 to 3/10	N 1/100 N 1/32 N 1/16 N 1/10 N 15/100 N 2/10 N 1/4 N 3/10	HN 0 to 3/10
C 3/8 C 1/2	HC 3/10 to 1/2	N 4/10 N 1/2	HN 3/10 to 1/2
C 3/4	HC 1/2 to 3/4	N 6/10 N 3/4	HN 1/2 to 3/4
C 1 C 1-1/4	HC 3/4 to 1-1/4	N 8/10 N 1 N 1-1/4	HN 3/4 to 1-1/4
C 1-1/2 C 1-3/4	HC 1-1/4 to 1-3/4	N 1-6/10 N 1-3/4	HN 1-3/10 to 1-3/4
C 2 C 2-1/2	HC 1-3/4 to 2-1/2	N 2 N 2-1/2	HN 1-3/4 to 2-1/2
C 3 C 3-1/2	HC 2-1/2 to 3-1/2	N 2-8/10 N 3-2/10 N 3-1/2	HN 2-1/2 to 3-1/2
C 4 C 5	HC 3-6/10 to 5	N 4 N 5	HN 3-1/2 to 5
C 6 C 7	HC 5 to 7	N 6-1/4 N 7	HN 5 to 7
C 8 C 10	HC 7 to 10		

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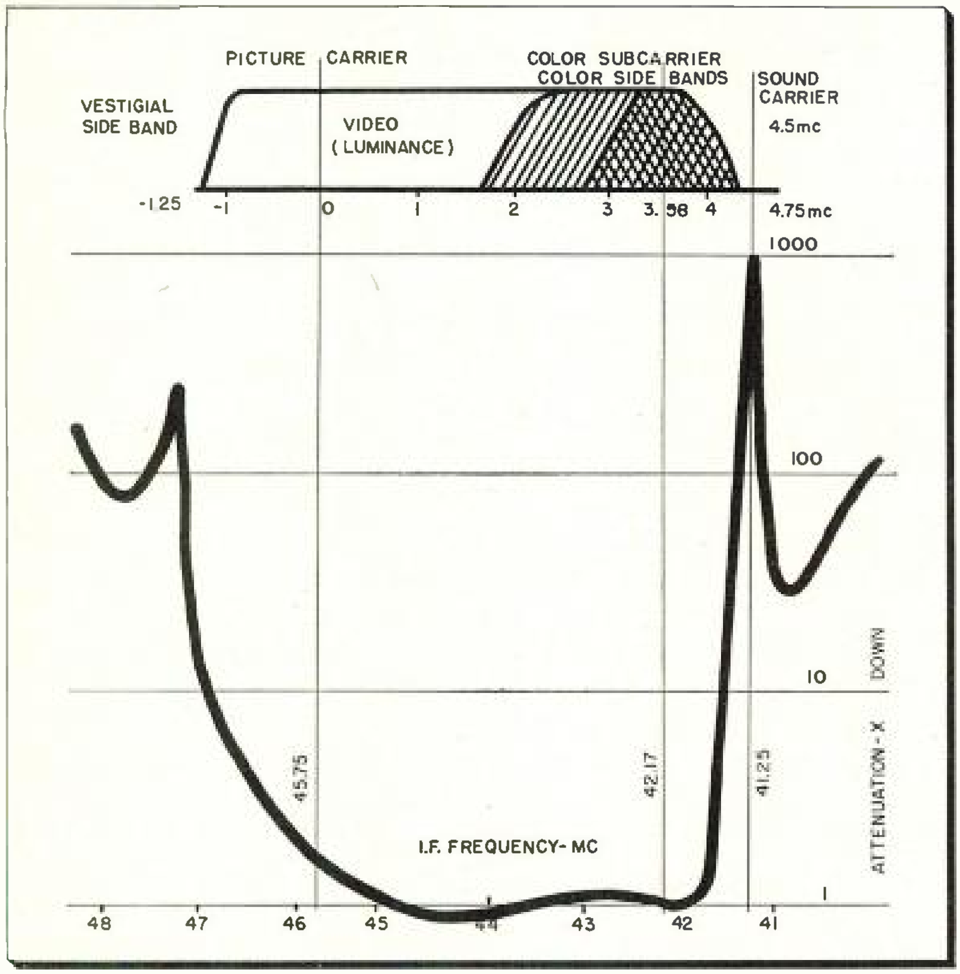

Fig. 1: (top) Spectrum of transmitted color signal. Fig. 2: I-F selectivity curve related to spectrum

Designing

Results of engineering investigation point up criteria for obtaining desired response characteristics. How to make performance tests

THE introduction of color television and its increased eye appeal has brought with it the addition of several new basic circuits to the usual monochrome receiver. The effect of the input tuner upon the operation of these circuits has been the subject of much conjecture and it will be the purpose of this article to present additional data on this subject.

The color television signal covers a channel 6 mc wide, as illustrated by Fig. 1. The monochrome picture carrier components extend from 1¼ mc below the carrier frequency to 4.3 mc above it. The color carrier frequency occurs at 3.58 mc (3.579545 mc) above the picture carrier and its sidebands extend from 4.3 mc on the high frequency side to approximately 1.7 mc on the low frequency side. The double crosshatched area represents the Q or quadrature component of the color carrier, while the single sideband extension of the I or in-phase

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component is shown by the single crosshatched area. The sound channel occurs at 4.5 mc above the picture carrier and 4.75 mc represents the upper limit of bandwidth allotted to this channel.

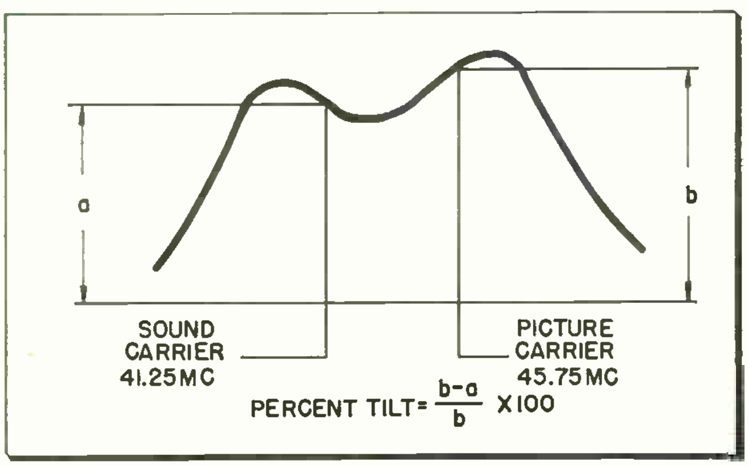
It is obvious, therefore, that the tuner should pass the frequencies extending from approximately 0.75 mc below the picture carrier to 4.3 mc above it. If a 40 mc i-f amplifier is used, the picture carrier would occur at 45.75 mc, with the sound carrier at 41.25 mc.

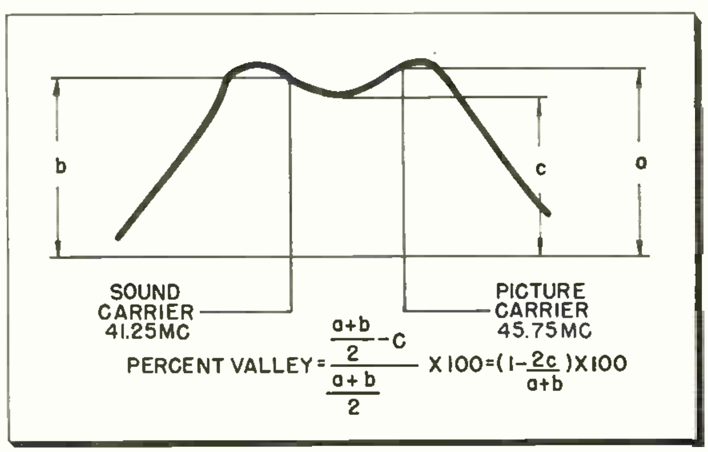
Selectivity Curve

A typical i-f selectivity curve for a color TV receiver is shown in Fig. 2, together with guide lines relating it to the transmitted carrier. If the input tuner is properly designed, its effect upon the over-all selectivity will be slight. Generally, its response should be reasonably flat, not wide enough to cause adjacent channel or spurious interference and not so narrow as to restrict the i-f response.

Although most tuners contain only two tubes, they are required

Fig. 3: (l) Tilt in television tuner response. Fig. 4: (r) Valley in TV tuner response





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TV Tuners for Color Receivers

to perform a number of functions and meet many requirements. A good tuner must be electrically acceptable from the standpoint of tilt, valley, VSWR, drift, noise figure, gain, i-f rejection, balance to unbalance ratio, image rejection, adjacent channel rejection, cut-off characteristics, oscillator injection, radiation and fine tuning range. In addition, it must also meet mechanical requirements such as size, smooth action, positive detent, ease of service, ease of assembly into the main chassis and adaptability to various manufacturers' special requirements.

Only a few of the above characteristics are likely to affect color-TV reception, however, and these will be discussed in detail.

A lopsided response curve known as "tilt" may under certain conditions affect color reception. Tilt is defined in a two peaked over-all response curve (antenna to mixer grid) as the ratio of the difference between the height of the response curve at the frequencies of the sound carrier and the picture carrier to the higher one of the two. See Fig. 3.

Test Setup

To observe this effect, a test setup was made using a complete color TV signal generator, together with a flying-spot scanner and slide projector adapted for showing color slides. The video output was fed into an r-f modulator of the vacuum tube variety capable of 90% modulation. A frequency modulated sound carrier, modulated 30% at 400 cycles, was accurately adjusted to be exactly 4.5 mc above the picture carrier by means of a frequency counter. Both picture carrier and sound carrier were coupled to the TV receiver through a suitable network and balun to present a balanced input at 300 ohms. A picture carrier of 50,000 microvolts was used. In addition, a Standard Coil Products sweep generator and an oscilloscope were used to adjust the response of the tuner.

The equipment was first set up to give an acceptable black and white picture by observing an RMA test pattern slide. A horizontal resolution of 300 lines could be obtained with no noticeable transients or smear. At this point, the response of the tuner alone was rechecked and found to have a tilt of 0% and a valley of 7%. These values are typical of a production tuner. Channel 3 was used in making all tests because of freedom from local TV signals.

A color test slide was next inserted into the flying-spot scanner and all controls adjusted to give the best possible color picture. The sound carrier amplitude was then adjusted to have 70% of the peak power of the picture carrier. (This may vary between 50% and 70% according to the NTSC signal specification.)

The tuner was then detuned to produce a 40% tilt with the picture carrier higher than the sound carrier and the following results were observed:

a. The color burst voltage at the video detector was unchanged due to the AVC action in spite of the reduction of over-all gain at the color sub-carrier frequency due to the tilt.

b. The chrominance output remained the same.

c. Close observation of the picture indicated no change in color intensity or hue.

d. The horizontal sync pulse remained unchanged.

e. The RTMA black and white test pattern slide was inserted and no deterioration of the test pattern could be observed.

Tilt Limit

A limit of 30% tilt is placed on production tuners and the average value is considerably less than this amount. It was further observed that the 40% tilt introduced by the tuner alone produced only a 12% corresponding tilt in the response, through the tuner and i-f amplifier combined. This result confirms the relatively smaller effect of the tuner on the over-all response.

The tuner was then readjusted to produce a similar tilt with the picture carrier lower than the sound carrier this time. In this relation, the color sub-carrier and the color components should suffer no attenuation. The results observed were the same as before; that is, there was no observable change in the hue or intensity, or in the burst voltage or horizontal sync pulse. However, it was found that adjustment of the fine tuning control to eliminate the 920 kc sound carrier beat pattern was definitely more critical. This is due, undoubtedly, to the increased amplitude of the sound carrier relative to the color sub-carrier.

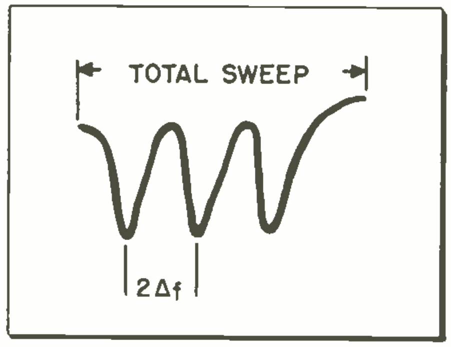

Fig. 5: SWR pattern, incorrect terminations

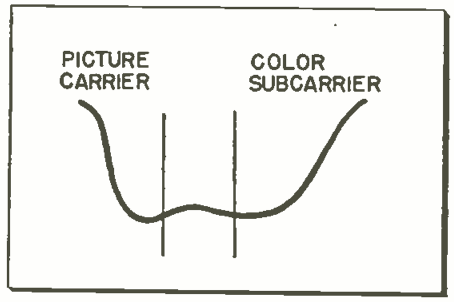

Fig. 6: Normal response of tuner from antenna input to mixer grid using a matched antenna

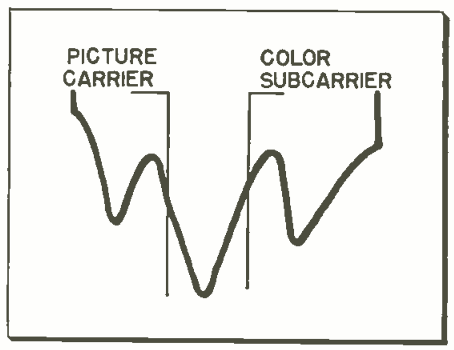

Fig. 7: Tuner response using a badly mismatched antenna and 34-foot transmission line

This beat pattern appears as a crosshatch pattern of dark lines and is produced by the 920 kc beat resulting from a mixing of the sound carrier at 4,500 kc and the color sub-carrier at 3,580 kc.

To determine the effect of an extreme amount of tilt in the tuner,

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Exhibitors' List and booth locations at Kingsbridge Armory and Kingsbridge Palace. Additional descriptions and illustrations of new products on display on pages 84, 85, 102-104, 108

Additional descriptions and illustrations of new products on display on pages 84, 85, 102-104, 108

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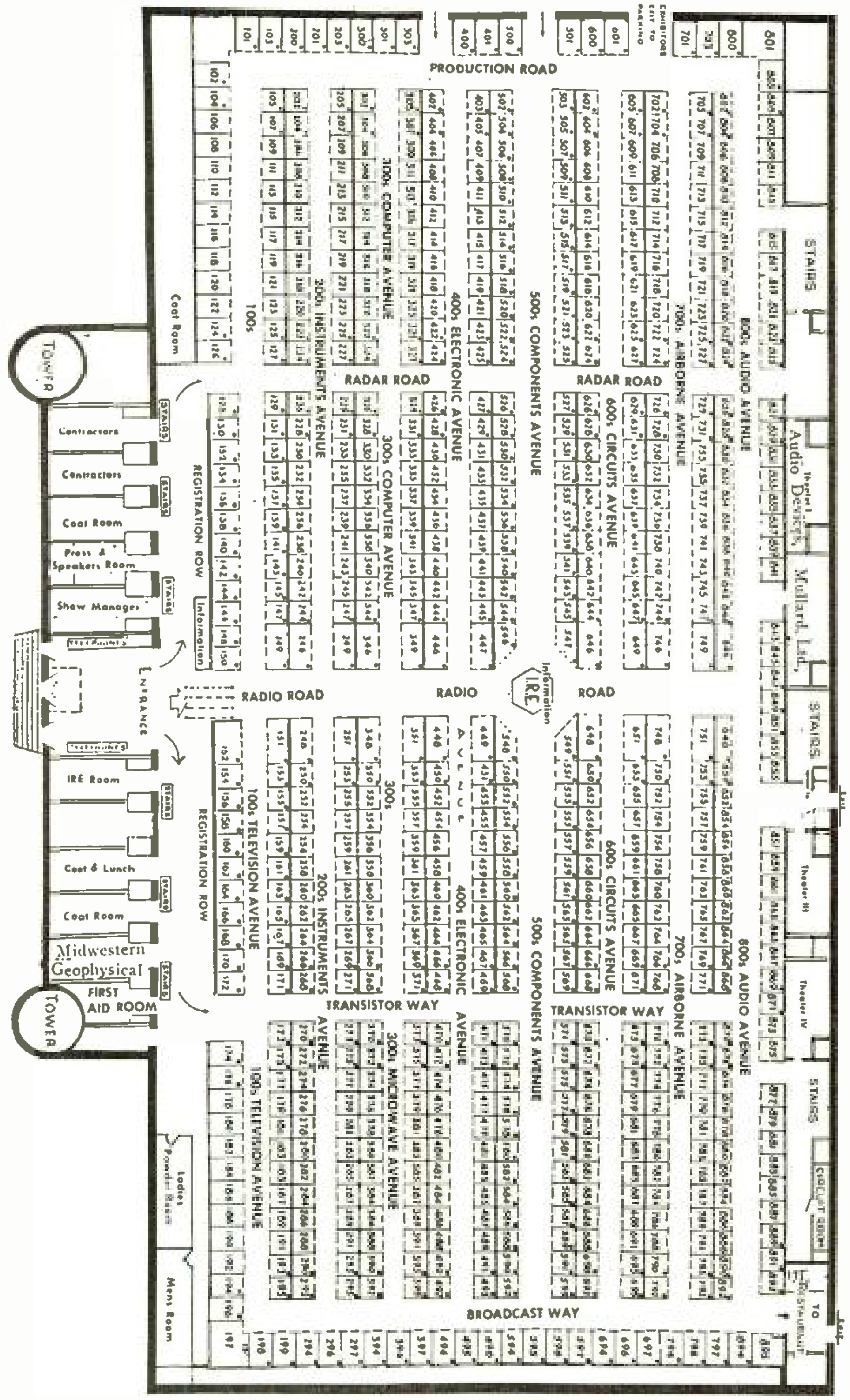
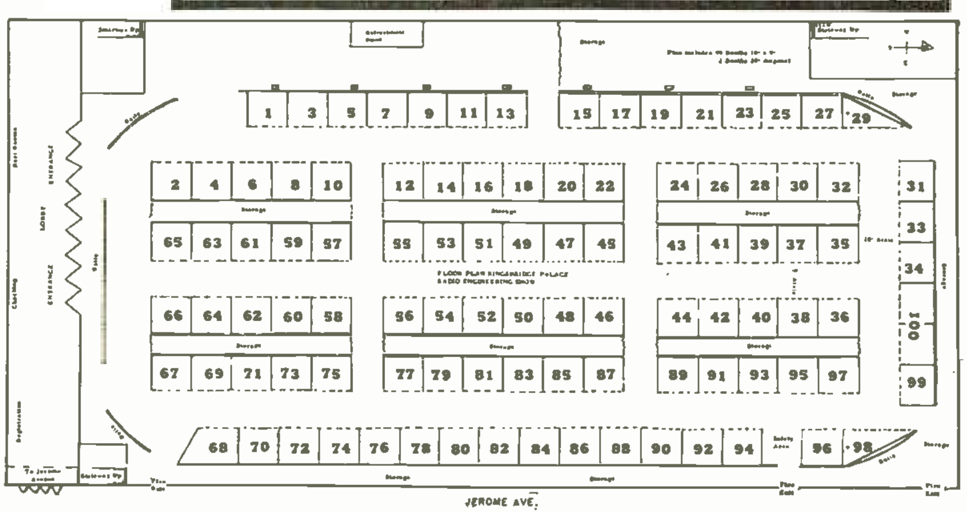
Linear Equipt. Labs., Inc. 786
Littelfuse, Inc. 525

(Continued on page 132)





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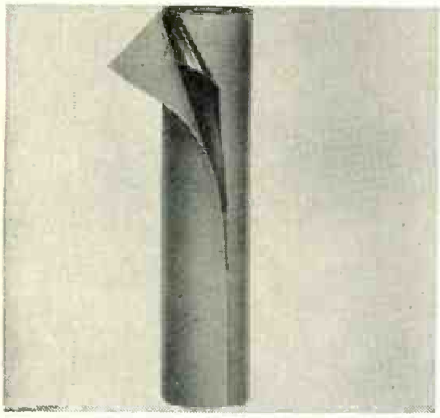
New Electronic Products at

Technical resumes, illustrations and booth numbers

Booth 605 — Adhesive Film

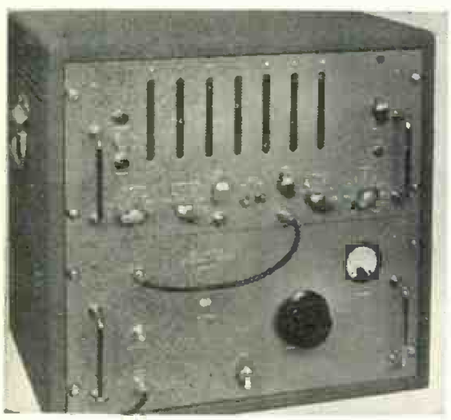
"Permacel" 18 adhesive film 2 Mil-green is a thermosetting unsupported adhesive film supplied on a paper interliner said to have many advantages over liquid or paste adhesives. Its



dry film form avoids messiness and time is not lost waiting for solvent evaporation. Adherence is assured at the glue line and visibility provides control over lamination. Absence of solvents provides better and safer operating conditions. Can be die-cut or preformed. **Permacel Tape Corp., New Brunswick, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-29)

Booth 752-75 — Frequency Meter

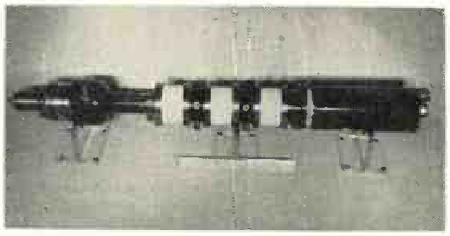
The Model 5571 frequency meter incorporates 6 instruments without plug-ins. It features a 0-42 MC frequency meter-extendable to 515 MC; a frequency ratio meter, a 0-1 MC period meter, a 1.0 μsec to 10^7 sec time interval meter, a 0-2 MC events/unit time meter, a 1 MC counter. Has direct connections to digital-to-analog converter, or data converters for IBM



card punches, electric typewriters, telemetering systems, etc., provisions for external frequency standard output. **Berkeley Div., Beckman Instruments Inc., 2200 Wright Ave., Richmond 3, Calif.**—TELE-TECH & ELECTRONIC INSTRUMENTS. (Ask for 4-32)

Booth 549-55 — Klystron

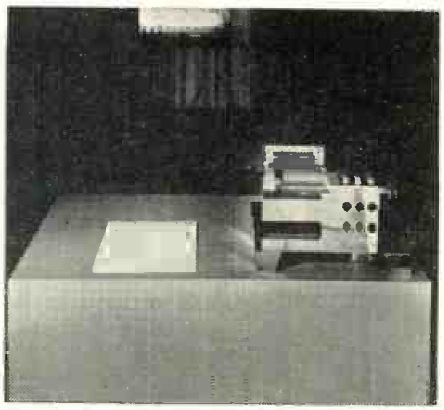
The 3K50,000LQ high power UHF klystron, in CW operation at 850-1,050 MC, delivers 10 kw output with only 10 w. drive power—a power gain of 1,000 times. The unit features resonant



cavities completed outside the vacuum system which is free from circuitry and enables easy wide range tuning and input coupling adjustment. The tube adds to the "Eimac" power klystrons to give high power at UHF from 470 MC to 1050 MC. Complete circuit components are also available. **Eitel-McCullough, Inc., San Bruno, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-35)

Booth 51-53-55 — "Univac"

A small working model of the "Univac" high-speed printer exhibited explains the unit. Also exhibited is the



magnetic-core storage matrix now being used in the "Univac Scientific" and the electroacoustic delay line used in the Remington "Univac." **Remington Rand, Inc., 315 Fourth Ave., New York, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-41)

MORE TECHNICAL INFORMATION

describing the new products presented here may be obtained by writing on company letterhead to New Products Editor, TELE-TECH & ELECTRONIC INDUSTRIES, 480 Lexington Ave., New York 17, N.Y., listing numbers given at end of each item of interest. Please mention title of position held.

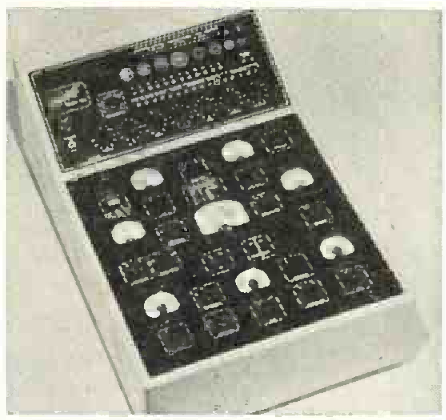
Booth 220 — Sweep Generator

Model #780 Special "Do-All" electronic sweep generator is available for checking TV community antenna systems and alignment of front-end TV circuits. A new, 34 MC sweep width

having amplitude linearity within +2 db at 54 to 88 MC has been incorporated. Other provided features are continuous tuning—with no skips, triple-shielded high-quality attenuator with push-button fixed positions in addition to additive combinations. SWR held at approximately 1. Discontinuity due to mismatch is minimized. **Radio City Products Co., Inc., Easton, Pa.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-31)

Booth 458-460 — Tube Tester

The model 700 laboratory tube tester can be operated in two ways: One, by making use of ac null method of measurement in which capacitance and resistance errors have been eliminated; two, by direct reading on a meter. The null method, the more accurate, is recommended when sufficient time is available. The faster direct reading method, which can be used



for tube production testing, involves merely reading a built-in tube transconductance meter scale. The **Hickok Electrical Instrument Co., 10514 DuPont Ave., Cleveland 8, O.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-40)

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IRE National Convention

for products to look for at this year's show.

Booth 226-228 — Potentiometer

The Type PD-2 dielectric potentiometer is designed for manual control and is arranged for panel mounting. The output in decibels is linearly related to control shaft rotation angle,

therefore, the device is referred to as a logarithmic potentiometer. Frequency range is 20 CPS to 10 MC. Variable loss range is 25 db (17.8-to-1 voltage ratio). Linear within 0.25 db over 20 db of range. Minimum initial loss (maximum output) is 8 db (2.51-to-1 voltage ratio). **Technology Instrument Corp., 531 Main St., Acton, Mass.** —TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-38)

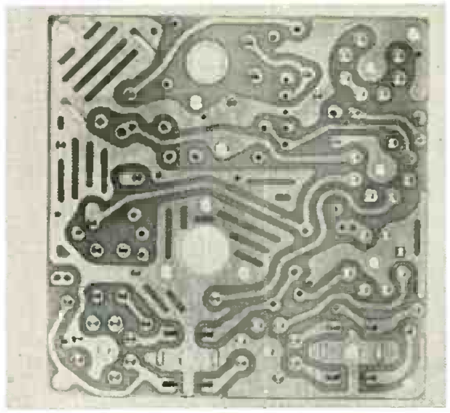
Booth 233-235 — Thermocouple Gauge

Type TG-029 single-station thermocouple gauge supersedes type TG-02. The new unit employs printed circuitry to improve stability. The meter scale is nonlinear and calibrated for air. Reading from right to left, the highest indicated value is 1,000 microns with 5 microns as the lowest. Zero drift has been reduced to the absolute

minimum by using a lower heater current to decrease the rate of thermal decomposition of organic vapors within the tube. Power, 115 v., 60 cps, ac. **Consolidated Vacuum Corp., Rochester 3, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-39)

Booth 174-196 — Print Wire Board

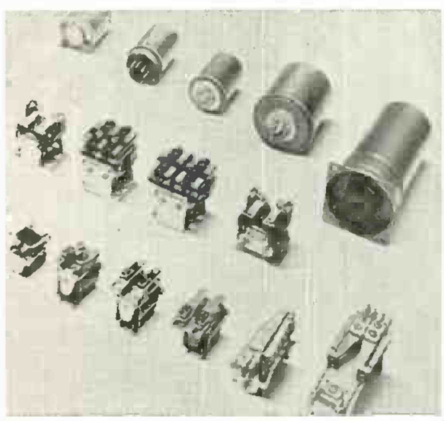
An animated cross section of the GE "Thru-Con" print wire board is exhibited that illustrates the through plating and resulting solder connections. Other items shown include fer-



rites, resistor capacitor networks, delay lines and delay sticks, "Kor-Les Cool Blue" resistors, and precision metal parts. Featured also is the new GL-6442, 2-5/8 in. long, metal and ceramic, lighthouse tube of radically different design, and the GL-2C39-B for oscillator, power amplifier, and frequency multiplier applications up to 25 MC. Other tubes exhibited are the GL-6019, GL-6182, GL-6183, GL-6251, GL-6283, and GL-6299, and the "Series 600". **General Electric Co., Electronics Div., 1811 Lemoyne Ave., Syracuse, N. Y.** and **Tube Div., Schenectady, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-33)

Booth 554 — Electronic Components

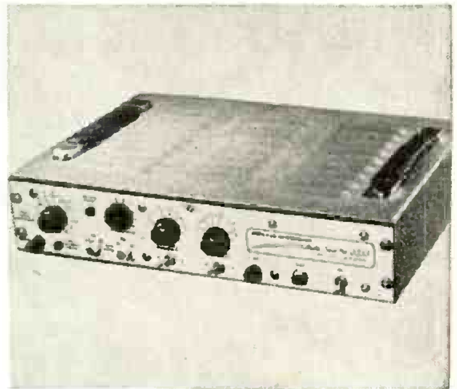
"Amrecon" all purpose relays, shown for the first time, are ruggedly designed to give the maximum in precision performance, dependability, and long life. Also shown is the complete line of Ohmite vitreous enameled power type wire-wound resistors and rheostats.



Many types of precision resistors, r-f chokes, and MIL type resistors, and a complete line of rotary power ac tap switches are also displayed. **Ohmite Manufacturing Co., 3601 Howard St., Skokie, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-36)

Booth 221 — Pulse Instruments

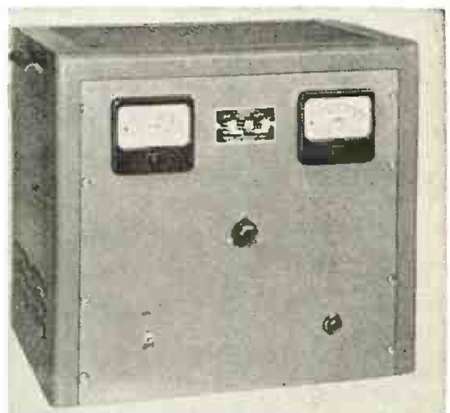
The Model 4120A variable pulse generator is designed for the generation of variable delay and width pulses up to 330 KC. Also displayed is the Model 3420A pulse oscillator that provides



half-period related trigger pulses—variable and direct indicating—from 100 cps to 3.3 MC. Featured among the exhibits as well are several newly developed analog and digital time delay generators, and various block-unitized precision pulse generators. **Electro-Pulse, Inc., 11811 Major St., Culver City, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-30)

Booth 13 — Germanium Rectifier

Model G 125-25 is a germanium rectifier dc power supply that contains no moving parts. Has inherent regulation of 4% from no load to full load. Specifications: DC output, 125 v. at 25 amps. AC input, 230 v., 60 cps, 3 phase. Ripple 5% RMS. Efficiency, 94%. Power factor, 98%. Cooling, convection. Weight, 125 lbs, approximately. Dimensions, 22 x 15 x 19 in. Tap switch adjusts output voltage over the range



115-125 v. for normal line and load variations. Metering, 4-½ in. ammeter and 4-½ voltmeter, 2% accuracy. **Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-37)

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Frequency Multipliers and Converters

System for extending operational range of frequency standards proves valuable tool in precision work. Circuit design and auxiliary equipment described

ABSTRACT

The development of compact, highly stable frequency multiplier chains and converter systems for monitoring and extending the primary standard of frequency is described. Multipliers using dual triodes, which gave best overall performance, are described in detail. Pentode and diode-pentode multiplier methods which gave somewhat inferior performance are considered briefly. Useful converter and amplifier circuits and a cavity type multiplier-converter unit for extending the frequency range, or comparison sensitivity, to 1000 Mc are also discussed. A brief description of auxiliary equipment and applications is given.

By
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THE measurement and intercomparison of high-precision frequency standards of the type now widely used in technical and scientific work is greatly facilitated by the use of frequency multiplier and converter systems. Because of the high sensitivity generally required, the phase stability and output wave purity of the frequency multiplying chains must be as high as possible for best results. Other uses for highly stable frequency multipliers are in extending frequency standards into the microwave region and in the control systems of atomic clocks.

An experimental program was conducted in the High Frequency Standards Laboratory of the National Bureau of Standards to determine which of several types and arrangements of harmonic generators and filter networks were most suitable for use in intercomparing the primary frequency oscillators and resonators. In making precise frequency comparisons between pairs of oscillators, such as the 100-kc frequency standards now in general use, several possible methods are available.

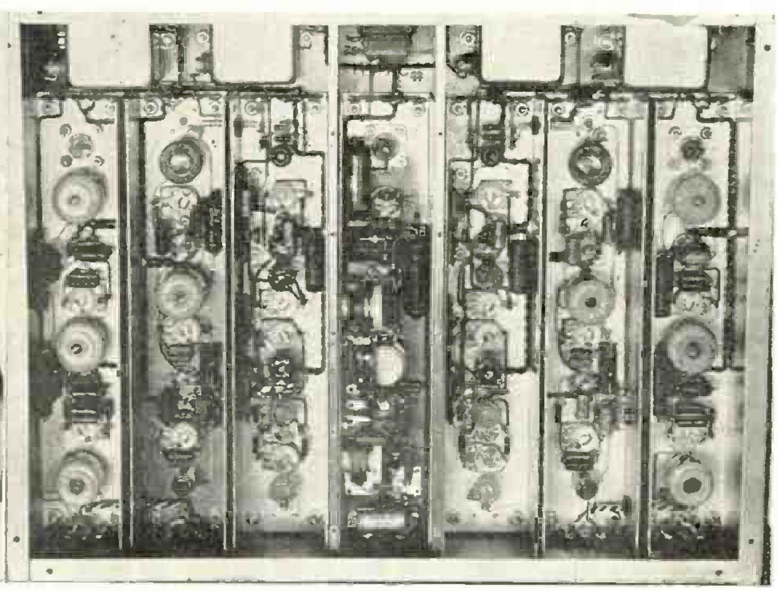
In one method, each of the two frequencies to be compared is multiplied to a high harmonic frequency and the difference frequency, obtained from a converter, is measured or recorded. With this method bandwidth limitations are the same in all stages and frequency deviations of as much as 1% may be handled easily. The use of cascaded decade frequency multiplier stages permits observation of the difference frequencies at any decade level consistent with the degree of precision required in a given case. It also extends the range of calibration frequencies into the increasingly important UHF band. The frequency multipliers described were designed for use in this manner.

Design Considerations

The general design aims were to eliminate or reduce many of the difficulties found in previously used frequency multipliers. The more serious of these were hum modulation from filament and plate supply power, multiplier sidebands caused by insufficient rf filtering in the intermediate multiplier stages, and phase instabilities caused by inadequate shielding and decoupling from external interference. Other desired improvements were the elimination of the need for critical input or bias adjustments, reduction of microphonic instability and temperature sensitivity of the tuned circuits, and protection against overloading in case of loss of input excitation or improper output loading.

The principal requirement was to obtain the highest possible phase stability, or freedom from internally generated random or periodic phase shifts and noise. Also, the ability to give long uninterrupted service un-

Fig. 1: (l) Top view of dual-triode frequency multiplier and converter chassis. Fig. 2: (r) Underchassis view of unit



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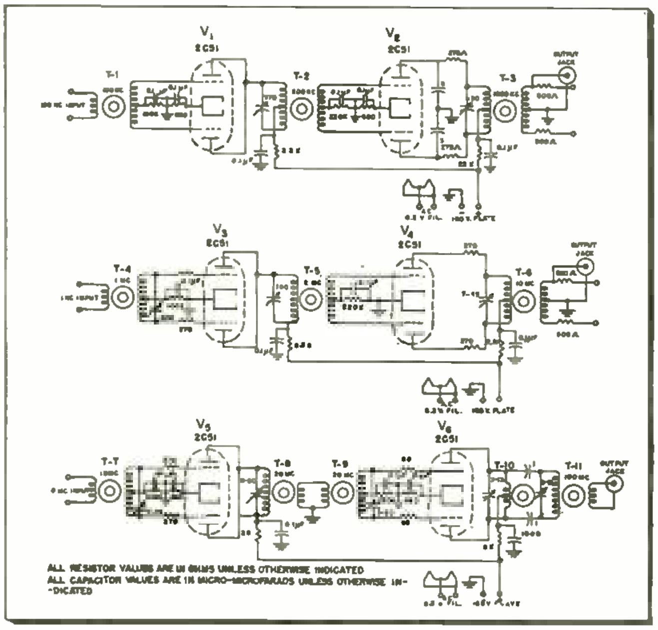

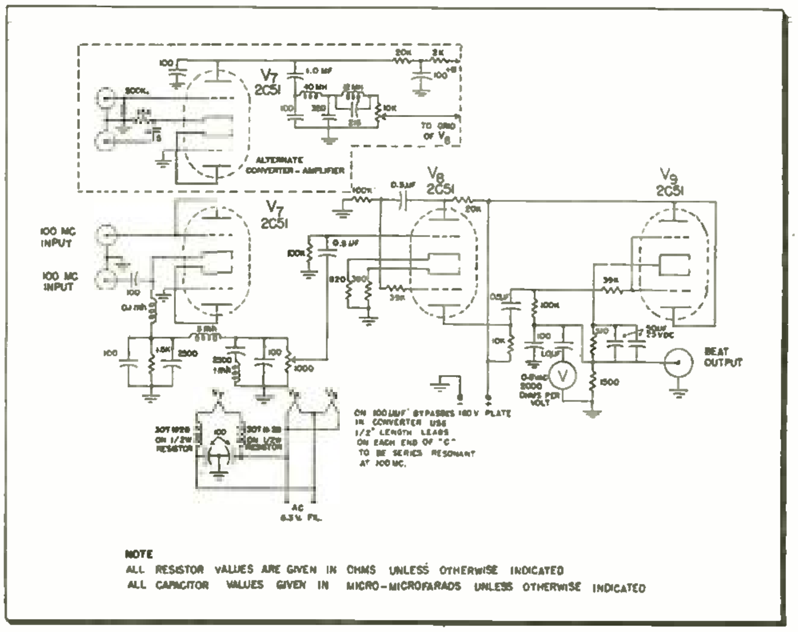

Fig. 3: (l) Circuit diagram of dual triode frequency multiplier. Fig. 4: (r) Diode converter driving cascaded dual-triode amplifier

der continuous use was considered highly desirable. This was assured by operating all tubes and components well below rated capacity. External ac power supplies of regulated type were used to isolate the principal sources of heat and to reduce the coupling of stray magnetic fields into the filter networks from the power transformers and chokes. Two frequency multiplier chains, 100 kc to 100 mc, and a converter-amplifier giving the difference frequency between the 100 mc outputs were installed in a completely shielded single unit along with separate power-lead filters for each multiplier chain.

For the frequency multiplier chains, biased germanium diodes with class-A amplifiers, and electron-tube harmonic generators of triode and pentode types were tried, in a variety of circuit arrangements, in the order listed. The diode type of multiplier chain offered a new approach, with the possibility of many desirable features such as compactness, low-level operation, small power consumption and minimum number of tubes. After considerable effort to optimize performance, it was still inferior to that of several tube multipliers already in operation and the other types were then tried. The multiplier chains using dual-triode harmonic generators gave the best over-all performance and are described in detail. Brief descriptions of the other types are also given, including relative comparisons of performance.

Dual-triode Frequency Multiplier & Converter

The physical details of the dual-triode frequency multiplier and converter chassis are shown in Figs. 1 and 2. The unit contains two identical frequency multiplier chains located on the left and right sides and a centrally located converter-amplifier arrangement. The rear compartments contain power supply terminals and separate rf power-lead filters for each multiplier chain. Each of the decade multiplier stages and the converter-amplifier are constructed on separate U-channel subchassis. These chassis are wired and adjusted as separate units and then assembled in the main chassis with tubes and connectors fitting through standardized clearance holes. The input and output jacks are used directly as wiring terminals, simplifying construction and eliminating the need for a number of shielded leads within the unit. The folded method of assembling the multiplier stages in the main chassis permits use of short interconnecting rf leads, including the external 100-mc coaxial leads normally used to connect the converter inputs.

The subchassis are separated a small amount to avoid intermittent contact noise effects and to reduce coupling between stages through circulating ground currents. Heavy shield barriers are placed on each side of the converter-amplifier to stiffen the chassis and permit use of separate subbottom covers, or the installation of waveguide-below-cutoff channel barriers on the bottom cover. These precautions were found to be unnecessary as no mutual coupling between channels was observed with the bottom cover on or off. However, operation of the unit during tests with the chassis ungrounded caused an undesirable phase modulation, which resulted from the common electrostatic coupling between channels at the 100-kc input transformers.

Theory of Operation

Electron tubes operated as class-C amplifiers are the most widely used type of frequency multiplier. Grid excitation is supplied at a relatively high amplitude along with a high grid bias, so that plate current flows in short pulses only when the instantaneous grid voltage is above plate-current cutoff. A parallel-resonant circuit, tuned to the desired harmonic, is used as the plate-coupling element, which presents the proper load impedance at the output frequency and a very low impedance at the other harmonic frequencies. The amount of power contained in the plate-current pulses

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Frequency Multipliers (Continued)

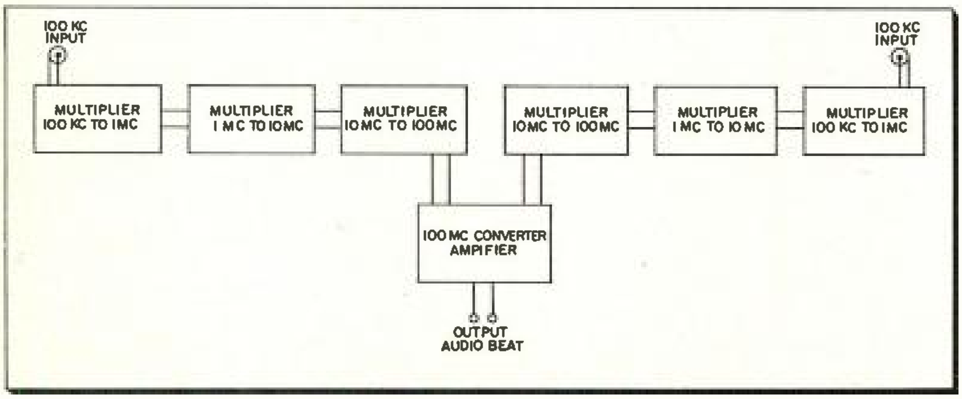

Fig. 5: Block diagram of multiplier-converter and power supply, including r-f line filters

at a given harmonic is largely determined by the angular period during which plate current flows, and to a much lesser extent by the nonlinear characteristic of the tube and the effect of grid current. The theory and design of electron-tube harmonic generators have been well described in the literature.

The plate circuit impedances and conduction angles used in the triode frequency multipliers agree generally with the accepted conventional values for obtaining a maximum percentage of harmonic output. Each stage is adjusted to have a reasonable plate swing while supplying only enough power to make up for the loss in the filter network and to drive the succeeding stage. The balanced method of harmonic generation, used both in the doubler and quintupler stages, simplifies the filtering problem by greatly reducing the first pair of sidebands resulting from the driving frequencies. Thus fairly simple filter networks give very high attenuation to all sidebands and greatly reduce phase modulation associated with unsymmetrical sideband coupling. Because of the rather high operating Q of the tuned filter circuits (ranging between 50 and 100) and the occurrence of power pulses each cycle for the doublers and each two and one-half cycles for the quintuplers, the decay in tank voltage between pulses is small. This aids the phase stability and makes operation less critical to tuning discrepancies that might occur in the filters.

Fig. 8: Exploded view of cavity filter

Construction Details

The circuit diagram for the dual-triode frequency multiplier is shown in Fig. 3. Details of the tuned transformers and coupling networks are given in Table I. The physical dimensions of the cores listed are not especially significant, the sizes being those available or conveniently adaptable. Each decade stage consists of a push-push doubler and a push-pull quintupler using type 2C51 tubes. These tubes are well suited for use in balanced multiplier circuits over a wide range of frequencies and have pin connections more suitable than some of the other types considered. The type 5670, a high reliability equivalent of the 2C51, is also available.

Toroidal transformers with cores of appropriate material for the frequencies, which range from 100 kc to 100 mc, and adjustable ceramic trimmer capacitors are used entirely in the filtering and coupling networks. High Q filter circuits are used, although operating Q values beyond about 100 are likely to be more sensitive to thermal detuning and more apt to require readjustment when tubes are changed. Also higher Q values might limit the bandwidth excessively for certain applications.

In addition to serving as frequency multipliers the first two stages operate as effective limiters, giving nearly constant 1-mc output for 100-kc input levels between 1 and 10 volts. The nominal output available from the driving oscillators is 3 volts from balanced 100-ohm lines. The multiplier input impedance is about 2000 ohms; thus it may be connected periodically to 100-kc sources having other loads without causing appreciable voltage changes. It is in the first few stages, also, that the greatest phase stability is needed, as any phase or frequency modulation generated in them is multiplied in all of the succeeding stages. The balanced doubler input aids in obtaining the highest phase stability at the most important point in the chain and, because of the high multiplication efficiency, serves most effectively as a limiter.

Harmonic Content

If cutoff bias voltage, or a 180° conduction angle, is used in a push-push doubler, the plate current pulses in the tank circuit have a wave shape and harmonic content closely similar to that obtained from a full-wave rectifier. For this condition, the peak amplitude of the second harmonic component for each triode is about 21% of the peak plate-current amplitude. A maximum second harmonic content of about 28% occurs at a conduction angle of about 120°, while at 60° a content of 20% is still available. By using a high value of grid bias resistance the grid circuit acts similar to a peak reading voltmeter with

TABLE I

Tuned Transformer Data for Triode Frequency Multiplier

Trans No. 1	Freq Mc	Core Material	µ	Toroid Size (In) OD	ID	H	Turns Pri	Sec	Coil Q	C_T µµf	Cvar µµf
1	0.1	Ferrite	1100	1.00	0.50	0.40	30#28	200#30	22	(distr)	none
2	0.2	Molyperm	60	1.06	0.60	0.45	140#28	108#30	70	386	7-45
3	1	Pwd. Iron	8	1.00	0.50	0.70	80#28	4#28	195	200	7-45
4	1	Pwd. Iron	8	0.50	0.19	0.50	4#28	60#34	150	331	7-45
5	2	Pwd. Iron	8	1.00	0.50	0.70	40#28	54#28	110	103	7-45
6	10	Pwd. Iron	8	1.06	0.60	0.45	24#22	2#22	180	28	7-45
7	10	Pwd. Iron	8	0.50	0.19	0.50	1#28	20#30	100	34	7-45
8	20	Textolite	1	0.62	0.25	0.50	30#28	2#28	110	13	1.5-7
9	20	Textolite	1	0.62	0.25	0.50	2#28	38#28	110	13	5-20
10	100	Textolite	1	0.62	0.38	0.19	16#24	none	115	10	3-13
11	100	Textolite	1	0.62	0.38	0.19	16#24	1#28	115	10	3-13

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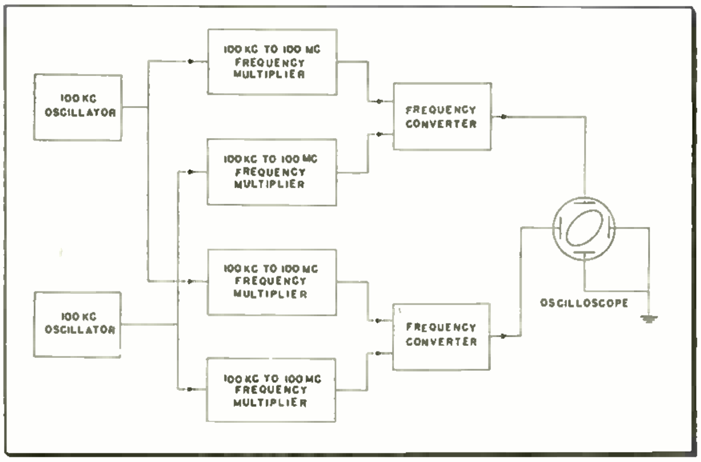

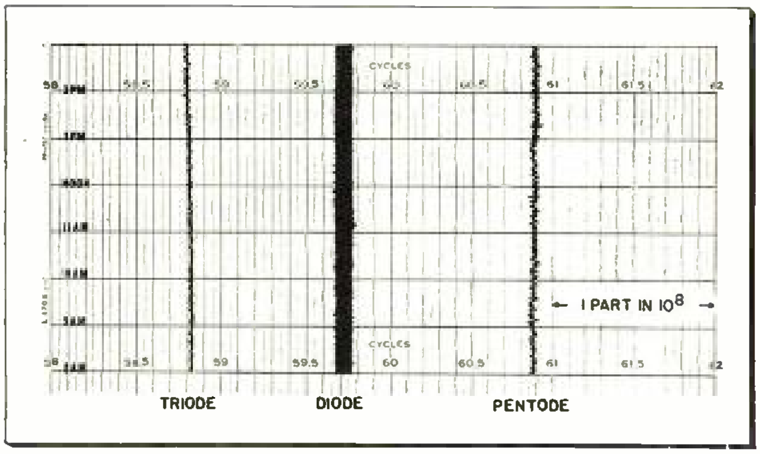

Fig. 6: (l) Arrangement for studying random phase fluctuations. Fig. 7: (r) Recording of beat frequency

the grid going positive only a small amount. Thus the bias adjusts itself to the input level and varies the conduction angle so as to maintain fairly constant output over a considerable input range. The limiting feature is desirable to make the multipliers self adjusting over a wide range of separate source levels rather than to remove amplitude variations from a single input. Grid bias resistors of 100,000 ohms proved optimum for both the limiting and multiplying functions. Cathode bias resistors of 680 ohms permit the tubes in each stage to draw about the same plate current with or without excitation, protecting both the tubes and the power supply from overload in case of loss of input signal.

Transformer Secondary

The 100-kc input transformer secondary is self resonant and supplies about 15 peak volts at the push-pull tube grids with normal 3-volt input. The plates are connected in parallel and operate into a tapped tuned impedance of about 30,000 ohms, with a peak plate swing of about 120 volts. The secondary winding drives the grids of V_2 at about 90 peak volts. The tapped primary on T_2 was provided to permit use of a more convenient value of tuning capacitor and still maintain the desired tube load at a reasonable tank Q.

For quintupler operation the optimum conduction angle is about 60 degrees. The computed value of grid bias resistor for this angle with a plate voltage of 180 was 220,000 ohms and this value proved more suitable. A plate-to-plate impedance of 100,000 ohms proved satisfactory and is approximately the value presented by T_3 with one-half of the secondary loaded with 50 ohms. The peak plate swing of each triode when driving only the next stage is about 120 volts, and about one-half this amount with a 50-ohm load connected at the 1-mc jack. The computed plate circuit efficiencies of both the doubler and quintupler stages were about 40%. Measured values showed reasonably close agreement with the computed data.

The resistors and capacitors shown in the plate leads of the 1-mc stage were installed to stop a parasitic pulse oscillation which occurred when the input was removed or below 0.5 volt. A two-stage sine wave oscillation developed in one of the four units constructed when the input was removed. It was eliminated by rewinding T-2 with two layers of nylon electrical tape between primary and secondary windings, which reduced the capacitive coupling.

The 1-mc to 10-mc stage follows the same general circuit and physical layout as used in the first decade. The 200-ohm balanced-line coupling between stages is provided to accommodate either balanced or coaxial distribution lines for special purposes where the decades are used separately. The 500-ohm decoupling resistors in the lines give optimum grid drive and permit the tank circuits to operate at higher Q without overcoupling. Filter L/C ratios and tank impedances are somewhat lower in this decade stage as a constant input level is available and some loss in efficiency can be taken to gain better filtering effectiveness. Parasitic suppressor resistors are used in the grid and plate circuits as a precautionary measure although no oscillations occurred if these were shorted.

Input Section

The input section of the 10-mc to 100-mc decade is similar to the previous stages. The 20-mc and 100-mc filters are double tuned, with approximately critical coupling, to give additional filtering in these stages. Precautionary parasitic suppressor resistors are used in the grid circuits as shown. Although the grid drive on the 100-mc stage is adequate, the plate circuit efficiency of this stage is low. However, the available output of 10 to 20 milliwatts is sufficient for satisfactory operation of the converter unit.

The tuned transformers in the filter networks may be easily adjusted by connecting a dc voltmeter of 20,000 ohms per volt or higher across

(*Continued on page* 120)

TABLE II

Multiplier Sidebands and Harmonics at Output Jacks with Respect to Desired Outputs (Average for two Triode Units)

1. 1 Mc, output into 50 ohms						2.1 volts, rms
1 Mc ±	100 Kc	200 Kc	300 Kc	400 Kc	500 Kc	600 Kc
db down	52	30	62	36	74	46
Second harmonic, down 60 db; Third harmonic, down 64 db						
2. 10 Mc, output into 50 ohms						1.0 volts, rms
10 Mc ±	100 Kc	200 Kc	1 Mc	2 Mc	3 Mc	4 Mc
db down	71	58	48	29	56	31
Second harmonic, down 55 db; Third harmonic, down 57 db						
3. 100 Mc, output into 50 ohms						0.7 volts, rms
100 Mc ±	100 Kc	200 Kc	1 Mc	2 Mc	10 Mc	20 Mc
db down	70	70	54	57	65	72
Second harmonic, down 64 db; Third harmonic, down 70 db						

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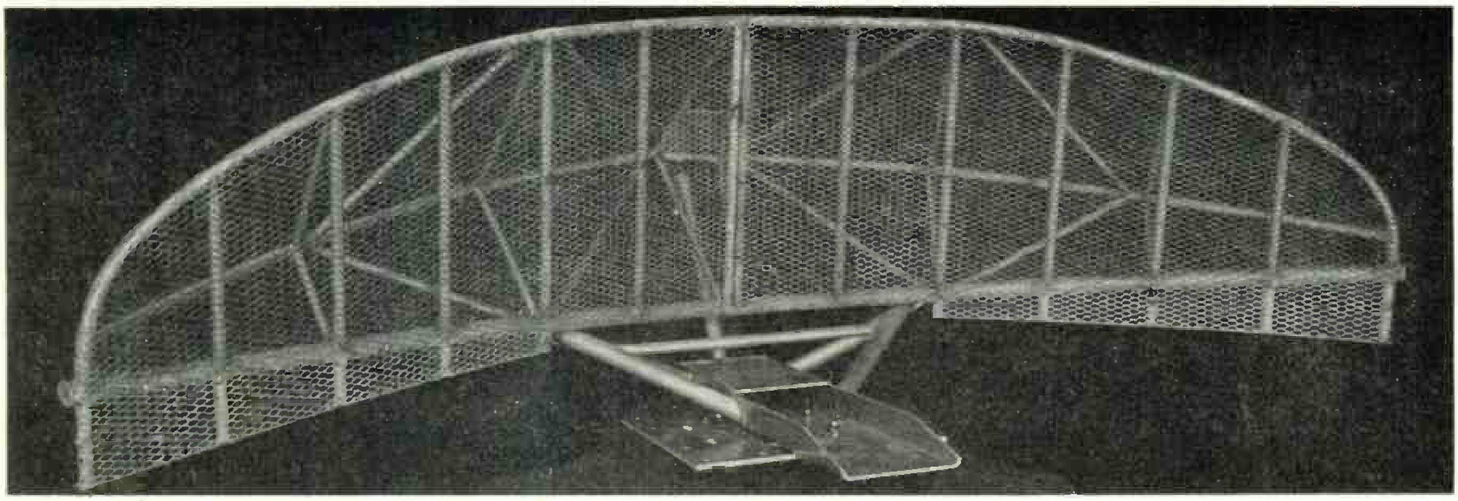


Fig. 1: Rotating parabolic type reflector of 12 in. mesh was found to cause minimum loading on antenna driving and supporting mechanism

Aerodynamic Loading of

ABSTRACT

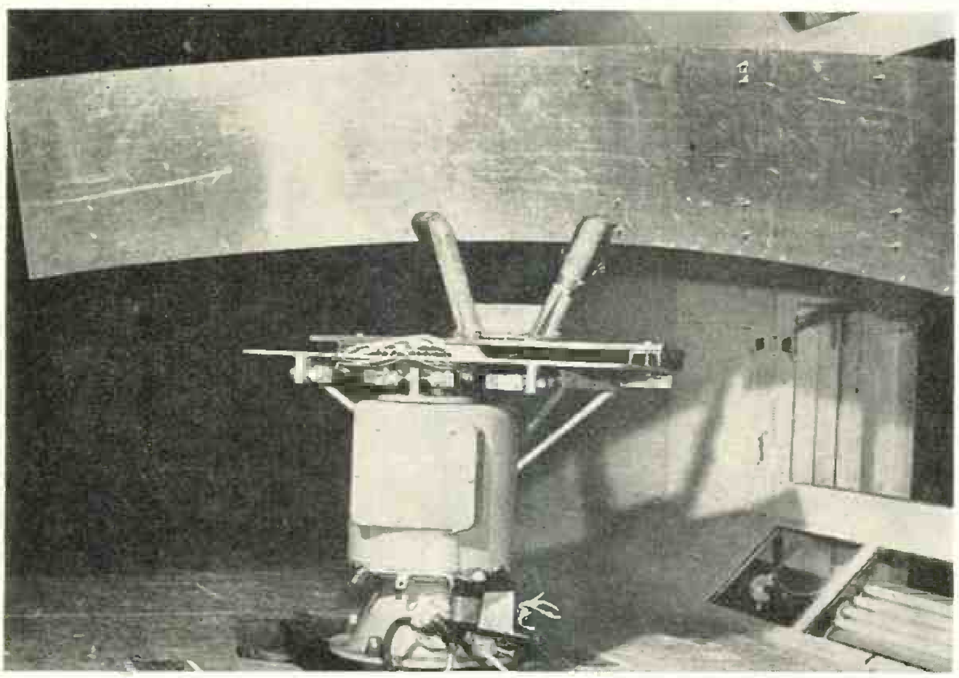
A knowledge of the wind loads developed on radar antennas is essential to obtain optimum design in the driving and supporting mechanism. The results of wind tunnel tests on a number of radar antennas are presented and discussed in this article. The horizontal wind force on the antenna is seen to be a function of the type of reflector, the azimuth position, and the wind velocity. The torque required to rotate the antenna varies with the type of reflector, azimuth position, elevation angle, pivot location, rotating speed and wind velocity. In general, for a given antenna shape and size, a solid reflector surface develops a higher force and requires much higher torques to rotate at a given speed in a given wind velocity than a mesh or slatted surface. A means for correlating such data is presented here.

In the design of the antenna driving and supporting mechanism close attention must be paid to antenna configuration, material, pivotal point and speed of rotation

By DR. MELVIN MARK,
Equipment Engrg. Div.,
Raytheon Mfg. Co.,
Newton 8, Mass.

DURING the past few years the performance requirements for radar antennas have developed to the point where operation has been required in higher and higher ambient wind velocities. Antennas have grown larger without de-emphasizing the need for weight reduction.

Fig. 2: Experimental solid reflector and torque measuring equipment in wind tunnel



To obtain the optimum design for the driving and supporting mechanism, a knowledge of the loads imposed on the antenna at the maximum wind velocities is necessary.

The problem of estimating the horizontal wind force on a given antenna and the torque required to turn it at any rotational speed in a given wind velocity is an exceedingly difficult one. The aerodynamic problems involved are considerably complicated by the configuration. Consequently, empirical methods appear to offer the quickest and most direct solutions.

Not much concerning the antenna wind loading problem is available in the literature. Over the past few years some wind tunnel test data have accumulated at Raytheon Mfg. Co. These results form the basis of this paper. Since a good share of the testing was directed toward solving individual problems relating to a particular antenna a complete answer is not to be expected from this data. However, a number of interesting and valuable conclusions can be drawn and a step made toward the solution of the general problem.

Definitions

The term reflector as used here will refer to that part of the antenna that receives the electromagnetic energy from the power source and radiates it into space in the form of

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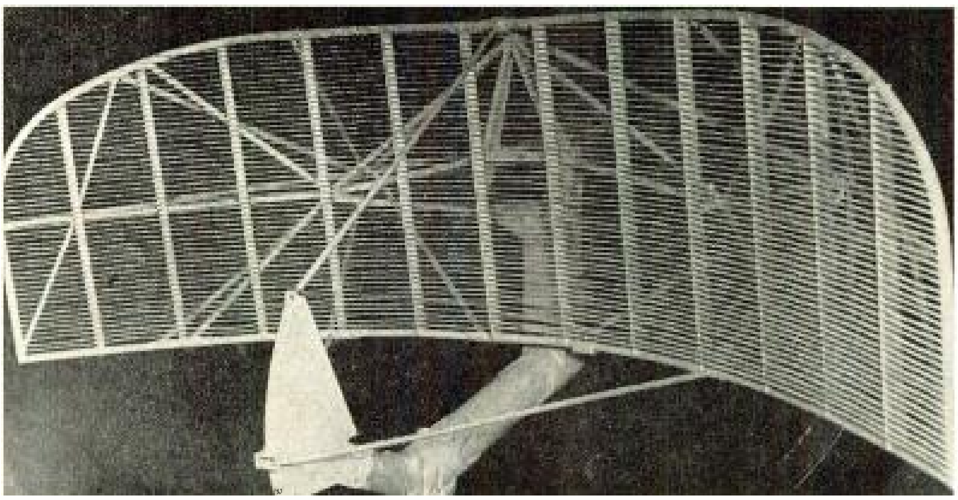


Fig. 3: Slatted parabolic reflector, with ½-in. spacing, gave favorable results

Radar Antennas

a beam. From the standpoint of wind loading, it is a critical item in the antenna configuration. The reflectors discussed are pivoted to rotate in azimuth. Azimuth angle will refer to the angle, measured in the direction of antenna rotation, that the beam makes with the zero position, the zero position being with the beam directed parallel to and into the wind. The pivot position in azimuth is generally located in the plane of symmetry of the reflector. Pivot distance will indicate the horizontal distance measured in the plane of symmetry from the bottom of the reflector to the pivot in azimuth. Elevation angle will refer to the angle the reflector makes with the vertical, positive when the reflector points up, negative when down.

Experimental Work

There are many different types of radar antennas. The data available concerns radar systems which have a rotating parabolic type reflector similar in shape to that shown in Figs. 1, 2, and 3. Three types of reflector surfaces are considered—solid (Fig. 2), screen or mesh (Fig. 1) and slatted (Fig. 3).

Horizontal force measurements were made generally by mounting the reflector in the wind tunnel on a special stand which, by means of a conventional balance system, allowed the downwind and crosswind components of the force to be measured. Data of this type on some 11 reflectors in wind velocities up to 100 mph are available. Of the 11 reflectors, 7 were slatted (similar to Fig. 3) and 4 solid (similar to Fig. 2). Their size varied with spans (horizontal distance measured across the reflector from tip to tip) from 2 ft. to 7 ft. and heights (vertical dimension at center of reflector) from .8 in. to 5. ft.

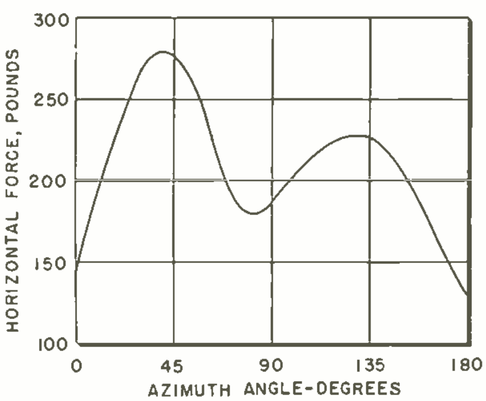
The torque measurements were made by mounting the reflector on a special pedestal which allowed the azimuth pivot location, or center of rotation, to be varied and measured torque. This pedestal was driven by a hydraulic motor and incorporated two independent sources for torque measurements. One consisted of the pressure drop across the hydraulic motor. This drop, measured by a sensitive strain gage element, was calibrated against the output torque. The second source of torque information consisted of two bars which transmitted all torque from the pedestal to the plate on which the reflector was mounted. Strain gages mounted on these bars were calibrated to give torque at the plate. Both of these sources can be seen in the photograph of Fig. 2, the torque bars with attached strain gages being just below the plate and above the pedestal, and the element measuring pressure drop being across the hydraulic inlet and outlet lines shown at the bottom of the pedestal. Azimuth position of the reflector was recorded every 18° of azimuth by means of a 10-speed synchro and marker system. All data were recorded on a Sanborn Twin Viso Model 60 Recorder. Torque measurement data are available on 4 reflectors: a solid reflector with a span of 90 in. and a height of 20 in. (Fig. 2); a screen reflector (Fig. 1) 90 in. by 20 in. with a surface consisting of ½-in. standard expanded metal; a screen reflector 84 by 26 in. with a surface of 3⁄16-in. expanded metal; and a slatted reflector (Fig. 3) 84 by 26 in. with 0.040 by 0.43-in. slats spaced ½-in. apart on centers. The torque tests were made at various pivot distances, elevation angles, wind speeds and rotating speeds.

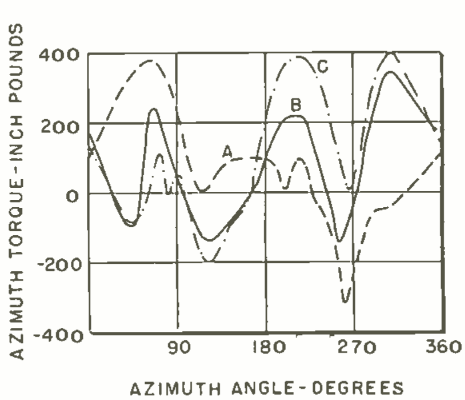
Results

The equipment for measuring the horizontal force resulted in giving the downwind and crosswind forces on the reflector. The resultant of these components was a force which acted at some angle to the wind direction. The results of the tests on the 11 reflectors showed the resultant force varies as the square of the wind velocity, and is a maximum when the reflector is at an azimuth angle of about 45°. A typical resultant force curve is shown in Fig. 4.

The results can be correlated through application of dimensional analysis. Consider a family of geometrically similar reflectors with the same type of surface. Their size can be characterized by some dimension L. The other important parameters are wind velocity V and air density ρ (neglecting viscosity on the as-

Fig. 4: (l) Slatted reflector in 100 mph wind. Fig. 5: (r) Torque. ½-in mesh screen reflector





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Aerodynamic Loading (Continued)

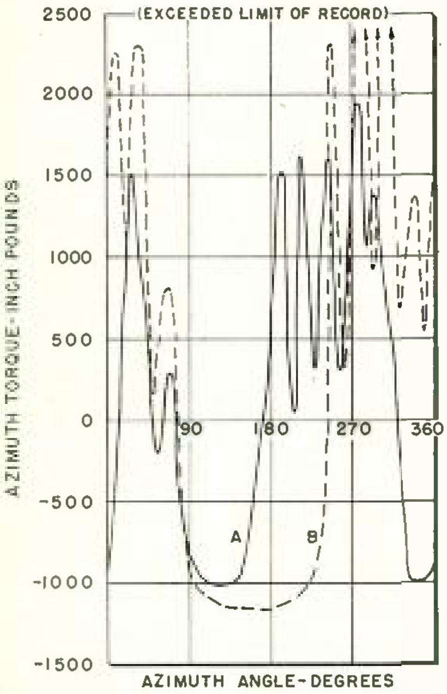

Fig. 6: Solid reflector in 60 mph wind

sumption the pressure forces are much larger than the skin-friction, due to flow separation). Since the maximum horizontal force F_{max} is of interest, the relationship is written

$$f_1 (F_{MAX}, V, L, \rho) = 0 \quad (1)$$

From the principle of dimensional homogeneity, a dimensionless product may be chosen and

$$f_2 (F_{MAX}/\tfrac{1}{2} \rho V^2L^2) = 0 \quad (2)$$

consequently

$$F_{MAX}/\tfrac{1}{2} \rho V^2L^2 = \text{Constant} \quad (3)$$

Eq. 3 may be rewritten

$$F_{MAX} = C_F (\tfrac{1}{2} \rho V^2D^2H) \quad (4)$$

where C_F, defined as a force coefficient, is the constant for the family of geometrically similar reflectors with the same type of surface, and D and H are the span and height respectively.

Deviations

For the four solid reflectors tested, the average value for C_F was 1.5; for the 7 slatted reflectors, with the slats (approximately 0.040 in. thick by 0.50 in. deep) at 0° angle of attack, C_F was 0.7 for ⅜ in. slat spacing, 0.55 for ½ in. spacing. The ratio D/H varied approximately from 2 to 5 for the reflectors considered. The deviation of individual values from the average was less than 20%. As the slat spacing decreases from ⅜ in., C_F for the slatted reflector could be expected to increase and approach the solid surface value, and similarly as the back or supporting structure tends to fill up the spacing, or as the angle of attack of the slats increases, a solid type surface is approached. Although no data was obtained for a screen or mesh surface, it could be expected to have a C_F value similar to the slatted for mesh openings comparable to the slat spacing. As the slat spacing, or mesh opening, increases from ½ in., C_F could be expected to be less than 0.55.

The torque measurements were obtained at various rotating speeds in different wind velocities for given pivot distances and elevation angles. The results can be correlated again by dimensional analysis. As before the parameters for the geometrically similar reflectors with the same surface are wind velocity V, air density ρ, and the characteristic dimension L, but now the rotating speed N is introduced, and the peak torque T_{max} is of interest. The relationship is written

$$f_3 (T_{MAX}, V, N, L, \rho) = 0 \quad (5)$$

Again applying dimensional homogeneity, two dimensionless products are chosen and

$$(T_{MAX}/\tfrac{1}{2} \rho V^2L^3) = f_4 \left(\frac{NL}{V}\right) \quad (6)$$

Rewriting Eq. 6

$$T_{MAX} = C_T (\tfrac{1}{2} \rho V^2D^2H) \quad (7)$$

where C_T is defined as a torque coefficient and D and H are introduced. Consequently

$$C_T = f_4 (ND/V) \quad (8)$$

for a given configuration and reflector surface, and the function may be obtained by plotting the results in the form of Eq. 6. Consistent units are to be used so that the parameters of Eqs. 2 and 6 are dimensionless.

Pivot Position

A search for the optimum pivot position (the pivot position resulting in minimum peak torques) on the four rotating reflectors showed the maximum torque occurring during a revolution varied approximately parabolically with the distance from the optimum position. The optimum pivot position varied with the elevation angle, being closer to the reflector as it elevated and presented a more symmetrical body. The rotating torque data available from the measurements made on the 3/16 in. mesh reflector (84 by 26 in. in height and span) were typical. For the reflector set at 45° in elevation, the pivot distance for minimum torques was approximately ½ in.; at 0° it was 12 in.; for the reflector depressed to —13°, the optimum distance was 16 in. The tests with this reflector at rotating speeds of 8, 15, and 25 rpm. showed the optimum pivot position to be relatively independent of rotating speed. The torque coefficient for this reflector pivoted near its optimum, based on plotting the data in the form of Eq. 6, was found to be the same for the case of 0° elevation and a pivot distance of 11.4 in. and the case of —13° elevation and a pivot distance of 14.8 in. This was

$$C_T = 0.037 + 33 (ND/V)^2 \quad (9)$$

For the same reflector at 45° elevation and a pivot distance of 1.67 in.

$$C_T = 0.028 + 33 (ND/V)^2 \quad (10)$$

(*Continued on page* 161)

TABLE 1—Dynamic Torque Measurements

A. 1/2-in. Mesh Reflector; —14° elevation; pivot distance = 14.5 in.:

V, MPH	*N, RPM*	*T_{max}, in-lb.*
40	18.5	240
50	18.5	320
60	18.5	440
70	18.5	550
75	18.5	600
80	18.5	680
40	10.6	170
50	10.6	230
60	10.6	330
70	10.6	420
80	10.6	560

B. 3/16-in. Mesh Reflector; —13° elevation; pivot distance = 14.8 in.:

V, MPH	*N, RPM*	*T_{max}, in-lb.*
40	25	560
60	25	800
80	25	1060
100	25	1600
40	15	350
60	15	540
80	15	900
100	15	1400

C. Slatted Reflector (1/2-in. spacing); —13-1/2° elevation; pivot distance = 14.5 in.:

V, MPH	*N, RPM*	*T_{max}, in-lb.*
60	16.6	360

D. Solid Reflector; —16° elevation; pivot distance = 24 in.:

V, MPH	*N, RPM*	*T_{max}, in-lb.*
30	18.7	500
40	18.7	680
50	19	1100
60	19.9	1950
65	20.3	2500

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Cathode-Inductance and Amplifier Output

An analysis of effects on the tube output conductance at high frequencies. Mathematical expression derived

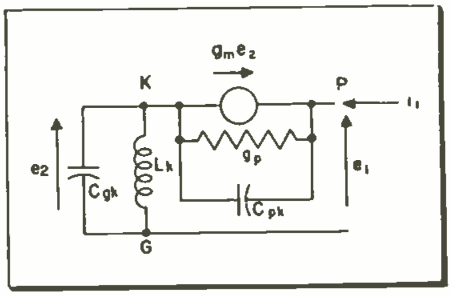

Fig. 1: Equivalent circuit diagram of amplifier tube having a shorted input

By
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IT is a well-known fact that the input conductance of an amplifier tube at high frequencies, neglecting Miller Effect, results from two effects, cathode lead inductance feedback and cathode-to-grid transit-time. The input conductance due to cathode lead inductance is given by the expression[1]

$$G_{fk} = G_m \omega^2 L_K C_{gk}$$

where,

G_m = transconductance of tube
ω = $2\pi f$ = radian frequency
L_K = inductance of cathode lead
C_{gk} = grid-to-cathode capacitance

The input conductance arising from transit-time effects is[1]:

$$G_\tau = K G_m \omega^2 \tau^2$$

where,

K = constant depending on electrode voltages and ratio of cathode-grid to grid-plate transit times.
$K \cong 0.1$ in small tubes.
τ = cathode-to-grid transit time.
$\tau \cong 10^{-9}$ second in small tubes.

The total input conductance due to both effects is, then,

$$G_i = G_m \omega^2 L_K C_{gk} + K G_m \omega^2 \tau^2$$

This conductance is defined and measured with a short-circuit plate load. It should be noted that the input loading increases as the square of the frequency and with increase in cathode lead inductance. The derivation of G_{fk} assumes that,

$$\omega^2 L_K (C_{gk} + C_{pk}) \ll 1$$
$$G_p = 1/r_p \ll$$
$$\text{and } G_m^2 \omega^2 L_K^2 \ll 1$$

where,

C_{pk} = plate-to-cathode capacity
r_p = plate resistance

There seems to be nothing in the literature regarding the output conductance of a tube. An expression will now be derived for the output conductance (or apparent plate conductance), which shows a variation similar to that of G_{fk}. Consider the equivalent circuit of Fig. 1, which shows the grid shorted to the cathode lead.

Applicable Nodal equations are,

$$i_1 + G_m e_2 = (G_p + j\omega C_{pk}) e_1 - (G_p + j\omega C_{pk}) e_2 - G_m e_2$$
$$= -(G_p + j\omega C_{pk}) e_1 + [G_p + j\omega (C_{gk} + C_{pk}) + 1/j\omega L_K] e_2$$

Whence,

$$i_1 = (G_p + j\omega C_{pk}) e_1 - (G_m' + j\omega C_{pk}) e_2$$
$$0 = -(G_p + j\omega C_{pk}) e_1 + \left[G_m' + j\omega (C_{gk} + C_{pk}) + \frac{1}{j\omega L_K} \right] e_2$$

where,

$$G_m' = G_m + G_p$$

The output admittance is given by:

$$Y_o = \frac{i_1}{e_1} = G_p + j\omega C_{pk} - \frac{(G_p + j\omega C_{pk})(G_m' + j\omega C_{pk})}{G_m' + j\omega (C_{gk} + C_{pk}) + 1/j\omega L_K}$$

Separation into real and imaginary parts yields the output conductance,

$$G_o = G_p - \frac{G_m'^2 \omega^2 L_K^2 + \omega^2 L_K C_{pk} [\omega^2 L_K (C_{gk} + C_{pk}) - 1] G_p + G_m' \omega^2 L_K C_{pk} (\omega^2 L_K C_{gk} - 1)}{G_m'^2 \omega^2 L_K^2 + [\omega^2 L_K (C_{gk} + C_{pk}) - 1]^2}$$

Subject to the conditions,

$$\omega^2 L_K (C_{gk} + C_{pk}) \ll 1$$
$$G_p \ll G_m$$
$$G_m^2 \omega^2 L_K^2 \ll 1$$

The output conductance becomes,

$$G_o = G_p + G_m \omega^2 L_K C_{pk}$$

This result shows that the output conductance of the tube consists of the parallel combination of the plate conductance and frequency-dependent conductance resulting from cathode lead inductance. The latter has exactly the same variation a G_{fk}, with C_{pk} replacing C_{gk}. The apparent high-frequency plate resistance may thus be appreciably lower than the low frequency value.

This fact is of vital importance in the design of wideband amplifiers or power amplifiers and should be considered in all such cases.

Two numerical examples follow to illustrate the magnitude of the effect and the excellent agreement between theoretical and experimental values. First consider the subminiature 5639 video pentode. The pertinent values used in the calculations were as follows:

G_m = 9000 μmhos
G_p = 20 μmhos (r_p = 50,000 ohms)
C_{gk} = 9 $\mu\mu$f
C_{pk} = 5 $\mu\mu$f
L_K = 0.005 μh
τ = 10^{-9} sec.
f = 150 MC.

	CALCULATED	MEASURED
$R_i = \frac{1}{G_i}$	= 860 ohms	934 ohms.
$R_o = \frac{1}{G_o}$	= 450.	3900 ohms.

Power Pentode

A second tube that was investigated is the miniature 5763 power pentode, with the following data:

G_m = 7000 μmhos
G_p = 125 μmhos (r_p = 8000 ohms)
C_{gk} = 9 $\mu\mu$f
C_{pk} = 4 $\mu\mu$f τ = 10^{-9} sec.
L_K = 0.015 μh   f = 150 MC.

	CALCULATED	MEASURED
R_i	= 685 ohms	750 ohms
R_o	= 2010 ohms	1900 ohms

It is evident that agreement between theoretical and measured values is of the order of 10%, which is certainly adequate for any amplifier design considerations. It is further apparent that the high-frequency output resistance may be appreciably lower than the low-frequency, or data sheet, value.

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New Design in Closed-

Spiral scanning method offers significant advantages over conventional TV transmission, notably lower power requirements and more efficient use of lenses

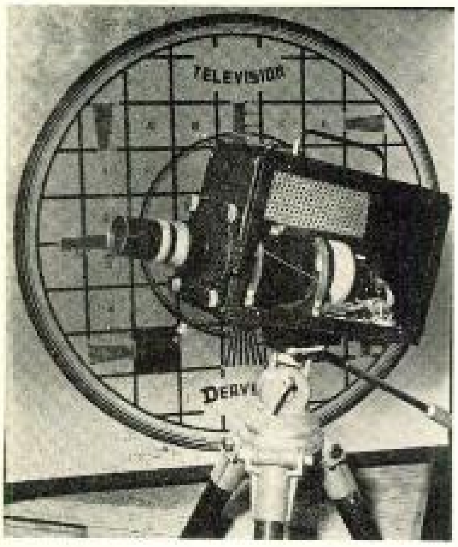

Fig. 1: Standard camera and test card

By A. V. J. MARTIN,
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HAVE you ever asked yourself why the TV picture is a quadrangle whose sides are in the approximate ratio of 3 to 4?

If you think that it is because of the motion picture standard, you are right, but you have only replaced the problem by a new one. At the beginning of the movies, the choice was wide between a great number of different aspects. Undoubtedly, commercial or industrial considerations came into play, but it remains that the actual aspect ratio was chosen on an essentially aesthetic basis. It was known as far back as the ancient Greeks that certain aspects are more pleasant to look at and lend themselves easily to special composition effects. They thus contribute to the artistic appeal of a picture and help to convey the meaning of the subject.

The 3:4 rectangle is one of those aspects, and it was sensible to choose it—for movies at first, and then for TV.

Scanning

Starting with a rectangular picture, it was logical to think of scanning it by a combination of orthogonal movements—the classical horizontal and vertical sweeps.

It is not at all certain that this constitutes the best method, and its principle has been put in question several times these last years.

However, the official standards of all the TV stations in the world are based on the two rectangular sweeps, and, barring some revolutionary discovery (such as non-scan TV), it is too late to try and modify it.

What are the drawbacks of the standard scanning? As the displacements should be linear, the waveform in use is the familiar sawtooth, which is not as easy to use as long habit would lead us to believe. Suffice it to recall the difficult problems of linearity and flyback high voltages.

Effectively, it should be borne in mind that the usual scanning presents a double discontinuity, at line, and frame scanning rates. These discontinuities are made necessary by the fact that the sweep does not end where it begins, and that it has to fly back to the starting point each time a sweep is completed. Despite all efforts, there is a minimum duration for these two flybacks, owing to practical and economical considerations. In the usual standards, the allotted flyback times are of the order of 10% for vertical and 16% for horizontal sweep.

It then becomes necessary to introduce blanking signals to suppress the flyback lines.

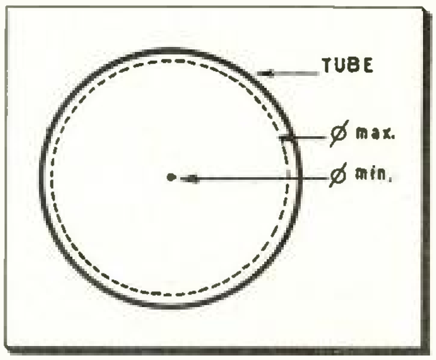
What is more, the actual useful time is reduced to 90% in vertical and 84% in horizontal. Hence, the total useful part is $0.9 \times 0.84 = 0.774$, or under 78%.

In these times of ether crowding, bandwidth reduction and information theory, this seems rather inefficient.

Have you ever stopped to think of the tremendous complexity due to the absolute necessity of rigorously synchronizing the receiver's and the transmitter's sweeps?

A good part of the available transmitter power is lost in the sync signals; the sync generators are costly and complex, the receiver embodies one or more sync separators, clippers, comparators, etc.

If only such a complexity was paid for by absolute efficiency! But such is not the case. . . .



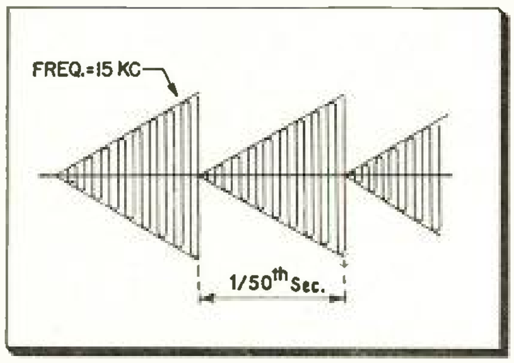


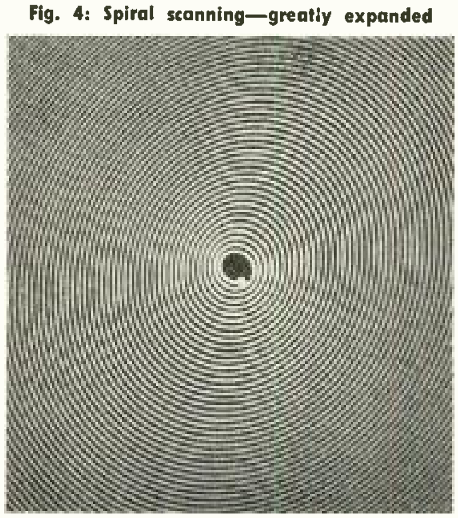
Fig. 2: (l) Limits of the usable circles. Fig. 3: (r) Waveform is a sawtooth modulated 15 kc signal

It can easily be understood that it is difficult to change the telecasting standards, owing to the aesthetic considerations and to the fact that it is practically impossible to modify radically a world accepted standard.

It is more difficult to see why such standards should be adopted for industrial television.

Of course, the temptation was

Fig. 4: Spiral scanning—greatly expanded



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Circuit Television

great to simply adopt the telecasting methods and techniques. One then felt on solid and familiar grounds; the special parts were easily found: almost no important design and development was necessary, etc.

But such a solution, even if it satisfies laziness, opposes the most elementary logic. Since in the new field of ITV everything is still permitted, here is the time to think over the problem again, and try to find more rational approaches.

Rectangle vs. Circle

If the rectangular picture is satisfying on aesthetic grounds, it leads to a bad utilization of lenses, pick-up tubes, and receiving kinescopes, which all have a circular symmetry. It must be remembered that this remark led to the making of rectangular tubes especially adapted to the standard.

Moreover, in the usual picture, the interest lies in the center part, and it is usual practice to cut off the corners, and even part of the sides, by using a picture size larger than the mask opening.

All this points to the following conclusion: from a purely utilitarian point of view, a round picture has much to recommend itself.

Spiral Sweep

A spiral sweep (see Fig. 4.) offers several interesting advantages. It scans continuously, and the horizontal flyback, with its attendant surges, oscillations, and loss of time, has disappeared. The necessary waveform is a simple sinusoid, easy to create and manipulate. The usual synchronizing system is replaced by a simpler and rigorous locking.

To maintain the apparent continuity of moving pictures, it is still necessary to repeat the spiral scanning at a rate of 50 CPS and this constitutes the equivalent of frame sweep.

However, two important advantages are secured; one concerns the flyback time, which can easily be kept well under 3%, and the other lies in the synchronizing method.

Compared to the 22% loss of time of the usual standard, the spiral scanning, with its 3% at most, is over 7 times better. Moreover, even this 3% loss can be spared, and the system then becomes 100% efficient on a time basis.

The Cartesian scanning being abandoned for a polar type, how can the spiral be obtained?

The familiar Lissajous figures show that, by combining two sinusoidal deflections of the same frequency, an ellipse appears on the screen. Under certain conditions, this ellipse reduces to a circle.

At zero amplitude of the sinusoids, this circle itself reduces to a point, called the zero point, at the center of the screen.

Spiral Trace

If the amplitudes of the two sinusoids are then increased simultaneously and linearly, the circle diameter will increase regularly, and the spot will trace a linear spiral. When it reaches the limit of the screen, a quick flyback brings it back to the center, where the scanning starts again. (Fig. 2.)

Hence, the waveform giving a spiral scan is shown in Fig. 3. It is a sinusoid modulated by a sawtooth.

The spiral scan thus uses two frequencies, which are the equivalent of the familiar line and frame frequencies. The numbers chosen are purely arbitrary and can be easily

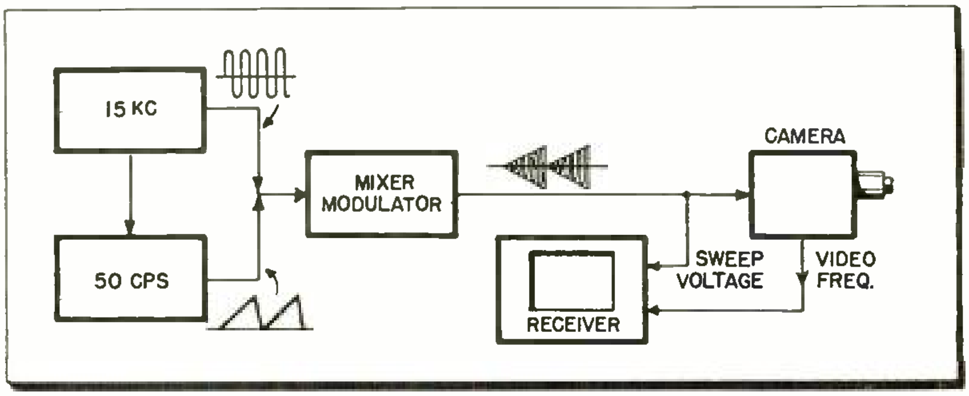
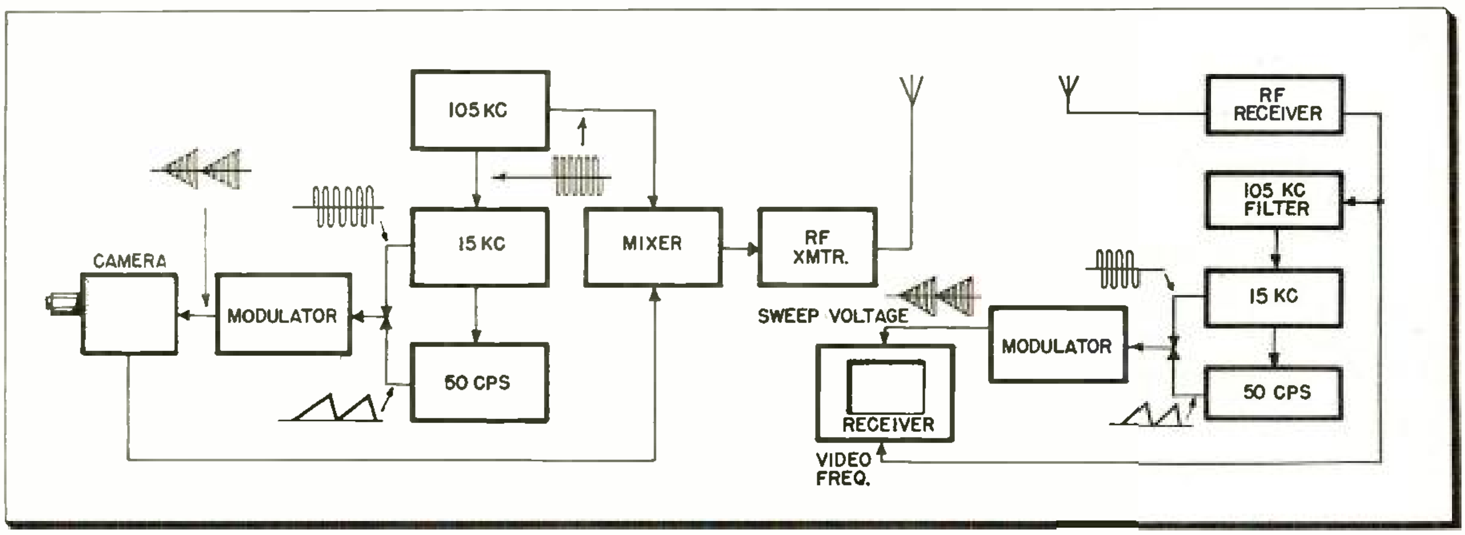


Fig. 5: Block diagram of closed-circuit TV system utilizing cable link between camera and receiver

Fig. 6: System using radio link is more elaborate. Additional sections are needed to generate the 105 kc r-f carrier and to demodulate at the receiver end



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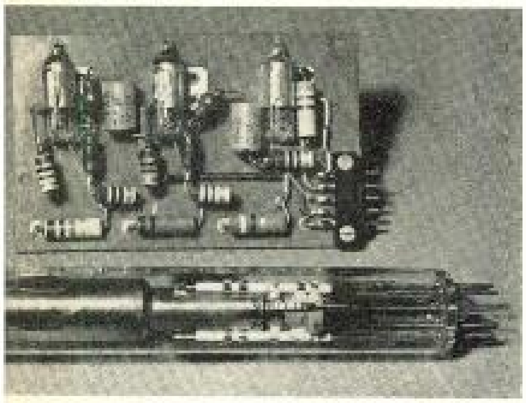


Fig. 7: Resistron pick-up tube. Preamplifier

modified. However, most of the equipment now in use employs a sinusoid of 15 KC and a sawtooth of 50 CPS.

Hence, there are 15,000/50 = 300 turns per spiral and 50 spirals/sec. To avoid a turn crawling (similar to line crawling), the two frequencies are exact harmonics. The 50 CPS is obtained by dividing the 15 KC, as well at the transmitter as at the receiver.

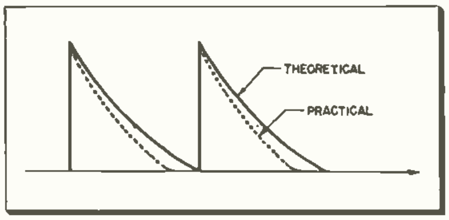
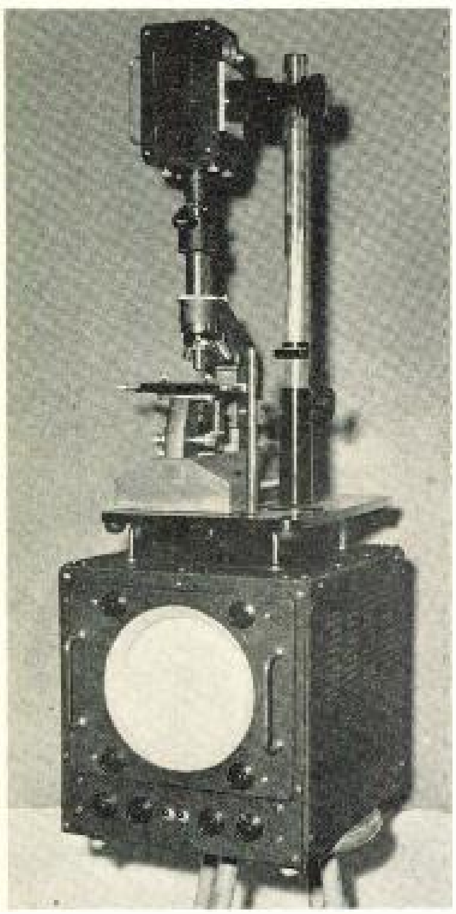


Fig. 8: Brilliance correction voltage

Fig. 9: Set-up for television microscopy



Resolution

The spiral scan proceeds at a constant angular speed. This means that, in the same time, the spot moves a shorter distance near the center than near the edges of the screen. This is equivalent to saying that the resolution decreases radially, starting from a theoretically infinite maximum at center.

It would not be unduly difficult to vary the frequency of the scan to obtain a constant resolution over the whole screen, but the effort was not judged worth while for the applications in mind, where the enhanced resolution near center is a distinct advantage. It should be noted that the maximum resolution is limited by several factors—spots, diameters and bandwidth in particular.

If the picture were cut by a vertical passing through the zero point, there would be 600 points of intersection with the scan. This shows that, if an analogy were to be drawn between the familiar lines and the spiral, each turn of the spiral would equal two lines. The attending resolution decreases when the vertical moves towards the edge of the scan, since the number of points of intersection decreases.

Cable Link

The two distinct equipments which have been developed are distinguished by the link between transmitter and receiver.

In the simplest case, the link is a cable, and a diagram of the equipment is shown in Fig. 5.

The 15 KC fundamental frequency is crystal controlled. A divider provides the 50 CPS sawtooth, which in turn modulates the 15 KC sinusoid to give a waveform similar to Fig. 3. This waveform ensures the spiral scanning of the camera and receiver. The video frequencies (V.F.) are conveyed by a coaxial cable.

Two types of dividers have been satisfactorily used. One is the usual staircase type, with counting diodes and flip-flops; the other employs tuned circuits.

The deflections are electromagnetic and use two similar sets of coils. The necessary phase relations are obtained through classical RC circuits or transformers.

R-F Link

When the link between transmitter and receiver uses a radio wave, the diagram is slightly more complicated and is given in Fig. 6.

The fundamental frequency is 105 KC. It is highly stable and obtained by beating together two crystal oscillators. It is divided by 7 to obtain 15 KC. Another division by 300 yields the 50 CPS, and a modulator shapes the 15 KC sinusoid at a 50 CPS sawtooth rate.

This waveform is used to sweep the camera, but is not transmitted.

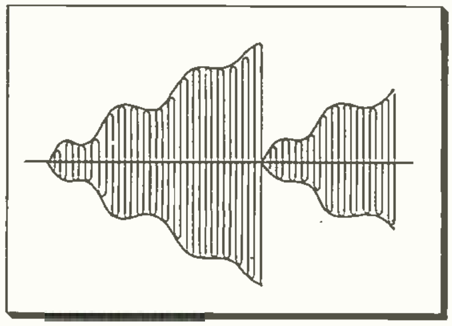


Fig. 10: Parasitic modulation on waveform

Instead, very sharp filters cut a slice at 105 KC in the video frequency spectrum. The quality of the picture is in no way impaired.

The fundamental 105 KC is then inserted in the "hole" by a special mixer, and the video frequency modulates an r-f transmitter as per usual.

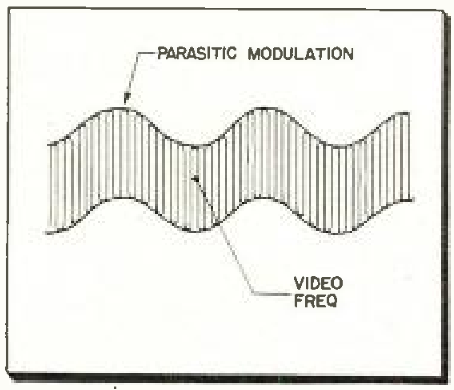
At the receiver, a sharp filter separates the 105 KC from the V.F., and a chain of dividers, similar to those used at the transmitter, yields the 15 KC and 50 CPS.

A modulator mixes the 15 KC sinusoid and the 50 CPS sawtooth and reconstitutes the scanning waveform.

It will be noted how the synchronization problem has been attacked, in view of obtaining a complete safety. This might not be so important when a cable link is used, but becomes of paramount importance

(*Continued on page* 112)

Fig. 11: Parasitics on sinusoidal waveform



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Relay Characteristics and Uses

ABSTRACT

Often unrecognized relay performance characteristics and operational problems are described. Transient build-up, operating time, saturation and force-distance curves are analyzed.

Close examination of electrical and mechanical aspects of relay performance clarifies design techniques required for proper circuit application

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Oklahoma A. & M. College
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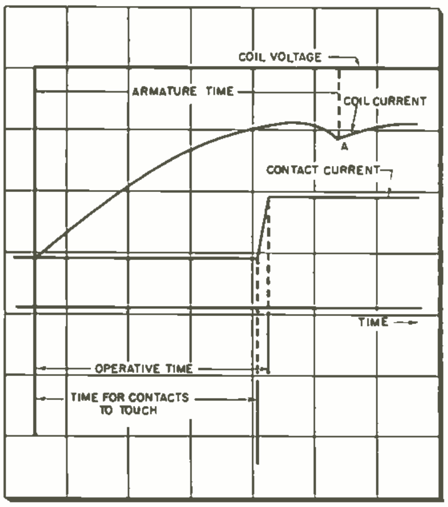


Fig. 1: Relay transients during operation

A RELAY has been called an electrically operated switch. In an electro-magnetic relay, the force which causes the relay to close is derived from the ampere-turns of a coil. The simplicity of this component is disarming.

The coil current of a relay does not reach the final value instantaneously. For a simple R-L circuit with a dc voltage impressed, the growth of current is found to be

$$i = \frac{E}{R}\left(1 - e^{\frac{-Rt}{L}}\right).$$

This equation applies to a circuit where the resistance is constant and the inductance is constant. The internal resistance of the source of voltage is assumed to be small compared to the resistance of the R-L circuit. These conditions may not apply in every circuit or, more particularly, a relay circuit. In a relay, the situation is somewhat different. At the instant the circuit is closed, the current starts to build up, but since the inductance of the circuit is not constant, the instantaneous value of the current will not be described by the foregoing equation.

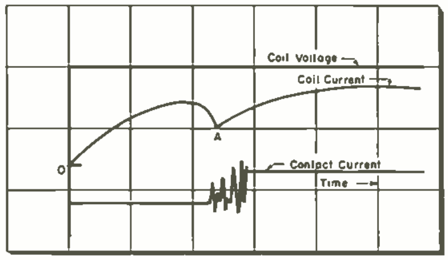


Fig. 2: Electrical effect of contact bounce

When the relay armature is in the open position, the air gap will account for the greater part of the ampere-turns required to set up flux in the magnetic circuit. With the armature of the relay closed, and, if the air gap is assumed to be very small, a given number of ampere-turns will cause a larger amount of flux than for the open position. For specific values an equivalent magnetization curve of the magnetic circuit for both cases would have to be used.

The equation for the transient build-up of current was for the case where voltage was applied directly across the coil of the relay, and it was assumed that the internal resistance of the source was negligible. This assumes that the resistance and inductance of the relay coil are constants. However, consider the case when the coil is in series with another resistance. Then, the instantaneous value of current will be

$$i = \frac{E}{R_1 + R_2}\left(1 - e^{\frac{-(R_1 + R_2)t}{L}}\right).$$

Here R_1 would represent the coil resistance and R_2 would be the added resistance in the circuit.

It is apparent that the voltage across the relay is reduced by the addition of resistance in series with the relay coil. The operate time will have changed as well as the final value of the coil current. The final value of the ampere-turns of the coil will be decreased which in turn will decrease the pull exerted on the armature. Shock and vibration will tend to cause improper operation as the voltage across the coil is decreased.

In the discussion of the build-up of current in an R-L circuit, it has been assumed that the inductance was constant. For a relay, this is not the case. In other words, the inductance of the coil of the relay changes as the coil current changes. The variation will depend upon the magnetic characteristics of the iron, and the inductance cannot be assumed to be constant if precise results are desired.

Actual Coil Current

The current trace in Fig. 1 is the time-variation of the coil current of a relay. As previously mentioned, the current does not follow the build-up in a simple R-L circuit. After reaching a value which would have a horizontal tangent, the current decreases very rapidly for a

(*Continued on page* 172)

Fig. 3: Magnetization characteristic curves

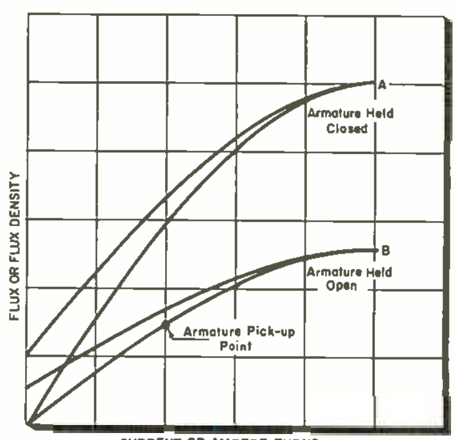
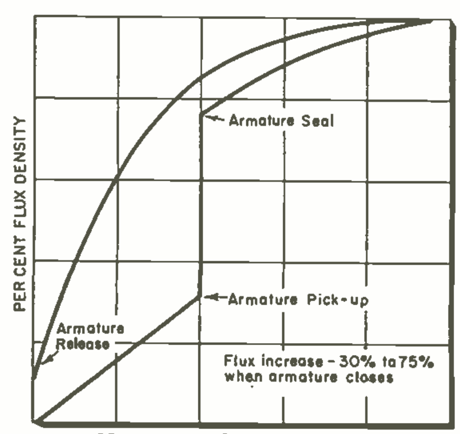


Fig. 4: Relay hysteresis characteristic



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How to Plan for Color Television

Part Three of Three Parts

Practical three-step sequence provides for logical expansion of facilities from handling network programs, slides and films, to live studio originations

By L. E. ANDERSON & W. O. HADLOCK
Engineering Products Dept., Radio Corp. of America, Camden, N.J.

PLAN #3 EQUIPMENT FOR TELECASTING LIVE COLOR IN YOUR STUDIO

The major item, in the plan #3 equipment is RCA's latest Color Studio Camera, TK-41. This equipment consists of a complete color camera chain including color camera, viewfinder, camera control, processing amplifier, color monitor, colorplexer and necessary rack mounted equipment.

It provides the ideal "minimum" setup for live studio color and may be added to plan #1 and #2 facilities. When this is done, the station can program from four different sources (1) network (2) films and slides and (3) studio. The arrangement of a plan #3 station is shown pictorially and functionally in Figs. 13, 14 and 16.

TV stations desirous of installing plan #3 live facilities, ahead of the film facilities of plan #2, can do so anytime after the color bar and local origination (sync generator) equipment of plan #2 is installed. This is mentioned since some stations may choose to start programming with live color spots and commercials in the studio as a continuous part of the regular live show—and add film facilities later. Either way, plans #2 and #3 comprise both logical and economical additions.

It is true that stations do not need elaborate live studio setups to accommodate the color camera chain of plan #3. This camera chain is identical in every respect with those used in the largest multiple camera setups. Thus the station starting with just one studio camera is nevertheless assured of the very highest quality, and has assurance of being able to add more cameras as desired without obsolescence of any previously purchased equipment.

TK-41 COLOR CAMERA

The TK-41 color camera (Fig. 15) is all-electronic, and employs the latest in circuitry such as the unique processing amplifier which has resulted in compact auxiliary equipment, improved operating stability and economical operation.

The color camera chain is similar in many respects to monochrome camera chains now in use in that it contains a live pickup camera as well

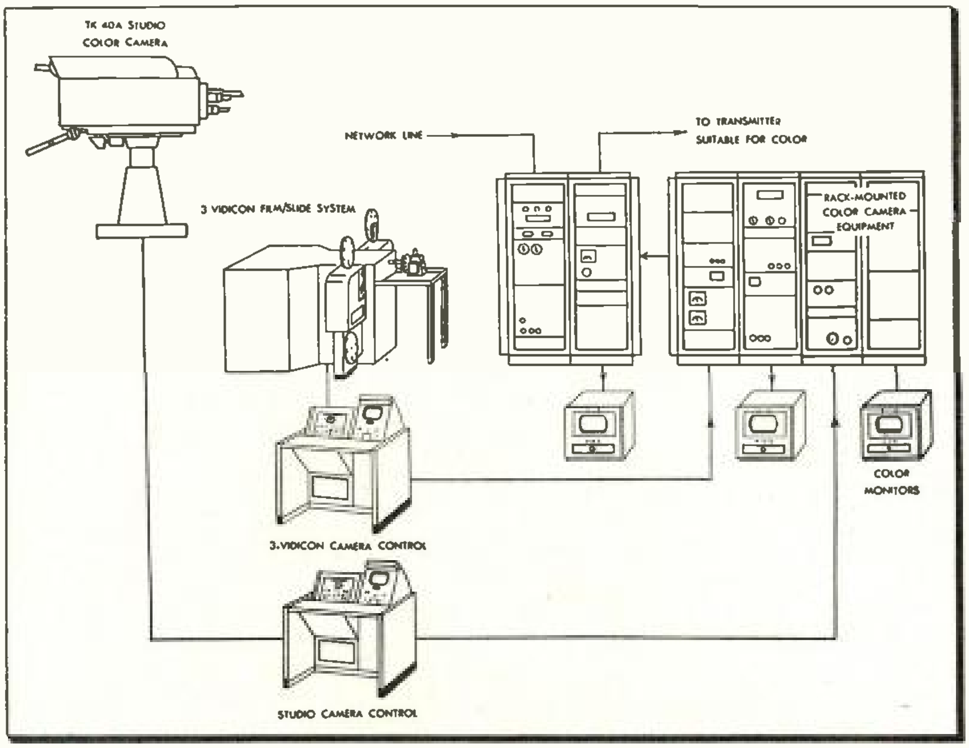


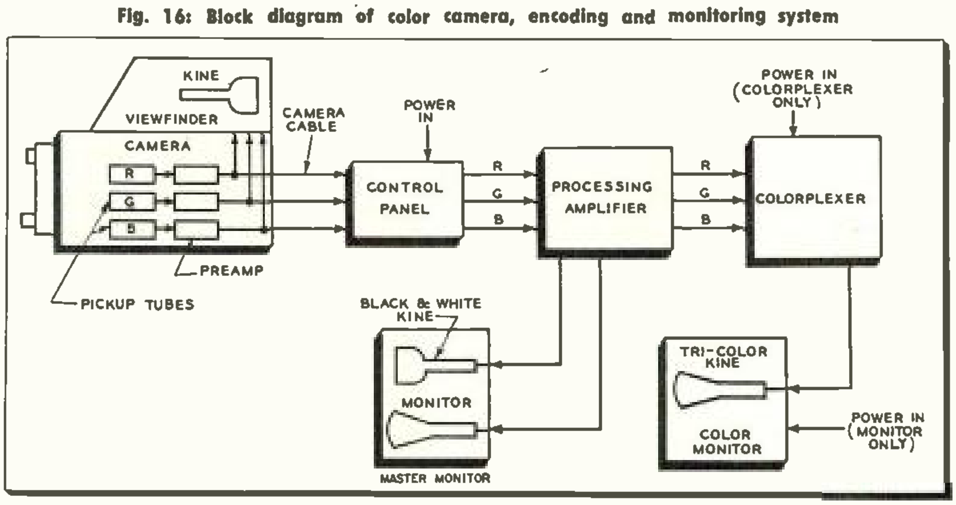
Fig. 13: Minimum equipment for originating live colorcasts from studio

as signal processing and control units. The principal components of the TK-41 color studio camera chain enumerated previously are shown in the block diagram, Fig. 16. The line-up features considerable space and cost saving advantages over previous color chains.

As in the standard monochrome camera, the optical system, the deflection circuits, the pickup tubes and the preamplifiers are located in the three-tube color camera. The turret on the camera is designed to accommodate four standard television lenses (the same as those used on monochrome cameras).

The color camera proper contains a light splitting optical system and three separate image orthicon tubes to provide red, blue, and green signals, three video preamplifiers, hori-

Fig. 16: Block diagram of color camera, encoding and monitoring system



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zontal and vertical deflection circuits for the image orthicons, and power supplies for these deflection chassis. A selsyn-operated iris control is also part of the optical system and serves as a gain control as well. The electronic viewfinder is comprised of a 7TP4 kinescope with necessary deflection and video circuits to provide a picture for the camera operator. The plug-in video preamplifiers and the deflection circuits are arranged for accessibility, ease-in-operation and maintenance.

The camera proper, with attached viewfinder can be mounted on the TD-4A studio pedestal similar to that used for monochrome cameras. The weight of the camera is accurately balanced on a new heavy-duty cradle-type tilt-head (Fig. 15).

Fig. 15: Color camera on cradle tilt head

This enables it to be panned and tilted in any direction.

VIEWFINDER

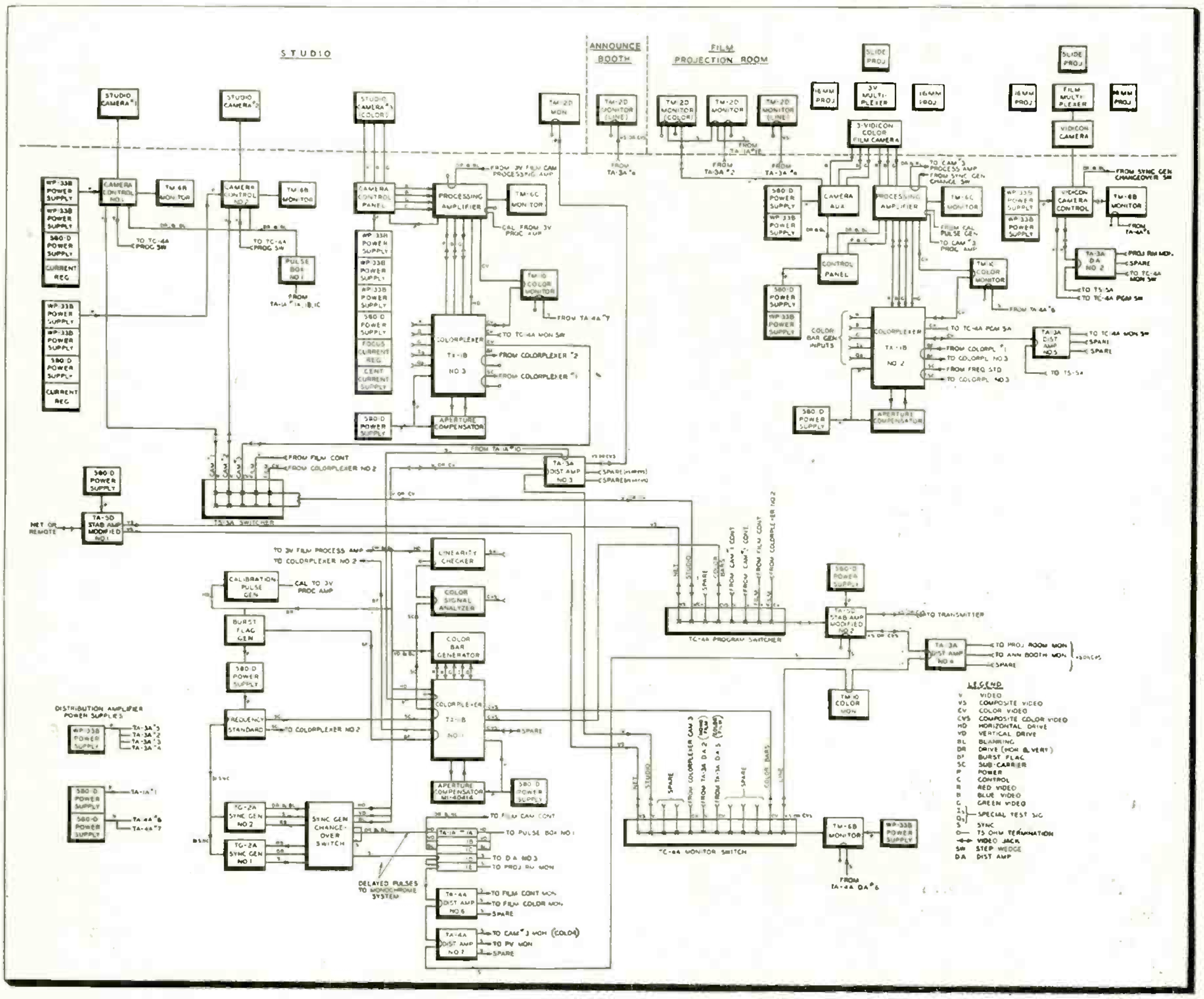
The viewfinder provides the cameraman with a high quality monochrome picture on a seven-inch kinescope for checking picture composition and optical focus during operation. The camera registration may be checked at the camera position since it is possible to view the primary color picture signals, both separately or in various combinations on the viewfinder.

STUDIO CAMERA CONTROL

The studio camera control equipment is similar to the film camera control supplied in plan #2 and includes the same processing amplifier and master monitor. Mechanically, this equipment is housed in two console housing units and may be mounted next to the film camera control to form a single console, if desired. The advantages of standardization such as common tubes, panels and circuits are realized.

Electrically, the three video signals from the camera are fed directly to the camera control panel on which both operating and selected set-up controls are located. These signals are fed in turn to the processing amplifier which performs the functions of cable compensation, video amplification, blanking and shading insertion, feedback clamping, linear clipping, gamma correction, and output amplification as well

Fig. 14: Combined functional diagram of Plan #3 station with facilities for color program switching



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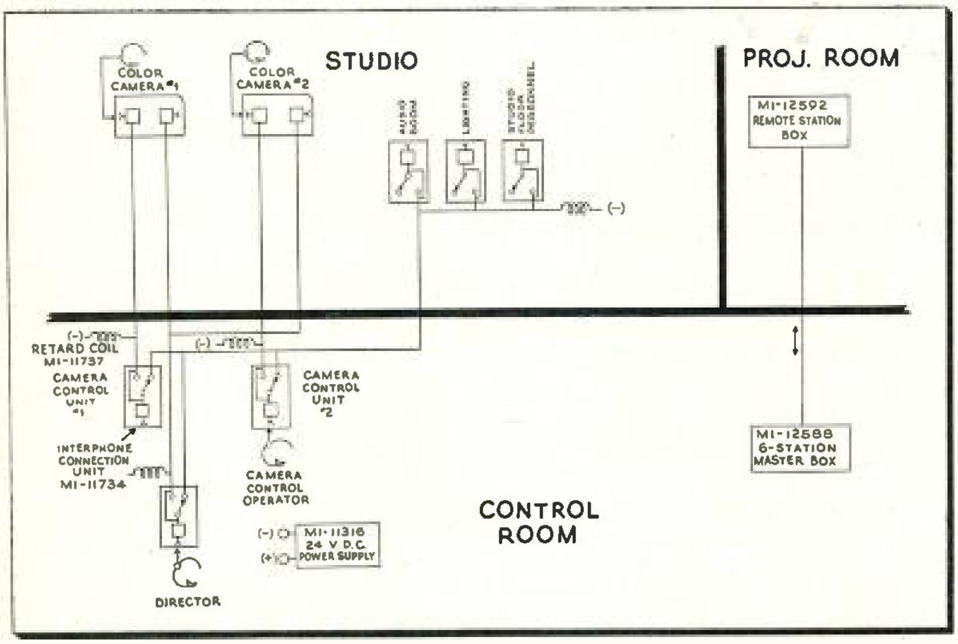


Fig. 17: Intercom arrangement connecting color studio, projection and control rooms

as providing auxiliary switching for the master monitor. The processing amplifier was previously described in detail in plan #2 and will be only briefly mentioned here. It is perhaps important to point out that the processing amplifier now takes the place of numerous rack equipment items formerly required to perform the functions mentioned above.

It feeds a master monitor, which provides both kinescope and CRO displays of the processed camera signals, and a colorplexer, which combines the processed video signals into a single FCC standard color signal. The colorplexer feeds a tricolor monitor so that the color picture may be viewed by the video operator.

MONITORING

In plan #3 (as in plan #2) a monochrome master monitor (TM6-C) and a color monitor (TM-10) are furnished. The master monitor which is mounted in the console housing permits the checking of levels of individual color signals and camera registration. The color monitor is a separate unit and may be mounted in a rack, suspended, or placed atop the flat deck of the control console. Since both camera control operators and directors need to see the monitor it should be placed at some such vantage point.

COLORPLEXER AND RACK EQUIPMENT

The colorplexer, distribution amplifier, aperture compensator and miscellaneous power supplies are the plan #3 items usually rack mounted. All of the equipment requiring rack mounting can easily be accommodated by the two racks furnished.

The colorplexer operation is similar to that previously described in plan #2. The R, G and B signal outputs of the studio color camera are fed into a colorplexer, just as are

Fig. 18: Control console with color monitors

the outputs of the film camera. A colorplexer is supplied as a part of each camera chain. The video signal from each chain is an independent and compatible color signal. The color bar generator is used to align the colorplexer which can also be adjusted for perfect matrixing. Using this adjustment as a reference, and color monitor for observing, the elements of the camera chain can be lined up for the best possible picture. An aperture compensator, a 2" high unit, is mounted above the colorplexer and connected to function as part of the colorplexer's luminance channel.

STUDIO CONTROL ROOM CONSIDERATIONS

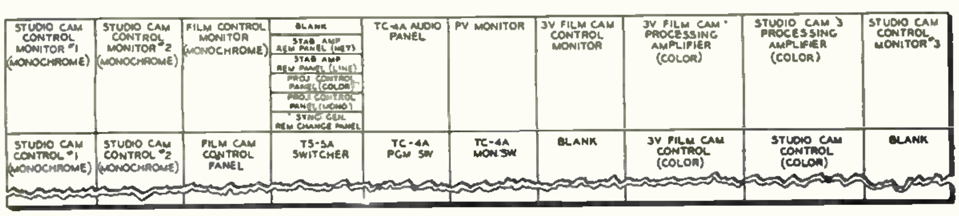
Just as in monochrome TV, the color TV control room requirements of stations will vary with (a) size of station and number of cameras and studios, (b) the desires of the particular station programming staff and most important of all (c) existing space conditions. Most stations installing color have been able to solve their space problems satisfactorily. Color gear does take up more room and will add up to 2 racks for plan #1, up to 2 more for plan #2 and again 2 more for plan #3. A two-section film control console is added in plan #2 and another two-section camera control unit for plan #3.

Color monitors are also added as required (at least one for each new program source). See Fig. 18.

The color camera, of course, should be kept carefully adjusted in order to maintain good color balance where more than one camera is used. Proper control of the camera is simple and straightforward. Once initial set-up is completed only two operating controls are needed: (1) remote iris control used as a master gain control and (2) master pedestal control which causes all three pedestals to track up and down together. Station operators and engineers will find it easy to master these color television controls. Certainly, familiarity with monochrome camera control will be a great aid. In setting up the color camera the operator must use three separate sets of controls, those required for red, green and blue signals. While the video operator sees the picture in black-and-white on the camera control monitor, he may select a black-and-white presentation, a separate red, green or blue signal or combinations of these signals (red plus green, green plus blue in addition to red plus green plus

(*Continued on page* 116)

Fig. 19: Panel arrangement of equipment, including monitors, amplifiers and controls



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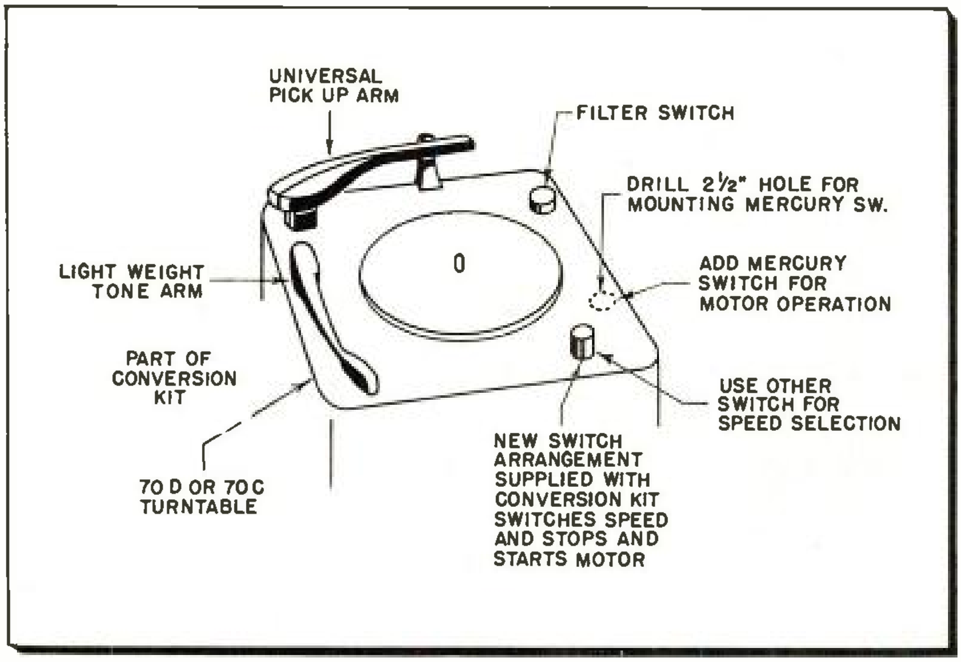
CUES for BROADCASTERS

Practical ways of improving station operation and efficiency



Extra switch on transcription turntable aids operation after 45 rpm conversion

Ribbon Microphones

DONALD M. WHEATLEY, Chief Engineer, WJOY, Burlington, Vt.

IF you are wondering why your ribbon microphones are going bad you might be interested to learn that low flying jet aircraft flying over WJOY damaged at least six of our ribbon microphones by stretching out the ribbons!

Extra Switch on Turntable

HAROLD GILBERT, WCRK, Morristown, Tenn.

AFTER converting one of our 70D turntables to 45 RPM operation the new switching and speed selection arrangement was quite inconvenient to use. Turntable operation was much smoother after the following simple addition was made to the turntable.

When making the conversion to 45 RPM don't discard the old mercury switch. Drill another hole in the turntable top along side the old hole where the new speed selector and switch arrangement is mounted. Mount the old mercury switch in this new hole using the switch plate from the old installation. Connect the AC leads. Now there are two switches, one for speed selection, the other for the turntable motor operation.

This arrangement has proven far superior in turntable operation over the speed and switching operation using only the one switch supplied with the Conversion Kit. The Micro switch supplied with the kit should be removed to eliminate the possibility of mechanical clicks.

45 RPM Turntable

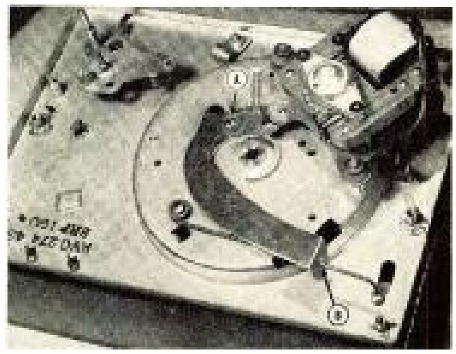
DAVIS E. WILSON, WKKO, Cocoa, Fla.

WITH some conversion the small RCA 45 rpm changers can be used for broadcast work. The wow and rumble can be held to very acceptable values by weighting the table with a 6-in. diameter plate of metal ¼ in. thick. This can be turned from brass by a machine shop if you are particular. We melted solder in an aluminum pie pan of the correct diameter, removed it when it cooled, and cut a hole with a Greenlee punch at the point where it balanced on a nail.

In order to protect the idler wheel from "flats" and allow the turntable to be completely freed for cueing, a leverage system was installed to retract the idler from the motor and the turntable. A separate motor switch was installed on the side of the case with a neon pilot light to indicate when the motor is running. With the motor running, even a weighted turntable will get up to speed in less than a quarter-turn when the idler is engaged.

The changer can be obtained from a local dealer, sometimes for very low cost if you return all the removed changer parts to him for use in repairing other changers. The ceramic cartridge may be replaced with a GE cartridge by using a knife and soldering iron to remove any obstructing plastic from the arm, and replacing the spring counterweight with a piece of one of the stronger springs removed from the changer.

Disassemble the changer completely, taking care not to lose the washers or small bearings at the base of the turntable, and drill two holes for 6-23 screws at the two pivot points. Each screw will be inserted first through a wide, flat washer to hold the lever arms, and then through a small lock washer (or washers) about which the arms pivot; thence through the chassis,



Modified small 45 rpm turntable

and secured with a nut on the top side. It should be possible to place those pivot points with sufficient accuracy by studying the photograph closely. The curved lever arm can be cut from sheet aluminum from an old transcription. At the pivot point "A" drill a hole just large enough to accommodate a small lock washer that is not much thicker than the aluminum. At point "B" drill a hole just large enough to admit a

(*Continued on page* 126)

$$$ FOR YOUR IDEAS

Readers are invited to contribute their own suggestions which should be short and include photographs or rough sketches. Typewritten, double-spaced text is requested. Our usual rates will be paid for material used.

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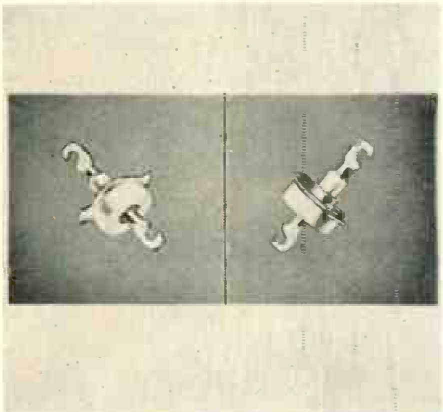
New Electronic Products at

Technical resumes, illustrations and booth numbers

Booth 794 — Feed-Thru Capacitors

Disçoidal feed-thru capacitors do not exhibit parallel resonance effects that produce high "coupling impedances" at frequencies of 1,000 MC or less. Absence of these effects, and relatively high



capacitance values with low coupling impedances, make the discoidal feed-thru capacitors suitable for UHF-TV receiver applications. These tiny units are currently available with capacitance values between 1,000 and 2,000 µµf for all usual operating temperatures. **Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee 4, Wis.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-21)

Booth 666-668 — Controllable Inductor

The LP series controllable inductor uses a direct current to control the inductance of a signal winding suitable for high frequency circuits. A reduction of more than 5 to 1 in distributed capacity of the signal winding results from the new yoke configuration. This latter improvement and improved core

materials minimize variation from unit to unit. The LP series controllable inductor is designed for operation up to 1.0 MC **C.G.S. Laboratories, 391 Ludlow St., Stamford, Conn.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-13)

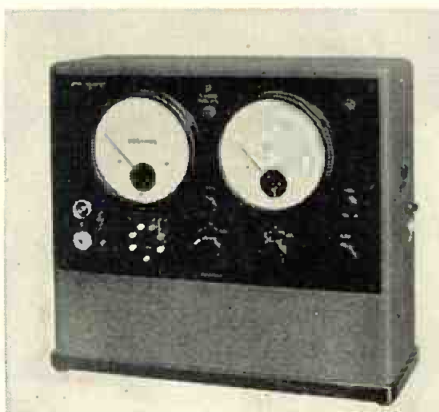
Booth 763 — Panel Meters

A line of 1½ in. ruggedized miniature panel meters, Model 163, meets the requirements of Specification MIL-M-10304 (Sig. C.) with ranges of 0-100 dc µa, 0-1.0 dc ma, and 0.10.0 dc mv.

Passes rigid moisture resistance, water tightness, thermal shock, tumbling and high shock tests; and the salt spray Specification QQ-M151A. Designed for a dielectric strength of 1,500 v. RMS. Operates over the temperature range −55°C to +85°C. **International Instruments, Inc., 486 Derby Ave., New Haven, Conn.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-18)

Booth 877-893 — "Tera-ohmeters"

A line of insulation measuring instruments—"Tera-Ohmmeters"— having a maximum sensitivity of 500 tera-ohms is produced by R. Jahre, West Germany instrument maker. Various types are available with sensitivities from 0.2 megohms to 500 x 10^{12} ohms and provide fixed test voltages of 10, 100, or 500 v.



One model has a variable test voltage from 100 to 1,000 v. Samples can be measured grounded, ungrounded, with guardring electrodes. **Instrument Div., Federal Telephone and Radio Co., Clifton, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-19)

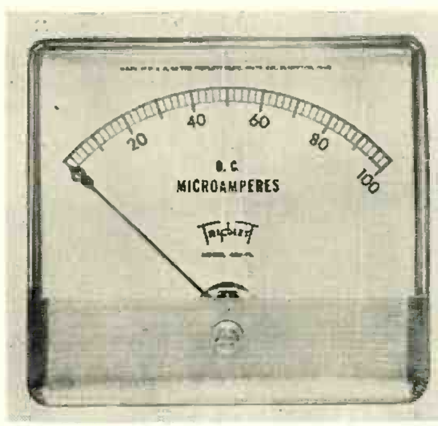
Booth 278 — Panel Instruments

A complete line of precision reference standard panel instruments are available that include curved face edgewise panel type current meters, voltmeters, wattmeters, thermocouple in-

struments, differential galvonometers. Accuracies, 0.5 of 1% and 0.25 of 1%, depending on desired sensitivity. DC current, 4 µa, voltage 2 mv. AC current 2 ma, voltage 200 mv. Full scale. Scale length, Type EW case, 5 in., Type JW case, 4 in. **Sensitive Research Instrument Corp., 9-11 Elm Ave., Mt. Vernon, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-22)

Booth 217-219 — Panel Meter

A new panel meter added to the 4-in. line, the Model 420 PL, combines a plastic case with a model base. The case front projects over the rim of the instrument and gives a longer scale length and easier readability. Mounts on studs inserted through the panel. Available in two basic types, dc perma-



nent magnetic moving coil, and ac iron van. Full open dial. Designed to enable imprinting customer's trade mark. **Triplett Electrical Instrument Co., 122 Main St., Bluffton, O.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-20)

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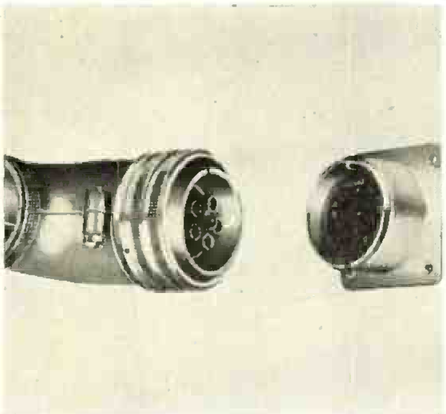
for products to look for at this year's show.

Booth 628 — Connector

The PM6/HV, six-contact, high-voltage, miniature connector features a one-piece molded mineral-filled melamine insert body designed to fit standard AN 20 shells. Plug and recep-



tacle halves assembled in any 3100 to 3108 solid or split shells required. Contacts are rated at 5 amps. Solder cups for No. 20 AWG wire. Gold plated over silver. Weight of plug insert 0.4 oz., receptacle insert, 0.3 oz. Voltage breakdown, sea level, 6,800 v dc; 60,000 ft. alt., 1,400 v dc. **Winchester Electronics, Inc. Dept. M, Norwalk, Conn.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-17)

Booth 309 — Frequency Standard

The Model 620 frequency standard can deliver up to 5 v. at a precise frequency of 60 to 120 CPS (factory set within ± 0.01%). Other precisely set frequencies supplied on request. Temperature variations from —40°C. to +85°C. or line voltage variations from 105—125 v. will affect frequency of

oscillation by less than ±0.01%. Output distortion is less than 1%. Dimensions: 9 x 15 x 8 in. Weight, 17 lb. **Industrial Test Equipment Co., 55 E 11th St., New York 3, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-11)

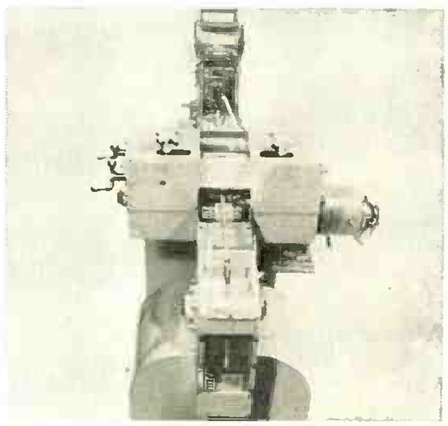
Booth 614 — Amplifier-Gain Control

The Model MLA all-channel TV amplifier and the Model MAGC automatic gain control comprise all essential features necessary to install and operate large or small TV systems. The

amplifier provides more than 37 db gain over the entire VHF band. Frequency response is flat within ±½ db over any 6 MC channel and within 2 db over either high or low VHF band. Constant output levels can be maintained with the auxiliary AGC. **Blonder-Tongue Laboratories, Inc. Westfield, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-12)

Booth 553-555 — Lead Cutting Machine

Model LCM-2 cuts resistor leads at full production rate of 33,000/hr.; but, a conservative rate of 20,000/hr. provides time for lead-length variation adjustments and material handling. For ½ w. fixed composition resistors with nominal diameters of 0.125 or 0.140.



Gives cut lead lengths of 3/16 in. from resistor body to the resistor lead end. Motor, ¼ hp., 110 v., 60 cps. Requires 40 to 60 lbs. air supply. **International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-16)

MORE TECHNICAL INFORMATION
describing the new products presented here may be obtained by writing on company letterhead to New Products Editor, TELE-TECH & ELECTRONIC INDUSTRIES, 480 Lexington Ave., New York 17, N.Y., listing numbers given at end of each item of interest. Please mention title of position held.

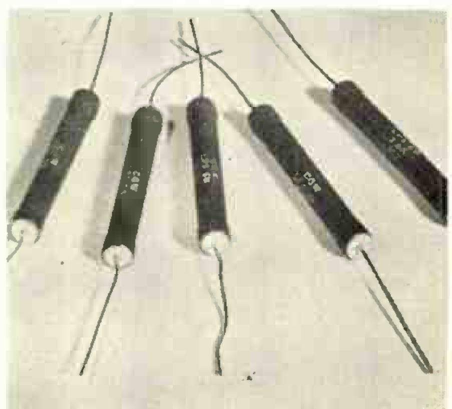
Booth 711 — Power Monitor

Model 164, bi-directional power monitor, operates at all frequencies from 25 to 1,000 MC. Employs only two plug-in elements for coverage, respectively, from 25 to 250 MC and 100 to 1,000 MC.

Both inserts have direct reading full scale power ranges of 10, 50, 100, and 500 watts. Accuracy is ±5% full scale on all ranges and frequencies. VSWR is less than 1.08. No auxiliary power is required. Can be equipped with most connectors used with 50-ohm lines. **Sierra Electronic Corp., 1050 Brittan Ave., San Carlos 2, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-14)

Booth 397-494-495 — Resistor

The LP-5 low power glass resistor is a 5 w. unit available in ratings from 200 to 60,000 ohms. The second in a projected line of low-power resistors, the unit is made of a metallic oxide film permanently bonded to "Pyrex" glass rod. Tolerance is ±10%, but 5% is available at a slightly higher price.



Power rating is based on 40°C. ambient temperature and an average hot spot of 240°C. Well-designed for color TV and applications requiring low-cost power. **Corning Glass Works, Corning, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-15)

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IRE Exhibitors' New Products

Booth 360-362 — Transistors and Controls

Six of the Minneapolis-Honeywell Regulator Co., participating divisions feature a new magnetic null indicator, a new tubeless data transmission system for testing and monitoring, a two-stage 400 CPS magnetic servo amplifier, a selected range amplifier and a dc indicating amplifier. Also exhibited is the Model 700-C recording oscillograph—an improved dynamic testing instrument, a new thermistor level switch, a jet engine temperature indicating system, and the E-10 electronic autopilot. Shown, too, is a new line of illuminated, push-button, snap-action switches and a number of new multi-circuit assemblies incorporating subminiature snap-action switches. The company's power-type transistors are also on display. **Minneapolis-Honeywell Regulator Co., 2747-53 Fourth Ave., S. Minneapolis 8, Minn.** TELE-TECH & ELECTRONIC INDUSTRIES.

Booth 634 — Miniature Transformers

Displayed are miniature transformers that are typical of the stock items described in the Microtran 1955 catalog. Also shown is a hermetically-sealed "Veri-Miniature" transformer 0.60 in. in diameter, 13/16 in. high—said to be the smallest micro-miniature unit available. **Microtran Co., 2117 Mott Ave., Far Rockaway, N.Y.** TELE-TECH & ELECTRONIC INDUSTRIES.

Booth 273-275 — Power Tubes

Triodes, new 15 kw industrial r-f amplifiers and oscillators, air-cooled and water-cooled, Types 6617 and 6618. Magnetrons, new small, light-weight, packaged, tuneable Types 6229 and 6230. Transmitting and power tubes, rectifiers, thyratrons, Hi-Fi tubes, ignitrons, Geiger tubes, germanium diodes, and junction transistors. All products on display. **Amperex Electronic Corp., 230 Duffy Ave., Hicksville, N.Y.** TELE-TECH & ELECTRONIC INDUSTRIES.

Booth 152-154 — TV Equipment

GPL shows three separate lines of TV equipment; a line of studio and field equipment for commercial use, a new projection system for hotels, schools, hospitals, and closed circuit programs, and a new industrial TV camera chain. **General Precision Laboratory Inc., Pleasantville, N.Y.** TELE-TECH & ELECTRONIC INDUSTRIES.

Booth 560-562 — Coil Winder

No. 107 a fully automatic winder for producing paper insulated coils in multiple with electronic speed control will be shown by **Universal Winding Co., P.O. Box 1605, Providence, R. I.** TELE-TECH & ELECTRONIC INDUSTRIES.

Booth 216 — Transistor Equipment

Displayed will be test equipment, transistor comparison, Model TT-11A. Transistor supply, high-power Model 30. Transistor amplifiers and transistor controlled, packaged magnetic amplifiers. **Electronic Research Associates, Inc., P.O. Box 29, Caldwell, N.J.** TELE-TECH & ELECTRONIC INDUSTRIES.

Booth 352 — Transmission Lines

The new air dielectric, flexible 1⅝ in. "Heliax" transmission line is seeworthy. **Andrew Corp., 263 E. 75th St., Chicago 19, Ill.** TELE-TECH & ELECTRONIC INDUSTRIES.

Booth 44 — Materials

Silver and silver alloys used for electrical and electronic purposes.—**Handy & Harmon, 82 Fulton St., New York 38, N.Y.** TELE-TECH & ELECTRONIC INDUSTRIES.

Booth 796 — Diodes and Transformers

Exhibited is the new line of grown junction silicon power diodes—a new line of 15 high voltage units. Also displayed are 32 standard models of subminiature (transistor) transformers, and a new line of glass-encased, high voltage capacitors. A new line of subminiature pulse transformers is introduced also. **Texas Instruments Inc., 6000 Lemmon Ave., Dallas 8, Texas.** TELE-TECH & ELECTRONIC INDUSTRIES.

Booth 533-535 — Panel Instruments

In addition to a new line of instruments with "Cormag" self-shielded mechanism, a new miniature clamp volt-meter and a new line of TV test equipment to simplify and speed servicing and alignment are among the items on display. Also shown, is the "Inductronic" line for precision measurement and control, an integrating fluxmeter, a product resolver, and a multi-range dc amplifier. **Weston Electrical Instrument Corp., Newark 5, N.J.** TELE-TECH & ELECTRONIC INDUSTRIES.

Booth 115 — Fasteners

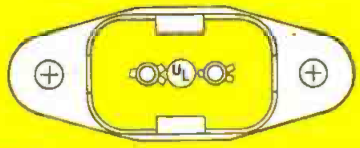
SPS visitors not only will see the company's fasteners used by the electronic industries, but will receive several useful gifts and samples. Available is a pocket-size calculator that determines the dimensions of each "Unbrako" socket screw; a "Flexloc" clinch nut and an attractive key chain tag. There is also a key tag with a socket set screw, and a small card to which is attached a plastic bag of samples containing SPS fasteners most used in the electronic industries. **Standard Pressed Steel Co., Jenkintown, Pa.** TELE-TECH & ELECTRONIC INDUSTRIES.

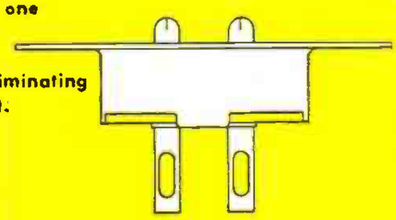
Booth 221 — Pulse Generators

Equipment on display: Pulse oscillator, direct indicating from 100 CPS to 3.3 MC, Model 3420A. Variable pulse generator, for variable delay and width pulses at repetition rates up to 330 kc, Model 4120A. **Electro-Pulse, Inc., 11811 Major St., Culver City, Calif.** TELE-TECH & ELECTRONIC INDUSTRIES.

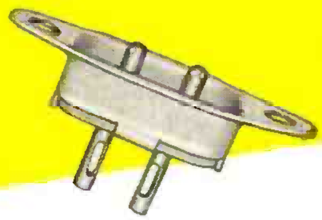
TV 110 VOLT DISCONNECT PLUG:

... one piece pin with solder tail is featured in the 110 volt TV lead in. Underwriters approved. Eliminates intermittents. The new one piece pin with solder tail insures positive electrical flow through plug to set by eliminating old style pin-lug riveted joint.



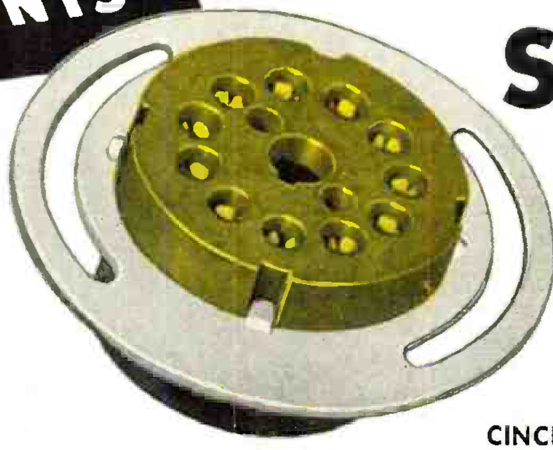


Saves scarce materials . . . eliminates one piece of insulation and two soldering lugs. Saves solder and soldering operations.



Cinch ELECTRONIC COMPONENTS

KINESCOPE SOCKETS

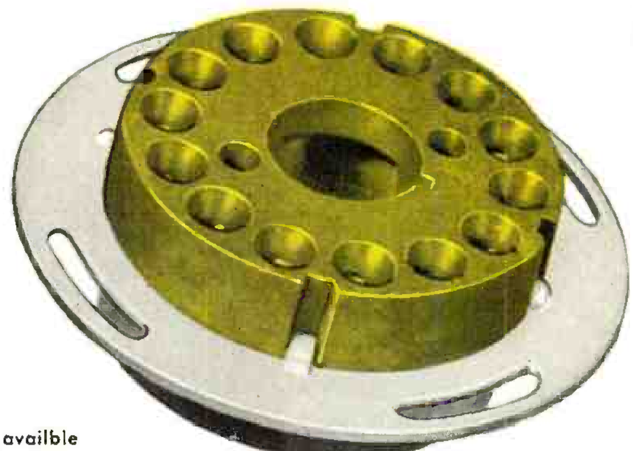


QUANTITY PRODUCTION OF LOW LOSS MICA COMPONENTS

Finest molding machines and equipment operated under most experienced guidance and engineering supervision with adequate and unequaled facilities has advanced CINCH to the foremost in production of low loss Mica components in quantity.

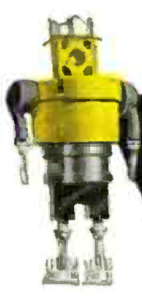
. . . Magnal and Diheptal; molded of high dielectric black or low loss mica-filled phenolic material. Full floating CINCH solder coated phosphor bronze contacts insure easy insertion of tube and provide excellent electrical connections.

Consists of main casting with required number of contacts assembled. Insulator is assembled in position but not fastened. Supplied with two screws, two nuts and two lock washers. Available with .062 steel mounting ring as shown.



Cinch components are availble at leading electronic jobbers—everywhere.

Cinch automatically assembled parts assure the uniformity and quality mandatory for use in AUTOMATION in the end users equipment.



Cinch ELECTRONIC COMPONENTS

CONSULT CINCH!

CINCH MANUFACTURING CORPORATION

1026 South Homan Ave., Chicago 24, Illinois

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

For product information, use inquiry card on last page.

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WASHINGTON
News Letter

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

SUBSCRIPTION TV—By early May the FCC will have advanced another step in its consideration of a regulatory blueprint for the establishment of subscription television with the submission of comments on the legal and public interest questions involved in this service. The FCC called for these comments to be filed by May 9 on its proposed rules to create this service on a regular public operating basis. Citing that the service proposed by the Zenith Radio Corp. and Skiatron TV, Inc., called for detailed and careful consideration, the FCC requested legal views on whether subscription TV should be considered broadcasting or a "common carrier or other type" service; whether the FCC has authority to permit use of channels assigned to television broadcasting; and, if the FCC does not have authority to authorize or regulate the service, what amendments to the Communications Act would be required to permit subscription TV's establishment. Objection to the immediate authorization of subscription TV has been made by the NARTB.

MOBILE RADIO SURVEY—The nationwide survey of mobile radio services—public safety, industrial and transportation—which was begun a year ago in cooperation with the Radio-Electronics-Television Manufacturers Association, has been completed by the FCC. More than 11,000 licensees in the mobile radio services returned to the Commission completed questionnaires on the equipment in use and the conditions under which their respective services are being operated. The replies covered the operation of about 325,000 transmitters out of a total of 433,000 authorized by the FCC.

VIEWS OF FCC CHIEF—FCC Chairman George C. McConnaughey in his confirmation hearings before the Senate Interstate & Foreign Commerce Committee expressed the view that settlement of the ultra high frequency television problem is possible by the Commission and that increases in power of UHF stations may be "very helpful." He proposed that the FCC should consider rule-making for de-intermixture (of VHF and UHF outlets in the same market areas) on a selective basis. The FCC chieftain also told the Senate body that there had been close cooperation between the Commission and government agencies using radio frequencies, such as the military services, and expressed the view that he did not know whether the military has too much in the VHF spectrum area "tied up." Senate Committee Chairman Magnuson (D., Wash.) commented that maybe his Senate body should try and find out if the military has taken over too much of the spectrum space which could be available for television.

MOBILE RADIO BACKLOGS—Intensified efforts by the FCC to expedite the processing of mobile radio services' station construction permits and licenses was indicated by FCC Chairman McConnaughey in his Senate hearings. He cited that the backlogs in the safety and special radio services have increased, but by July 1 he forecast that the Commission will have decided more cases than in all of the last fiscal year which in the government begins each July 1. The FCC chieftain stressed to the Senate committee that because the Commission "was charged with the job of getting television to the people" it had given priority and concentrated attention during the last fiscal year and up to the present time to the handling of station expansion.

DROP BARRIERS—In order to loosen the procedural dam which has been holding back a flood of new special industrial radio service users, spokesmen for that service told six FCC Commissioners in a two-day oral argument that its proposed special industrial radio service rules should be relaxed with attention given to frequency assignments and usage so as to permit the healthy growth of this field. One spokesman emphasized his "confidence" in the radio equipment manufacturers to "come through" when engineering developments are needed to make room for future radio growth.

MANUFACTURERS RADIO—The Office of Defense Mobilization, the paramount government agency in defense mobilization planning, has been analyzing the plan of the National Association of Manufacturers' Committee on Manufacturers Radio Use for the utilization of a large portion of the unused FM broadcasting frequencies for that service. The ODM is understood to have expressed a keen interest in the plan for the expansion of manufacturers' radio operations which could be increased through this added spectrum space as important to both defense production and civil defense.

LOWER TARIFFS—To provide greater flexibility of network radio programming, and to meet the developing requirement of some customers for less than 16-hour daily service, the American Telephone & Telegraph Co. Long Lines Department has filed revised tariffs cutting the minimum daily service period to eight hours from sixteen for schedule A program transmission with the FCC. Under the proposed revision, filed to become effective April 1, eight hours of daily use would be offered at monthly contract rates of $4.50 per mile, compared with the present $6 for a 16-hour minimum. The rates for additional consecutive hours are 25 cents each per mile per month, from eight to eleven hours, and 15 cents each from 12 to 16 hours, so that a network using a 12-hour daily service period would pay $5.40 per mile.

National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington Editor

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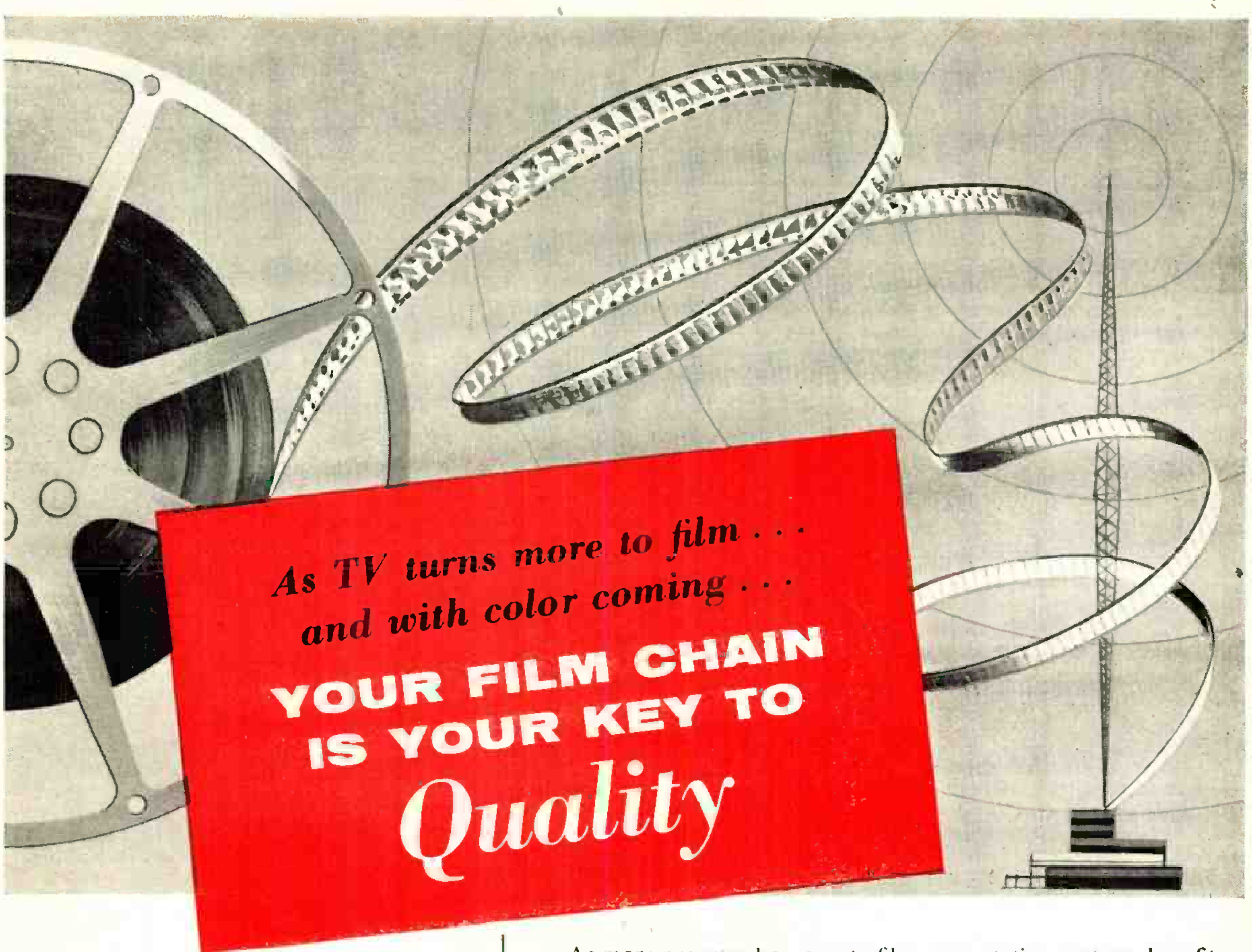

YOUR ADVANTAGE IN GPL PRODUCTS

GPL film equipment for television broadcasters is backed by more experience in motion picture equipment than any other supplier to the industry. GPL is part of the General Precision Equipment Corporation family, famous in motion picture equipment fields for Simplex commercial projectors and Ampro home projectors.

Through the GPE policy of coordinated precision technology, GPL's own capable staff is re-inforced with the technical know-how and facilities of its affiliates.

The results of this are known to the industry in the unique and widely accepted GPL 16 mm video recording camera, the GPL 16 mm and 35 mm monochrome telecine projectors, and now, superior color broadcast equipment.

As more program hours go to film, your station costs and profits will depend directly on your film equipment.

Right now — and the sooner the better — it will pay you to sit down with GPL engineers and discuss your film transmission problems. Here are the questions that confront you.

What are your maintenance costs? Operational efficiencies? Reliability? And, for your advertisers and audience — Quality?

And equally important — how does your present equipment fit into future plans? Color is coming. Will you be caught with your plans down?

GPL engineers will tell you about a new three-point long-range plan. It includes:

Iconoscope conversion
New Vidicon chains
Build-up for color

Start your survey today, of future needs. And call, write, or wire GPL for engineering consultation.

GPL

General Precision Laboratory
INCORPORATED
PLEASANTVILLE NEW YORK

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

Regional Offices: Chicago • Atlanta • Dallas • Pasadena

For product information, use inquiry card on last page.

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IRE Exhibitors' New Products

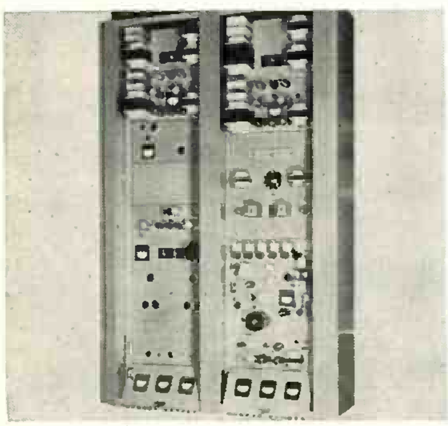
Booth 381-383 — Power Supply

The VFS-250 variable frequency power supply is a compact, self-contained, semi-portable source of 45 to 2,000 CPS ac with available output to 300 v. Voltage flexibility, frequency,

and power output make the frequency changer suitable for testing airborne electronic and electrical systems, synchro and selsyn equipment, servo amplifiers, transformers, inductors, and export equipment. Additionally, it is useful for powering choppers and controlling synchronous motors, etc. **Vectron, Inc., 408 Main St., Waltham, Mass.** —TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-23)

Booths 157-165 — VHF Transmitter

A new 50/100 watt TV transmitter, originally developed for Armed Forces overseas use at remote military stations, meets all FCC requirements and will furnish standard TV signal to small



areas—depending on terrain. Transmitter is 50 in. wide, 84 in. high, and 21 in. deep. A companion TV ring antenna has been developed for use with this low powered TV transmitter. **Gates Radio Co., Quincy, Ill.** TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-25)

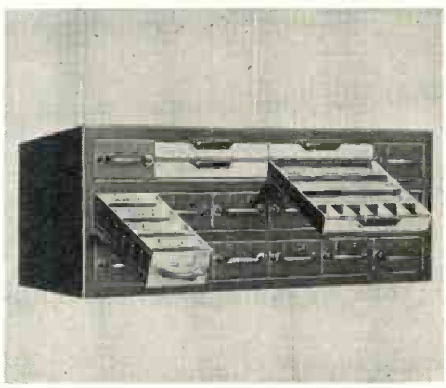
Booth 75 — Capacitors

Models 620S and 621S dielectric capacitors incorporate the humidity resistance of "Seramelite" capacitors and the electrical characteristics of "Mylar." Miniature in size, the units are

available in extended foil or inserted tab construction. Operating temperature is − 55°C. to + 125°C. Both models exceed RETMA specification REC 118-A and are available for standard printed circuit or specialty applications. **Good-All Electric Manufacturing Co., Good-All Bldg., Ogallala, Neb.** —TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-27)

Booth 874-876 — Storage Cabinets

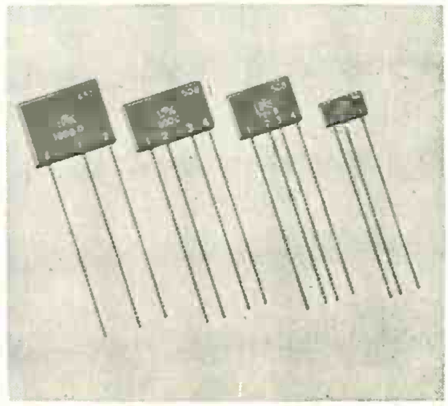
Six new storage cabinets combine drawers for different size small parts in a single unit. Parts can range in size from radio tubes and flashlight batteries down to watch parts. No. 8505 small parts drawers measure 5⅝ x 11 x 3⅛ in. and are regularly furnished with 2 flush-fitting adjustable dividers. The "Little Gem" small parts drawers



measure 11 x 11 x 1¼ in. and have 28 adjustable compartments. Any 2 of the latter are interchangeable with the former. **Equipo, Div. of Aurora Equipment Co., Aurora, Ill.** TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-24)

Booth 553-555 — Printed Circuits

Molded printed electronic circuits, designated as Type MCR, offer excellent load life and noise characteristics, moisture resistance, and stable temperature coefficients. They are re-



portedly unaffected by vibration. Available in four standard sizes, these units are designed and packaged for automation with tapped or round wire leads. Resistances are 10 ohms to 10 megs at ± 20% tolerance. Capacitances are 5 μμf to 25,000 μμf at +50%, −20% tolerance. **International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.**—TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 4-28)

Booth 403-405 — Slip Ring and Brush

The "Makepeace" standard "off-the-shelf" slip ring and brush assembly is designed to meet a wide variety of electro-mechanical rotating devices. From 2 to 10 circuits can be obtained from one assembly, and two or more assemblies of 10 each can be stacked to produce a greater number of circuits. Currents to 20 amps and ex-

tremely low noise level make the units useful for strain gauges, telemetering, radar test equipment, etc. **D. E. Makepeace Co., Div. of Union Plate and Wire Co., Attleboro, Mass.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-26)

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Survey of

New Products of the Month

Capsule summaries of electronic developments provide handy reference for engineers seeking new equipment

POWER AMPLIFIER, Model UF-101, recently introduced by Krohn-Hite Instrument Co., 580 Massachusetts Ave., Cambridge 39, Mass., is an ultra-low 50 w. unit with only 0.005% distortion. (Ask for A-3-62)

FUNCTION GENERATOR, Model DEFG-201 Mod I, is a new 5-channel diode unit capable of generating a function of two variables with greater speed and precision. Made by Reeves Instrument Corp., 215 E. 91st St., New York 28, N. Y. (Ask for A-3-63)

PAPER TUBULAR CAPACITOR, STT Midget is a miniaturized version of the regular "Budroc" line of Cornell-Dubilier Electric Corp., S. Plainfield, N. J. The "Steatite" encased units range from 7/32 in. diam. and 11/16 in. length to ⅜ in. diam. and ⅛ in. length. (Ask for A-3-75)

P.A. AND SOUND SYSTEM CABLE. A new cable, "Belden" No. 8790, a balanced color-coded pair made by Belden Mfg., Co., 4647 W. Van Buren St., Chicago 44, Ill., features a new spiral-wrapped tinned copper shield and has a chrome vinyl plastic water jacket. O.D., 0.225 in. (Ask for A-4-1)

MINIATURE ELECTRIC RELAY, RCA-204W1, announced by Radio Corp., of America, Tube Div., Harrison, N. J. is a 26.5 v., six-pole, double-throw type for use in a wide range of critical applications. (Ask for A-4-2)

RECTIFIER, Type 8Y1, made by Semi-Conductor Div., Radio Receptor Co., Inc., 251 W. 19 St., New York 11, N.Y., is ½ in. cubed, and, in the control of a fence charger, delivers a measured shock of strong intensity, 0.004 secs. on.; 1.0 sec. off. (Ask for A-4-3)

PLIERS. The "Sta-kon Plus" pliers, WT-161, performs all the functions of an electrician's pliers and installs a wide range of terminals, splicers and wire joints, etc. Made by Thomas & Betts Co., 36 Butler St., Elizabeth, N. J. (Ask for A-4-4)

"SOLDER GUN," a magneto-restrictive transducer driven by an electronic generator, provides a fluxless soldering method for aluminum alloys, germanium, and other hard-to-solder materials. Alcar Instruments, Inc., 20-21 Wagaraw Rd., Fair Lawn, N. J. (Ask for A-4-5)

WAVEFORM MONITOR, Type TA-202-A, a multi-channel instrument, monitors simultaneously three color signals, red, green, and blue, and the encoded output of one color channel. Allen B. Du Mont Lab., Inc., TV Transmitter Dept., 1500 Main Ave., Clifton, N. J. (Ask for A-4-6)

LABELS. "Speedy-Marx" F.O.A. labels, announced by North Shore Nameplate, Inc., Bayside, L. I., N Y., are of pressure-sensitive tape made to government specification and mounted on fiber dispenser cards. Can be used on virtually any surface. (Ask for A-4-7)

TUNING DRIVE AMPLIFIER, ED-400, announced by Electronics Div., North American Phillips Co., 750 S. Fulton Ave., Mt. Vernon, N. Y. is for operation with "Norelco" ED-100 or ED-101 control panels. Mounts directly on radio compass AN/ARN-6. Eliminates AM-203/ARA-19 and mounting assy. (Ask for A-4-8)

KINESCOPE, RCA-5AZP4, announced by Radio Corp. of America, Tube Div., Harrison, N. J., is a 5-in. unit that produces black-and-white TV pictures up to 8 x 6 ft. when used with a suitable reflective optical system (Ask for A-4-9)

DIELECTRIC CAPACITORS, series 337 and 338, comprise a new line of miniature flat "Mylar" polyester film units recommended by Gudeman Co., 340 W. Huron St., Chicago 10, Ill., for high humidity applications operating from −55°C to 85°C and up to +125°C when proper voltage derating is applied. (Ask for A-4-10)

COMPUTER, Model 210-A, employing the "Regatron" control system, provides 0-3 amps at ±360 v. directly calibrated on a multi-turn dial, plus a 3 v. electrical vernier that permits fine control. Made by Electronic Measurements Co., Lewis St., Eatontown, N. J. (Ask for A-4-11)

CATHODES, A-30, A-31, A-32, and P-50, produced from nickel "Cathaloys" by Superior Tube Company, Norristown, Pa., are made from welded and drawn or mechanically-locked tubing in round, oval, and rectangular shapes. (Ask for A-4-12)

ADJUSTABLE SPEED DRIVES, Series 200 made by Servo-Tek Products Co., Inc. 1086 Goffle Rd., Hawthorne, N. J., are available in ¼ and ½ stock models with either 1800 or 3600 rpm as the base motor speed. (Ask for A-4-13)

MULTI-BAND FREQUENCY MULTIPLIER, Model 504C, a new exciter unit by Barker & Williamson, Inc., 237 Fairfield Ave., Upper Darby, Pa., covers the 80 through 10 meter bands. Nominal Power output, 25 w. (Ask for A-4-14)

PLUG-IN DELAY LINES, called "Pluglines" by The Jacobs Instrument Co., Bethesda 14, Md., are available in 186 types. Designed to change the value of a delay or impedance, for laboratory use, and prototypes. (Ask for A-4-15)

X-RAY SPECTROGRAPH. An automatic, multi-element indexing unit, the "Autrometer," gives percentages of as many as 12 elements in a specimen within 70 elements in the periodic table. Made by Research and Control Instruments Div., North American Phillips Co., Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y. (Ask for A-4-16)

SIGNAL GENERATOR. Model FS-1 generates 12 selected standard frequencies between 100 kc and 20 cps. Has long-time accuracy of 100 kc standard crystal of 20 parts/million over normal room-temperature ambient range. D&R, Ltd., 402 E. Gutierrez St., P. O. Box 1500, Santa Barbara, Calif. (Ask for A-4-17)

BROADBAND-PASS FILTERS. Five models, covering 650 to 13,000 MC, announced by Polarad Electronics Corp., 43-20 34th St., Long Island City 1, N. Y., feature sharp skirt selectivity. (Ask for A-4-18)

HERMETIC SEAL TERMINALS, introduced by Robco Mfg. Div., Pilot International Corp., 27-01 Bridge Plaza N., Long Island City, N. Y. are composed of "Steatite" insulators that compress a silicone rubber grommet to form a leak-proof header hole oil seal. (Ask for A-4-19)

H-PLANE FOLDED HYBRID T, invented and licensed by Hughes Aircraft Co., and introduced by Microwave Development Labs., 92 Broad St., Babson Park, Mass., is now available in production quantities in two classes of performance, standard and special, in the frequency range 8,500-9,600 MC for RG 52/U waveguide. (Ask for A-4-20)

LACING TAPE, trade-marked "Gude-lace-H" by the Electronic Div., Gudebrod Brothers Silk Co., 225 West 34th St., New York 1, N. Y., is a braided "Nylon" lacing tape with continuous or interrupted ties. Complies with fungus resistant requirements of JAN-T-713. Non-slip rubber coating. (Ask for A-4-21)

MORE TECHNICAL INFORMATION

describing the new products presented here may be obtained by writing on company letterhead to New Products Editor, TELE-TECH & ELECTRONIC INDUSTRIES, 480 Lexington Ave., New York 17, N.Y., listing numbers given at end of each item of interest. Please mention title of position held.

TERMINALS AND HEADERS. A new line offered by Hermaseal Co., Inc., Elkhart, Ind., includes both individual terminals and multiple electrode headers. Can be used as direct replacements in current and new designs. (Ask for A-4-22)

TUBELESS RECTIFIER, a new type of 25 kw rectifier power supply, announced by Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif., is rated at 230 v. dc output when operated from a 230 v. 3-phase. 60 cps ac input. (Ask for A-4-23)

WIDE-BAND AMPLIFIER, suitable for TV antenna and cable systems, etc. announced by Community Engineering Corp., State College, Pa., will distribute up to 12 channels—5 low VHF and up to 7 subchannels. (Ask for A-4-24)

INSTRUMENTS PACKAGE, announced by Electronics & X-Ray Div., F-R Machine Works, Inc., 26-12 Borough Place, Woodside 77, N. Y., for measurements in the X-band frequency range, consists of a regulated klystron power supply, tube mount, slotted section, and standing wave amplifier. Designated, FXR "MicroVal." (Ask for A-4-25)

DRIVE, Model RAD, announced by The National Co., Inc., 61 Sherman St., Malden 48, Mass., is a right angle unit that has a die cast zinc housing and gears. Total length, including shaft, 4½ in. Diam. ¼ in. (Ask for A-4-26)

POWER RESISTORS with wire leads, when preferred to solder-lug terminals, feature a resistance element wound on a glass fiber core inserted and sealed in a ceramic tube. Mounted on ring brackets. Meet UL requirements. By Clarostat Mfg. Co., Inc., Dover, N. H. (Ask for A-4-27)

DEPOSITED CARBON RESISTORS, announced by Dale Products Inc., Columbus, Neb., Type DCM, are manufactured in resistance values from 10 ohms to 2 megohms with tolerances of 1%. Higher or lower values available. (Ask for A-4-28)

CLASS H IMPREGNANT, ECCO W 28 G, announced by Emerson & Cuming, Inc., 869 Washington St., Canton, Mass., is a solvent-free, epoxide-base material for transformers, coils, and electronic components. For continuous use at 200°C. (Ask for A-4-29)

CAPACITORS, type ITC, of the "Illinois" line, have a standard tolerance of ±20% Available in capacity ranges from 0.0005 to 1.0 µf and 200, 400, 600, and 1600 WVDC. Made by Illinois Condenser Co., 1616 N. Throop St., Chicago 22, Ill. (Ask for A-4-30)

CORROSION RESISTANT SYNCHRO, R900 series, introduced by Kearfott Co., Inc., 1378 Main Ave., Clifton, N. J., has stator integrally bonded with housing which prevents null shifts when rotating or clamping in mount. (Ask for A-4-31)

ADJUSTABLE TORSION SPRING, on the BD5S and BD5E "Ledex" rotary solenoids, made by G. H. Leland, Inc., 123 Webster St., Dayton 3, O., enables close tolerance return-spring settings. Settings are made by a vernier type adjustable spring anchor plate. (Ask for A-4-32)

RELAY, 100-C with 10 mw/contact with thorough wiping effect, made by the Hedin Tele-Technical Corp., 640 W. Mt. Pleasant Ave., Livingston, N. J., is engineered for dc applications. Available hermetically sealed or with dust cover. Contacts SPST to DPDT. (Ask for A-4-33)

PORTABLE MICROPHONE STAND, Model BS-37 "Port-o-Boom," released by Atlas Sound Corp., 1451 39th St., Brooklyn 18, N. Y., has 5¼ ft. upright, retracted, 9 ft., extended; boom 7 ft., retracted, 18 ft., extended. (Ask for A-4-34)

POWER MOTOR GEAR TRAIN, Type 3094, made by John Oster Mfg. Co., Avionic Div., 1 Main St., Racine, Wis., consists of a motor and gear train that is a single unit. Covers any ratio from 3:1 to 10,500:1. Has exceptionally high torque for its size and weight. (Ask for A-4-35)

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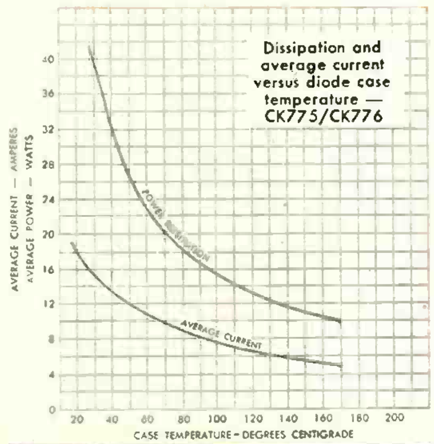

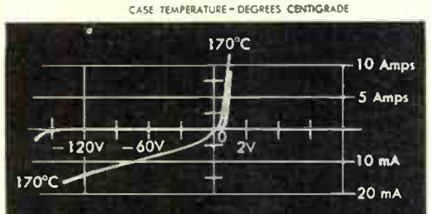

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HIGH TEMPERATURE-175°C

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REDUCED COOLING REQUIRED

EXTENDED FREQUENCY RANGE better than 100kc

RAYTHEON SILICON POWER RECTIFIER CHARACTERISTICS

	MAXIMUM VOLTAGE RMS VOLTS	MAXIMUM VOLTAGE PEAK VOLTS	MAXIMUM CURRENT PEAK AMPERES	MAXIMUM CURRENT AVERAGE AMPERES	TYPICAL DISSIPATION WATTS
TYPE CK775					
CASE TEMP. 30°C*	40	60	50	15	40
CASE TEMP. 170°C*	40	60	15	5	10
NO HEAT RADIATOR					
AMBIENT TEMP. 25°C	40	60	6	2.0	3.0
AMBIENT TEMP. 170°C	40	60	2.0	0.5	2.0
TYPE CK776					
CASE TEMP. 30°C*	125	200	50	15	40
CASE TEMP. 170°C*	125	200	15	5	10
NO HEAT RADIATOR					
AMBIENT TEMP. 25°C	125	200	6	2.0	3.0
AMBIENT TEMP. 170°C	125	200	2.0	0.5	2.0

*maintained by external heat radiator

ADDITIONAL RATINGS (25°C)

Both CK775 and CK776 have maximum drop at 5 amperes of 1.5 volts
CK775 has maximum reverse current at −60 volts of 25 mA
CK776 has maximum reverse current at −200 volts of 25 mA

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Design Criteria for Mutual Inductance

SINCE the original development of mutual inductance transducer by M. L. Greenough, the device has found increasing application at the National Bureau of Standards in electronic distance measuring instruments. The transducer detects extremely minute changes in the position of a nearby conducting plate and can be made to record such changes with an accuracy of 5% or better. This useful characteristic, together with ease of calibration, has led to its adoption in a number of noncontacting displacement gages for both static and vibratory types of measurements. Examples include an electronic micrometer, a manometer, an oil film thickness indicator, a vibration pickup calibrator, and others.

Until recently design analysis of the transducer has been restricted to its immediate use in a particular instrument. However, there has been a growing need for general design criteria for use in future applications. To provide the necessary data, H. M. Joseph and N. Newman of the Bureau's electronic instrumentation laboratory have made a detailed study of the device's operating principles with major emphasis on transducers using highly conducting reference plates. Their investigation was carried out as part of a program of basic instrumentation sponsored at the Bureau by the Office of Naval Research, the Air Research and Development Command, and the Atomic Energy Commission. The results include a number of design recommendations for obtaining optimum combinations of stability, sensitivity, and linearity over the range in which the instrument is to be used.

A typical mutual-inductance probe contains two coplanar, coaxial coils wound on a dielectric core. An r-f source that is regulated with respect to the product of the frequency and the current energizes the primary coil. The a-c voltage induced in the secondary coil then depends on the distance from the probe to the reference plate. Suitable electronic circuitry detects and amplifies the output voltage from the secondary coil, and this voltage is indicated on a calibrated meter that gives the change in probe-to-surface measurement in inches or centimeters. The instrument is adaptable to very rapid displacement changes; detection of these changes is limited only by the response of the amplifier and by the energizing frequency applied to the probe.

Results of the NBS investigation show quantitatively the change in mutual inductance between two coils when a conducting plate moves toward or away from the coils. The change in mutual inductance can be calculated by use of the theory of images whereby the conducting plate is replaced by an "image coil" that has the same effect as the plate on the mutual inductance between the two coils. Thus, a system of three coils is substituted for the system of two coils and plate. The equivalence of electrical and magnetic effects between the two systems allows the use of the image coil in mathematical analysis of the flux-linkage variations. One of the assumptions in this analysis is that the plate is perfectly conducting; in practice, however, plate conductivity is finite. Although detailed studies of finitely conducting plates have not yet been made, preliminary investigations indicate that in most applications the effect reduces the instrument's sensitivity by only a negligible amount if a sufficiently high frequency is used.

Design Criteria

From the analysis made so far, the following design recommendations can be specified:

(1) The reference plate should be as nearly a perfect conductor as practicable.

(2) The primary or exciting coil should be larger than the secondary coil to permit greater heat dissipation.

(3) If it is not possible for the primary coil to be coplanar with the secondary coil, then the primary should be the farther coil from the plate.

(4) The excitation frequency should be as high as possible, provided that the instabilities of resonance are avoided. Although it is true that operation at resonance will greatly enhance the sensitivity, a high degree of sensitivity is not usually a ruling consideration in probe design.

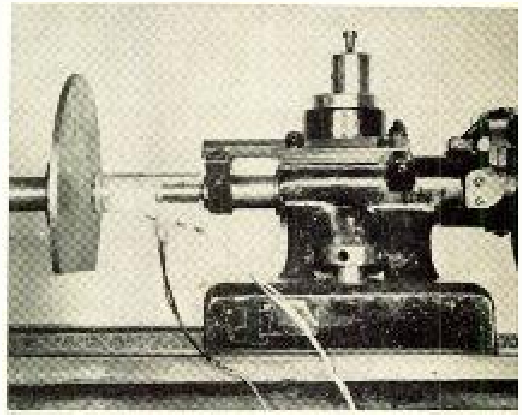
(5) The leads to the primary coil and to the secondary coil should be shielded from each other or should be fixed with respect to each other.

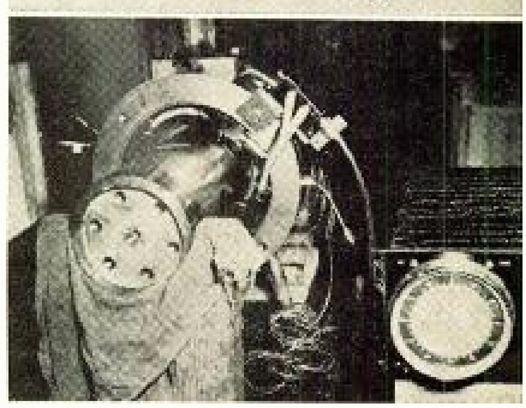
(6) The number of ampere-turns on the primary should be as large as possible.

(7) The number of turns on the secondary should be as large as possible provided that resonance effects are avoided.

(*Continued on page* 132)

Fig. 1: (Top) Experimental mutual inductance set-up. Reference plate is at left. Fig. 2: System applied to vibration pickup and accelerometer calibrator. Fig. 3: System for measuring relative position of high speed rotating shaft. Power supply and alarm circuits are at left. Center and at right are exciter and indicator unit. Fig. 4: (Bot) Oil film-thickness indicator. CRO right





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Closed-Circuit TV (Continued)

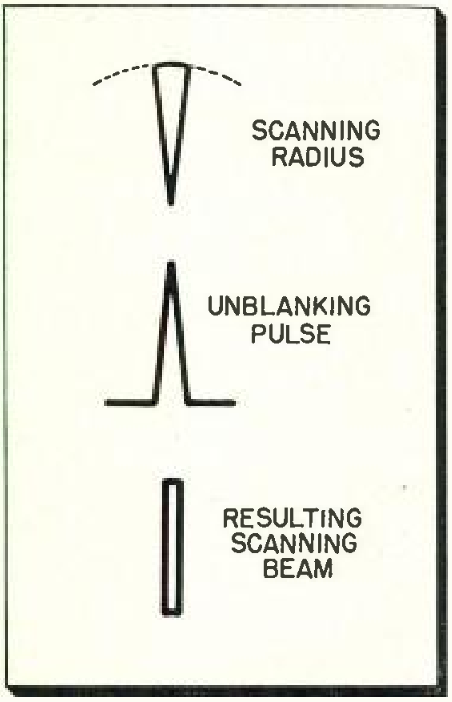

Fig. 12: Production of scanning beam

with a radio link, mainly used in the numerous military applications of ITV.

Actually, with this method, either there is no picture at all (in which case synchronizing does not matter) or there is a picture, as faint and bad as can be, including 105 KC and hence a rigorous locking of the scan.

The necessary phase relations are taken care of by a simple variable-phase R-C circuit, adjusted manually to the correct value. This makes the picture rotate on the tube.

Zero Point

The central point sets a particular problem. It must be highly stable, which is arrived at by stabilizing the amplitudes to less than 1 per 1000 with the help of negative feedback.

It must be a point, and right at the center of the sweep. Centering and zeroing circuits, similar to those used in PPI radar take care of this.

One of the remarkable properties of the system is that, whatever the conditions, the zero point at the receiver is the absolute homologue of the zero point at the transmitter. This is important when sighting a target, for example, with guided weapons. If the target is at the zero point on the receiver one can be certain that it is also at the zero point on the camera, that is on the axis.

To assist a precise sighting, the sweep can be considerably expanded, since the resolution is highest near the zero point.

Brilliance Correction

The sweep being of an increasing linear velocity when it moves away from the center, the screen would be white near the center and dark at the edge. This means that a brilliance correction is necessary. It is easily obtained by applying, to the grid or cathode of the tube, a waveform derived, by shaping, from the sawtooth (Fig. 8). In practice, the best correction is obtained by a waveshape somewhat different from the theoretical curve.

The 50 CPS flyback is similarly blanked out by a negative pip, directly obtained by differentiation of the sawtooth.

Practical Considerations

Any ITV equipment should have maximum safety and minimum size and weight, especially if military applications are in mind.

The safety is inherent to the system, as has been seen.

Minimum size and weight have been secured by using miniaturization techniques and printed circuitry.

The camera itself constitutes an excellent example of miniaturization technique. It is cast in light alloy and measures 7½ x 4 x 3 in. It contains a pick-up tube of the vidicon type and associated coils, and a plug-in preamplifier, using three sub-miniature tubes and printed circuitry.

Another model, rather larger, and mainly used for "civilian" applications with a cable link, employs a photocon type tube. It is worth noting that, to correct keystoning due to the oblique beam, it is sufficient to reduce one amplitude, which transforms the circle into an ellipse.

The special elements are easy to manufacture, since one is concerned only with sinusoids. This remark applies particularly to the coils, transformers and amplifiers in the sweep circuits. Similarly, it is quite easy to modify the phases as necessary.

The deflecting coils are of the cosine type to insure good linearity. To obtain a pure sinusoid, efficient circuits and filters have been designed.

A peculiar trouble was observed in connection with the use of this equipment on airplanes. It was a kind of parasitic modulation due to the rotating propellers, the frequency of which was of the order of 50 to 200 CPS.

This "propeller effect" is shown in Fig. 10 acting upon the sweep waveform. The AGC circuits being inefficient, the problem of obtaining a clean scanning signal was solved by transmitting a sinusoid.

The propeller effect appears then as in Fig. 11. It is eliminated by proper limiting, and the resulting constant amplitude waveform serves to reconstitute the original sinusoid.

Another very special problem arose with TV-controlled rockets which rotate about their axes at a few turns per second. The result is that the received picture rotates simultaneously on the receiver screen.

A simple means to eliminate this rotation is to control the phase of the fundamental scanning sinusoid with a gyroscope. This phase then remains fixed and independent of the rocket spin, and so does the received picture.

The spiral ITV has been put to use to transmit a radar picture with a kind of PPI scan.

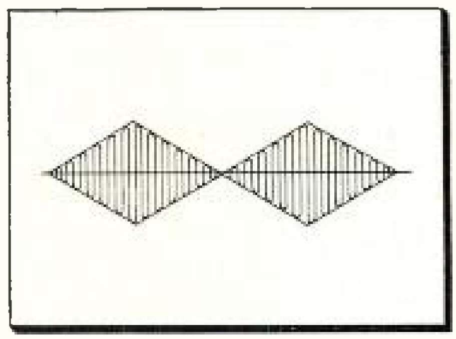

Fig. 13: Waveform for double spiral scan

This scan has been obtained by blanking out the spiral, except for a radius, made of aligned points.

As the obtained scanning radius would diverge, being larger near the periphery, for a constant opening of the beam, the unblanking pip has been given an exactly opposite shape. The resulting scanning radius is then of constant width (Fig. 12).

This radius rotates slowly, due to a progressive variation of phase of the scanning sinusoid. This process has been used to transmit slowly varying radar pictures at great distances with a small bandwidth.

Bearing in mind the 3% loss in the sawtooth return, there exists an easy way to reduce this loss to zero. It consists in the use of a bispiral scanning, using the waveform illustrated in Fig. 15. In this case, there

(*Continued on page* 133)

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- Completely automatic . . . utilizing features contained in the now famous Telop and Telojector . . . Slides change by push button control.
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Telop III by the elimination of extra manpower assures the production and projection of low-cost commercials that local sponsors can afford. It can be used with any TV camera including the new Vidicon camera. Telop III projects on single optical axis opaque cards, photographs, art work, transparent 3¼" x 4" glass slides, strip material, and 2" x 2" transparencies when Telojector is used with optical channel provided. Telop III eliminates costly film strips and expensive live talent.

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"Mylar Film" (Continued)

on numerous samples of 25 gauge film.

Fig. 1 gives the average dielectric strength obtained in ten measurements. The scatter in the data is believed to be within the limits of accuracy of measurements. According to the curve, the breakdown gradient of 25 "Mylar" C film in air with painted silver electrodes is about 10 kv per mil.

Dielectric Strength

The dielectric strength of wound capacitors is easily affected by a variety of external conditions. Under normal conditions, dust, uneven tension on windup, mechanical pressures on the film, wrinkles, trapped air, and other factors combine to lower the attainable dielectric strength. Erratic results under apparently similar conditions have been reported not only with "Mylar," but also with multi-layer paper insulation.

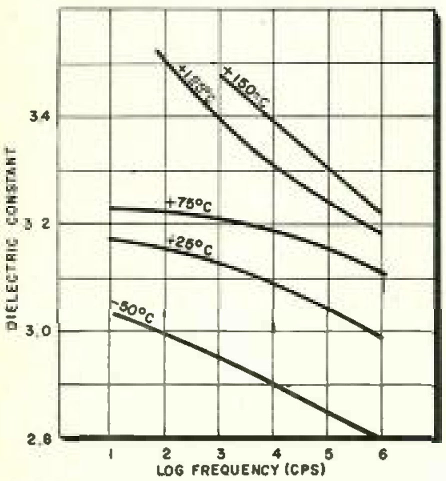

Fig. 3: Strength changes with temp., frequency

For single-layer units wound from very thin film, the variables combine to induce considerable spread in the dielectric strength of wound capacitors. In practice for 25 "Mylar" C polyester film, single-layer construction, a certain percentage of units will be shorted, and very few will fail in the region of 100 to 300 volts. Significant breakdowns occur beyond this voltage. Although electrical fault count is extremely low for the 25 gauge film, there are inclusions which cannot be completely eliminated in a manufacturing process.

Fig. 2 illustrates the general behavior of single-layer 0.5 µf units wound with 25 "Mylar" C and 50 "Mylar" C. The curve for the 25 gauge film represents the percentage of failures out of a group of 50 capacitors. Each group of 50 capacitors was wound with "Mylar" taken from 27 production rolls over a period of about nine months. The dotted lines are inserted to roughly show the extremes of observed dielectric strength to be expected in one test of 50 capacitors. The experimental curve can be approximated quite well by a straight line in the range 400 to 2800 volts, indicating that the units are equally likely to fail in equal intervals of this range. Capacitors wound with 50 "Mylar" C show a relatively small percentage failing up to 4,000 volts. Beyond this point the failure rate increases sharply.

From the capacitor manufacturer's standpoint, the most important property of the dielectric strength distribution is the percentage of units failing before a given voltage. Production capacitors are required to withstand a short time application of a test voltage which in a given capacitor design varies widely with the service conditions. Associated flash requirements will also vary so that no unit flash specification applies. A single-layer unit rated at 100 volts dc at a given temperature may be required to withstand a flash of only 250 volts. If the unit is meant to operate only a few minutes, the rating may be 600 volts, requiring a flash test of 1,200 volts.

Dielectric Constant

Dielectric constant measurements on "Mylar" polyester film, using the ASTM D-150 method with silver electrodes painted on the film samples, show that the dielectric constant generally increases with increasing temperature, and with decreasing frequency. The minimum measured value is about 2.80 at —70°C and 1 MC, and the maximum about 3.50 at 125°C and 60 cycles. Fig. 3 shows these changes.

Below the second order transition temperature (about 85°C), the dielectric constant changes slowly with temperature and frequency. This change in dielectric constant with temperature causes a change in capacitance which is of direct interest to the capacitor manufacturer. Fig. 4 is a plot of the average per cent change in capacitance for 0.5 µf capacitors measured at 60 cycles per second. It shows the capacitance drops about 4% from 20°C to 85°C.

"Mylar" polyester film has a very high insulation resistance over a wide temperature range. (See Fig. 5.) The insulation resistance shown in the chart was determined on 0.5 µf capacitors. Of the commonly used dielectrics for capacitor applications, only polystyrene exhibits better high temperature insulation resistance. However, polystyrene's low softening point and generally poor mechanical properties limit its use in capacitors. "Mylar" polyester film capacitors have approximately 10 times the insulation resistance of paper capacitors.

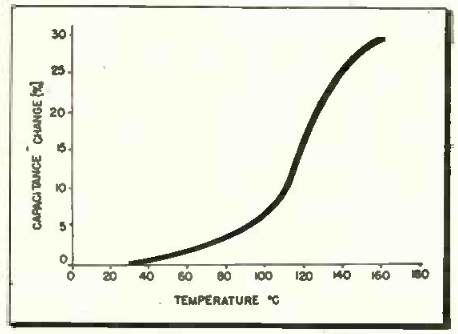

Fig. 4: Capacitance-temperature characteristic

The volume resistivity of "Mylar" C film lies between KEL-F and paper capacitor tissue, as is shown by the curves in Fig. 6. "Mylar" A film exhibits volume resistivity approximately one-tenth that of "Mylar" C film. The volume resistivity given in the curves was measured at 125 volts dc, with seven minute charge, using 2-in. diameter silver electrodes painted on the surface of the film.

Fig. 7 shows some interesting information on volume resistivity of "Mylar" C polyester film as a function of electrode voltage with temperature as parameter. It shows the existence of a marked voltage dependence throughout a wide voltage range.

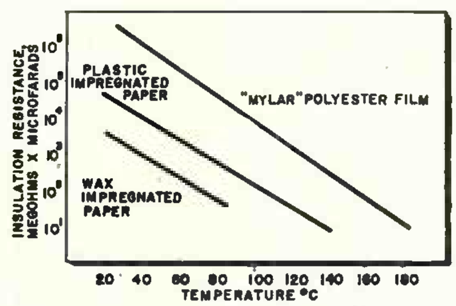

Fig. 5: Insulation resistance characteristic

Leakage resistance of capacitors will vary considerably from that of the film itself. But evaluation along this line is not sufficient to permit stating any specific values for actual capacitors.

(*Continued on page* 130)

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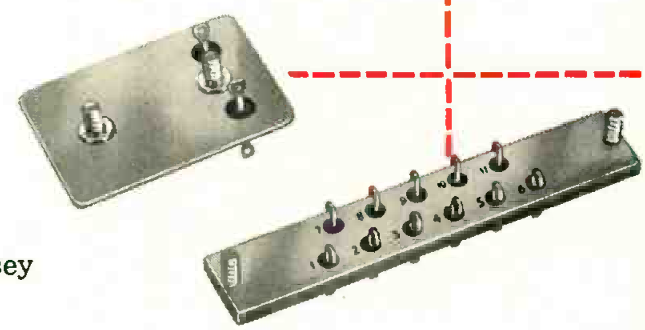

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Color Television (Continued)

PLAN #3 EQUIPMENT

COLOR STUDIO CAMERA CHAIN TK-41

Qty.	Description
1	TK-41 Color Studio Camera Chain (Includes: color camera, viewfinder, processing amplifier, colorplexer, master monitor, color monitor, power supplies, console housings and cables)
1	Cradle Head
1	TD-4A Heavy Duty Pedestal
1	Video Jack Panel
10	Video Jack Plugs
5	Video Jack Cords
1	TA-4A Pulse Distribution Amplifier
2	Type BR 84 Cabinet Racks

blue.) A color picture presentation can be seen on conveniently located color monitors. These are usually positioned so that both the video operator and the technical director may see them.

FACILITIES FOR COLOR PROGRAM SWITCHING

The description on preceding pages has indicated how unit equipment groupings may be added step-by-step to increase the color video facilities of a TV station. Further increases can be made by adding film, slide or studio cameras.

As the color facilities of the station grow, some means of selecting a picture from one of several sources and feeding it to the transmitter must be provided. Fig. 14 shows a combined functional diagram of a plan #3 station employing switching facilities. The makeup of this "Switching System" will vary according to (a) its physical location, (b) the number of camera positions provided for, and (c) the "effects" facilities included.

Conventional switching equipment methods may be used since only a single output signal need be handled by the equipment. Thus, it becomes possible to use a standard monochrome relay system with only slight modifications to accomplish camera switching functions.

The need for three identical sets of switching equipment is eliminated by using a colorplexer as part of each camera chain—so that only a one compatible signal (containing a subcarrier component) need be switched. When this approach is used, the synchronizing signal is added at a common point after switching, so that control information to the deflection circuits of home receivers is never interrupted.

To insure that color synchronizing bursts are always in the proper phase relative to the subcarrier components of the video signal, it is desirable to provide burst keyers within each colorplexer. This adds the bursts to the rest of the subcarrier signal as soon as possible after modulation, giving no opportunity to drift in relative phase. The switching system intended to handle compatible signals has carefully adjusted delay characteristics. The time delay for signals passing from any colorplexer to the switcher should be equalized.

SWITCHING EQUIPMENT

Fortunately, RCA can furnish a wide selection of switching equipment for use by the color TV planner. Many TV stations have already installed and are familiar with the RCA TC-4A ("Basic Buy") audio/video switcher. This provides video control and program switching selection of any of 8 signals, as well as audio control of 8 inputs to 4 mixer positions. TV stations using plan #1 (network) and plan #2 (network film and slides) equipment will find that the RCA *TS-5A switcher* makes a very versatile supplement to the ("Basic Buy") TC-4A for handling color switching.

Fig. 20: Switching console for color TV

The TS-5A video switcher is designed to mount in a single standard console housing. The push-button and fader panel may be located in the upper face of the console. The TS-5A is designed for color use as well as for monochrome.

If the station already includes a studio switcher, and there is a need to provide for more inputs and rehearsal facilities—the TS-5A switcher may be employed. A typical arrangement of these two equipments will provide for independent studio rehearsal plus 5 extra inputs. The TS-5A also may be used for independent switching systems where maximum program flexibility and economy are desired. The TS-5A can be conveniently mounted in a standard console housing adjacent to other console control units.

The *TS-11A Switching System* is also available for consideration for color TV (Fig. 20). Perhaps the planner (for both small and large stations) would be wise to consider carefully this *new TS-11A system* which is a very versatile direct switcher. It provides 9 inputs and three rows of push buttons for fades, lap dissolves, super-positions. It will handle composite or non-composite video switching and fading, either color or monochrome.

Two of the three rows of push buttons feed a manual fader assembly and the third row is the preview channel. A program transfer switch is provided to interchange the preview and fader busses so that the fader section can be used for previewing fades, lap dissolves and super-positions. This also makes it possible to use the fader channel for rehearsals while the preview channel handles the on-the-air signal. The fader assembly feeds a mixing circuit and three program line output amplifiers, eliminating the need for additional elaborate distribution amplifier systems on the output of the switcher. This new switcher is free of microphonics and low frequency tilt and bounce. Thus a stabilizing amplifier is not required as part of the switching system.

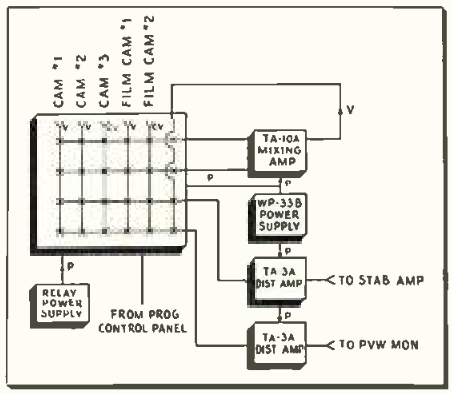

Fig. 21: Relay control switching system

Where requirements dictate a still more flexible switching system or where more than six video inputs are used, it is recommended that a relay switching system be considered. The *TS-20 Relay Control Switching System* is designed for use in television studio control and master control rooms. It consists of different types and quantities of equipment depending upon the size and type of switching operation desired. The equipment may be used for switching a minimum of six inputs to two outputs or a maximum of twelve inputs to six outputs (five

(*Continued on page* 155)

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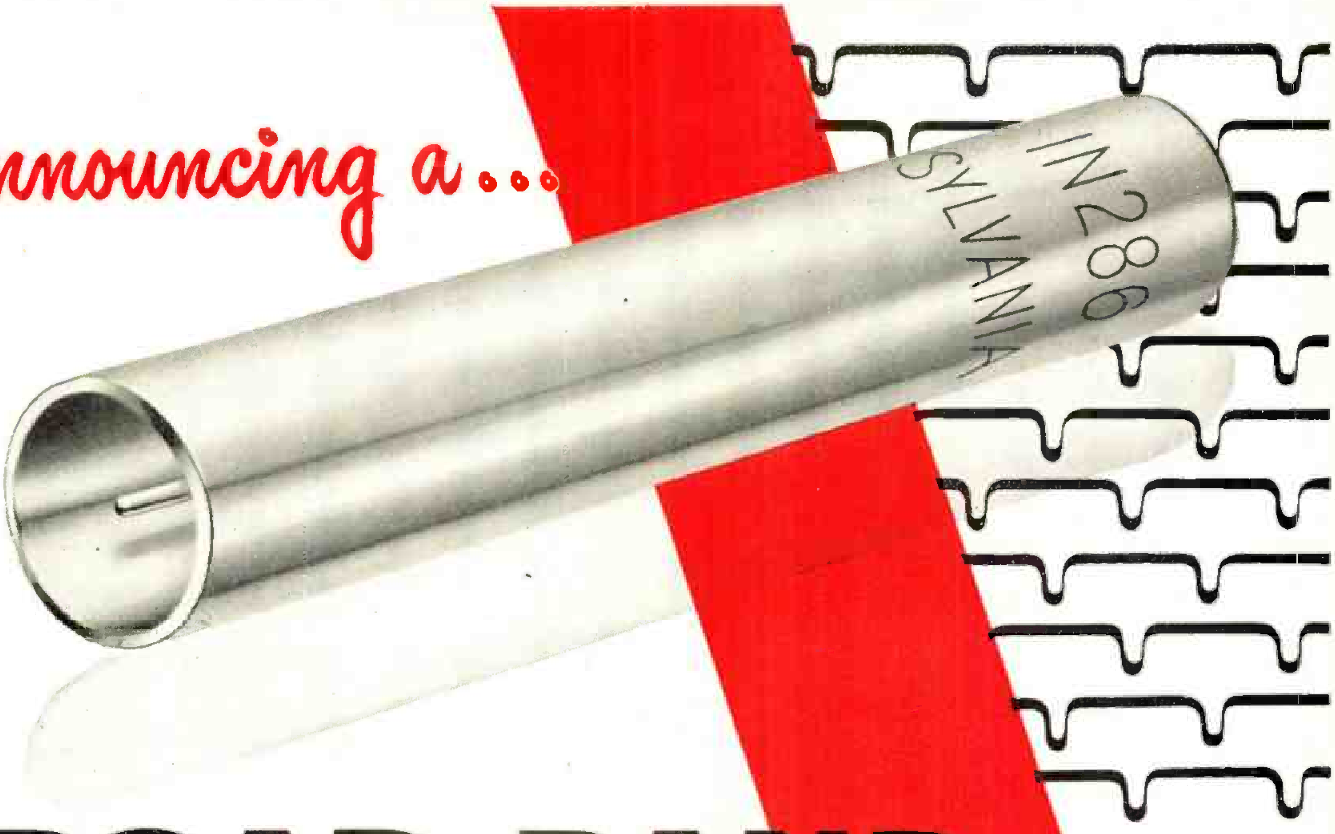

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TYPE IN286 covering the frequencies from **10,000 to 22,000 mc**

Its broad-band characteristics make the new Sylvania Type IN286 especially useful in tunable radar systems and counter-measure devices. The IN286 is a coaxial, point-contact silicon crystal diode designed for use as a mixer in the frequency range from 10,000 to 22,000 mc.

RF IMPEDANCE

The RF impedance of the IN286 is designed to match a 65-ohm load over its entire frequency range.

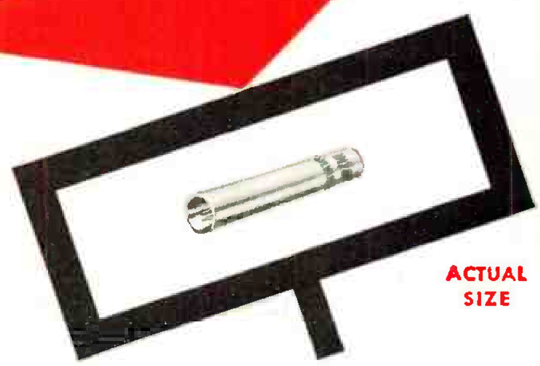
CRYSTAL HOLDERS

A variety of crystal holders may be used with the IN286

—standard X, K_u, K-band waveguide holders to cover appropriate segments of the band.

—WR-51 waveguide holder to cover the range from 15,000 to 22,000 mc.

—WR-75 waveguide holder to cover the frequency range from 10,000 to 15,000 mc.



ACTUAL SIZE

SPECIFICATIONS

Conversion Loss	8.5 db max.
Output Noise	2.5 times max.
IF Impedance	250—450 ohms
RF Impedance	3.0 VSWR max.
Burnout	each crystal subjected to 20 mw (cw) at 10,000 mc.

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Equipment Fuses (Continued)

to and including this maximum.

The Underwriters' Laboratories, Inc. establishes the voltage rating of fuses on a d-c circuit capable of delivering 10,000 amps at the voltage for which the fuse is rated. When a fuse is blown on such a system the fuse must remain intact and open the circuit without emitting sufficient flame or molten metal to ignite surgical cotton entirely surrounding it. Hence, this test establishes that

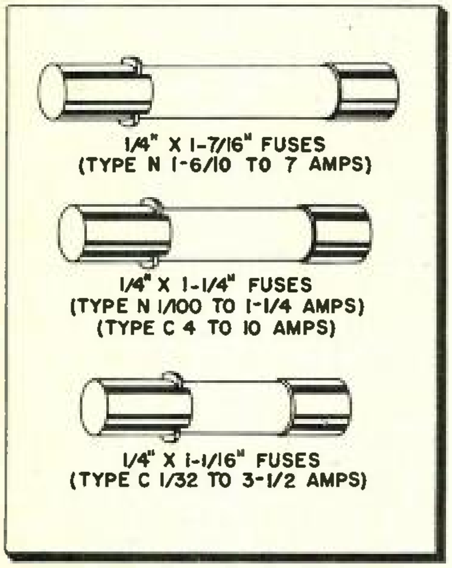

Fig. 2: Appearance and physical size dimensions for the three new types of fuses

the fuse will perform satisfactorily without creating a fire hazard at rated voltage under the most severe conditions.

Actually, the 32 v. glass tube fuses used in the original battery operated radio receivers performed satisfactorily at the higher voltages because the short-circuit currents were limited by the impedance of the circuit and the capacity of the battery. Hence, the only problem was to be sure the user replaced the blown fuse with one of the proper ampere rating. This same problem existed in the use of these fuses for the protection of the electrical circuits in automobiles and was solved by the development of the SFE series of glass tube fuses.

The SFE glass tube fuses are rated at 32 v. or less in ampere ratings from 4 to 30 amps. The ampere ratings were selected so as to form a geometric progression, each size being 50% greater than the preceding one. In other words, the 6 amps. rating of the SFE 6 fuse is 50% greater than the 4 amp rating of the SFE 4 and the SFE 9 is 50% greater than the SFE 6. The sizes so selected were considered adequate to cover the range required.

All the SFE fuses are ¼-in. in diameter but the length varies with the ampere rating. The SFE 4 is ⅝-in. long; the SFE 6 is ¾-in.; up to the SFE 30 which is 1⁷⁄₁₆-in. long. Because of its greater length, a SFE 6 fuse cannot be inserted in a fuseholder designed for a SFE 4 so that this series of fuses prevents the insertion of an oversize fuse when the original one blows. Hence this series was adequate for battery powered radio receivers.

However, when a-c radio receivers and television receivers were introduced, the problem of fuse selection became more difficult. The picture was further complicated by the fact that the industry became highly competitive and cost of protection influenced the selection. It soon was realized that the device protecting the branch circuit to which the radio or television receiver was connected could not furnish adequate electrical protection. Currents which would damage if not destroy the receiver, were too small to cause the branch circuit protector to operate. Therefore, additional electrical protection was required and particularly in television receivers, this protection might be called upon to handle short-circuit currents of sufficient magnitude to blow it up, creating a hazard, if applied improperly.

Glass Tube Fuses

Since small dimension glass tube fuses are available commercially, rated at 250 v. or less, the television manufacturers were most interested in using this type of fuse. However, the Underwriters' Laboratories did not consider this application safe because there was the possibility that the blown fuse would be replaced by a fuse of higher ampere rating or lower voltage rating, either of which could create a hazard.

For this reason there was a demand for a fuse for the protection of appliances, low in cost, which could not be replaced with a fuse of larger ampere or lower voltage rating. In addition, the fuse manufacturers imposed the additional requirement on the development that fuses of different time-current characteristics should not be interchangeable.

The Underwriters' Laboratories principal interest and sole reason for existence is safety. Any product that does not create a fire or health hazard and meets its standard is acceptable to it even though the device

(*Continued on page* 134)

Military Contract Awards

Electronic products, dollar value, and names of manufacturing contractors receiving awards as reported by U.S. Dept. of Commerce.

Compass, magnetic—121,342—Airpath Instrument Co., St. Louis, Mo.
Voltage Regulator, dc—113,272—Westinghouse Elec. Corp., Dayton, O.
Generator—319,528 Westinghouse Elec. Corp., Dayton, O.
Generator, starter—61,281—General Elec. Co., W. Lynn, Mass.
Receiver, radio—92,791—Sylvania Elec. Products Inc., Radio and Television Div., Buffalo, N. Y.
Computer Assy—43,390—AC Spark Plug Div., GMC, Flint, Mich.
Projector, 16mm sound motion picture—297,613—Federal Mfg. & Engr. Corp., Brooklyn, N. Y.
Humidity Indicating Set—28,298—Minneapolis-Honeywell Regulator Co., 2753 Fourth Ave., S. Minneapolis, Minn.
Rectifier—27,053—Carol Electronics Corp., 315 W. Stephen St., Martinsburg, W. Va.
Tube, electron—149,640—Radio Corp. of America, Harrison, N. J.
Radio Set—581,758—CBS Columbia, 3400 47th Ave., Long Island City 1, N. Y.
Tube, electon—149,640—Radio Corp. of America, 415 S. 5th St., Harrison, N. J.
Tube, electron—109,407—Sylvania Electric Products, New York, N. Y.
Tube, electron—72,243—Radio Corp. of America, Harrison, N. J.
Tube, electron—31,020—Radio Corp. of America, Harrison, N. J.
Motor, electric—45,000—Reliance Electric and Engineering Co., Cleveland, Ohio
Radio Transmitting Set—2,155,220—CBS-Columbia, Div. Columbia Broadcasting System, Inc., Long Island City, N. Y.
Motor and Gear Assy—55,593—Bachman Wholesale Co., 1073 Clinton Ave., N. Rochester, N. Y.
Connector Plugs—29,210—The Ucinite Co., Div., United Carr Corp., 459 Watertown St., Newtonville 60, Mass.
Dials, miscellaneous—26,392—Bendix Aviation, Radio Div., E. Joppa Rd., Baltimore, Md.
Phase Monitor—49,872—Control Electronics Co., Inc., 1925 New York Ave., Huntington Sta., N. Y.
Transformer—25,000—Western Electric Co., Inc., North Carolina Works, Winston-Salem, N. C.
Switches, motor control—32,209—Curtiss-Wright Corp., Caldwell, N. J.
Cable, electric—17,089—Hall-Mark Electrical Sales Co., Inc., 542 Wortman Ave., Brooklyn 8, N. Y.
Cable, electric—21,106—John A. Roebling's Sons Corp., 640 S. Broad St., Trenton 2, N. J.
Tubes, electron—344,187—Matchlett Laboratories Inc., 1063 Hope St., Springdale, Conn.
Tubes, electron—30,129—Continental Electric Co., 715 Hamilton St., Geneva, Ill.
Tubes, electron—204,791—Raytheon Manufacturing Co., Foundry Ave., Waltham, Mass.
Tubes, electron—47,215—Radio Corp. of America, RCA Victor Div., Harrison, N. J.
Crystal Unit—31,590—Midland Manufacturing Co., Inc., 3155 Fiberglas Rd., Kansas City 15, Kan.
Thermostat—104,338—The Garrett Corp., Airesearch Manufacturing Co., Div., 9851-9951 Sepulveda Blvd., Los Angeles 45, Calif.
Stand, test—2,050,262—Sun Electric Corp., Harlem and Avondale Ave., Chicago, Ill.
Transformer, pulse—31,951—Bendix Aviation Corp., Bendix Radio Div., Baltimore 4, Md.
Crystal Unit—58,080—Standard Piezo Co., 20 N. Hanover St., Carlisle, Pa.
Cable, power—26,700—Collyer Insulated Wire Co., 249 Roosevelt Ave., Pawtucket, R. I.
Cable, switch board—63,053—Phelps Dodge Copper Products Corp., Habirshaw Cable & Wire Div., 40 Wall St., New York 5, N. Y.
Cable, watertight—57,810—General Electric Co., Construction Materials Dept., 1285 Boston Ave., Bridgeport 2, Conn.

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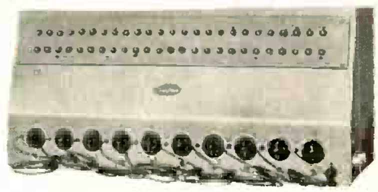

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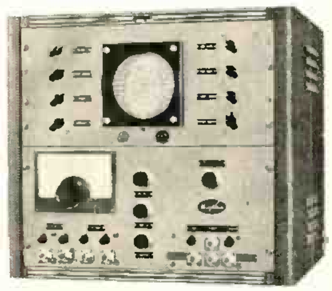

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Frequency Multipliers (Continued)

the grid biasing resistors in each stage and tuning the previous stage for maximum deflection. An adjustment tool of insulating material is helpful when tuning the higher frequency stages. Changes in driving level or operating temperature cause negligible variation in the tuning of the filter networks. Vibration and aging effects also are slight and adjustments are usually not required if tubes are changed.

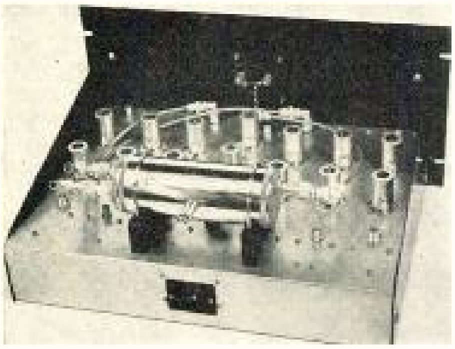

Fig. 9: Cavity unit extends sensitivity

Frequency Converter and Amplifier

In the circuit diagram shown in Fig. 4, a simple diode converter drives a cascaded dual-triode amplifier and a cathode follower output stage. This unit is generally used to obtain the difference frequency between the two 100-mc inputs. The 10-mc or 1-mc outputs, available from the multiplier chains at levels of 1 to 2 volts, may also be connected in pairs to the converter input to measure an oscillator of only moderate stability, such as a secondary frequency standard.

An alternate converter-amplifier arrangement, shown at the top in Fig. 4, was developed for use either as a converter at 100 mc, or as an amplifier for the difference frequency when used with the 1000-mc cavity type of multiplier-converter described in a following paragraph. In the latter use, the output of the cavity converter is connected to the jack which leads to the grid of the converter-amplifier triode. This stage is adjusted to give about the same output voltage when serving either as a 100-mc converter or as an amplifier for the 1000-mc crystal converter.

Inductance-capacitance filters are used in the converter heater leads, and a filter having an m-derived section with maximum attenuation at 100 kc is provided in the converter output. The overall amplifier response is essentially flat from 5 to 50,000 cps, with half-power cutoff at about 70 kc, caused primarily by the filter.

The cathode follower output stage is somewhat unusual, it also having been designed to perform either of two separate functions without need of internal switching. In one use the output is connected to an electronic counter or other high impedance, such as an oscilloscope where low distortion is desired over a wide frequency range at a level of 3 to 5 volts. In another use the output is connected to a limiting amplifier operating over a narrow frequency range near 60 cps, and having a 500-ohm transformer primary as input impedance. Again about 3 volts is needed, but at a higher power level. Some distortion is permissible, as the limiting amplifier operates by squaring and amplifying the input and then eliminating harmonics by use of a low pass filter. The arrangement shown prevents the transformer winding from shorting out the cathode bias, and performs both functions with a reasonable drain in plate current and without the need of extra transformers and switching.

The converter injection levels and phasing of the converter output are arranged so that the second harmonic distortion caused by rectifying two signals near the same level is of opposite phase to that caused by slight overdriving of the cathode follower. Thus a higher output level may be obtained before distortion becomes appreciable. A gain control allows the beat-frequency voltage output from the amplifier to be adjusted to any desired value, which may be read from the panel voltmeter.

Power Supply

A commercially available regulated power supply is used to operate the frequency multiplier and converter. As a comparatively low dc plate voltage is used, an input filter choke was added in the power supply, which gave a saving of 15 watts in power drain and in heat dissipation. The multiplier-converter chassis requires 180 volts at 85 ma and 6.3 volts ac at 4.5 amps. The total ac power drawn with the choke added is about 110 watts. A block diagram of the multiplier-converter and the power supply, including rf line filters, is shown in Fig. 5.

The frequency multiplier chains give constant output and show no change in phase stability at 100 mc for 100 kc input levels between 0.5 and 10 rms volts. Frequencies ranging from 5 to 70,000 cps may be obtained from the converter-amplifier for measurement or recording at power levels up to 5 volts into 500 ohms. With only one 100-mc input connected and the amplifier gain control at maximum setting, the 100-kc component in the output is about 20 db above the converter noise level.

The desired output from the 100-mc jacks is better than 50 db above multiplier sidebands and harmonics. Measured values of sidebands and harmonics in the outputs of the multiplier chains are given in Table II. The 1-mc and 10-mc outputs are taken from the plate transformers in each stage. Additional filtering is provided in the tuned input transformers in the following stages before proceeding with multiplication. There is no indication of ac pickup

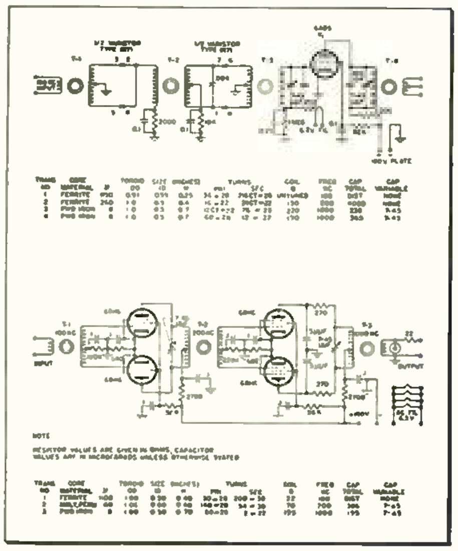

Fig. 10: (a—top) Multiplier-converter circuit. (b) Modified pentode multiplier-converter

or hum modulation in the output of the multiplier or converter-amplifier. No discernible change in performance was noted when one of the units was operated entirely from batteries.

Random phase fluctuations in the frequency multiplier chains were investigated by connecting two complete multiplier-converter units as shown in Fig. 6. For any frequency difference between the two driving oscillators other than precisely zero, an elliptical pattern was obtained on the oscilloscope. Random phase fluctuations were noted with a maximum amplitude of about 14°, and with periods ranging from 0.1 to 2 sec. Thus a maximum phase

(*Continued on page* 122)

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Frequency Multipliers (Continued)

shift of about 3.5° per multiplier chain occurs if one assumes the phase shifts to be uniformly divided between the four channels. This phase fluctuation constitutes a maximum uncertainty contributed by each multiplier chain of about 1 part in 10^{10} for a one-second observation.

These fluctuations are attributed principally to what is generally called the "flicker effect" in the electron emission from the tube cathodes. It is believed to result from localized irregularities at the cathode surface and can be reduced by special cathode techniques. In class-C harmonic generators these variations result in slight changes in the instant of plate-current conduction, causing phase modulation of the harmonic frequencies. Thus the input stage, which is followed by the greatest amount of frequency multiplication, contributes most of this variation. Similar effects probably occur also in the oscillators and buffer amplifiers generally associated with them, although these effects were cancelled out in the method of evaluation used.

The beat frequency recording on the left side of the chart in Fig. 7 is a typical example of the performance of the triode frequency multiplier and converter system when intercomparing two highly stable frequency standards at the 100-mc range as described later under auxiliary equipment.

Diode-Pentode Frequency Multiplier

Two complete multiplier-converter systems having four multiplier chains, 100 kc to 100 mc, were constructed using circuit arrangements as shown in Fig. 10-a for the first decade stage. Germanium-quad diodes, type 1N71, are used as harmonic generators. These diodes, when self biased by rectification of the input signals, have current waveforms and harmonic content very similar to those obtained from class-C tube harmonic generators. A full-wave doubler input stage is used for more effective limiting and filtering, followed by a balanced quintupler and a 1-mc grid filter. The amplifying tube operates class-A and, because of the high value of screen resistor, draws about the same total current with or without input. The cathodes are grounded to avoid possible hum pickup from the heater leads, with bias being obtained from the rectifying action of the grid. The plate-circuit tank is also tuned to 1 mc and is provided with center-tapped output for driving the diode rectifiers in the next stage.

In the 1-mc to 10-mc and 10-mc to 100-mc decades, the quintupler stages are placed first with the more efficient doubler stages operating at the lower power level. Either 6AG5 or 6AK5 tubes may be used, but the latter are more satisfactory in the high frequency decade.

Tank Impedances

Because of the tuned input and output in each stage, difficulties developed if tank impedances were made too high. Resonant impedances of 25,000 to 50,000 ohms proved generally satisfactory. Also, because of the high-impedance, low-level grid circuits, some coupling between the two multiplier chains occurred through ground currents with the bottom cover installed. This effect was greatly reduced by splitting the bottom cover into two pieces separated by a bakelite spacer. The principal difficulty, however, is the random noise generated by the diode rectifiers, which amounts to about 10% of the beat frequency output amplitude from the converter-amplifier. This may be reduced by low pass or band pass filters on the output, but such devices limit the usefulness.

A typical beat frequency chart recording obtained at 100 mc with the diode-pentode frequency multiplier is shown in the center of Fig. 7. This record compares unfavorably with the other types shown. The equipment, however, is quite satisfactory for obtaining the beat frequency between pairs of oscillators with electronic counters and is used regularly for this purpose. This type of multiplier seems to be most adaptable to small signal or medium stability applications.

Pentode Frequency Multiplier

A pentode model of the frequency multiplier-converter generally similar to the triode model was constructed to investigate any possible superior features. Type 6BH6 tubes are used because of their high transconductance and low power consumption. Because of the higher sensitivity, grid drive is reduced to about two-thirds of the amount used with the triode multipliers. Other

(*Continued on page* 142)

PERSONAL

Victor Le Gendre has been appointed Chief Engineer of Haydu Brothers' Plainfield, N.J. tube plant, a division of Burroughs Corp.


V. Le Gendre


E. F. Grant

Eugene F. Grant, former Engineering Manager at W. L. Maxson Corp., has joined the National Company as Director of Engineering. Mr. Grant will be responsible for all development activities involving communications, audio, components and electronic devices.

Russell T. Lowe has been appointed Assistant Chief Engineer of the Barry Corp., manufacturers of vibration isolation equipment.

Edward K. Doherr has been named assistant director to handle service at the government field engineering department of Raytheon Mfg. Co. **G. Edward Dodge** has been appointed government field engineering supervisor.

Howard S. Orcutt has been appointed Chief Engineer of the rectifier division of Pyramid Electric Co. Mr. Orcutt was formerly senior engineer at Federal Telephone and Radio.


H. S. Orcutt


H. E. Ruehlemann

Herbert E. Ruehlemann, authority on electric fuses, has taken the position of Chief Engineer and Director or Research and Development at the Instrument Div. of Roller-Smith Corp. Mr. Ruehlemann has served as consultant to the Naval Ordnance Lab.

Lawrence S. Brown has joined Ford Instrument Co., Division of The Sperry Corp., Long Island City, N.Y. to work with the management staff in coordinating company projects.

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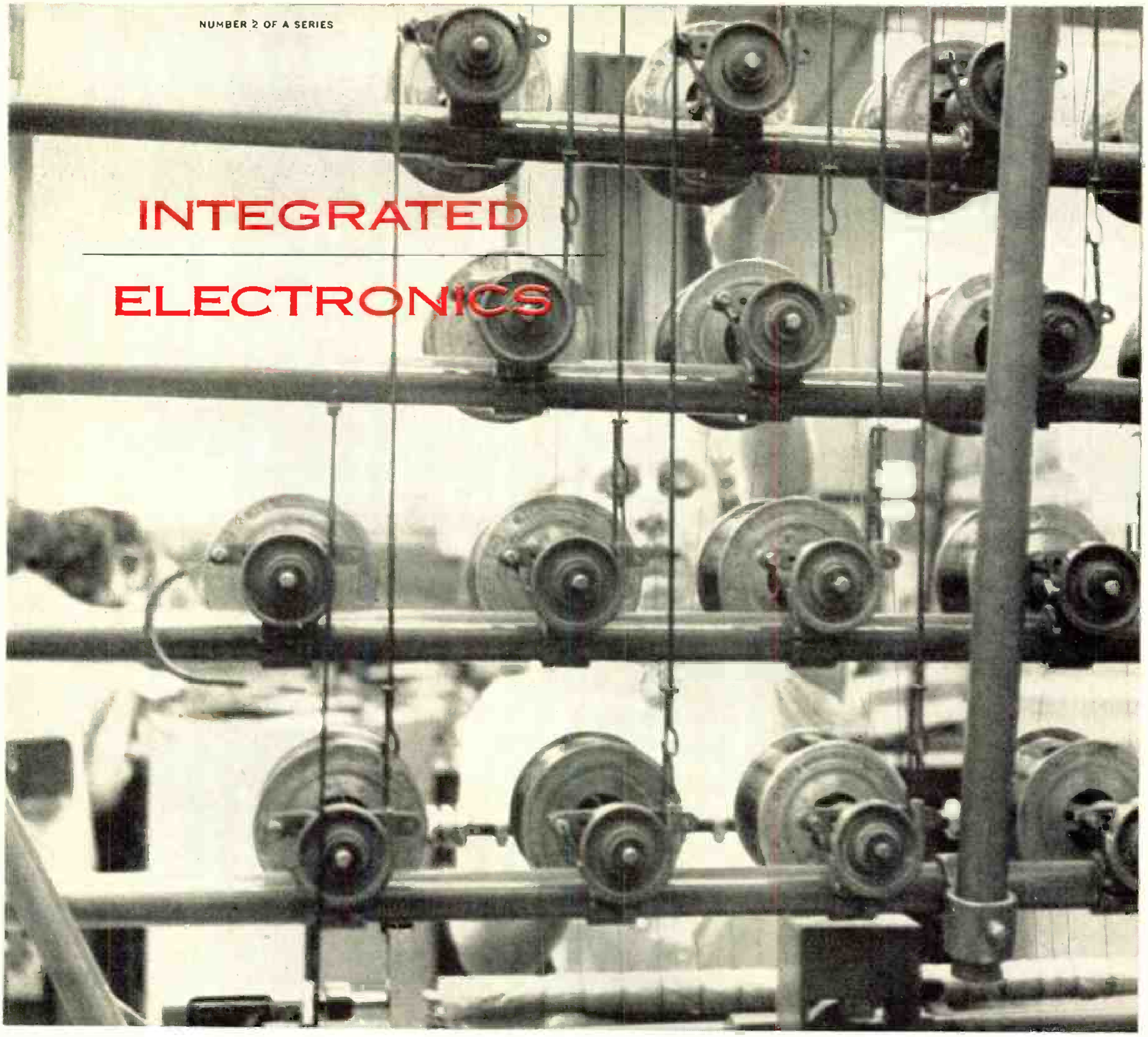

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Dielectric Amplifiers (Continued)

ohms for maximum output. This load reduces the Q from 27 to 21. Rewriting Eq. 6, the voltage gain is obtained as

$$\frac{\Delta E}{\Delta V_{in}} = \frac{0.7\, I\, Q^2}{2\, \omega_o\, C^2} \frac{\Delta C}{\Delta V_{in}} \qquad (9)$$

The peak r-f current which the r-f amplifier used in the experiments could supply was 12 ma., with source impedance of about 100,000 ohms. There are three independent variables which determine the power output per unit input voltage of the dielectric amplifier, viz. the Q of the components, the current output of the r-f power source, and the r-f voltage at which the condensers have their maximum non-linearity. As noted above, increasing the r-f

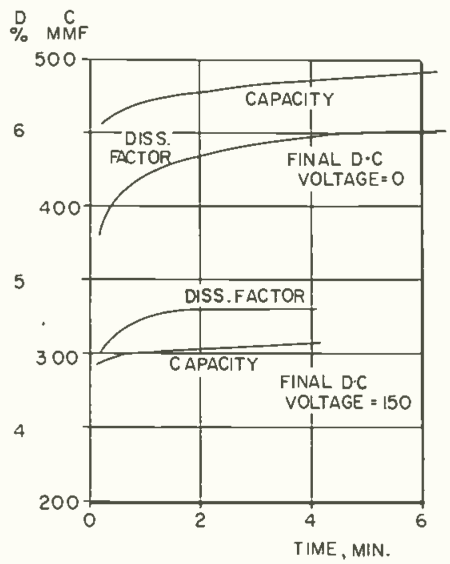

Fig. 9: Voltage sensitive capacitor drift

voltage would have the opposite effects of directly increasing the amount of r-f power from which the signal output is recovered, while at the same time reducing the sensitivity of the condensers and hence directly reducing the gain. Using a coil with higher Q will increase the voltage across the condensers; it is anticipated that a small increase in Q will improve the gain, since the output is directly proportional to the r-f voltage and hence to the Q, while the change in condenser sensitivity with r-f voltage is as diagrammed in Fig. 8. With a Q of 27 and an r-f current of 12 ma., the voltage across the condensers at resonance is

$$E_o = \frac{I\, Q}{\omega_o\, C}$$

and at the maximum-sensitivity point, from the universal resonance curve,

$$E = \frac{0.7\, I\, Q}{\omega_o\, C} = 36 \text{ v.}$$

which is quite close to the desired value of 40 v. If the Q had been higher or lower than 27, then the resulting difference in the r-f voltage would have required a respectively lower or higher value of load resistance than the calculated optimum, in order to obtain the best gain from the amplifier. If the relationship between the voltage-sensitivity of the capacitor and the r-f voltage across the capacitor is included in the above analysis, it will be discovered that a resistance somewhat lower than 3 times the resonant circuit resistance is required for maximum power gain. In view of the errors introduced by the original assumptions, it was not considered worthwhile to include this refinement in the analysis.

A calculation of the voltage gain of the dielectric amplifier from Eq. 9 gives

$$\frac{\Delta E}{\Delta V_{in}} = 1.3$$

and the measured gain was 1.1. For an input of 1 v., the output power would be

$$P_o = \frac{1.1^2}{12{,}000} = 10^{-4} \text{ watt}$$

The input dissipation factor is 2% at 1000 CPS, corresponding to a resistance of 200 megohms. At 1 v., the input power is $1/(2\times10^7) = 5\times10^{-8}$ watt, for a power gain of 2×10^3.

Voltage-History

It was noted in the course of the work that the results of a given series of measurements could not be repeated at a later time. Further investigation revealed that the characteristics of a non-linear condenser are not only a function of the applied voltages and temperature, but also of the history of voltages applied. The capacitance and dissipation factor as measured immediately after a set of voltages are applied are considerably different from the same quantities measured at a later time, with no change having been made in any of the parameters in the meantime. The amount of drift of these quantities depends on the difference between the initial and final voltages. The direction of the capacitance drift was opposite to the dissipation factor in all cases. However, the two types of commercially-available condensers, the Mucon type VSR and the Radiation, Inc. type R2-226, exhibited drifts in opposite directions. Fig. 9 is a plot of the drift of the Mucon type VSR voltage-sensitive condenser after 150 vdc is applied, and after 150 vdc is removed. Note that the dissipation factor appears to reach a steady state in about 6 mins., and that at that time the capacitance has changed the greater part of its eventual change. No explanation for this phenomenon has been found to date. The effect of temperature is at present being investigated.

New IBM Control System Tightens Plant Operation

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The system operates over existing lines in the plant or building, using carrier-current pulsed signals having a strength of approximately ½v. The frequencies used are in the audio range; how many frequencies used will depend upon the number of functions being controlled, and the time sequence of their operation.

Control over the entire system is provided by a central control panel. In addition to providing immediate manual control over the various remote-controlled units, this panel also provides a continuous indication of the on-off status of the different machines or functions, and is the housing for the coding transmitter and programming device. The latter is a revolving drum in which are inserted toothed bars, the programming being determined by the positioning of the particular teeth.

Prices for the system range upward from $1,100, the final cost being determined by the number of functions to be controlled and the number of actuating relays which will be installed at the remote-controlled machines.

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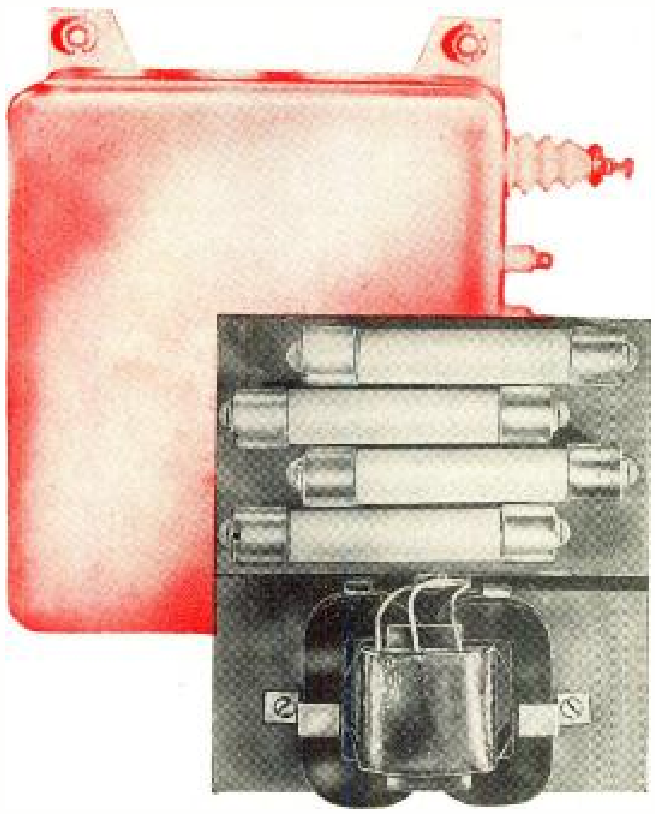

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This versatile component is ideal for any application, military or commercial, where space and weight are critical factors . . . and it is typical of the unique components produced by Keystone to meet unusual standards of performance, adaptability and reliability. Each is a custom-engineered unit designed to solve specific problems which standard transformers or magnetic amplifiers cannot solve.

If you have an application for a low-input D.C. power supply like the one above—or if you have an unusual specification demanding unique performance from a transformer or magnetic amplifier—contact the Engineering Department today.

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This new brochure describes and illustrates a wide variety of transformers and magnetic amplifiers produced to meet unusual and difficult specifications.

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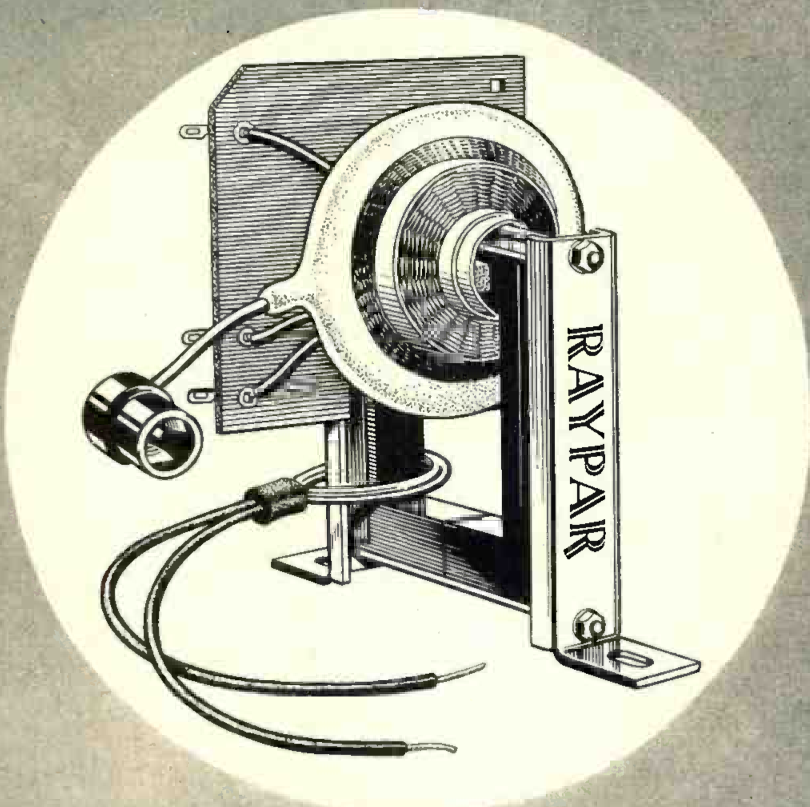
Another RAYPAR FIRST...

27" HORIZONTAL OUTPUT TRANSFORMER FOR 90° DEFLECTION ANGLE



Raypar's newly developed 27" horizontal output transformer is a perfect example of RAYPAR'S electronic knowledge to produce uniform components of consistent quality for radio and television.

RAYPAR'S HORIZONTAL OUTPUT TRANSFORMER gives the following advantages:

(1) High efficiency drive circuit application.
(2) Output voltage . . . . 18,000 volts.
(3) Full scan at low line voltages.
(4) Various types of mountings available.
(5) Always quality workmanship.

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SERVING AMERICA'S LEADING RADIO & TV MANUFACTURERS

Cues For Broadcasters

(Continued from page 101)

piece of heavy coat-hanger wire. The wire is bent into a loop at the pivot end, and the other end is bent up through the switch slot, where, after inserting through hole "B," it can be soldered into a drilled piece of quarter-inch shafting for a control knob. The shafting is locked in the knob so that the wire rubs slightly against the metal chassis to hold the leverage assembly in any position in which it is placed.

A small, notched piece of metal, such as heavy sheet copper, must be soldered to the end of the metal arm which carries the idler wheel. The "bent up" edge of the curved lever arm catches in this notch to retract the idler. The soldering must be done carefully in order to get a strong joint with no surplus solder, but this is not as hard to accomplish as it might appear. When the idler is retracted, the added piece, unless it is kept small, may hit the knob which secures the turntable.

The red cap is removed from the spindle, which is then sawed through with a hack-saw at such a point as to just nick the hollow steel shaft at its upper end. A beveled edge is cut around the top of the spindle with a grinding wheel or file, and the top is sanded smooth.

The resulting turntable is small, light, and easier to operate than most of the large transcription turntables, while providing equal or even superior performance.

COAST AES OFFICERS

New officers of Los Angeles Section, Audio Engineering Society, for 1955 are: (l to r) Thomas Gibbons, Treas.; Olin Dupy, Vice Chairman; Sidney Alder, Chairman; Fritz Held, Secretary

Basic Electronics

By Van Valkenburgh, Nooger & Neville, Inc. Published 1955 by John F. Rider Publisher, Inc., 480 Canal St., New York 13, N.Y. Five volumes, 560 pages. Price $9.00 per set or $2.00 per volume. Texts of courses currently taught in Navy specialty schools now released for civilian use. Text covering entire gamut of electronic art, including tubes, amplifiers, oscillators, transmitters, antennas, receivers and antennas, is supplemented with abundant illustrations.

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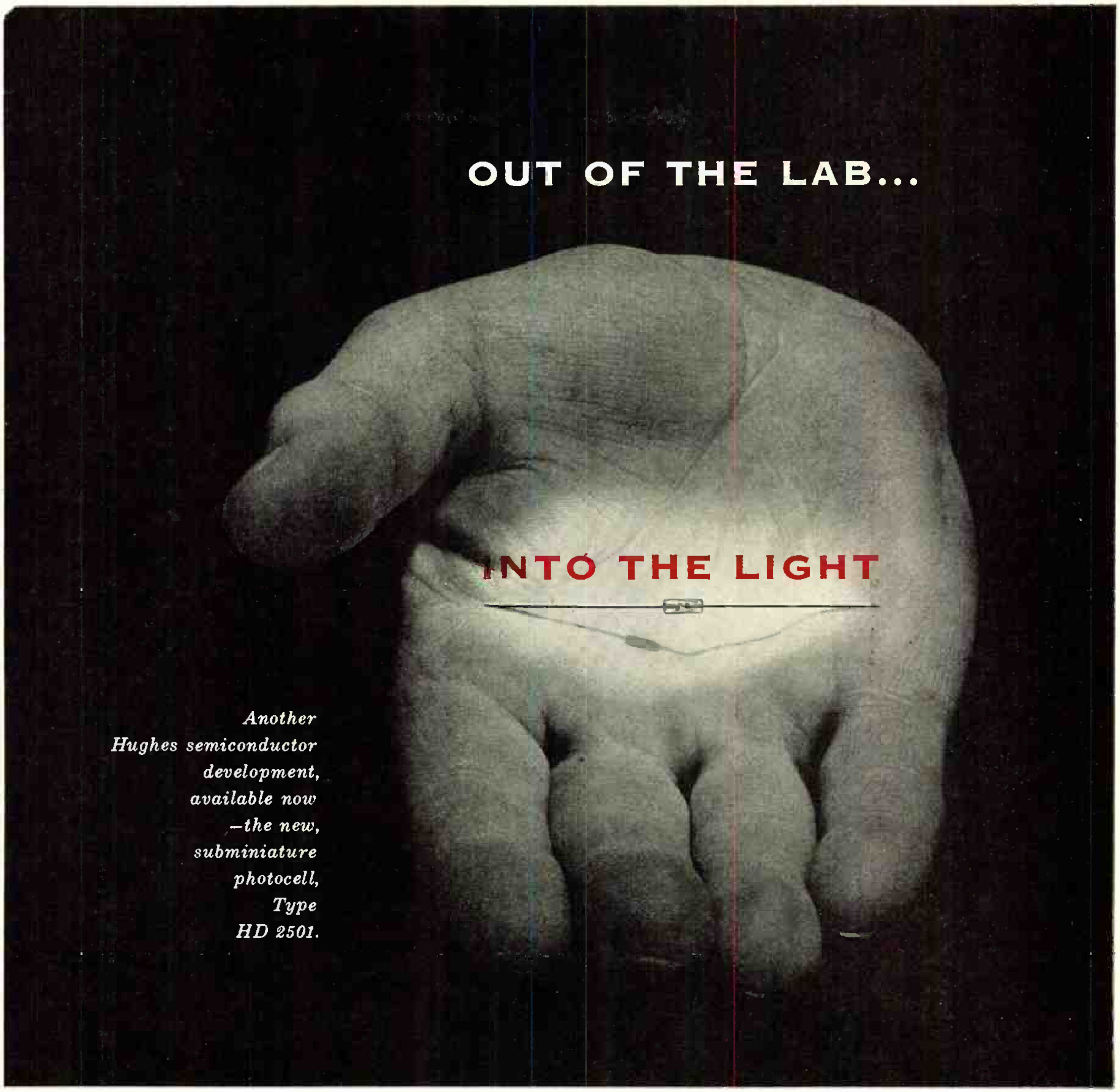

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VERSATILE—non-directional sensitivity (360°) and photovoltaic properties lend unusual flexibility in equipment design.

RUGGED—welded whisker construction withstands severe shock, vibration, and acceleration.

RELIABLE—packaged in the famous Hughes one-piece glass envelope, impervious to moisture and external contamination. A 100% testing ensures uniformity of characteristics.

Hughes Type HD 2501 germanium point-contact photocell can be used as a light detector in card readers, binary encoding and decoding wheels, motion picture sound—and for near infrared applications. Because of this infrared response, tungsten light sources can be operated at voltages below normal and their effective life increased accordingly.

For other diode applications in high and low temperature ranges, be sure to check the growing family of Hughes semiconductors. Scores of types of germanium point-contact and silicon junction diodes are available in RETMA, JAN, and Special listings.

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Photocell dimensions, glass envelope
Length: 0.263-inch, maximum
Diameter: 0.086-inch, maximum

TYPE HD 2501 PHOTOCELL—SOME CHARACTERISTICS AT 25° C.

Dynamic Breakdown Voltage: 175 Volts, minimum.
Maximum Dark Current: 20 μA at 50 Volts.
Minimum Sensitivity: 1mA/L at 50 Volts and 25 ML.
Dynamic Resistance: 1 megohm at 50 Volts and 25 ML.

For product information, use inquiry card on last page.

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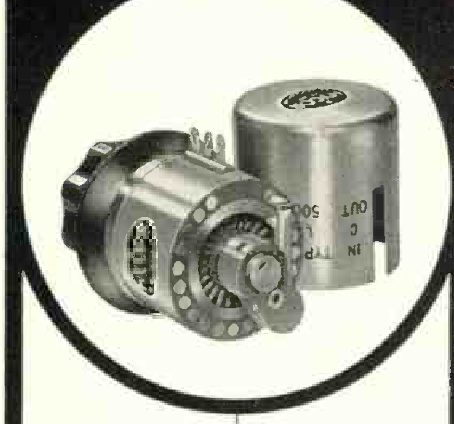

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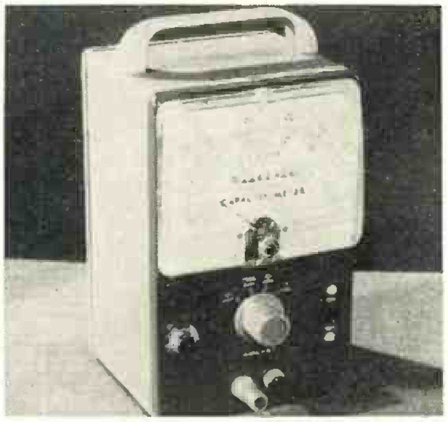
CAPACITY METER

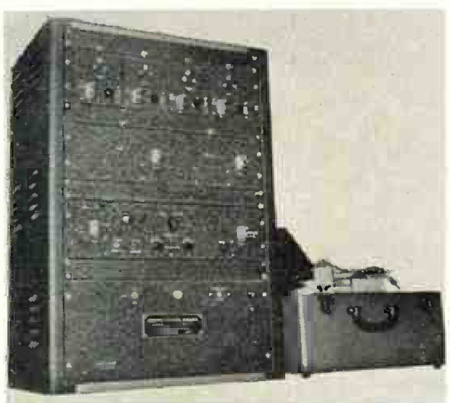
The Model CM-1 direct-reading capacity meter, used extensively in quality control and production line testing, measures capacity directly without calculation from 100 μμf to 0.10 μf. The



unit is simply connected to binding posts, the correct range selected, and the capacity value is read on the 4½ in. meter. Residual capacity is less than 1.0 μμf. The instrument is not subject to hand-capacity effects. Lowest range will even indicate capacity of tuning capacitor as it is rotated. **Heath Co., 305 Territorial Rd, Benton Harbor, Mich.** TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-55)

4-CHANNEL RECORDER

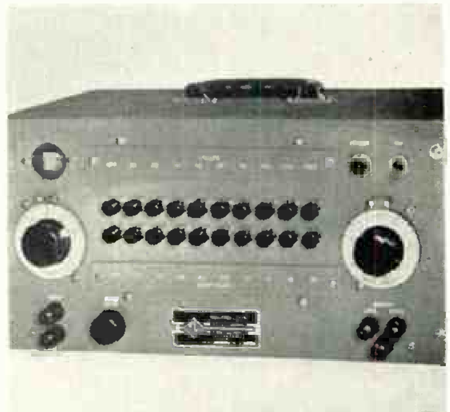
The Type 104 transient recorder is capable of magnetically recording up to 4 signals simultaneously. Provides a frequency response of dc to 2 kc, a 1-second record period, and simultaneous playback of any two channels. Features use of magnetic discs that can be stored, or erased and used again. Any two recorded equipment transients can be



viewed on a dual beam oscilloscope, thus enabling direct comparison. The unit records and erases continuously in the absence of a transient. **Magne-Pulse Corp., 140 Nassau St., New York 38, N.Y.** TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-54)

TEST OSCILLATOR

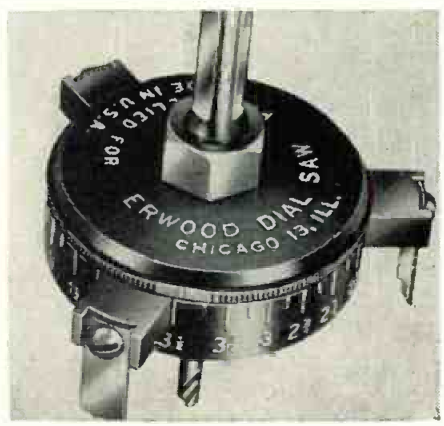
Any of 19 different pre-selected frequencies in the range from 20 CPS to 20 kc can be selected by push-button controls on the Model TO-100A push button test oscillator. A deviation dial



permits calibrated deviation from the center frequencies up to ± 10%. The output frequencies include those recommended by the FCC for distortion measurements on broadcast transmitters. Output amplitude is calibrated from 1 to 25 v. open circuit from 600 ohm source. Wave form distortion at 18 mw output is less than 0.25% above 100 CPS, 0.5% below. **Teletronics Laboratory Inc. 54 Kinkel St., Westbury, L.I., N.Y.** TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-51)

DIAL SAW

The new No. 400 dial saw has a larger capacity than the previous model. Cuts holes from 1⅛ in. to 3½ in. diameter in steel, copper, brass, aluminum, plastics, wood, and other materials. Each No. 400 is complete with pilot drill and



three sets of cutting blades—one for ⅜ in. depth steels, one for non-ferrous metals and plastics, one with 1 in. depth for wood and similar materials. **Erwood, Inc., 1770 Berteau Ave., Chicago 13, Ill.** TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-52)

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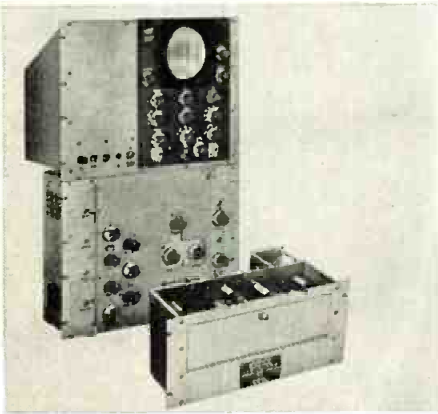
Industries

PHASE CERTIFICATION

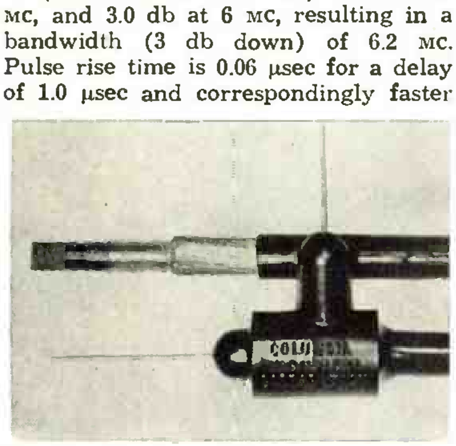
Two new equipments, a Vectorscope and a Subcarrier Regenerator, provide easier color TV phase certification for operating personnel. The Model 1811 Vectorscope presents a continuous,



easy-to-analyze, illuminated display of phase angles and amplitudes of the color signal. A self-checking feature assures reliability. Signal inputs required are composite video and CW subcarrier. The Model 1812 Subcarrier Regenerator supplies a CW subcarrier output locked in phase (—1.0 degrees) with color burst contained in composite video input. Pull-in time over 300 CPS range is less than 1.0 second. Also features a convenient field-rate sync output. **Hazeltine Electronics Corp., 58-25 Little Neck Pkway., Little Neck, N.Y.** TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-53)

DELAY CABLE

The Type HH-4000 delay cable has a nominal characteristic impedance of 4,000 ohms and a time delay of 1.0 μsec/ft. The attenuation for a delay of 1.0 μsec is 0.2 db at 1 MC, 1.2 db at 4 MC, and 3.0 db at 6 MC, resulting in a bandwidth (3 db down) of 6.2 MC. Pulse rise time is 0.06 μsec for a delay of 1.0 μsec and correspondingly faster



for shorter time delays. A polyvinyl chloride jacket protects the cable from moisture and abrasion. O.D., 0.32 in. **Columbia Technical Corp., 5 East 57th St., New York 22, N.Y.** TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 4-50)

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A NEW LAMINATING PROCESS FOR FLUSH "PRINTED" CIRCUITRY

We can supply either the fabricated plates and discs or complete electro-mechanical assemblies.

Photocircuits Corporation has pioneered printed-etched circuitry processes and now offers long enduring flush surfaced (bounceless) conductor configuration and Melamine to satisfy the most exacting specifications. The "Melacon" Process represents Photocircuits Corporation's newest achievement in coplanar electro-formed circuitry, resulting in low costs for the most complex or the simpler patterns.

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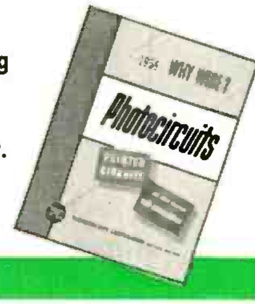

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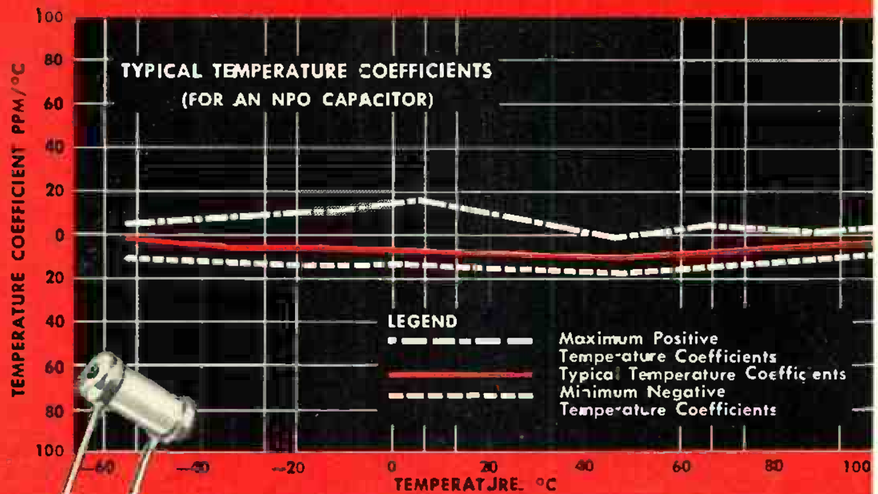

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"Mylar" Film

(*Continued from page 114*)

Capacitor manufacturers have evaluated "Mylar" mainly on the basis of accelerated life tests. Accelerated life testing is based on the assumption that capacitors ultimately fail due to electrochemical deterioration and that the decomposition reaction can be accelerated a controlled amount through increased voltages and temperatures.

As indicated previously, no attempt has been made to derive a rating schedule for a commercial line of capacitors using "Mylar" as the dielectric. The extremes of service for which modern capacitors are manufactured, the wide range of techniques available to the capacitor designer, and the information and data shown, indicate that a complete evaluation study would be extremely complex.

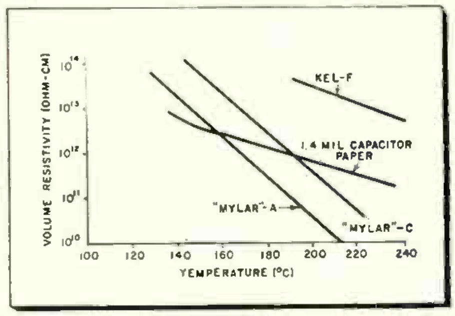

Fig. 6: Volume resistivity characteristics

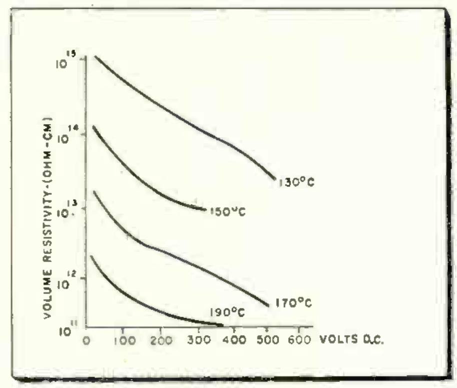

Fig. 7: Mylar volume resistivity parameters

Manufacturing

However, the techniques of manufacture, incidental to practical utilization of the dielectric, may be of prime importance to the service obtained from "Mylar" capacitors. The factors involved which play such an important part include winding, tab and foil electrode design, filling, canning, sealing, etc. These practices vary between manufacturers and they lead to

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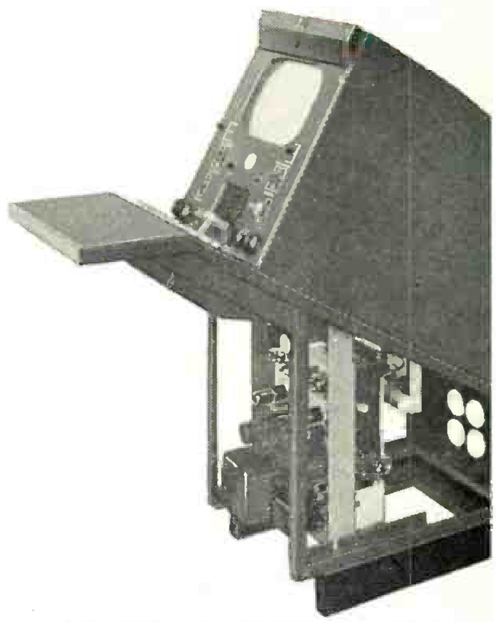
Extra Program Versatility from NEW RCA TS-11A Switcher

The TS-11A is a "nine-input" switcher designed to handle composite or non-composite video switching for color or monochrome. Two rows of push buttons feed a manual fader assembly; a third row feeds a preview channel. A program transfer switch is provided to interchange the preview and fader busses with the output busses so that the fader section can be used for previewing fades, lap dissolves and superimpositions. This makes it possible to use the fader channels for rehearsals while the preview channel handles the "on-air" signal. The fader assembly feeds a mixing circuit and three output amplifiers which are a part of the TS-11A, eliminating the need for installing elaborate distribution amplifier systems external to the switcher. The new switcher is free of microphonics and low frequency tilt and bounce, so that a stabilizing amplifier need not be added as part of the switching system.

For further information about this exclusive RCA development get in touch with your RCA Broadcast Sales Representative. In Canada, write RCA Victor Ltd., Montreal.



The TS-11A Switcher is supplied with an RCA console housing (MI-26266-B), a TM-6B master monitor and power supplies to form a complete versatile system.

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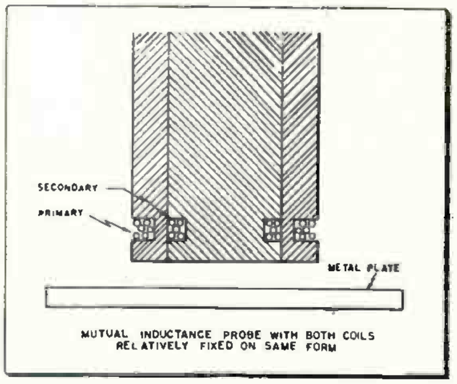

Fig. 5: Schematic of typical mutual inductance probe. Primary and secondary are fixed in relation to each other

(8) The ratio of the secondary coil radius to the primary coil radius should be as large as possible.

(9) The primary coil should be as large as possible. However, for linear response with displacement, it should not be larger than the reference plate.

All of these recommendations refer to probes designed for static measurements. However, no error results from using static considerations when making measurements on vibrating reference plates, if the highest mechanical frequency is less than the electrical frequency.

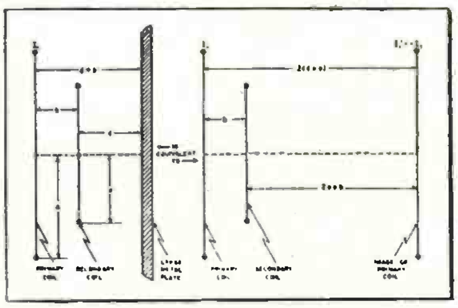

Fig. 6: Diagram demonstrating theory of images. Two coils and plate are at left. Equivalent three coil system is at right where reference plate becomes image coil

Another aspect of the investigation has been the application of electrodynamic similitude to reduce the amount of experimental work required for the design and construction of probes. Electrodynamic similitude is a method for changing design parameters of a given dimension (such as length or plate conductivity) by a scale factor so that the original output voltage can be maintained by properly altering all parameters of other dimensions. Scaling thus permits a probe of convenient size to be used for experiments instead of one which is too large or too small for ease of handling or fabrication.

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(Continued from page 83)

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(Continued on page 170)

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"Mylar" Film

(Continued from page 130)

some difference of opinion as to rating.

On the basis of a number of limited accelerated life tests indications are that, with a flash dielectric strength test of 2½ times rated voltage, uncased and unfilled single-layer 25 "Mylar" C polyester film capacitors can be operated continuously as follows:

TEMPERATURE °C	VOLTS DC
90	250
130	100
150	75

The ratings indicated above are based on a service life of about one year. It is felt that they are conservative and can be greatly increased in many special cases of importance, particularly for units where short life expectancy is satisfactory.

Metalized Paper Capacitors

Metalized paper capacitors are now commercially available, and the metalizing technique has also been applied to "Mylar." It appears that the potential for capacitors using metalized "Mylar" will eventually equal that of capacitors using "Mylar" polyester film and aluminum foil.

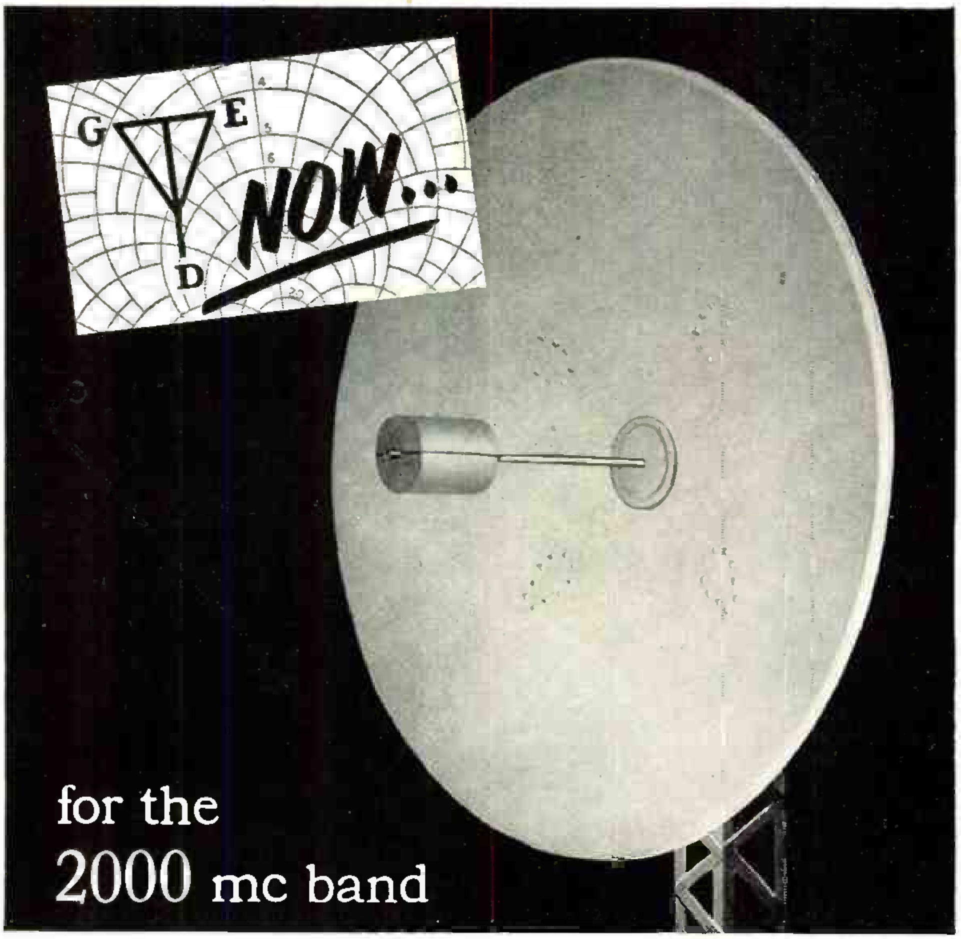
Closed Circuit TV

(Continued from page 112)

are two crossing spirals, one going outwards and the other inwards. There is no return time, and hence no loss. The two crossing spirals may produce a more or less pronounced spiderweb pattern, but, contrary to what might be expected, do not produce a pattern of bright points at the spirals crossings. The advantage of the bispiral is important in a simple system of color ITV: the outgoing spiral is used for green-blue, and the return spiral is used for orange-red. This gives a bichromatic color ITV. The process can easily be extended to higher orders, giving a real color TV.

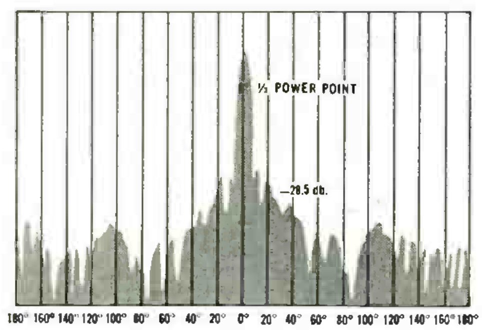
Similarly, one spiral has been used for left-eye, and the other for right-eye view, in a "3D—ITV" system.

An interlaced spiral scanning is obtained quite simply through a flip-flop, which fires every two scans and shifts the zero starting point by an amount equivalent to half the spiral pitch.

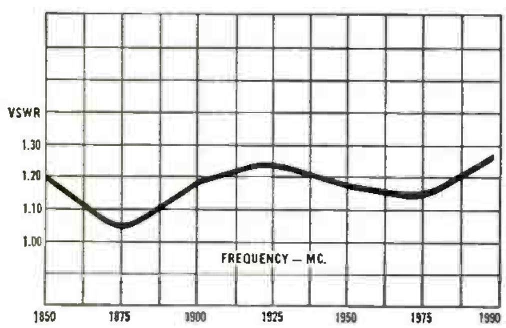


Model 2K6CF
6-ft. Parabolic Antenna

new **GABRIEL**
narrow beam parabolic antenna



Model 2K6CF Beam Pattern, E. Plane, at 1920 MC



VSWR for Model 2K6CF with radome

- Low Side and Back Lobes
- Low VSWR
- High Gain
- Pressurized and Weatherized
- Easily Installed

For non-interfering operation in the crowded 2000 mc microwave relay band, Gabriel announces a radically new antenna with highly directive feed. A combined dipole-corner reflector unit, developed by the famous Gabriel Laboratories, remarkably improved primary radiation pattern, and secondary radiation pattern is 3 db better than the various types of previous feeds.

Visit us at the I.R.E. Show — Booth 193-195

For detailed specifications, write for Bulletin GF.

GABRIEL · ELECTRONICS DIVISION

THE GABRIEL COMPANY, Endicott Street, Norwood, Mass.

For product information, use inquiry card on last page.

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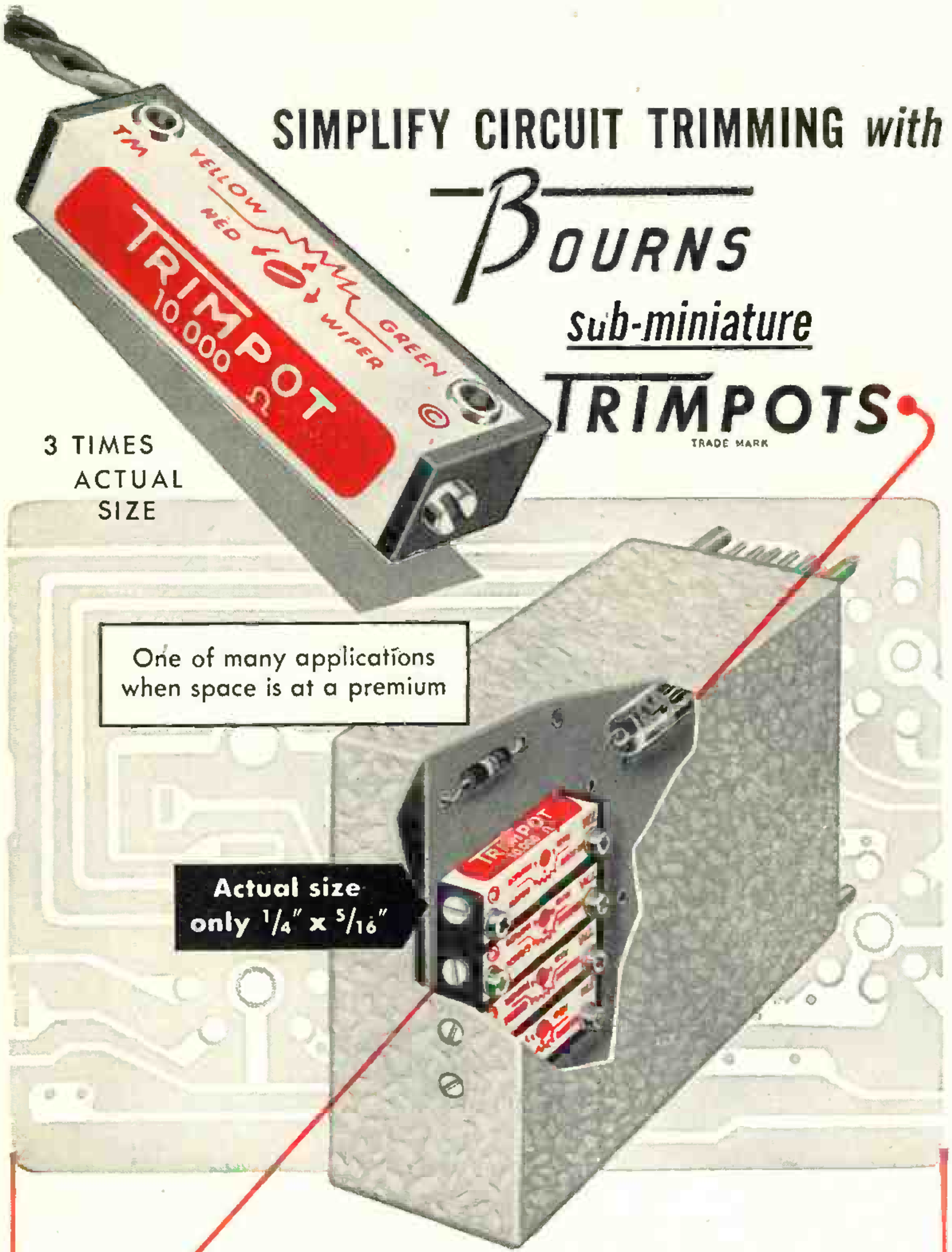

- RESOLUTION: AS LOW AS 0.25%
- POWER RATING: 0.25 WATT AT 100° F.
- WEIGHT: ONLY 0.1 OZ.

BOURNS TRIMPOT is a 25 turn, fully adjustable wire-wound potentiometer, designed and manufactured exclusively by BOURNS LABORATORIES. This rugged, precision instrument, developed expressly for trimming or balancing electrical circuits in miniaturized equipment, is accepted as a standard component by aircraft and missile manufacturers and major industrial organizations.

Accurate electrical adjustments are easily made by turning the exposed slotted shaft with a screw driver. Self-locking feature of the shaft eliminates awkward lock-nuts. Electrical settings are securely maintained during vibration of 20 G's up to 2,000 cps or sustained acceleration of 100 G's. BOURNS TRIMPOTS may be mounted individually or in stacked assemblies with two standard screws through the body eyelets. Immediate delivery is available in standard resistance values from 10 ohms to 20,000 ohms. BOURNS TRIMPOTS can also be furnished with various modifications including dual outputs, special resistances and extended shafts.

BOURNS *also manufactures precision potentiometers to measure Linear Motion; Gage, Absolute, and Differential Pressure and Acceleration*

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Technical Bulletin On Request, Dept. 172

Fuses

(*Continued from page 118*)

may have little value to industry because of other short-comings. Hence, its tests determine only the safety of the fuses. All fuses are tested under the same standard for fuses and all that meet the requirements of this standard may be listed by the Underwriters' Laboratories. This standard requires that small dimension fuses shall carry 110% load indefinitely, open at 135% load within 60 min., open at 200% load within 2 min., and withstand a 10,000 amp. d.c. short-circuit at rated voltage. The standard does not go beyond these requirements in establishing the time-current characteristic of the fuses because any fuse meeting these requirements will not create a fire hazard if applied properly.

Time Current

However, both fast acting glass tube fuses and fuses with long time lag meet the Underwriters' Laboratories standard for fuses but their time-current characteristics are entirely different. To illustrate, a one ampere fast-acting fuse will carry 1.1 amps indefinitely, will open at 1.35 amps. within one hour, will open at 2 amps. within 2 min. but will blow at 300% load, or 3 amps., in approximately 0.1 sec. Any harmless transient load would cause the fuse to operate if it is continued for this length of time.

The fuses with long time lag, or dual-element fuses, have a fuse link which operates only on the high overloads or short-circuits and have a thermal cutout which operates at the lower overloads to give the required time lag. These fuses are furnished in the same physical dimensions as the fast-acting fuses even though they combine the two elements in a single fuse casing.

The fuses with long time lag also meet the Underwriters' Laboratories Standard for fuses. A 1 amp. fuse will carry 1.1 amps. indefinitely, will open at 1.35 amps. within one hour, and will open at 2 amps. within 2 minutes just as the fast-acting fuse did. However, at 300% load the fuse with long time lag will hold the three amps. for 8 sec. before blowing whereas the fast-acting fuse opened in approximately 0.1 sec. The long time lag fuse will carry the harmless transient currents which blew the fast-acting fuse but, if the overload is caused by some faulty condition, the fuse will blow to clear the circuit

(*Continued on page 136*)

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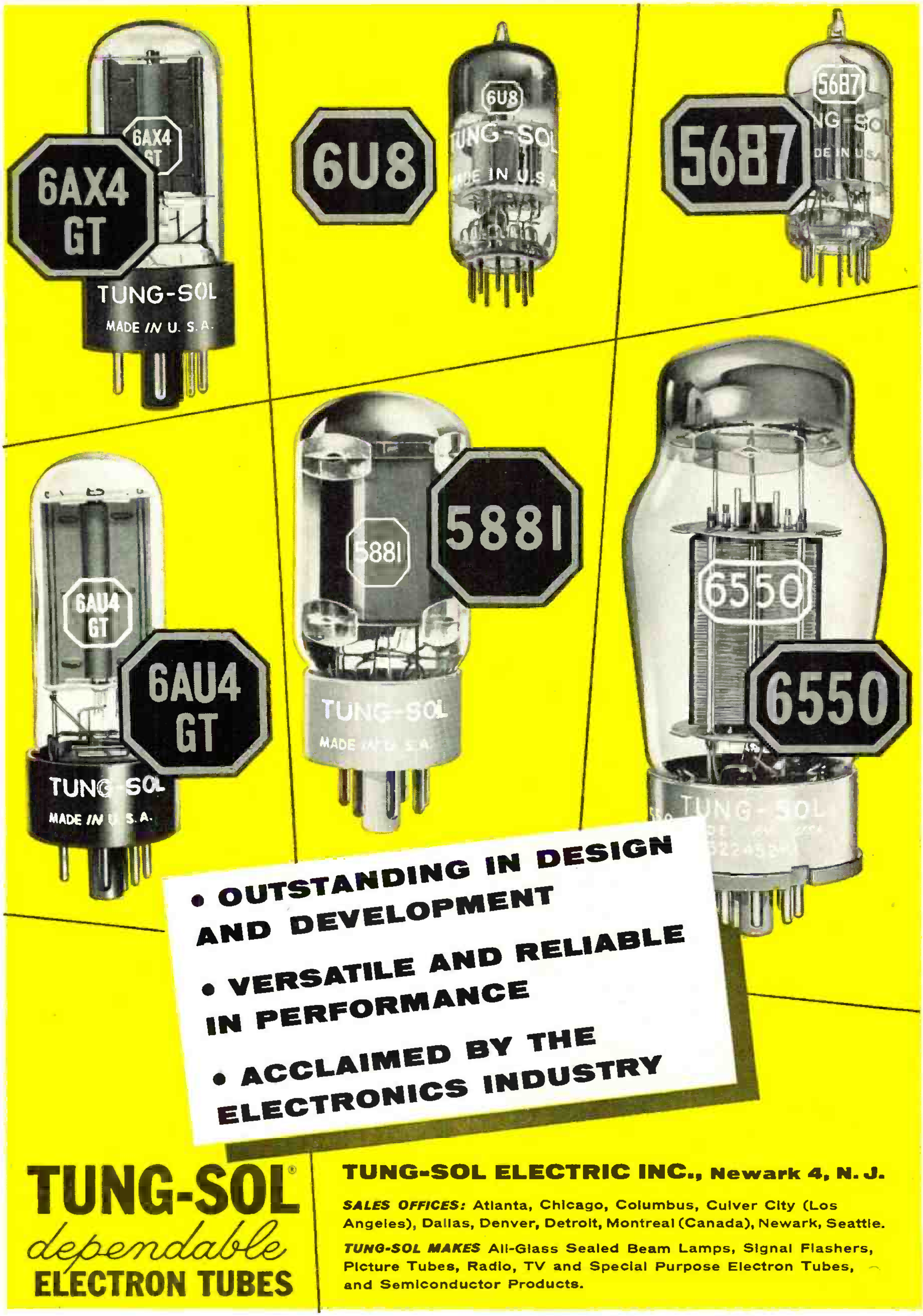

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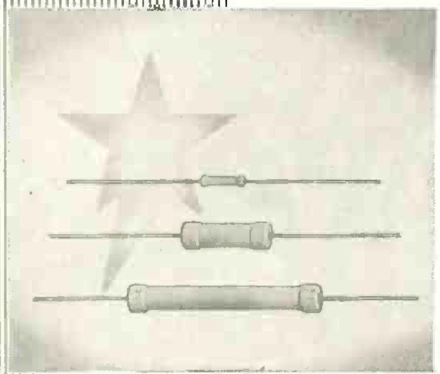
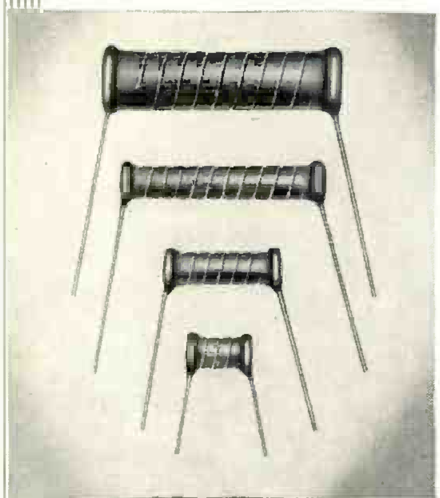
METAL FILM RESISTORS



with axial leads
(TYPE NA)



or radial leads
(TYPE NR)

INITIAL ACCURACY

EXCELLENT STABILITY

MOISTURE RESISTANT

PATENTED BY CONTINENTAL

The two types of terminals make possible a wider range of application. A layer of vitreous enamel protects metal film against unusual atmosphere conditions. The NOBLETTE type NA is available in 1/2, 1 and 2 watt, in resistance range of 1 ohm to 10 megohms. NOBLELOY type NR in 1/2, 1, 2 and 5 watt, in resistance range of 1 ohm to 15 megohms. Both types in standard tolerances of 1, 2 and 5%, available in 1/2 % on special order.

WM WIRE WOUND RESISTORS

Composed with a minimum of .0015 inch wire that is wound in true parallel winding to prevent shorting at turns. They are available in RETMA standard values in 1/3, 1/2 and 1 watt.

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CONTINENTAL CARBON, INC.
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Fuses

(Continued from page 134)

before the device it is protecting is damaged.

The fast-acting and time lag fuses, with their fuseholders, developed to provide positive electrical protection for television receivers are shown in Fig. 1. The bakelite body of the fuseholder for the fast-acting fuses, known as type C, and the time lag fuses, known as type N, is the same. A spring steel fastener is mounted on the shank of the fuseholder at the factory so that it can be snapped into a key-hole in the television chassis and held firmly without the use of special tools. Since the body is the same for both types of fuses the television manufacturer can punch a single hole in his chassis and change the ampere rating or type of fuse by merely changing the holder without changing his tooling.

Fuseholder Body

When the fuseholder body is snapped into place on the television chassis the shoulder on the body seats on the top of the chassis but both terminals are on the underside thereby simplifying the wiring of the device. One terminal is an extension of the bayonet socket at the top of the holder and the other an extension of the movable contact, surrounded by a coil spring, at the bottom of the holder. The bakelite key which prevents the holder from rotating in the key-hole in the chassis surrounds the side terminal and insulates it from the chassis.

The spring and movable contact are designed so that the fuseholder will take fuses 1 1/16 in. long, 1 1/4 in. long, and 1 7/16 in. long but only one length will fit in a particular holder. In other words, fuses 1 1/16 in. long will not make circuit in the fuseholder designed for 1 1/4 in. long fuses, and fuses 1 7/16 in. long will not even enter the holder for 1 1/4 in. fuses. Hence, one means of separation is obtained by the rejection feature resulting from the use of fuses of three different lengths.

To obtain greater separation the width of the slots in the bayonet socket on the fuseholder is varied. By varying the width of the slots from 0.060 in. to 0.180 in. in steps of 0.020 in., seven additional means of separation result.

As shown in Fig. 2, the fuses are furnished in three lengths and the ferrule on one end is provided with ears, ranging in width from 0.060 in. to 0.180 in., which engage the bay-

(Continued on page 138)

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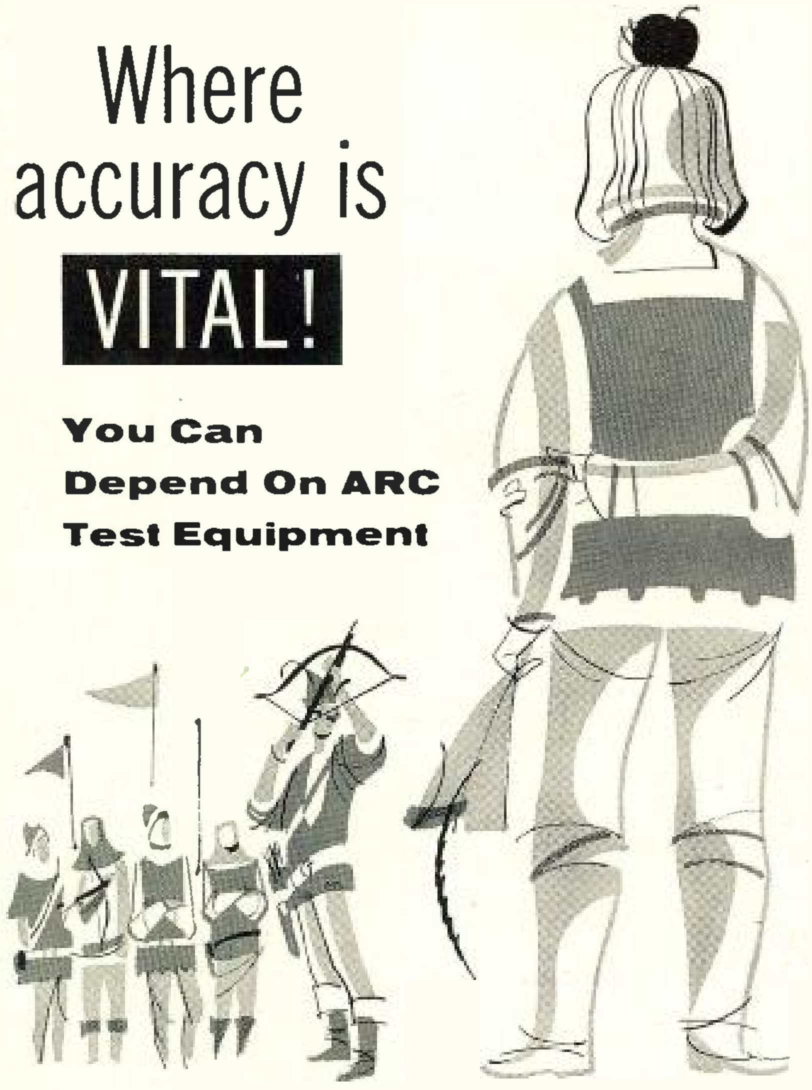
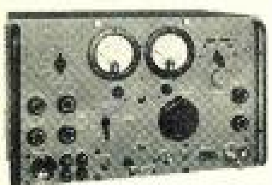
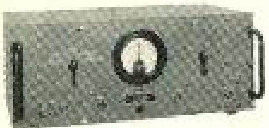
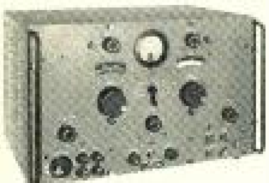




Type H-14A Signal Generator



Type H-16 Standard Course Checker



Type H-12 UHF Signal Generator

The Type H-14A Signal Generator has two uses: (1) It provides a sure and simple means of checking omnirange and localizer receivers in aircraft on the field, by sending out a continuous test identifying signal on hangar antenna. Tuned to this signal, individual pilots or whole squadrons can test their own equipment. The instrument permits voice transmission simultaneous with radio signal. (2) It is widely used for making quantitative measurements on the bench during receiver equipment maintenance.

The H-16 Standard Course Checker measures the accuracy of the indicated omni course in ARC's H-14A or other omni signal generator to better than ½ degree. It has a built-in method of checking its own precision.

Type H-12 Signal Generator (900-2100 mc) is equal to military TS-419/U, and provides a reliable source of CW or pulsed rf. Internal circuits provide for control of width, rate and delay of internally-generated pulses. Complete specifications furnished on request.

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Fuses

(*Continued from page* 136)

onet socket in the fuseholder. Fuses having ears wider than the slots in the bayonet socket will not enter but fuses of the same length having narrower ears will enter. Hence, the ears on the fuse do not provide complete separation but, if the narrower ears are used for the fuses of lower rating the condition results that the user can insert a smaller fuse in his fuseholder but never a larger one. This will never create a hazard and only will result in greater protection or, at worst, unnecessary fuse blowing.

As shown in Table I, the fast-acting, or Type C fuses, are furnished in ratings of 10 amps. or less, at 250 volts or less. Fuses rated at 3½ amps. or less are 1$\frac{1}{16}$ in. long and fuses from 3$\frac{6}{10}$ to 10 amps. are 1¼ in. long. Ten type HC fuseholders cover the range for the Type C fuse. All have the same body but rejection is obtained by the fuse length and width of the ears on the fuse ferrule.

The time lag, or Type N, fuses are furnished in ratings of 1¼ amps. or less, at 250 v. or less, and from 1$\frac{3}{10}$ to 7 amps. rated at 125 v. or less. The fuses 1¼ amps. or less are 1¼ in. long and fuses from 1$\frac{6}{10}$ to 7 amps. are 1$\frac{7}{16}$ in. long. Nine type HN fuseholders cover the range for the Type N fuses. The intermediate steps are obtained by varying the width of the slot in the bayonet socket of the fuseholder and the width of the ear on the fuse ferrule.

Positive identification of the fuseholder and fuse is provided by stamping the type and ampere range on the socket of the fuseholder and the type and ampere rating on the end of the fuse eared cap. In other words, the socket of the fuseholder for the 1¼ to 1¾ amp. fast-acting fuses is stamped "HC 1¼ to 1¾" and the 1¾ amp fast-acting fuse has its eared cap stamped "C 1¾" on its end. Since the eared cap projects from the fuseholder, above the chassis, when the device is installed in the set the replacement problem is simple. Both the rating of the fuse and the fuseholder are readily determined before removing the fuse and, if the improper fuse which may create a hazard is substituted in spite of the marking, it will not fit.

To simplify the original assembly of the fuse and fuseholder in the set, the fuseholder is furnished with the proper fuse already assembled in it so that the complete unit can be snapped into the hole in the chassis in one operation without the use of special tools.

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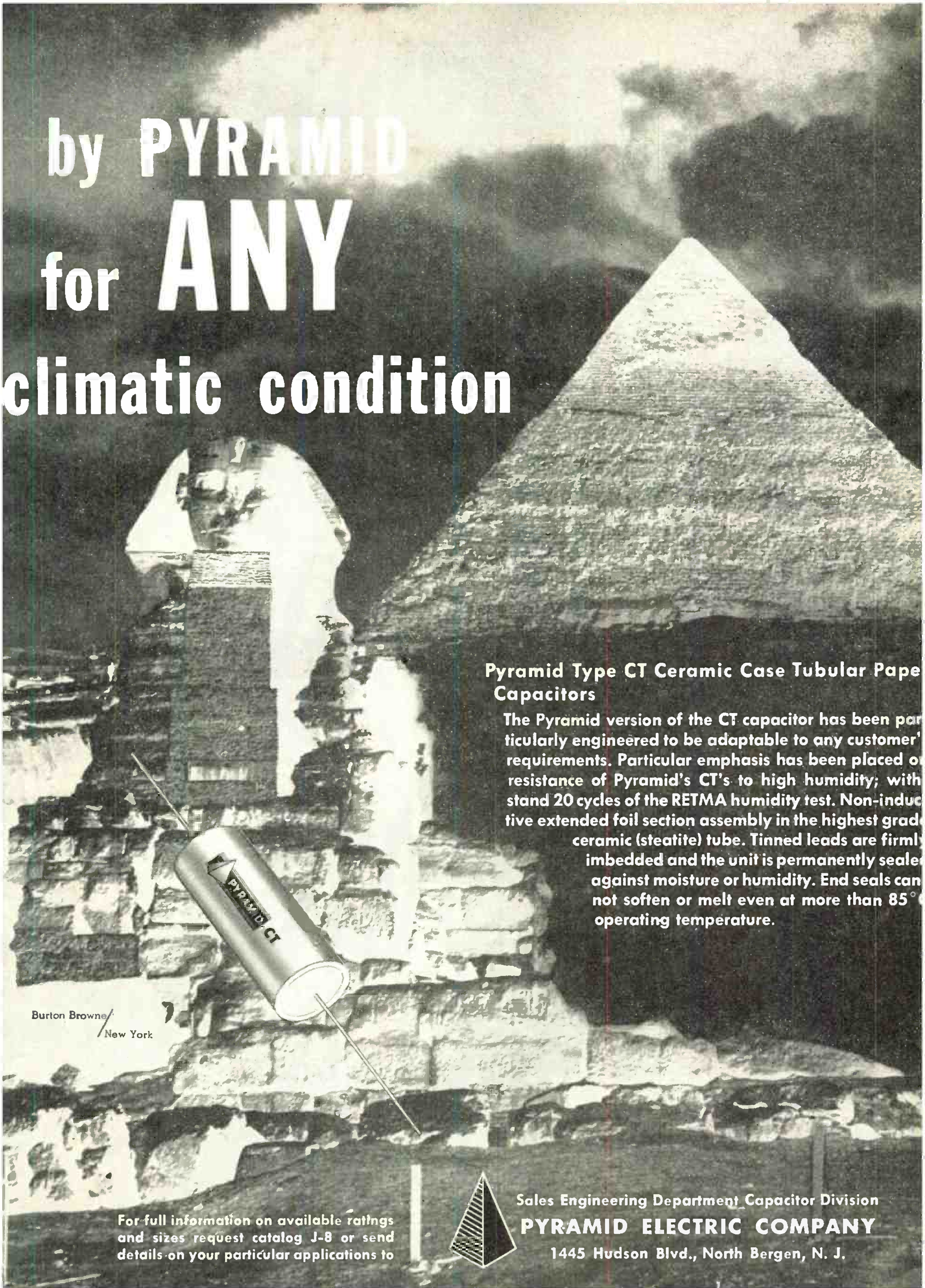

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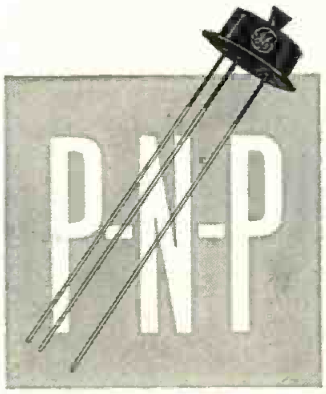

TYPE 2N43A

In military and commercial applications these G-E transistors offer precision quality, topmost reliability at mass-volume prices!

General Electric's P-N-P junction transistor, 2N43A, is the first to be written into Air Force specifications! MIL-T-25096 (USAF) was actually written around this G-E product which was developed for the military. Now it serves an ever-increasing number of commercial as well as military applications.

APPLICATIONS AND SPECIFICATIONS

TYPICAL USES: Audio and Intercom Amplifiers, Servo Amplifiers, Carrier Current Amplifiers, Test Equipment, Fuel Gauges.

SPECIFICATIONS OF THE 2N43A and USAF 2N43A

Absolute Maximum Ratings:

Collector Voltage (Referred to base)	−45 volts
Collector Current	−50 ma
Collector Dissipation	150 mw
Storage Temperature	100° C
Collector Cutoff Current (−45 volts)	−10 microamps

DESIGN FEATURES:

STURDY CONSTRUCTION... meets critical military tests for shock, vibration, humidity, life.

SEALED JUNCTION... contamination gases permanently eliminated!

HIGH POWER OUTPUT... case design makes possible a collector dissipation of 150 mw.

HERMETIC SEAL... unaffected by moisture.

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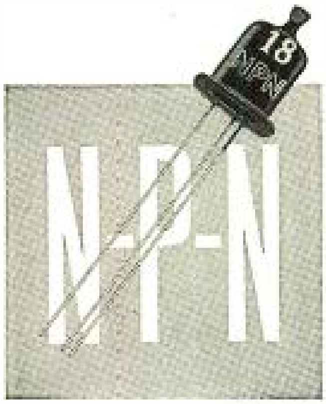

TYPE 2N78

- Making 2000 or more transistors from one rate-grown crystal.
- Achieving uniform characteristics in all 2000 transistors—*eliminating wasteful rejects.*

APPLICATIONS

For pulse and switching circuits, RF and IF amplifiers; high-frequency test equipment; telephone repeaters.

SPECIFICATIONS

Collector Voltage (Referred to Base)	15 V
Collector Current	20 ma
Emitter Current	—20 ma
Storage Temperature	100° C.
High Frequency Gain at 2 mc	13 db

- For further details on specifications and prices, write *General Electric Co., Section X4845, Germanium Products, Electronics Park, Syracuse, N. Y.*

Billet of germanium is removed from furnace, prior to cutting into enough tiny pellets for 2000 transistors.

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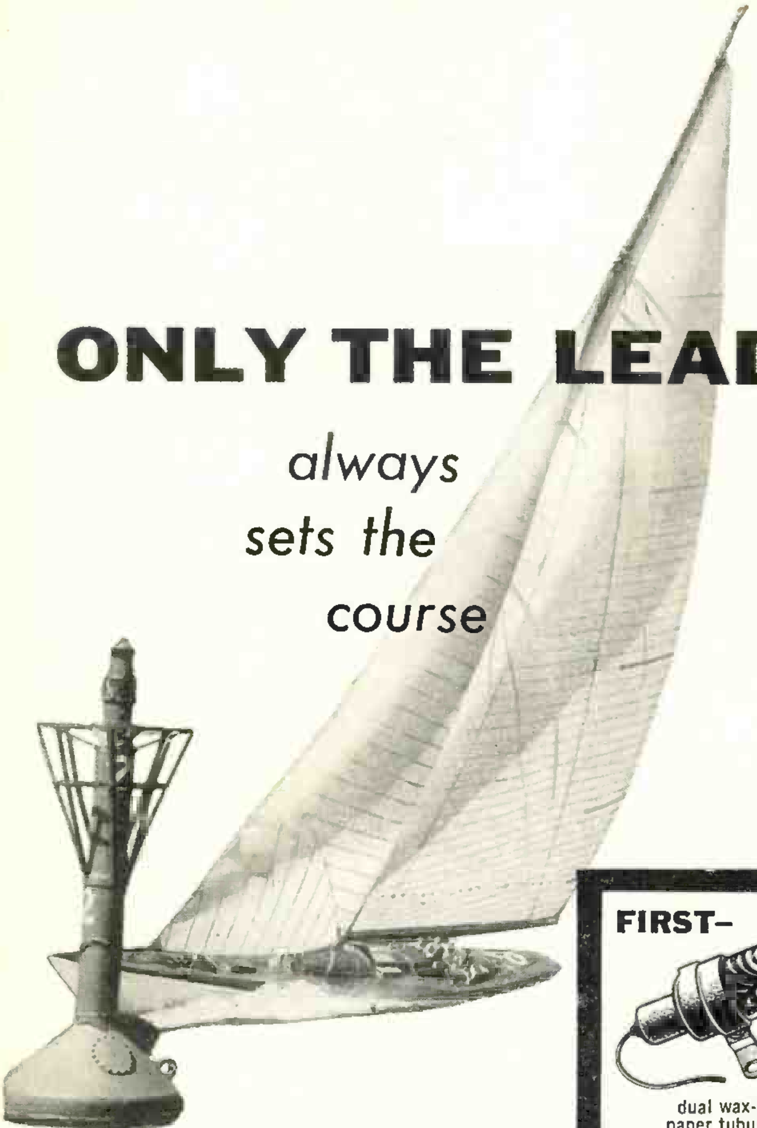

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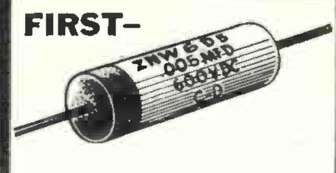

capacitor used in proximity fuse.

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Frequency Multipliers

(*Continued from page* 122)

changes, such as the addition of screen resistors and capacitors, are shown for the first decade stage in the circuit diagram in Fig. 10-b.

The higher frequency decades are generally similar except that lower values of screen and grid bias resistors are required, particularly in the high frequency decade, to get output comparable to that obtained with the triode unit. The efficiency of the 20-mc to 100-mc stage is especially poor. Also, although the multipliers operate over an input range of 0.2 to 10 volts, the phase stability is slightly degraded if 100-kc inputs greater than 2 volts are used. Because of this, and the added complexities of dual sockets and extra parts associated with the screen grids, the triode type of frequency multiplier seems definitely superior where a large number of stages are involved. Where driving power is limited or a high harmonic ratio is desired, the higher effective gain of the pentode tube may make it desirable in these cases.

A beat frequency recording at 100 mc, obtained with the pentode multiplier system, is shown on the right side of the chart in Fig. 7.

Other Circuits, Methods

In cases where extremely high wave purity is needed, such as frequency control for high powered transmitters, additional filtering, particularly in the earlier stages, may be desirable. The use of a series-resonant circuit in series with the ungrounded side of the coupling link between stages is very effective in further attenuating the undesired multiplier sidebands. Where outputs are not desired at each decade step a two-decade multiplication may be obtained.

High multiplication ratios require much more elaborate filtering but are sometimes necessary to obtain desired frequencies or a group of related frequencies. Very narrow pulse widths, obtained from special pulse forming circuits[9], or from saturated magnetic cores[10], are helpful.

Quartz-crystal filters are useful, especially where high multiplication ratios are used, to give highly selective output with high attenuation to undesired nearby frequencies. They are usually used in conjunction with LC filters and are somewhat critical in adjustment as well as temperature sensitive. They are also

(*Continued on page* 146)

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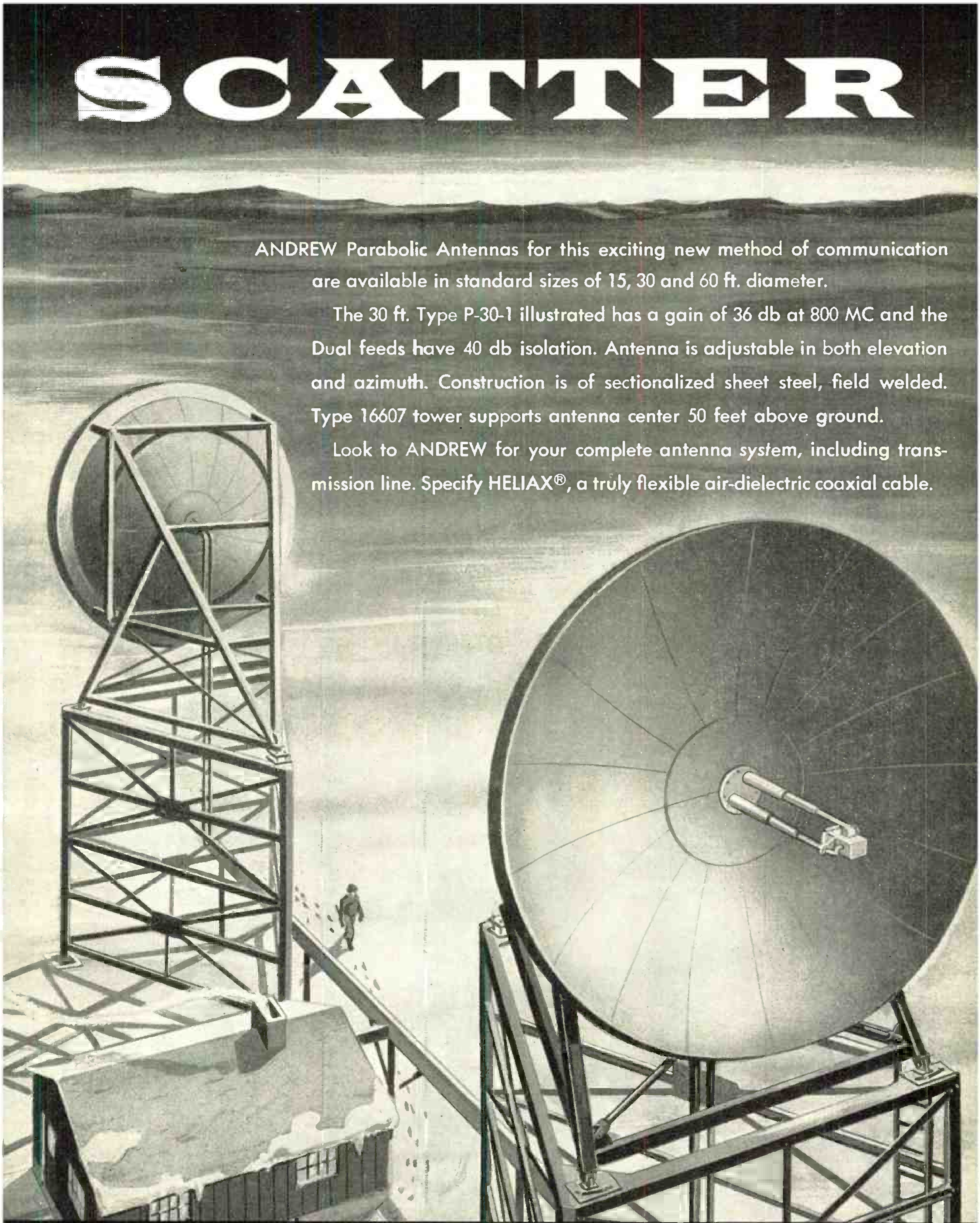

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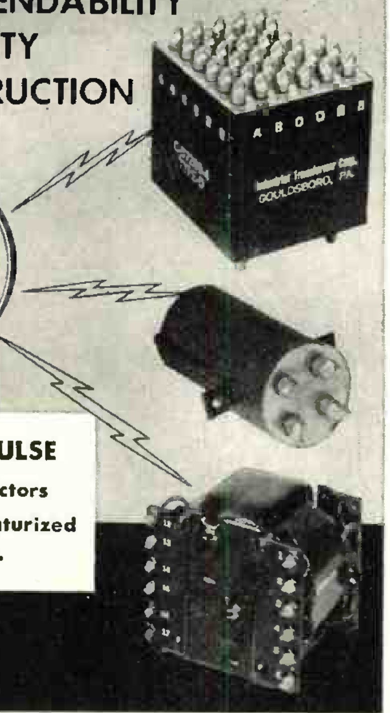

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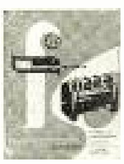

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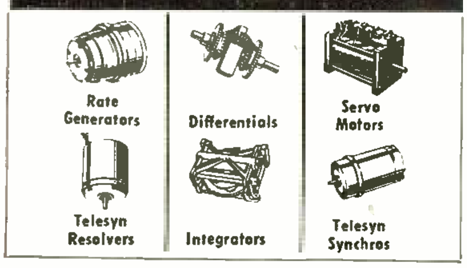
Ford Instrument's standard components



A. L. Coulson, formerly Assistant Sales Manager of Ford Instrument Co., Division of The Sperry Corp., has been appointed Sales Manager. Mr. Coulson has been with Ford Instrument since 1950 and also has served as Manager, Navy Contracts, for the Company.

Walter Jablon

A. L. Coulson

Walter Jablon has been appointed Sales Manager of Radio City Products Co., Inc., and its affiliate, Reiner Electronics Co., both of Easton, Pa.

Charles R. Lane, formerly Commercial Sales Manager of Gabriel Electronics, has just been appointed as Regional Manager for Andrew Corp. of Chicago. He will be in charge of the company's new branch office at Westwood, Mass. which serves upstate New York and all of New England.

Appointment of Frank F. Neuner to the newly created post of Manager, Semi-Conductor Marketing, Tube Div., Radio Corporation of America, has been announced.

F. F. Neuner

W. O. Spink

The appointment of W. O. Spink as Equipment Sales Manager for the Electronic Products Sales Division, Sylvania Electric Products Inc. was announced by D. W. Gunn, General Sales Manager, Electronic Products Sales of Sylvania.

Sola Electric Co., Chicago, announces two executive appointments. Nelson P. Marshall, formerly Manager of Eastern Division Sales, has been appointed General Sales Manager. Former Western Division Sales Manager Pat J. Morrisey has been appointed to the post of Field Sales Manager.

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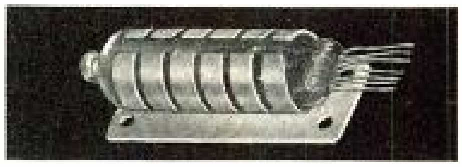

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KOOL KLAMPS are made of a specially developed heat-treatable alloy 99½% pure silver. They combine high thermal conductivity with great strength – *in a one-piece unit*. No need for special "inserts" which slow up installation and make maintenance difficult.

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Frequency Multipliers

(*Continued from page 142*)

less desirable where rapid transient recovery is required.

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An auxiliary cavity type unit for extending the sensitivity of frequency comparisons to the 1000-mc range is shown connected for use in Fig 9, with an exploded view of the cavity filter shown in Fig. 8. This unit contains two 1N21B silicon crystals in coaxial holders as harmonic generators, coupled to separate loops at one end within the cavity. A similar loop and crystal converter at the other end of the cavity are used to obtain the difference frequency between the two harmonic signals at 1000 mc. The converter output is connected by a coaxial line to the grid input jack of the main chassis converter, which in this case serves as an amplifier. With about 1 volt at 100 mc on each of the harmonic generator crystals, a converter output of about 20 millivolts is obtained at a source impedance of about 3000 ohms. Output of this difference frequency at levels up to 5 volts may be obtained by adjustment of the main amplifier gain control.

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(*Continued on page 148*)

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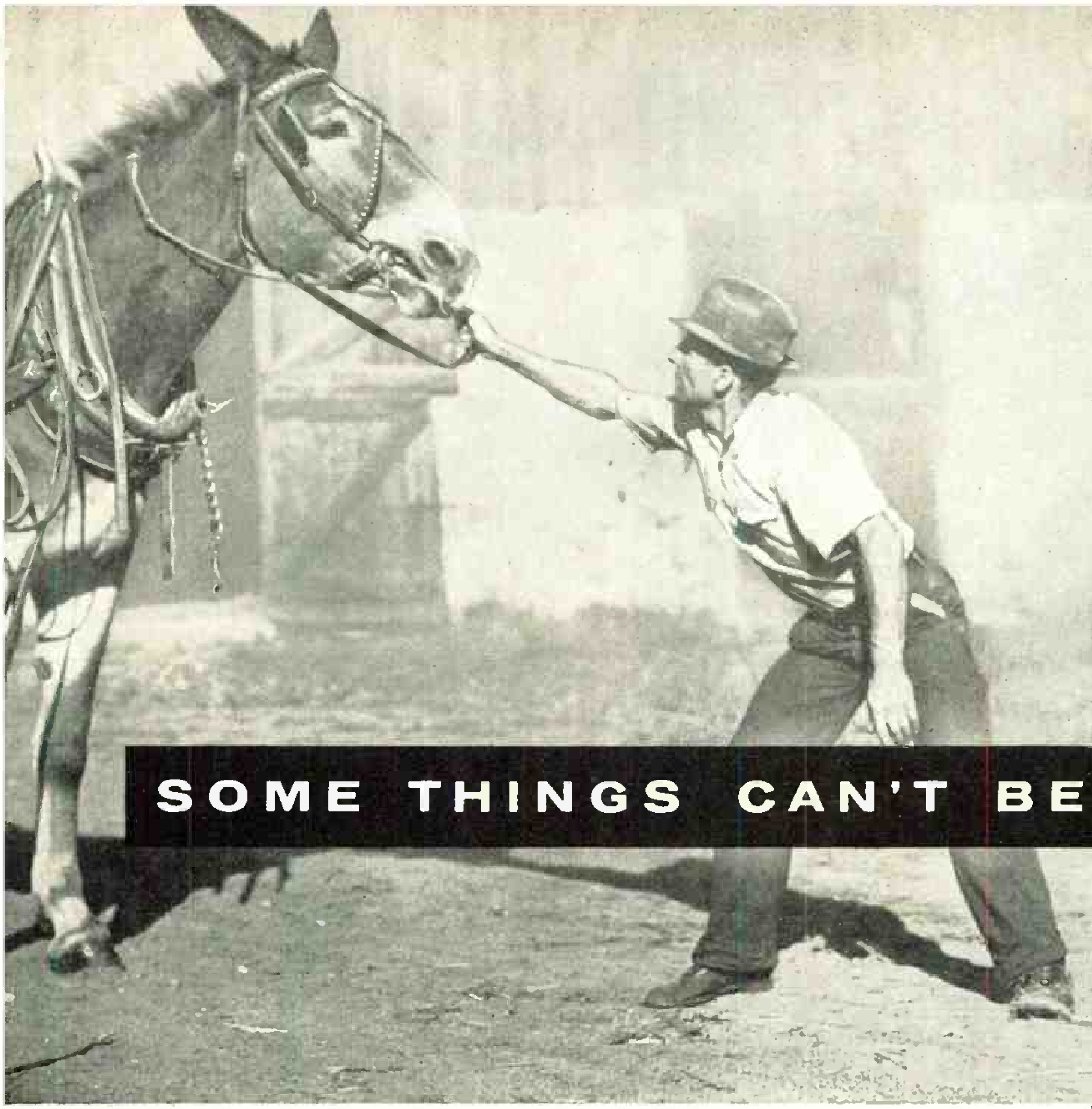

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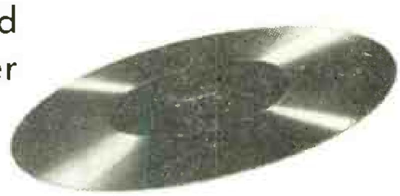

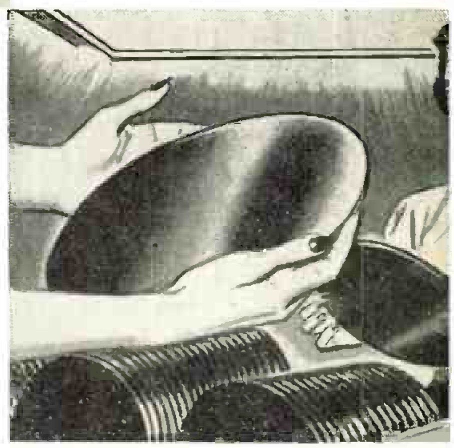

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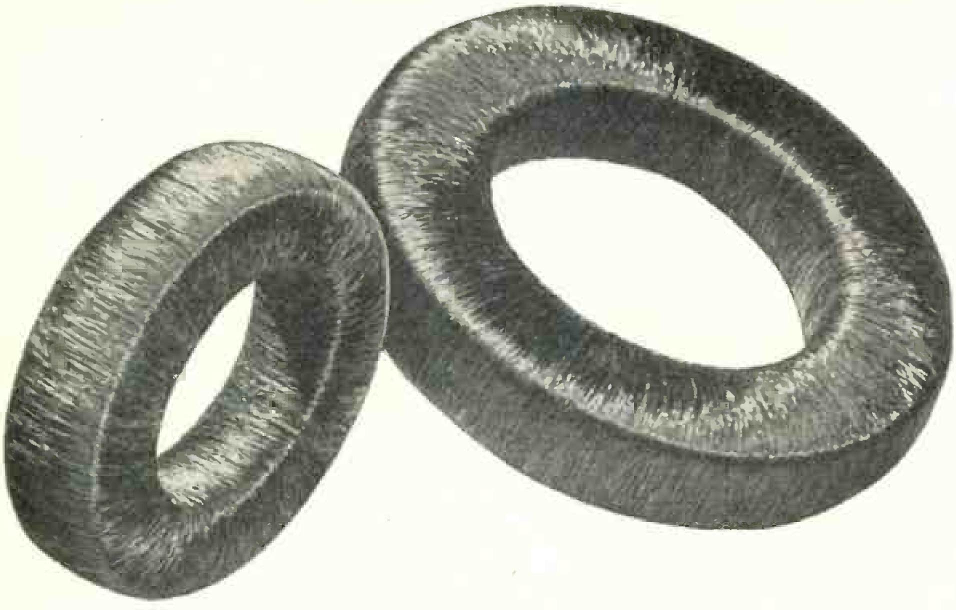

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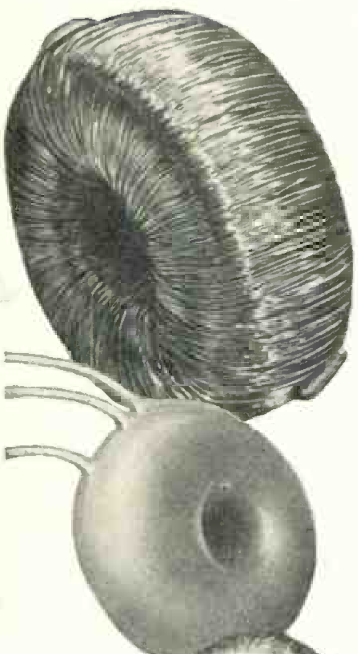

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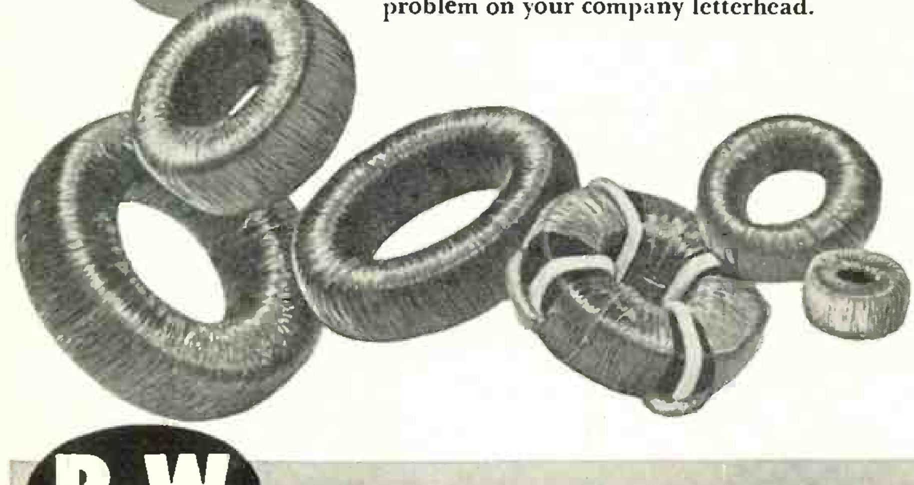

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Frequency Multipliers

(*Continued from page* 146)

through common coupling in the coaxial line shields and 1000-mc operation could not be obtained. The tee connectors used at the harmonic generator inputs give an approximate impedance match between the 50-ohm lines and the crystal holders resulting in about 3 db increase in converter output.

The silicon crystal harmonic generators in the 1000-mc unit operate with a power input considerably below the point of maximum converter output. While this requires careful shielding of the amplifier circuits, it results in long useful life for the crystal diodes. No appreciable improvement in performance is obtained if the power input to the crystal diodes is increased by raising the plate voltage on the entire frequency multiplier. No increase in the tenth harmonic output was obtained at the 1-volt level by use of dc bias on the crystal diodes. There is some indication that recently developed germanium diodes may give greater harmonic output if they can be conveniently adapted to the crystal holders[11].

The 1000-mc cavity multiplier-converter greatly extends the sensitivity and usefulness of the frequency multiplier systems without requiring additional space or ac power. Because of the high noise level from the diode frequency multiplier system the cavity arrangement cannot be used satisfactorily with it.

Auxiliary Equipment and Applications

The frequency multiplier and converter with cavity filter as shown in Fig. 9 is used, in one application, in a high precision automatic frequency comparator in conjunction with electronic counters and a recording system. This equipment continuously intercompares in sequence as many as six precision oscillators with a common reference oscillator. The attainable precision, during a 100-second interval, is 1 part in 10^{11}.

The same multiplier-converter equipment is also used to compare an adjustable, precision oscillator with a reference oscillator of the primary group when measuring precision quartz-crystal resonators. The beat frequency output, obtained at 100 or 1000 mc, is either measured with electronic counters, or compared directly with the output from an af interpolation oscillator by

(*Continued on page* 159)

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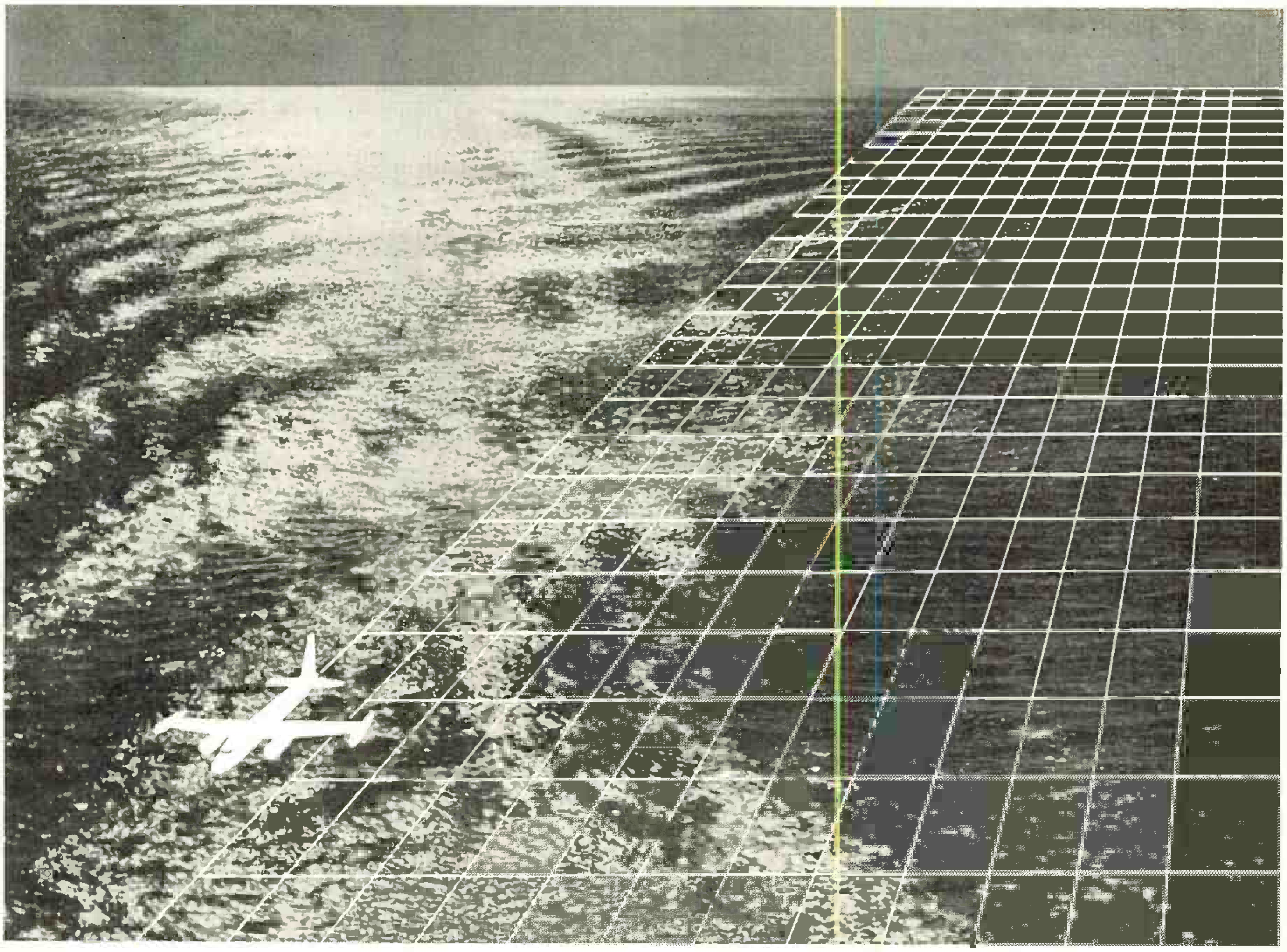

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Designing TV Tuners

(*Continued from page* 81)

its response was adjusted to produce a tilt of 60% with the picture carrier still lower than the sound carrier. As before, no change in the picture quality could be observed.

The effect of "valley" in the response was then tested. Valley is defined as the ratio of the drop in height between points on the response curve at the sound and picture carrier frequencies to the average height of the two points. See Fig. 4.

The same tuner was next restored to its original response and then readjusted to produce a valley of 30% in the response curve. The following results were observed:

a. Color intensity was unchanged.

b. Color hue was unchanged.

c. All signal voltages at the video detector were reduced by approximately 10%.

d. On a monochrome RTMA test pattern, a slight transient could be observed in the form of a faint white area following a solid black area. (This transient, although present, could not be easily observed on a color picture.)

Tuner Response

The tuner response was then made very narrow so as to give a single peaked curve (no valley) and a response of 4½ mc wide at 25% (2½ db down) from its peak value.

a. No reduction of the chrominance output (color signal) voltage at the video detector.

b. No change in hue except as indicated below.

c. The colors, however, had lost their brilliance and appeared muddied and indistinct. Most of this brilliance could be restored by advancing the contrast control. Referring to Fig. 1 again, it can be seen that a narrow response curve will cause loss of the higher frequency color sidebands to the right of the color carrier. The energy content of the color signal is therefore cut nearly in half at the higher frequencies, thus resulting in loss of color detail or indistinct colors.

d. The fine tuning control was also found to be more critical in its action. The total excursion of oscillator change for a satisfactory picture was reduced from a normal of 120 kc (for this receiver) to 90 kc. Detuning outside this 90 kc range produced an objectionable

(*Continued on page* 152)

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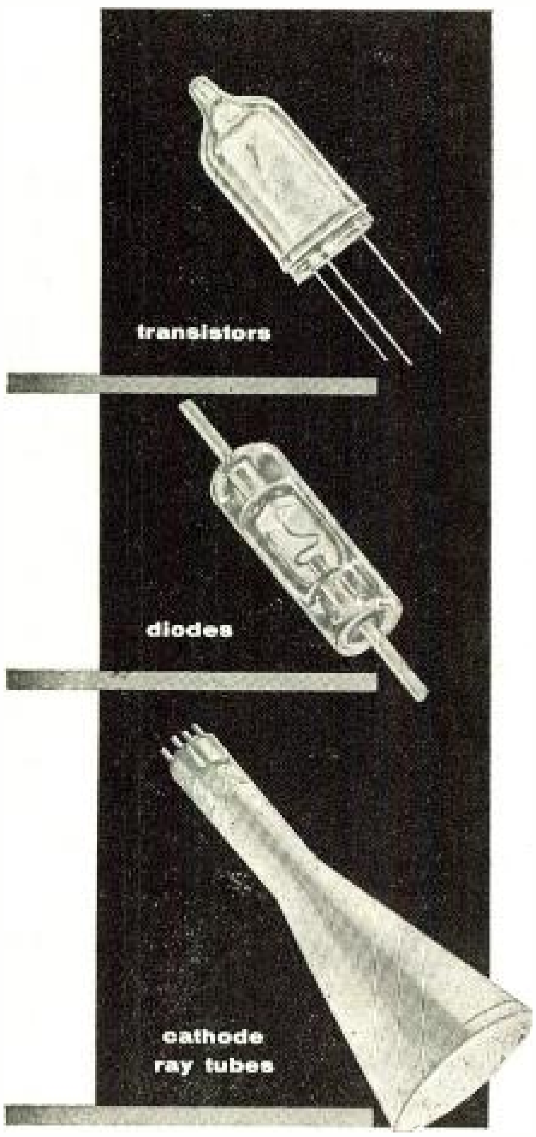

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Designing TV Tuners

(*Continued from page* 150)

920 kc sound beat interference pattern. The action of the fine tuning control is usually more critical on a color receiver since it is necessary not only to tune in a good color picture by centering the receiver response on the transmitted signal, but also to tune so that the sound carrier falls exactly in the sound rejection slot of the i-f amplifier. A slight detuning from this point causes the amplitude of the sound carrier to rise sharply, thus producing the sound beat (920 kc) interference pattern.

The effect of the antenna circuit was next investigated. Without affecting the signal power at the tuner input, the dummy antenna was mismatched to present an impedance of 100 ohms instead of 300. Fifty feet of 300 antenna lead-in wire was next inserted between the signal source and the receiver to produce standing waves.

a. There was no change of signal voltages at the video detector.

b. There was no change in color hue or color intensity.

c. The r-f tuner response showed a tilt of 35% with the sound carrier below the picture carrier.

The above test was repeated using an antenna impedance of 900 ohms. The results were the same except for the r-f tuner response which showed a tilt of 12% with the sound carrier above the picture carrier.

Color Loss

Under certain conditions, improper termination of the transmission line at the antenna and the TV tuner input can result in loss of color. Present TV antennas do not provide termination over the entire television band so it is necessary to provide correct termination at the tuner input. Under strong signal conditions, however, the loading of the antenna input circuit by the first r-f amplifier is greatly reduced with greater AGC action, thus producing some mismatch at the receiver. In addition, it was found that the receiver under test required at least 30% of normal color burst voltage at 1 volt signal input to operate the color killer as against 12% at 10,000 μV input. This is due in part to the added noise component at the lower signal input, plus some compression of the signal at the higher input.

Standing waves caused by incorrect termination can be observed

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with the aid of a sweep oscillator covering a TV channel and an oscilloscope fed by a high impedance crystal detector. The response, instead of being flat appears as in Fig. 5. The distance between a peak and a valley is given by $\Delta f = (246\ v/c)/l$(in feet), where v/c is the ratio of the propagation velocity in the line to that in free space.

Using a transmission line 34 ft. long, the separation between a peak and the valley following was exactly 3.6 mc. With a badly mismatched antenna circuit, the r-f response pattern appeared as in Fig. 7 instead of the normal response as shown in Fig. 6. However, under these conditions good color was still obtained. A slight detuning of the antenna coil caused the phase of the peaks to shift as indicated in Fig. 8. The ratio of picture carrier

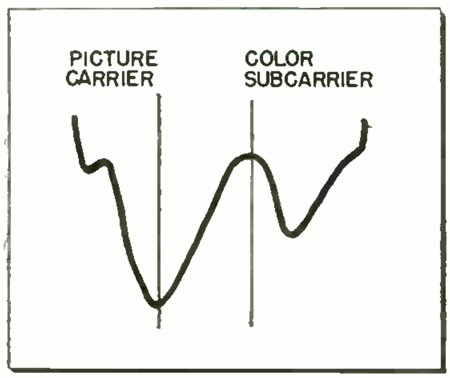

Fig. 8: Tuner response with standing waves giving greatest color subcarrier attenuation

to color sub-carrier transmission became 4 to 1 and the color disappeared from the screen due to operation of the color killer.

The insertion of a 6 db H type pad between the tuner input and the transmission line brought color back, even though the signal was attenuated because of the reduction of reflections and more equal response at the picture and color carrier frequencies. With the above pad removed, a slight change in tuning of the antenna coil was sufficient to bring color back into the picture.

The above tests show that while loss of color can occur due to cancellation, it requires a combination of circumstances, any one of which can be avoided with a little care.

The effect of oscillator stability was next investigated. As noted above, the most noticeable effect of oscillator frequency change is the presence of a 920 kc interference pattern between the color subcarrier at 3.58 mc and the sound carrier at 4.50 mc.

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(*Continued on page* 154)

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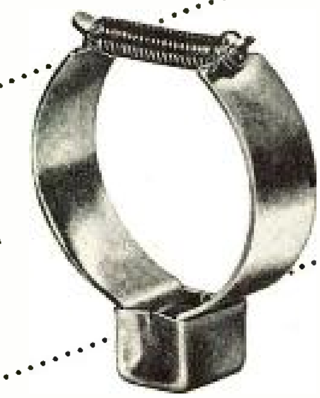

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Designing TV Tuners

(*Continued from page 153*)

the tuner set to normal response, it was found that the oscillator could be detuned by plus or minus 60 kc (a total of 120 kc) before the 920 kc interference pattern became objectionable.

With the sound carrier set at 50% of the picture carrier power (instead of 70%), the tuner could be detuned by plus or minus 70 kc before the same result appeared. Very little is gained in this respect by operating with the sound carrier at the lowest specified limit.

If the range of the fine tuning control is 1 mc over a rotation of 180° and we assume a permissible detuning of ± 60 kc for a good picture, this results in a tuning adjustment of plus or minus 11°. This is not difficult to obtain with a knob having a diameter of two inches or over. However, if the total range of the fine tuning control is 5 mc, the adjustment must be made within an arc of plus or minus 2°, thus making the fine tuning procedure extremely critical and beyond the ability of most laymen.

Other Characteristics

It was felt that the other characteristics of a tuner such as noise figure, gain, i-f rejection, image rejection, etc., produce corresponding results in a color-TV receiver as they have in the past in a monochrome receiver so that the effect of these was not investigated.

The above tests were made on a color-TV receiver built from information describing the original RCA color receiver. While the results apply strictly to this type of receiver, they can be interpreted as applying in a general way to other color-TV receivers using the same circuitry.

In conclusion, a tuner designed for good monochrome reception will give good results on a color-TV receiver with the exception of the fine tuning adjustment which is now more critical. In addition, the oscillator drift after a three minute warmup time should be held to within ± 60 kc if subsequent readjustments are to be avoided.

It should be further noted that all of the above tests were run at high signal levels. Reduction of tuner gain due to misalignment will produce noise (colored noise at that) in a color receiver at low signal levels in the same manner as in a monochrome receiver.

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Color Television

(*Continued from page* 116)

outputs if tally light relay panel is used). See **Fig. 21.**

For the studio control room the system can be set up to provide complete facilities for program monitoring, video switching between television studio cameras, film cameras, remote pick-ups or network programs. Controls can be provided for fading and lap-dissolving between local studio video signals. The system can provide for program previewing and many other monitoring functions. See Fig. 19.

The complete TS-20 remote control switching system consists of several types of individual units which fall in the following categories:

A. The video relay switching chassis and panels used to extend functions of basic units.
B. The push-button panels (for operating the video relays) which are available for several switching schemes and mounting arrangements.
C. The utility or master monitors, for use in conjunction with push-button panels.
D. Standard components.

Since the application of the video switching equipment can become complex and depends upon the size and type of operation desired, the planner should consult a qualified systems planning group.

LIGHTING FACILITIES FOR COLOR

Based on experience already gained in TV color programming, lighting for color is in some respects more straightforward than for monochrome. The existence of the different values and hues of color automatically help to define clearly separations between foregrounds and backgrounds and different shades or values, while in monochrome this is sometimes difficult to accomplish.

The lighting equipment used for color television productions is the same as that required for comparable monochrome sets—except for the amount of incident light necessary. A show that is properly lighted for black and white, with effects, low key and mood lighting may be duplicated for color with no changes, except for the substitution of light fixtures of higher output (standard voltage, long-life bulbs may be operated at about 2900° Kelvin).

Normal light levels should be such that the maximum highlight bright-

(*Continued on page* 156)

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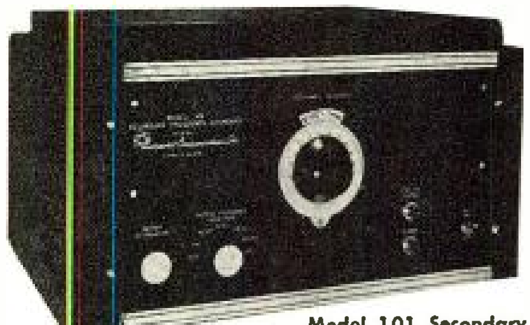

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Color Television

(*Continued from page* 155)

ness in a scene is about 260 foot-lamberts. Contrast range should not exceed a 30 to 1 ratio. For normal operation a contrast ratio of 20 to 1 is considered good practice. For effects such as silhouettes, the low-light is below the ratio indicated.

The techniques of lighting, hanging of fixtures and control of power to the lamps requires no changes (See Fig. 22). However, the addition of color gives apparent depth to the scene and a separation of actors from the sets. The use of colored lights opens up an entirely new field of lighting effects that may be used to enhance the beauty of programs. For example, colored lights can be used with neutral backgrounds to provide a number of different color combinations. Inexpensive theatrical gelatin filters may be placed in front of standard light fixtures. The three primary colors (red, blue and green) can be mixed by controlling the lamp voltage at a dimmer board. With a preset system, which is desirable for color, brightness of individual lamps in a grouping may be returned to the same brightness of manipulation of a single control at the lighting control console. Such facilities improve the ease and precision of returning to any pre-arranged condition.

SPACE REQUIREMENTS FOR COLOR

Some present monochrome equipment may be adapted for color use—while other items will be retained solely for black and white use. In any case, a certain amount of additional space will be required. The total space a broadcaster must provide for color TV operations will vary according to the scope of the proposed operation. For example, "network color only" stations will require very little additional space—while those stations who plan to use slide, film and live camera facilities must do more serious planning.

From observations of many existing stations it is obvious that most will either have to hunt for additional space, build it, or take existing space for color use such as present AM space or even doubling up in present monochrome studios.

There are undoubtedly many ideas which may occur to individuals concerning their own requirements, as for example providing a second deck for a control room where ceiling height is not limited.

Each camera chain—whether slide, film or studio—includes two units designed for console mounting. One

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of these is a standard master monitor and the other unit, of matching size, contains the color camera controls. The two units are mounted in standard console housings similar to those used in the RCA monochrome installations. These units, of course, can be combined with other camera units to form a control console.

The color studio camera is larger than a standard monochrome camera. However, it is moved by similar type dollies and, therefore, does not in itself require more floor space.

STUDIO SPACE REQUIRED

The stage, or performing, space required for color is no greater than for monochrome. However, the need for more lighting facilities, greater camera operating space and a wider assortment of backdrops will probably lead to the use of larger overall studio areas. It is likely that most stations will start by making use of existing studios (possibly adding a separate control room for color). When new studios are to be built especially for color the best present advice is to follow monochrome design practice but increase dimensions by 30 to 50% throughout.

INTERCOM AND AUDIO

As in any TV setup, for efficient operation a good *intercom system* is a necessity. The first significant step is when film facilities are added. In most existing stations some form of intercom system is almost certainly in use, and the addition of color film into the same area may not require any additional talk circuits. However, the addition of a color studio camera which has an intercom circuit built in, will require terminal equipment for communication in accordance with the number of cameras and control points involved. Inasmuch as the intercom circuit constants are the same as those used in the RCA monochrome cameras they may be easily integrated with an existing monochrome system.

Fig. 17 shows typical RCA inter-

(*Continued on page* 158)

Fig. 22: Studio light and camera set-up

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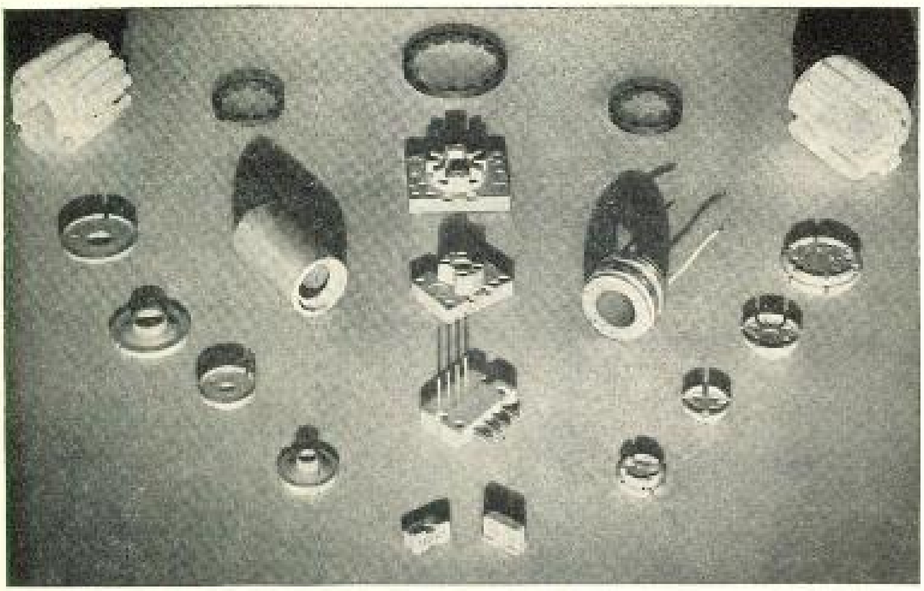

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Color Television

(*Continued from page* 157)

com items which may be used for a color camera studio arrangement and a film projection room. A six station talk-listen intercom and amplifier set is shown operating between the control room and projection booth. This unit is quite effective because it does not require that the projectionist use a set of headphones and he can answer from almost any spot in the room.

Audio facilities should be provided for the same purposes as in monochrome productions. In general, the layout of audio equipment facilities are the same as those used for black and white.

HOUSE MONITORING

Two new types of RCA Monitran units have been designed for color. The type TM-40 monitran is an all channel unit which permits the user to select any TV channel from 2 to 13. The type TM-41 monitran is a factory tuned unit which will operate on any single channel specified for the user. These units may be used to distribute a modulated r-f signal to color receivers for house or studio monitoring purposes.

MICROWAVE EQUIPMENT

A microwave link for a color TV system must not cause serious degradation of the color signal. This also applies to a monochrome system, but here requirements are not so stringent. For color operation, circuits within the microwave equipment must perform within rather close limits with respect to characteristics, such as differential phase, amplitude frequency response and differential gain.

A new microwave system, type TVM-1A, has been designed to transmit both color and monochrome. The specifications of this equipment are such that it is capable of adequately meeting the requirements of a color TV system. In the TVM-1A microwave transmitter, power has been increased over that of previous models to give more reliable transmission over longer distances. This increased power makes economical multi-hop operation feasible for both color and monochrome transmission. In monochrome use, the TVM-1A is a substantial, superior system offering increased stability, ease of operation and excellent performance characteristics.

It is possible that the broadcaster already may have an RCA TTR-1A/TRR-1B in monochrome operation.

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While the new TVM-1A microwave is recommended for the step to color, it should be remembered that the RCA TTR-1A and TRR-1B microwave equipment may be modified for this purpose.

CHECK POINTS

To present all of the equipment planning considerations necessary in the proposed operation or construction of a television station would be beyond the intended scope of this article and, further, would require an excessive amount of editorial space. However, it is recommended that the following "check points" be kept in mind. It is further recommended that the services of a qualified Engineering Consultant be obtained to assist in development of the basic planning.

(1) Power requirements of the color equipment
(2) Equipment arrangements (rack and control)
(3) Trench or duct layouts (new or integrated with existing monochrome)
(4) Floor loadings
(5) Heat dissipation of equipments (for air conditioning provisions)
(6) Studio lighting-control
(7) Control room and centralized control arrangement and facilities
(8) Extent of film programming
(9) Audience participation
(10) Film previewing, processing, editing and storage
(11) Clients' viewing rooms
(12) Audio and intercom facilities
(13) House monitoring equipment
(14) Required color test equipment and best arrangement (portable and/or fixed)
(15) Mobile
(16) Video link to transmitter
(17) Studio audio tie to transmitter.
(18) Delay considerations in integrating monochrome and color.

Acknowledgment: The authors wish to give credit to all who assisted with this article, particularly those concerned with the design and market planning of the equipment described.

Frequency Multipliers

(*Continued from page* 148)

means of Lissajous figures on an oscilloscope. A precision of comparison of 1 part in 10^9 to 1 part in 10^{10} is readily obtained, depending on the method or interval used.

In another application the multiplier-converter system is used with a commercial power frequency 58 to 62 cycle recorder driven by a limiting amplifier as explained previously in the discussion of converters.

(*Continued on page* 160)

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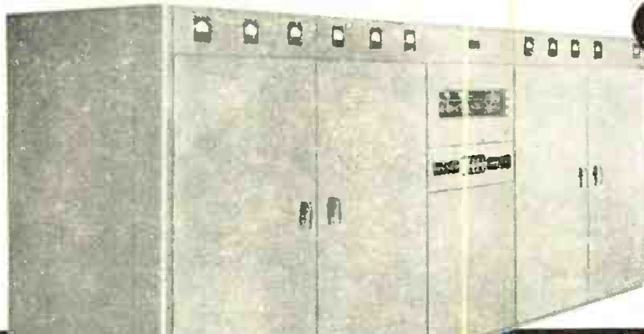

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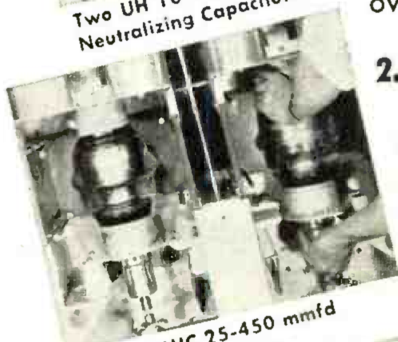
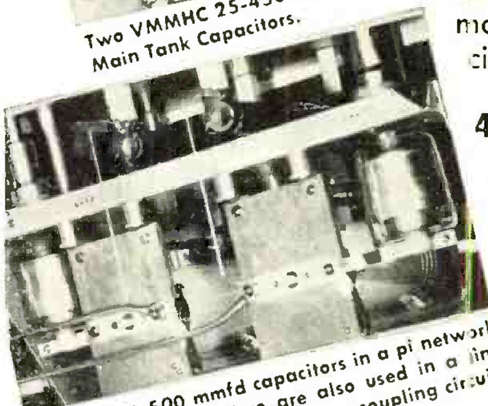

Two VMMHC 25-450 mmfd Main Tank Capacitors.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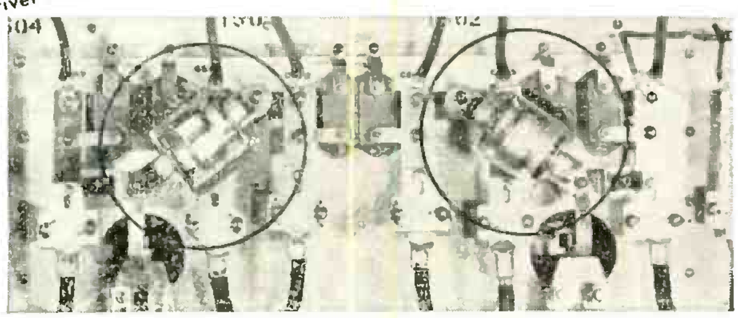
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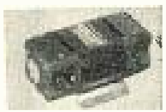

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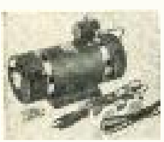

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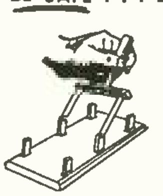

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Frequency Multipliers

(*Continued from page* 159)

In this use one of the oscillators is offset about 60 parts in 100 million to obtain a frequency difference of approximately 60 cps. The recordings shown in Fig. 7 were obtained in this manner with three separate records superimposed on a single chart. An equipment of this type is used at WWV to sequentially intercompare the main or operating oscillator and two standby oscillators with a fourth, offset or reference oscillator.

By means of simple harmonic generators of the crystal diode type, operating from one or more of the multiplier outputs, precision markers may be established throughout the frequency spectrum, from the LF through UHF bands. By use of auxiliary converters with an interpolation oscillator, a complete frequency measurement coverage of this entire frequency range may be obtained.

The double-tuned filters used in the frequency multipliers are readily adapted to band pass applications such as frequency modulation systems. The unitized method of construction and the use of toroidal transformers may also be readily adapted to similar equipment of a more general nature.

The author wishes to acknowledge the excellent workmanship of L. A. Horton in assembling and adjusting the multiplier chassis, and of T. E. Diedrich who constructed the cavity filter.

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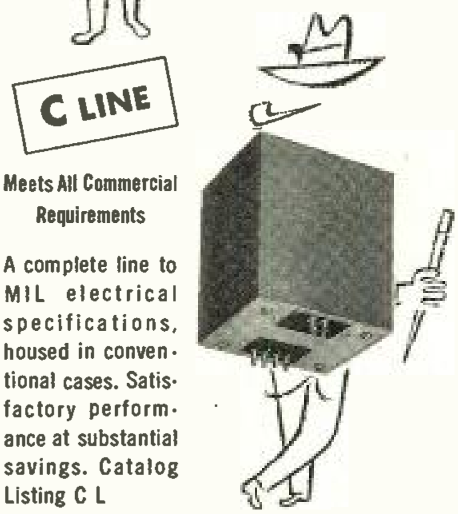

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Aerodynamic Loading

(*Continued from page 92*)

The results of rotating torque measurements on the 90 by 20 in. screen reflector with ½ in. expanded aluminum mesh, depressed to —13° in elevation and pivoted a distance of 17½ in. from the reflector gave a torque coefficient

$$C_r = 0.025 + 12.6 (ND/V)^2 \quad (11)$$

Some tests were made with this reflector at a pivot distance of 14½ in. and the same elevation angle. For this case

$$C_r = 0.029 + 17 (ND/V)^2 \quad (12)$$

Typical torque curves (plots of torque vs. azimuth angle) are shown in Fig. 5 for the ½-in. mesh reflector at three pivot distances. They indicate the optimum pivot distance to be about 18½ in.

Torque Tests

The results of some torque tests on the slatted reflector (Fig. 3), 84 x 26 in., are for a 60 mph wind, the reflector rotating at 16.6 rpm. No data is available at varying wind velocities; consequently it is not possible to give a value to the torque coefficient for this reflector. For a pivot distance of 14½ in., which appeared to be close to its optimum, and —13½° elevation the peak torque observed was 360 in.-pounds. Therefore, the torque coefficients for this slatted reflector would probably be a little less than that for the ½-in. mesh.

In general the antenna torque curves for the screen or slatted type reflector surface with given back structure and horn feed has major peaks in three azimuth regions—near 90°, between 180° and 270° and between 270° and 360°. Which of these peaks becomes the largest depends upon the pivot location. When the pivot is near its optimum position the torque curve is well balanced and consequently the peaks are approximately equal. On one side of the optimum location the peak at 90° is the largest. On the opposite side the peaks in the regions between 180° and 360° predominate. This can be observed from the curves of Fig. 5.

The behavior of the data for tests with the solid reflector was quite different from that with the mesh or slatted reflectors. The results were erratic in that variations in the torque curve from one cycle to the next could be observed for a given set-up of the solid reflector. This in-

(*Continued on page 162*)

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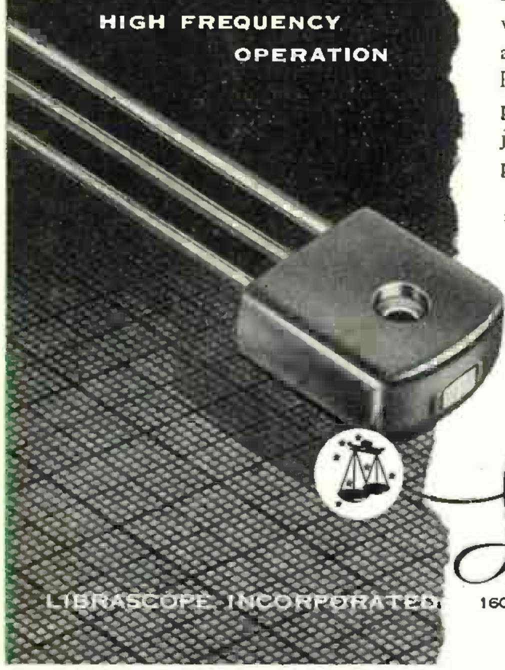

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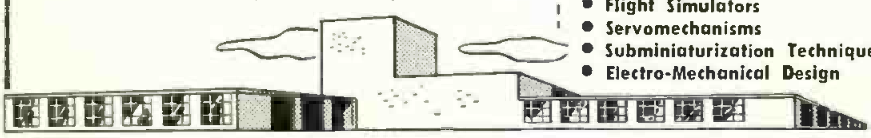

Aerodynamic Loading

(Continued from page 161)

cluded variations not only in magnitude of the torque readings but to a lesser extent in shape of the torque curve. Although the torque peaks occurred at the same azimuth position, from cycle to cycle their relative magnitudes changed. Discrepancies between a given run and a repeatability run were as great as 50%. All of these observations appear to indicate that the turbulence developed by the rotation of the solid reflector is very great. This may have been made worse by a blocking effect in the tunnel. (The tunnel test section was 7 ft. high by 10 ft. wide.)

The two sources for torque measurements, as described, gave fairly good agreement. Some of the discrepancies (possibly 20%) may be due to instrumentation and interpretation, but these cannot account for variations of 50%. (The tunnel velocity measuring instruments, located upstream of the reflector, indicated no variations at any of the speeds.) Turbulence and instability in the flow downstream of where the tunnel velocity is measured and in the region of the reflector is probably the main cause of this. The degree of instability and turbulence present in the air flow over the reflector, the degree to which the eddying and rough wake are set up, will depend on the antenna size, type of surface, and configuration. The condition is worse for a solid reflector than for a screen or slatted surface; test results showed this.

Far less of the discrepancies and variations were found in the results of the testing with screen or slatted reflectors, but always these characteristics were present with the data of any tests made with a solid reflector. For this reason the results of testing with the solid reflectors could not be correlated very well. The results indicated the optimum pivot distance for the 90 by 20 in. solid reflector would be about 30 in. There were peaks in the curve of the solid reflector at two regions—near 30° and in the region between 180° and 320°. These can be observed in Fig. 6 where an approximate torque curve for a solid reflector using average peak values is shown. Generally the largest torque occurred at the 280° azimuth position. The effect of offsetting the pivot 6 in. out of the plane of symmetry, keeping the same pivot distance, is shown also in Fig. 6. The offset was such as to favor the 180° azimuth position; it can be seen that the peak normally

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occurring in this region was eliminated, at the expense, however, of the peak at 280°. The nature of the torque curve for the solid reflector is such that it appears that modifications, like offset or the use of fins, would not be very effective in improving the torque characteristic. The relatively small differences between the magnitudes of the peak torques indicate that whatever might be done to reduce the peak torque at one point will probably result in an increased peak torque at some other point.

Table I gives the results of some of the rotating torque measurements on the reflectors discussed. It can be observed that the average peak torques for the solid reflector increase very rapidly at the higher wind velocities. This may be associated with the greater turbulence (larger eddies, etc.) created at the higher wind velocities. The results show peak torque values for the solid reflector approximately three to five times that for the ½ in. mesh or slatted reflectors.

Conclusions

1. The horizontal wind force on a radar antenna with parabolic type reflector is much higher for a solid surface than for a slatted or screen reflector surface. The horizontal force on a slatted surface with ⅜ in. spacing is approximately one half that for an equivalent solid surface.

2. The solid reflector requires a peak torque for rotation considerably higher than that for a screen or slatted type. The peak torque for a 90 by 20 in. solid reflector set at a pivot distance of 24 in. is approximately 4½ times that required for an equivalent screen type reflector (½-in. mesh) set 14½ in. back from the pivot in a 60 mph wind rotating at approximately 19 rpm.

3. The higher peak torques required by the solid reflector are probably associated with the greater turbulence it creates in rotating. This turbulence gives rise to a certain amount of irregularity in the results. The peak torques increase very rapidly at the higher wind velocities for a solid reflector.

4. The optimum pivot location for rotation gives a more uniform torque loading besides giving minimum peak torques. The further from the optimum position, the more unbalanced is the torque curve (large torques being required over half the cycle, little or none over the other half), and the larger the peaks.

5. Eqs. 4, 7, and 8 provide a means for correlating drag and torque data.

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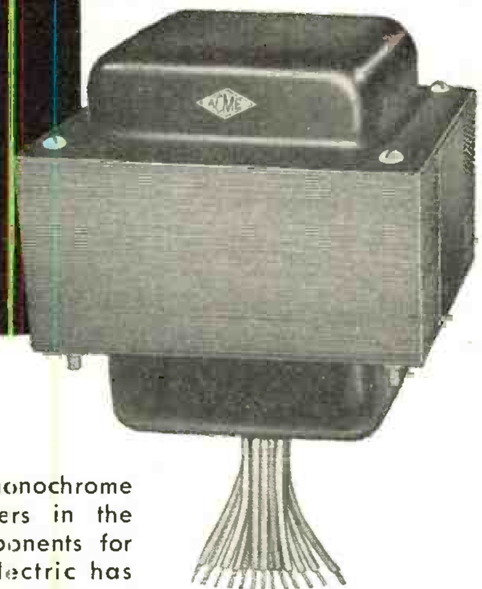

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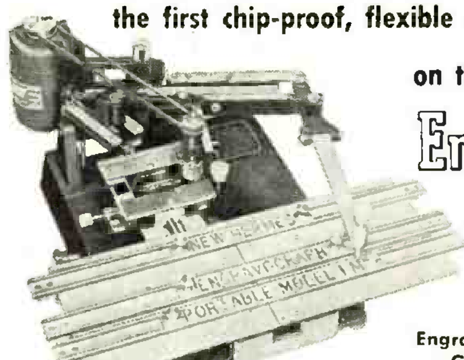

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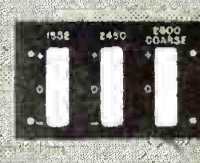

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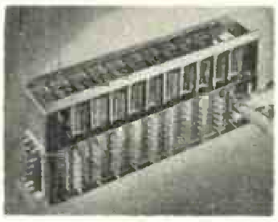

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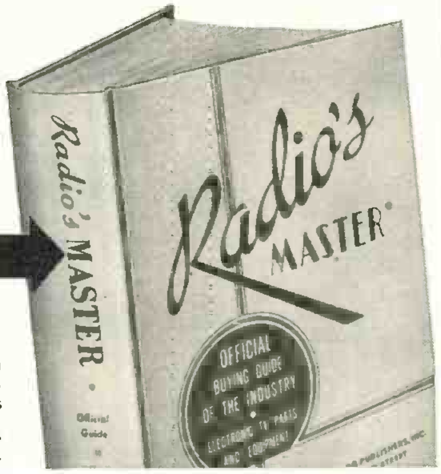

Wideband Transformer

(*Continued from page 75*)

beyond 50 MC. It is seen that the frequency response is definitely extended at the high frequency end if a near optimum impedance level is utilized. It is not understood at present why the 22 ohm impedance level gives apparently superior results at the high frequency end. Also shown for comparison is the performance of a British auto transformer[1] operating at a 100 ohm impedance level. As the British zero core permeability per ohm termination is only about twice that of the split screen unit, most of their increased frequency response at the low end can probably be attributed to superior choice of core material. The increase in frequency response at the high end is probably a result of auto transformer type construction.

Coupling Transformers

The problem discussed here is that of coupling relatively low impedance transmission lines to a vacuum tube via a transformer. Whether coupling to grid or plate a common objective is desirable—a high impedance level at the grid or plate leads to a higher noise figure or obtainable gain (up to 1000 ohms at least). This problem may be thought of primarily as a video amplifier coupling problem and secondly as a transformer design problem. The previous low pass filter design considerations may apply, except that in this case the capacity across the transformer as a result of the tube and its socket is usually larger than the interturn and distributed capacity of the transformer. Thus, it becomes worthwhile to endeavor to decrease the capacity between terminals at the expense of increased leakage inductance in order to maintain roughly the ratio of L/C required by the filter equations without making the LC product too high. Of course, the frequency response of the entire circuit must suffer in so doing compared to that of the transformer alone. In other words, the usual video gain-bandwidth relations pertain. At impedance levels of a few thousand ohms it was found that every precaution is required in order to hold the tube side capacity values down. The net capacity will often be sufficiently large that a series peaking inductance external to the transformer is required in order to satisfy the required L/C ratio.

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One of the complete circuits used in coupling the grid of a 6BQ7 r-f amplifier to a balanced pair of 75 ohm transmission lines is shown in Fig. 9b. This circuit was intended as the input circuit of a 2 to 20 MC direction finding receiver. The equivalent circuit at high frequencies is shown in Fig. 9c, where the distributed capacities and transformer parameters are included. It is of interest to see how the actual distributed capacities for this particular installation enter into the design. The following components contributed significant amounts of capacity: (1) the capacity of the transformer secondary, including the feed-through insulator in the case, was about 7.7 μμf (without the brass case, the transformer secondary capacity was about 3.5 μμf); (2) the capacity of two other feed-throughs used to inter-connect between various shields totaled about 2.8 μμf; (3) the capacity in the series peaking coil was reduced from 12 μμf to 4 μμf after insulating the slug from ground; (4) the input capacity to the 6BQ7 grid and its associated components represented about 8.0 μμf. If it is assumed for the sake of a simple low pass filter design that all of these capacities appear on the grid side of the peaking coil, there results the equivalent circuit shown in Fig. 9a. The total distributed capacity C is then about 22.5 μμf. The required total L (including transformer leakage reactance) becomes about 22.5 μh. This value still overshadows the leakage reactance for even the uncased transformer (13.3 μh), and indicates at first appearance that omitting the case would have been desirable. Unfortunately L=22.5 μh and C=22.5 μμf give an upper frequency, f_2, of about 7.1 MC—a rather low upper frequency limit for this particular receiver.

Distributed Capacity

Some advantage results from the fact that part of the distributed capacity appears across the transformer side of the peaking coil. This permits a design which resembles a two section filter (Fig. 9c). It was decided to place primary emphasis on obtaining a constant input impedance at the transformer primary rather than optimally flat frequency response. It was this consideration which resulted in the empirical values shown in the circuit of Fig. 9b.

Before entering into a description of the performance of this circuit,

(*Continued on page* 166)

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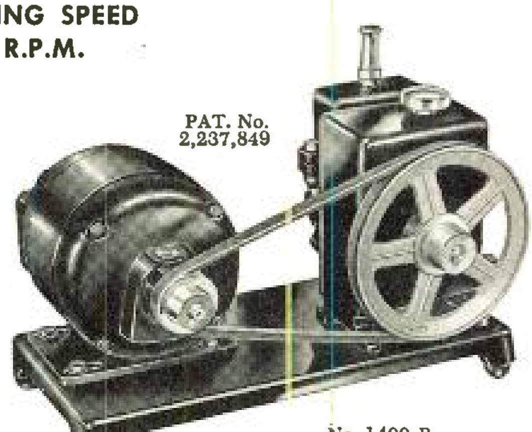

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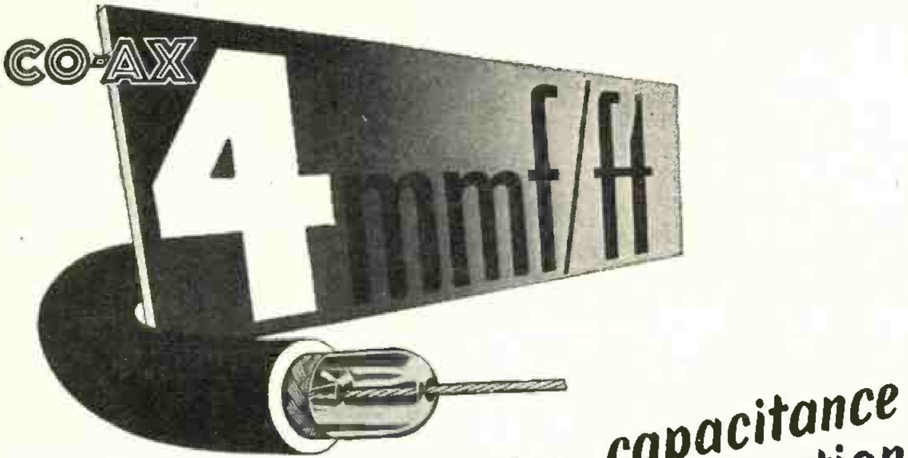

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Wideband Transformer

(*Continued from page* 165)

the transformer by itself will be considered in more detail. The primary of this transformer is as described in the previous section. That is, the primary is split into two separate windings of two turns each. The secondary consists of nine turns of No. 32 copper wire with about 1/32 in. spacing between turns. The leakage inductance of the cased unit is about 2.6 µh referred to the secondary (see Fig. 5). Note that in the circuit of Fig. 9b the external peaking inductance selected is about 7 µh. Even granting that a better balanced two section filter than that shown in Fig. 9c might be desirable, it is still advantageous to use the case in order to diminish the leakage inductance for this type of circuit. In other words, it is still necessary to take precautions in keeping the leakage inductance low, in spite of the increase in required L demanded by the leading capacity of the vacuum tube circuits.

In order to illustrate the extent to which the tube capacity limits the frequency response, the frequency response for the transformer alone operating between resistive terminations is shown in Fig. 8a. The load

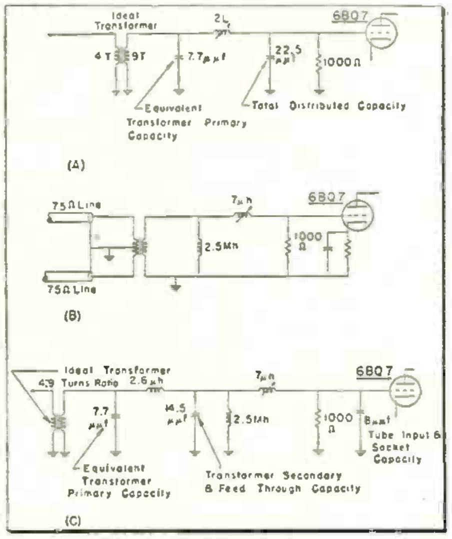


Fig. 9: Transformer with coupling network. (a) Assuming lumped capacitance. (b) Line to grid coupling. (c) Note hidden parameters

was connected to the low impedance side of the transformer for this data, in order to avoid neutralizing the capacity of the meter probe. Figure 8b shows the frequency response for the entire circuit using a source impedance near that actually used—nearly an impedance match. Figure half the primary was used and the 8c shows a similar frequency response curve, except that here only half the primary was used and the source impedance represents a theoretical match to 1000 ohms calculated from the actual turns ratio.

It would be relatively easy to extend the frequency response downward by using a higher permeability core material and a larger number of turns (considerably more leakage inductance could be tolerated). Extending the response higher would require extreme care to keep capacity values low but should be equally feasible.

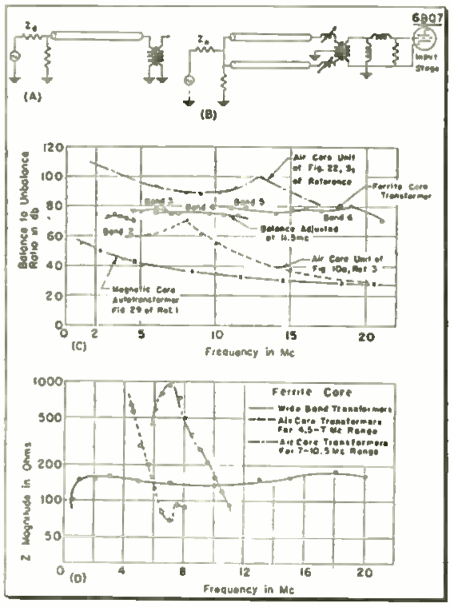


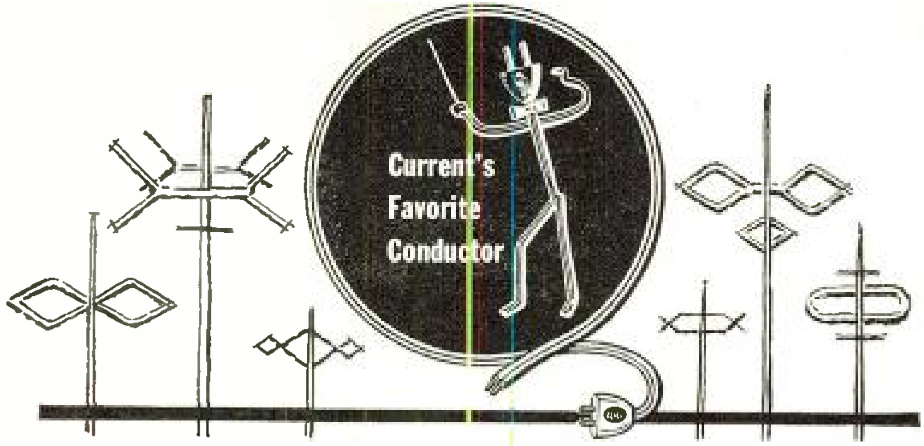
Fig. 10: Balance to unbalance measurement. (a) Balance measurement circuit. (b) Circuit for inductive balance to unbalance. (c) Balance to unbalance curves. (d) Input impedance curves

Figure 10d illustrates the input impedance measured with the circuit of Fig. 9b. For purposes of comparison the input impedances to a number of air core transformers, with tuned secondaries operating at the same impedance level, have been shown.

In Fig. 10c the balance-to-unbalance ratio has been plotted over the frequency range of the receiver for which this transformer was designed as a grid coupling unit in the first stage. The circuits for these measurements are shown in Figs. 9a and 9b. It should be remarked that to produce balance-to-unbalance ratios as high as those shown in Fig. 10c, it was necessary to make an inductive trim adjustment, effected by the positioning of the wires connecting the coaxial cable connectors to the transformers. It is not known for certain whether compensation was being effected for small differences in the coaxial cable lengths or for small differences in the transformer primaries. Probably both were present.

A low pass filter design technique is definitely advantageous where the maximum frequency range must be

(*Continued on page* 168)



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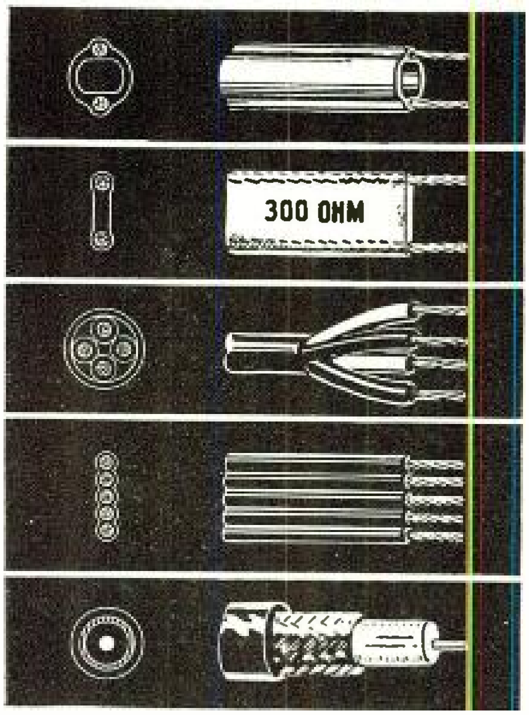

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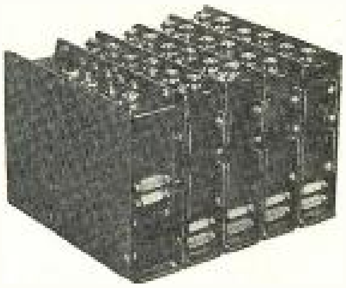
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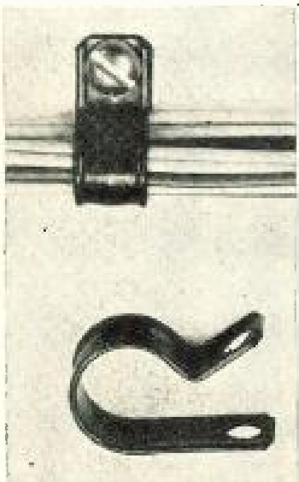

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Wideband Transformer

(*Continued from page 167*)

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For maximum frequency response range it is generally best to select a lossy core material with a high absolute value of permeability.

Split screen case construction is capable of reducing the leakage inductance by an order of four or five to one, for most types of windings which are physically separated to begin with.

Frequency response can be obtained from about 0.4 MC to something on the order of 18 to 20 MC (at the thousand ohm impedance level) when coupling to vacuum tubes if precautions are made to keep the tube side capacity values low. Low leakage inductance is not quite as essential in this application as in matching to purely resistive loads, but the required leakage inductance values are still sufficiently small to be out of range of the average air core coil.

Acknowledgement is due to Wesley W. Knight who developed the grid-to-line coupling circuit mentioned; to the Antenna Lab. of the U. of Ill. for making available the data on ferrites; and to the Office of Naval Research, under whose contract the work was done.

1. D. Maurice, R. H. Minns, "Very Wide Band Radio-Frequency Transformers," *Wireless Engineer*, Vol. 24, pp. 168-177; June, 1947; and pp. 209-217; July, 1947.

This article is a condensation of a paper presented at the 1954 National Electronics Conference, Chicago, Ill.

Strength & Behavior of Guyed Towers

In the article by Dr. D. A. Liamin entitled "Strength & Behavior of Guyed Towers," appearing in the Jan. and Feb. issues of TELE-TECH, mention should be made of the fact that Dr. Liamin was formerly professionally associated with the Wind Turbine Co. of West Chester, Penna. Thus several of the photographic illustrations should properly have been credited to the Wind Turbine Co. as the designer and builder. Specifically this involves the photos on page 72 of the January issue and on page 65 of the February issue. Mr. Robert W. Weeks, president of the Wind Turbine Co., points out also that the idea of the wrap around gusset also originated in his company and was originally submitted to the Coast Guard in 1946. Dr. Liamin's article, therefore, details further design points on this type of construction.

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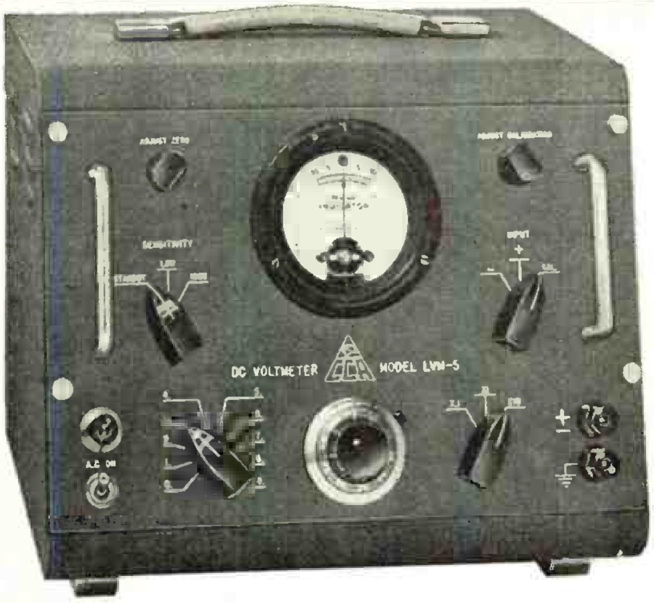

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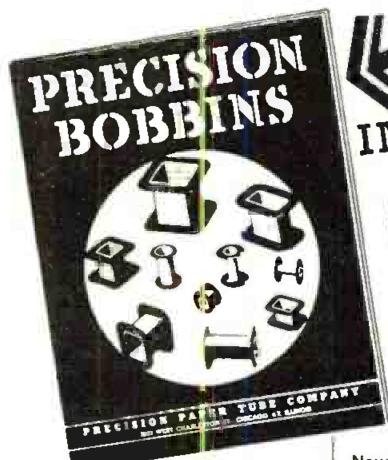

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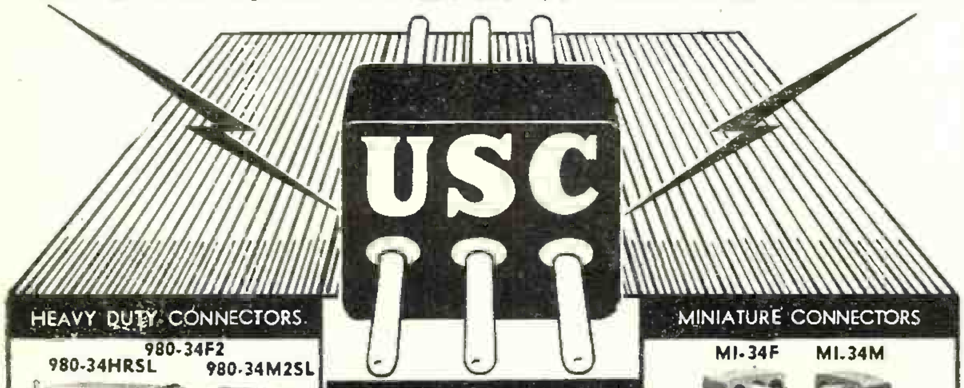

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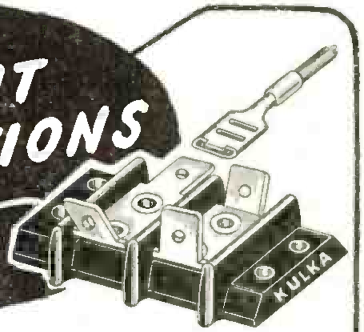

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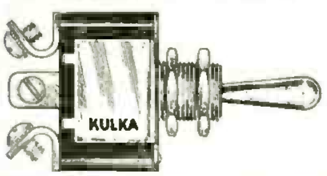

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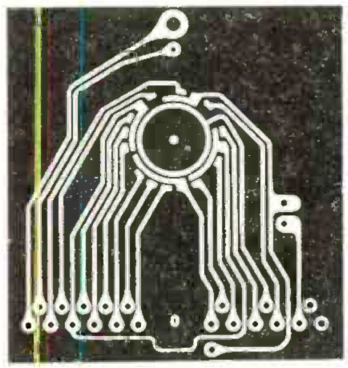

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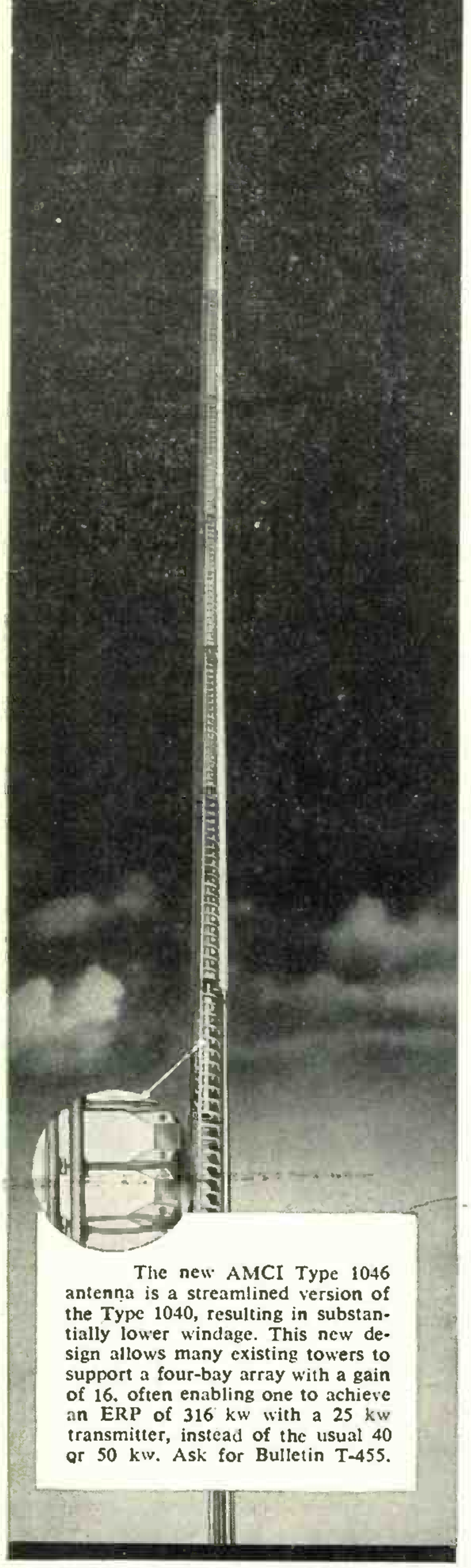

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Resistor manufacturer is seeking representation in Ga., N. C., S. C., Ala., Tenn., Fla., Texas, Okla., Ark., La., Colo., Wyoming, Mont., Utah and Nev., plus an export sales agency. (Ask for R-4-2)

A. W. Nash Co., Los Angeles, has been appointed by The Winslow Co. to represent the firm's line of instruments and test equipment in Southern California.

General Transistor Corp., producer of transistors and germanium diodes, has added the following four reps: **S. A. Shaw**, Jamaica, N.Y., for New England and New York; **George Petitt Co.**, Chicago, for Ill., Wis., and Minn.; **Don C. Wallace** and **W. H. Wallace**, Los Angeles, for Calif., Ariz., and Nev.

Perlmuth-Colman will handle the subminiature component line of Electro Development Co. in Southern Calif., Ariz., and Nev.

James W. Eckersley, Portland, Ore., will represent Columbia Wire & Supply in Ore., Wash., Idaho and Alaska.

Pivan Engineering Co., Chicago, will rep for Offner Electronics' direct writing oscillograph in Wis. & Ill.

Universal Motor Co. has appointed **M. F. Huseby**, Los Angeles rep, to cover Calif., Nev., Ariz. and N. M.

Wright Engineering Co., Pasadena, Calif., will represent Industrial Control Co. in the West.

Grant Shaffer, Detroit, will handle the product line of Chicago Standard Transformer in Michigan.

Two new reps for Heppner Mfg. Co., maker of iron traps, TV coils and transformers and speakers, are **William I. Duncan, Jr.**, 3451 N. 10 St., Philadelphia, covering Camden, Phila., and Baltimore and **Ben H. Tollefson**, 144 Collingsworth Dr., Rochester, N.Y., covering Syracuse, Rochester and Buffalo, N.Y.

Harold Lichtenstein has joined the staff of **Paul Hayden Associates**, P.O. Box 331, East Point Ga. He will serve as chief sales engineer and maintain headquarters at 217 Montgomery Lane, Birmingham, Ala.

Frank P. Deveny, 5200 Chowen Ave., S. Minneapolis, Minn., has been appointed representative for Ilsco Corp., Cincinnati, O., to cover Minn., N. D., S. D., Neb., and parts of Ia., and Wis.

Joe Murphy, 202 Pam Road, Meridian Meadows, Indianapolis 20, Ind., will handle the production yokes for TV sets and the military or special yokes and focus coils made by Syntronic Instruments, Inc., Addison, Ill., in Ind., Ky., and Western O.

Ben H. Newman has joined the **D. R. Bittan Co.**, 53 Park Pl., New York 7, N.Y., as office manager.

Harry Levinson Co., Seattle, Wash., has been appointed to represent Color Television Inc., makers of test and control equipment, in Washington and Oregon.

Bill Kolans & Co., 101 San Felipe Ave., S. San Francisco, Calif., will represent Clarostat Mfg. Co. in Northern California and Nevada. The firm's line includes resistors and controls.

Irv. M. Cochrane Co., Los Angeles, has been appointed West Coast rep for General Ceramics' line of cores, insulators, ceramics, terminals and other components. **Northport Co.**, 1838 Ashland Ave., St. Paul, Minn., will represent the firm in N. D., S. D., Minn., and Northern Wis.

Crescent Industries, Chicago, speaker and record changer manufacturer, has appointed **Jay Nierenberg** rep for upper New York State, and **L. D. Lowery** as rep for Eastern Pennsylvania, Del., Southern N. J., Md., Va., and Washington, D. C.

Joseph S. Sodaro, Culver City, Calif., will represent Ford Instrument Co., Div. of Sperry Corp., in that state. Line includes servos, synchros, and differentials.

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Relay Characteristics

(*Continued from page 97*)

short period of time. It is assumed that this is the point where the armature touches the pole of shim. The current then builds up to the steady-state value. The momentary decrease of the coil current is one distinguishing feature of a relay. Point A on Fig. 1 may take place before the contact current has reached a final value or before the contact current has started to flow.

Oscillograms of this nature were made for several relays. For some of these relays, this dip at point A was quite pronounced, while in others it was not easy to locate. The trace of the contact current shows that it could reach a final value in a short time if no bounce took place.

The contacts must have established a circuit before a contact current can flow. It is true that a small amount of arcing will take place as the circuit is established and as the circuit is broken. The constants of the contact circuit (R-L-C) will influence the type of transient which will occur.

Armature

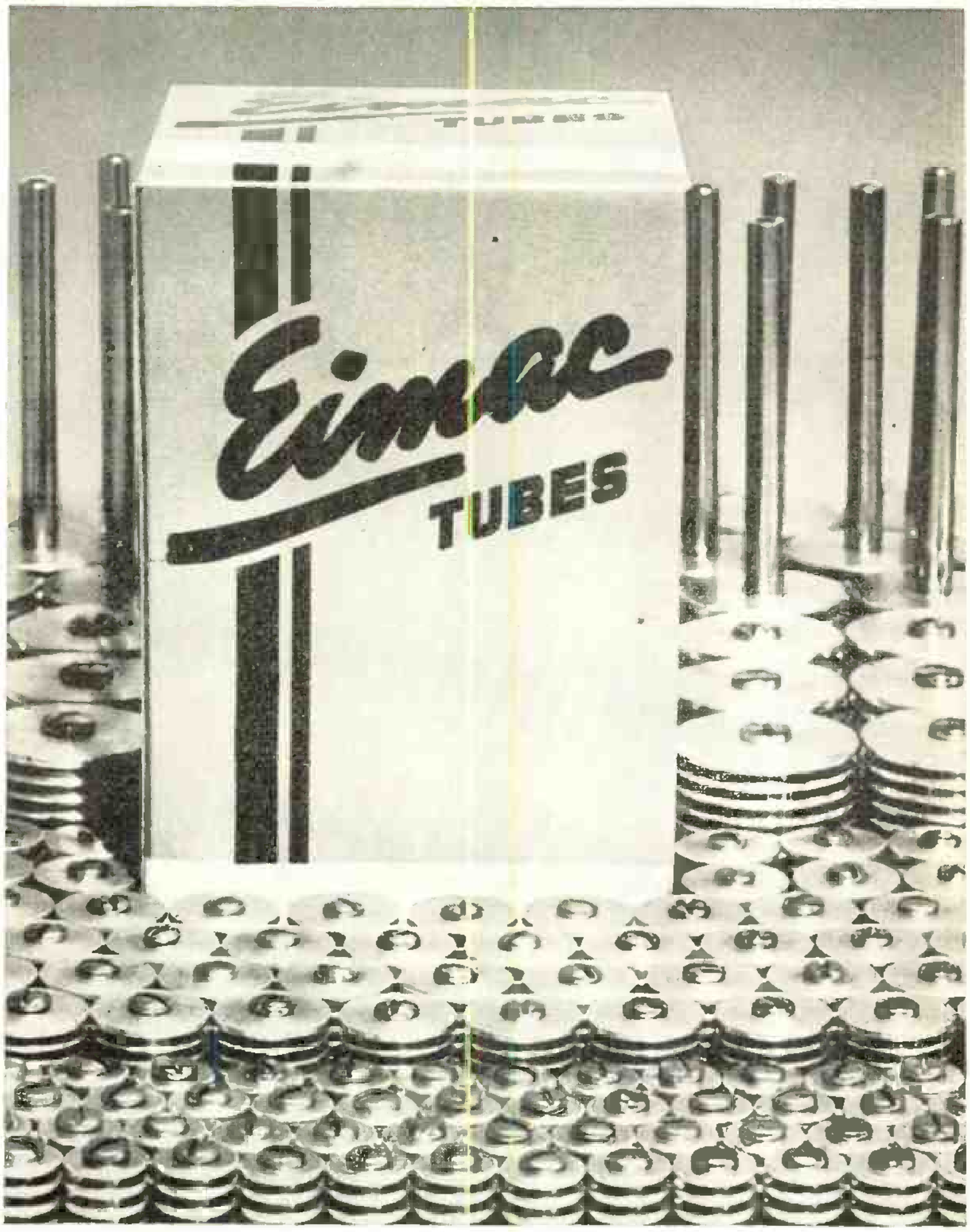
It has been assumed that point A indicates the time at which the armature touches the core or shim. However, there is no indication of the instant that the armature started to move. It would be instructive to have information of this nature superimposed on the transient-current response curve in Fig. 1. It is believed that a more detailed analysis of the mechanical system would be of value in future relay designs.

Fig. 2 illustrates the term "contact bounce" and the effect on the contact current when bounce occurs. It would be desirable to eliminate contact bounce, if for no other reason than that considerable arcing may take place during this time. Arcing may be the cause of contact failure and hence is undesirable.

The length of time between the maximum values of contact current during the period of bounce may be a more important factor than the total duration of bounce. If this time is such that in the circuit in which the contact current flows other relays drop out or circuit interruptions of this length of time may not be tolerated, then a more detailed analysis of contact bounce becomes imperative.

An analysis of several oscillograms indicates that the location of point A (Figs. 1 and 2) of the coil current

(*Continued on page 174*)



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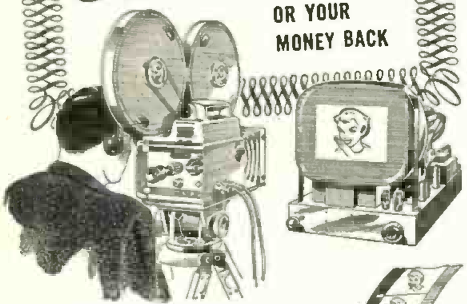
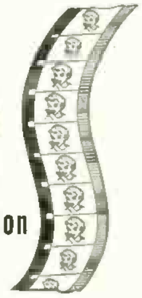

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Relay Characteristics

(*Continued from page* 173)

may determine or is in some way related to contact bounce. Point A seems to indicate the instant at which the armature touches the shim.

Operate Time

The diagrams in Figs. 1 and 2 show that some appreciable time elapsed before the armature moved from the open position to the closed position. It is usual to have a restoring spring hold the armature of a relay open until the magnetic pull caused by the flow of coil current becomes large enough to cause the armature to close. This means that the magnetic pull on the armature must exceed the pull of the restoring spring before the armature will begin to close.

It was noted in the paragraph on transient build-up of current that the inductance of the circuit was effective in retarding the build-up of coil current. The total operate time is composed of two components: (a) the time for the current to build up and (b) the time for the armature to move from the open position to the closed position. Fig. 1 shows the total operate time, but *using only this curve*, it is not possible to define the time during which the armature is stationary and the time during which it is in motion unless more information about the relay is known. If the minimum value of coil current at which the armature will begin to move is known, then the time intervals during which the armature is stationary and moving may be determined from Fig. 1. From test data taken on several different relays, it has been found that the time interval during which the armature is stationary may be an appreciable percentage of the total operate time.

If the total reluctance of the magnetic circuit is taken as equal to the reluctance of the air gap only, the force equation may be written

$$\frac{F}{A} = .142 \times \frac{10^{-6} N^2 W}{R l^2} \text{ lbs./sq. in.}$$

where F is pounds pull, A is the area of the pole in square inches, N is the number of turns, W is the watt input, R is the resistance of the wire and l is length of the air gap in inches. This relation shows that the force is directly proportional to the square of the number of turns and the watt input, and inversely proportional to the resistance and square of the length of the air gap.

Time is not an expressed factor in the force equation. It seems obvious that as the force is increased the operate time of the relay would be decreased or the acceleration would be increased. Anything which could be done to increase the force on the armature of the relay would help to decrease the operate time. It is evident that in a relay design it is desirable to use as short an air gap as possible. Mechanical considerations as well as the voltage across the contacts will enter into the final choice of air gap length. To increase the speed of operation of a relay, the watt input may be increased if other factors are held constant. The pull on the armature is increased by an increase in the ampere-turns.

The time for the armature to move from the open position to the closed position will depend upon the mass of the armature, the tension on the restraining spring, and the magnetic force which is caused by the coil. The above discussion assumes that the armature moves directly from the open position to the closed position and that no bounce of the contacts takes place.

Saturation Curves

There are two different saturation curves which may be found for a relay under static conditions. These two curves are determined when the armature is held closed and when the armature is held open.

With the current plotted against the flux for the armature held in the closed position, a curve similar to that shown in Fig. 3a will be found. As would be anticipated, the iron would have to be demagnetized in order for the curve to start at the origin. As the current is increased, the flux will increase to the point A. As the current is decreased, the curve will not retrace the first curve, but will intersect the vertical axis at some point C for zero current. This would be a part of a hysteresis loop.

There would be a small air gap between the armature and the core and also at the armature hinge, so that this curve would not be the magnetization curve of the iron alone. In the past, the relay operation has been investigated assuming that the ascending and descending portions of the magnetization curves were identical. In some instances, however, it is easy to see that the relay would not be operating on the same portion of the magnetization curve if the start of relay operation were to begin at point C rather than point O. Ordinarily, this effect is ne-

(*Continued on page* 176)

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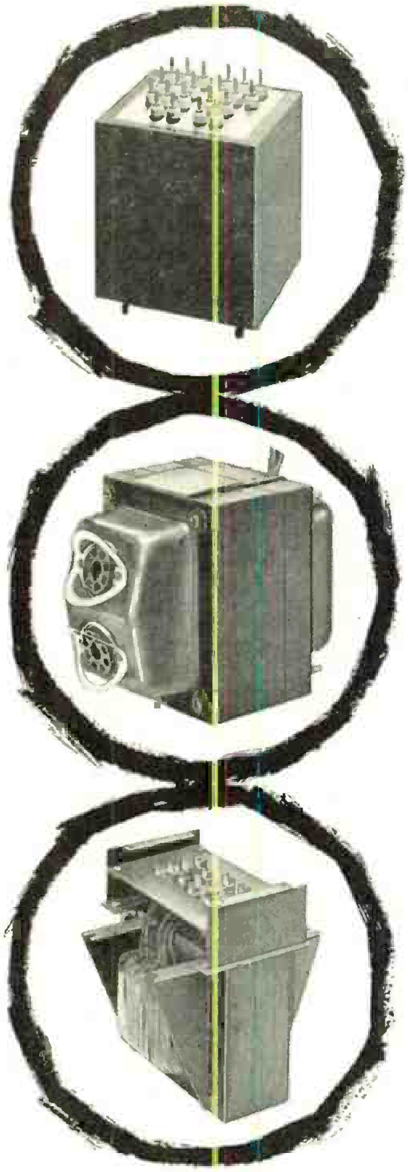

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Relay Characteristics

(*Continued from page* 174)

glected, but for the case where a prediction of the results of relay operation are required, some information is necessary.

With the relay held in the open position, the curves as given at B would be obtained. This again emphasizes the fact that there is considerably more flux in the magnetic circuit of the relay when the armature is closed than when it is open. Under open conditions, the air gap offers a larger amount of reluctance in the magnetic circuit than the iron part does. It is quite probable that the shape of the core near the armature end would determine the effects of fringing of the flux in the air gap.

Hysteresis Curve

The hysteresis curve for a relay presents some extremely interesting points. With the iron core demagnetized, the current may be plotted against the flux, or the ampere-turns and flux density may be used. In any case, Fig. 4 shows that the flux increases essentially in direct proportion to current as the current is increased up to the point of pick-up. This is due to the fact that most of the reluctance of the magnetic circuit is contained in the armature air gap and, of course, this reluctance is constant. At this point, the armature moves to the sealed or closed position. From the open position to the

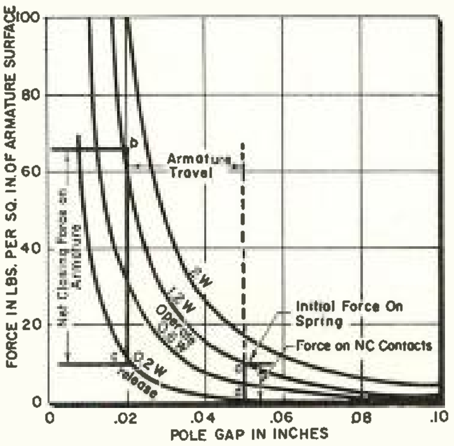
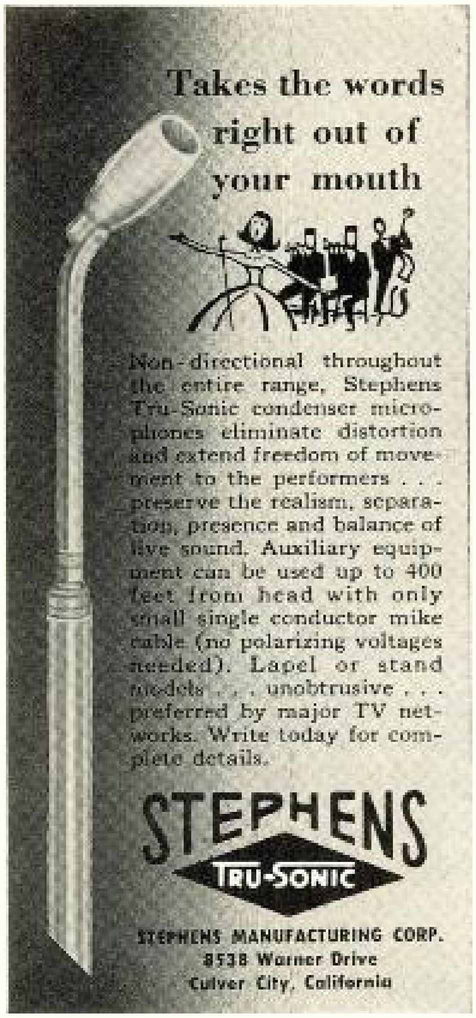


Fig. 5: Relay static characteristics

closed position the flux has increased from 30% to 75% of its maximum value. As the current increase continues, the relation between the current and the flux is the magnetization curves of the iron circuit with the small air gap.

When the current is decreased from the rated value, the foregoing curve is not retraced but another curve is followed. This resembles the hysteresis curve for iron in some re-



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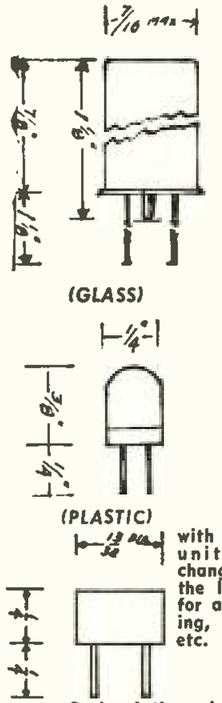

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spects. The release point (where the armature moves from the closed position to the open position) on the magnetization curve will depend upon the rate of decay of flux in the magnetic circuit.

There are several points on this curve which are important: (a) the value of current which causes pick-up, (b) the value of current which causes release, (c) the rated value of current, and (d) the ratio of rated current to pick-up current.

Force-distance Curves

Methods have been devised to determine the force-distance curve of a relay. This is a static characteristic which is found by measuring the pull or load on the armature at various positions of the armature in the air gap. Since these measurements are made while the armature is stationary, many questions as to the conditions when the armature is moving, or the dynamic characteristics of a relay still remain to be answered. This is the most crucial characteristic of a relay. This challenging problem has received a great deal of study, but as far as is known a satisfactory solution has not been found.

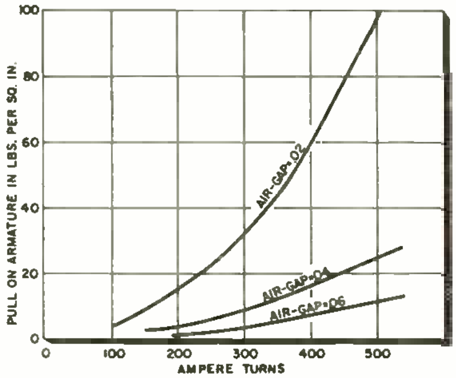

Fig. 6: Relay pull for different air gaps

Nevertheless, the force-distance curve of a relay is instructive and helps to explain some of the operational characteristics. If it is assumed that the coil is energized when the armature is in the open position, the curves of force-distance given in Fig. 5 show that the armature will pick up, i.e., the armature moves, for a certain number of ampere-turns. Since the coil turns will remain constant in any given relay, the current will be the variable. The pull exerted by the pick-up ampere-turns will cause the armature to close. However, if the current is allowed to reach the rated value, the pull on the armature (or the magnetic force) will be a larger amount as indicated on the curve.

The armature of a relay is held open by a restraining spring. The

(*Continued on page* 178)

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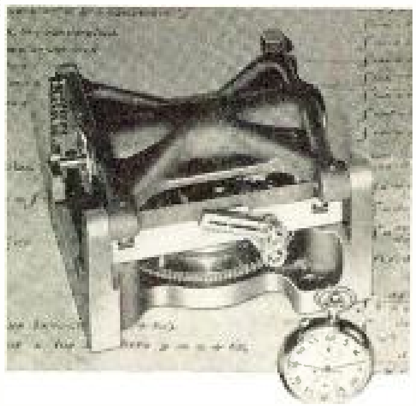

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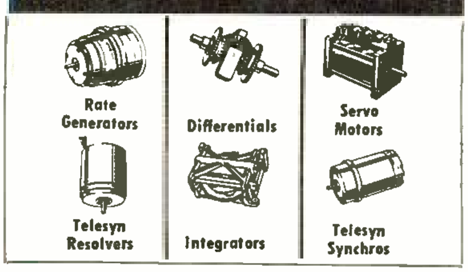

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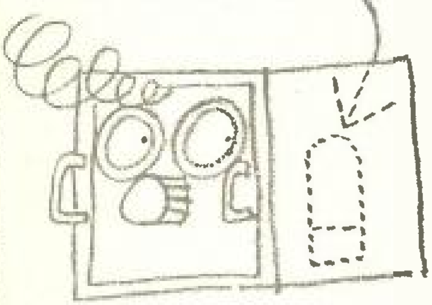

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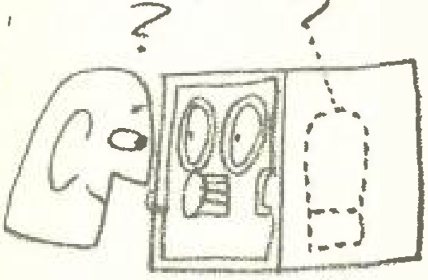

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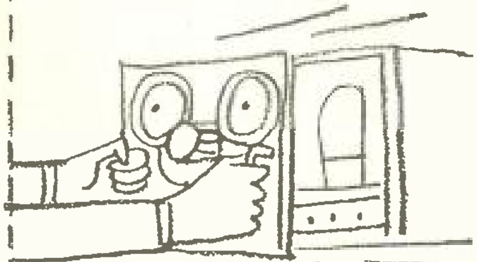

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Relay Characteristics

(*Continued from page* 177)

pull of the pick-up ampere-turns must exceed the spring force (or bias) before the armature will move. As the force is increased, the armature will move to the closed position. As the air gap is decreased, the force is increased.

With the relay armature closed, when the current is decreased to a value such that the ampere-turns are less than the drop-out ampere-turns, the armature moves to the open position, or the armature drops-out. This completes the cycle.

Another family of curves may be derived from the data used to plot the force-distance curves. For different value of air gap (or armature travel) the amperes (or NI) may be plotted against the force as shown in Fig. 6. It is evident from this family of curves that a small air gap will allow a larger force on the armature for the same amount of current (or NI) than a larger air gap.

This information presented at 1954 WESCON, Los Angeles, Calif.

Radar Detection

(*Continued from page* 72)

Thus,

$$\log R_n = \log K_2 + \tfrac{1}{8} \log (\omega/\omega'). \quad (11)$$

Similarly,

$$\Delta R_n = \frac{\Delta R}{R_o} = K_3 \frac{1/\omega}{(1/\omega)^{1/8}} \quad (12)$$

$$= K_3\, \omega^{-7/8} = K_3 (\omega')^{-7/8} (\omega/\omega')^{-7/8} \quad (13)$$

$$= K_4 (\omega/\omega')^{-7/8} \quad (14)$$

Thus,

$$\log \Delta R_n = \log K_4 - \tfrac{7}{8} \log \omega/\omega'. \quad (15)$$

The values of K_2 and K_4 are obtained by evaluating equations (11) and (15) at $\omega = \omega'$.

$$\text{Log } R_n = \log K_2 \quad (16)$$

and

$$\log \Delta R_n = \log K_4. \quad (17)$$

Hence Eqs. (11) and (15) reduce to the following functions of:

$$\log R_n = \log R_n |_{\omega=\omega'} + \tfrac{1}{8} \log \omega/\omega' \quad (18)$$

and

$$\log \Delta R_n = \log \Delta R_n |_{\omega=\omega'} - \tfrac{7}{8} \log \omega/\omega'. \quad (19)$$

Note that Eq. (18) and (19), which define the radar operating point, are each composed of two terms. The first term is obtained from the initial radar conditions, assumed aircraft speed, and the range at which the value of detection probability is desired; while, the second term involves only the variation of ω from the initial scan rate of ω'. Eq. (18) and (19) illustrate why the probabil-

(*Continued on page* 180)

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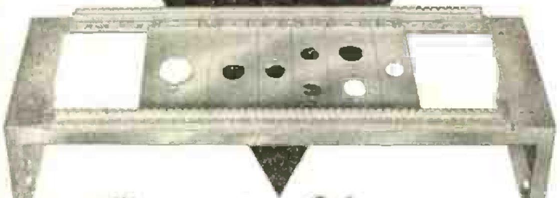

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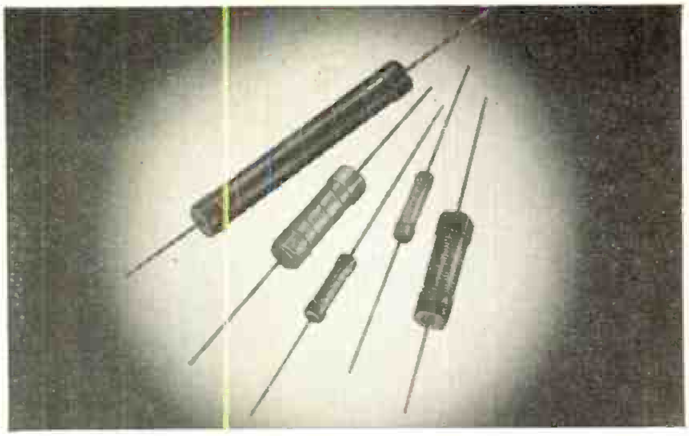

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Radar Detection

(Continued from page 178)

ity curves of Fig. 4 were plotted in logarithmic coordinates.

To simplify the procedure used to obtain the new operating points for variations of ω, a transparent overlay shown in Fig. 5 has been constructed. The second term of equations (18) and (19) on the same logarithmic scales of Fig. 4 has been plotted on this figure. Thus the origin of Fig. 5 may be placed over any operating point, and new operating points obtained for different values of the ratio ω/ω′. The straight line $\overline{ab}$ connects the different values of ω/ω′, and since this line contains all possible operating points for all values of ω/ω′, it is called the "operating line."

Example 2:

Referring back to Example 1,

(a) obtain the Cumulative Probability of Detection of a 600 knot aircraft by 90 nmi. for the same radar whose antenna is rotating at scanning rates of 5, 20, and 60 rpm.

(b) Between what values of ω will the probability of detection be greater than .90 at a range of 90 nmi.?

Solution:

The origin of Fig. 5 is placed over the original operating point previously calculated: $\Delta R_n = 0.0125$; $R_n = 1.125$. The new values of cumulative probability may now be read directly from the overlay for values of ω/ω′ of ½, 2, and 6 respectively, and are shown in Table 2. Also shown are the values of ω/ω′ for which the detection probability is equal to .90.

TABLE 2. TABULATION OF DETECTION PROBABILITIES.

ω	10	5	20	60	56	6.2
ω/ω′	1	½	2	6	5.6	1/1.6
P	.92	.87	.94	.89	.90	.90

Optimum Scan Rate

It can be seen either from observation or from a constructed plot of the results of Table 2 that the Cumulative Probability of Detection by 90 nmi. reaches a maximum at a scan rate of approximately 20 rpm. (However, this maximum is seen to be fairly flat, hence the value of ω is not too critical.) A method will now be described which enables one to rapidly obtain this optimum scan speed.

At each of the curves of constant probability in Fig. 4 the point can be found at which the slope of the curve was equal to the slope of the

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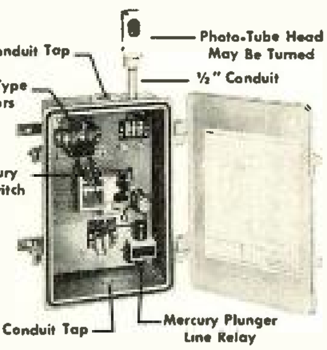

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operating line $\overline{ab}$ of Fig. 5. These points were connected by the curve $\overline{cd}$. It can be shown that after the origin of Fig. 5 has been placed over the initial operating point, the value of ω at the intersection of line $\overline{ab}$ with line $\overline{cd}$ is the optimum scan rate. This can be seen by considering the following points:

A. Each of the curves of constant probability is a monotonically decreasing function, containing only one point whose slope is equal to the slope of operating line $\overline{ab}$.

B. These curves cannot intersect one another.

C. Curve $\overline{cd}$ is assumed to contain all points on the different lines of equal detection probability which have the same slope as line $\overline{ab}$.

D. A curve of constant detection probability tangent to line $\overline{ab}$ could be constructed through the intersection of lines $\overline{ab}$ and $\overline{cd}$. Call this Curve X.

E. Because of the monotonically decreasing characteristic of Curve X, all other points of line $\overline{ab}$ must lie to the right of Curve X, and hence must lie on curves of lesser values of probability than Curve X.

Example 3:

Consider an airborne radar system travelling at a speed of 200 knots, the antenna rotation rate is 20 rpm., and the effective radar range is 60 nmi. The highest target speed to be considered is 800 knots.

(a) What will be the probability of detection by 80 nmi.?

(b) What is the optimum scan rate for maximum detection probability by 80 nmi.?

(c) Construct the curve of detection probability vs. range for this optimum scan rate.

(d) Through what limits can the scan rate be adjusted without decreasing the detection probability to more than 50 percent by 80 nmi.?

Solution:

$$\text{(a)}\ \Delta R_n = \frac{V}{60\omega R_e}$$

$$= \frac{1000\text{ knots}}{(60)\ (20\text{ rpm})\ (60\text{ nmi.})} = .0139$$

$$R_n = \frac{R}{R_e} = \frac{80\text{ nmi.}}{60\text{ nmi.}} = 1.333$$

$$\therefore P = 0.51.$$

(b) Operating line $\overline{ab}$ intersects curve cd at $\omega/\omega' = 1/1.7$, or $\omega =$ 11.8 rpm, yielding a value of P = 0.53 by 80 nmi.

(c) The optimum scan rate of ω = 11.8 rpm. occurred at value of $R_n =$ 1.26 which, by assumption, corresponds to R = 80 nmi. Thus the new

(*Continued on page* 184)

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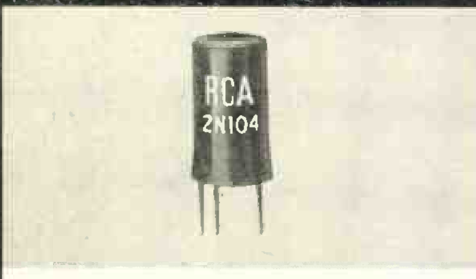

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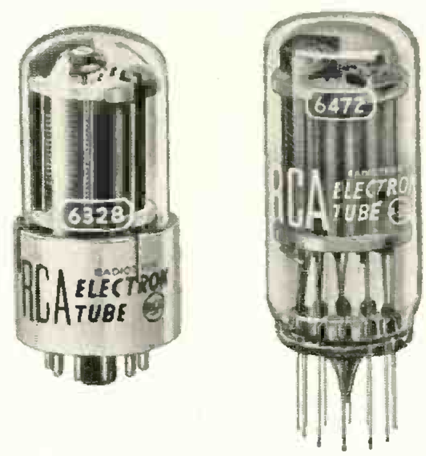

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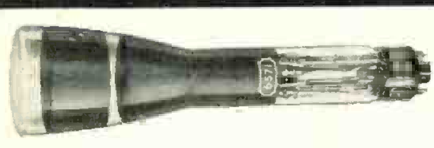

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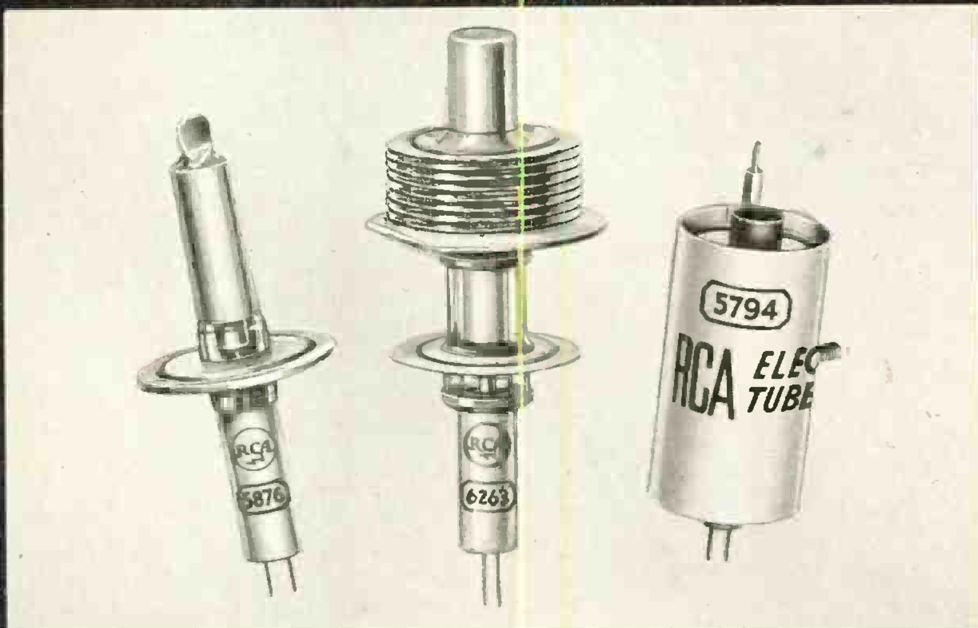
Well-suited for fixed and mobile uhf applications up to 470 mc, these unique twin beam power tubes offer designers unusual advantages—as balanced push-pull rf power amplifiers or frequency triplers. RCA-6524 delivers approx. 20 watts (ICAS) in push-pull class C amplifier service—at 462 mc! Max. plate dissipation: 25 w (ICAS). RCA-5894 delivers approx. 55 watts (CCS) at 470 mc. Max. plate dissipation: 40 watts (CCS).



RCA "PENCIL" TUBES FOR UHF

Available in a choice of types for uhf applications, RCA "Pencil Tubes" are designed to have minimum transit time, low lead inductance, and low interelectrode capacitances. Features include small size, light weight. low heater wattage, and good thermal stability. RCA-6263 with external plate radiator is intended for rf power amplifier and oscillator services; 6264 is like the 6263 but is well-suited for frequency-multiplier service. Additional RCA "Pencil Tubes" include 5674, 5794, 5876, 6173.

NEW 5" PROJECTION KINESCOPE (FOR CLOSED-CIRCUIT INDUSTRIAL TV)

Providing a clear, bright, projected picture about eight feet by six feet when used with a suitable reflective optical system, the RCA-5AZP4 is especially useful for closed-circuit industrial TV. Contributing to the brightness of the "auditorium-size' picture of high-efficiency, aluminized screen having very good color stability under varying conditions of screen current, and an unusually high operating ultor voltage (40,000 volts max.) for a tube of this type.

For technical information, write—specifying tube types in which you are interested—to RCA, Commercial Engineering, Section D-50-R, Harrison, N.J., or call your RCA Representative:

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

MIDWEST — WHitehall 4-2900, 589 E. Illinois St., Chicago 11, Ill.

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

RADIO CORPORATION of AMERICA
TUBE DIVISION — HARRISON, N. J.

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Among important activities at Hughes is a program involving comprehensive testing and evaluation in connection with Hughes-developed radar fire control and navigation systems for latest type military all-weather interceptors.

Convair F-102 all-weather interceptor

System Test Engineers

There is need on our Staff for qualified engineers who thoroughly understand this field of operation, and who have sufficient analytical and theoretical ability to define needed tests; outline test specifications; assess data derived from such tests, and present an evaluation of performance in report form.

Engineers who qualify in this area should have 1 a basic interest in the system concept and over-all operation of test procedures; 2 experience in operation, maintenance, "debugging," development, and evaluation testing of electronic systems, and knowledge of laboratory and flight test procedures and equipment; 3 understanding of basic circuit applications at all frequencies; 4 initiative to secure supporting information from obscure sources.

Hughes

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SCIENTIFIC AND ENGINEERING STAFF

Culver City, Los Angeles County, Calif.

Radar Detection

(*Continued from page* 181)

value of R_e for this scan rate must be:

$$R_e = \frac{R}{R_n} = \frac{80 \text{ nmi.}}{1.26} = 63.5 \text{ nmi.}$$

In addition, the y coordinate of the new operating point is seen from Fig. 4 to be $\Delta R_n = 0.021$, which for various values of R_n produce the probabilities shown in Table 3, and which may be plotted.

TABLE 3. DETECTION PROBABILITIES VS. RANGE FOR OPTIMUM SCAN RATE.

ΔR_n	0.021	0.021	0.021	0.021	0.021	0.021
P	.95	.90	.70	.50	.30	.10
R_n	.95	1.02	1.17	1.27	1.38	1.51
R	60.3	64.8	74.3	80.0	87.0	96.0

(d) Operating line $\overline{ab}$ intersects the 0.50 probability curve at values of ω/ω' of ¼ and 1.3, which yield values of ω of 5 rpm and 26 rpm. Thus, scan rate may be varied between 5 and 26 rpm without reducing the detection probability by 80 nmi. below 0.50. Since the maximum probability is 0.53, the radar designer has a wide choice in choosing the operating scan rate. This choice is, of course, determined by other factors including mechanical and tactical considerations.

Acknowledgement is made to H. Pollard, D. Van Tijn, and M. Glatt, of the Systems Analysis Section, for their aid in the derivation of the mathematical equation for the Cumulative Probability of Detection.

Philco Answers Gov't Suit Charging Trust Violation

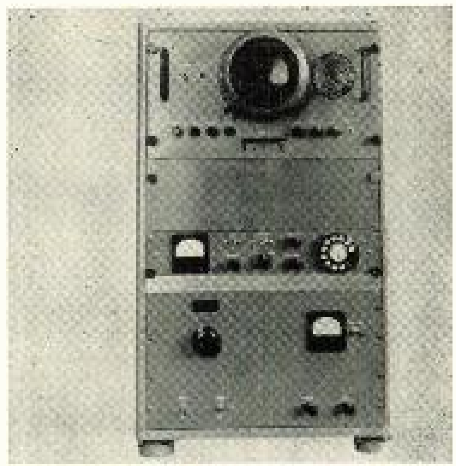
Philco Corp. has contended in U. S. Court that its distribution policy increases competition in the sale of TV receivers, radios and major appliances.

The Company made a sweeping denial of Government charges that Philco violates the anti-trust laws by restricting operations of its distributors and dealers. Further, Philco told the court that sales by untrained and unqualified dealers are harmful to the public and damaging to the Company's reputation. Philco said the suit presents a new and dangerous challenge to those manufacturers who are endeavoring to preserve the system of independent distributors.

Servo Corp. Unveils Bearing Indicator

An automatic visual-indicating direction finder that provides the airport control tower with instantaneous bearings of any aircraft with which they come in radio contact has been developed by Servo Corp. of America, New Hyde Park, N. Y. The new equipment adds a long-range supplement to the airport's comparatively short-range radar to permit improved air traffic regulation, an increasingly important problem with the advent of high speed jet transports.

The complete installation comprises a control and indicating console, which is located in the tower, and a 4-element Adcock antenna, with a 75-ft. counterpoise, associated goniometric equipment and receivers, at the antenna site. The two sites, which may be as much as 5 miles apart, are connected by an 11-pair cable. The cable carries the control and remote data transmission signals by which the control tower operator remotely controls the equipment at the site, and also provides a 2-way communication link.



Control console holds these units

Bearing indication is in the form of a propeller-shaped configuration which flashes on the face of a crt instantaneously upon radio contact with an aircraft. A sense switch is provided to distinguish the direct from the reciprocal bearing. The circumference of the crt is marked off in degrees similar to a radar scope.

As presently constructed the equipment utilizes 5 pre-set frequency channels, each of which employs an individual receiver, a Hammarlund Model SP-600-JX, at the antenna site. Any one of the channels can be selected by remote control from the control tower. The control equipment is designed to accommodate up to 10 channels should increased traffic require it.

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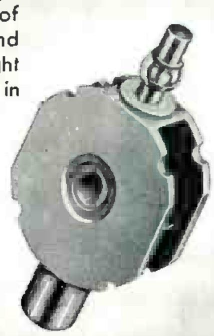
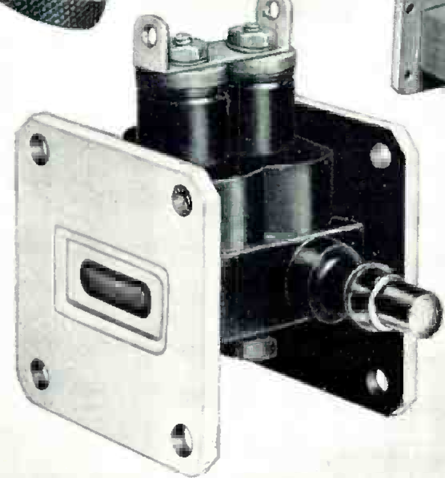
Bomac Firsts IN MICROWAVE

1N23D . . . Bomac was the first to manufacture the 1N23D silicon diode. System designers, for the first time, could obtain a diode with greatly increased sensitivity and superior electrical characteristics in relation to existing types.

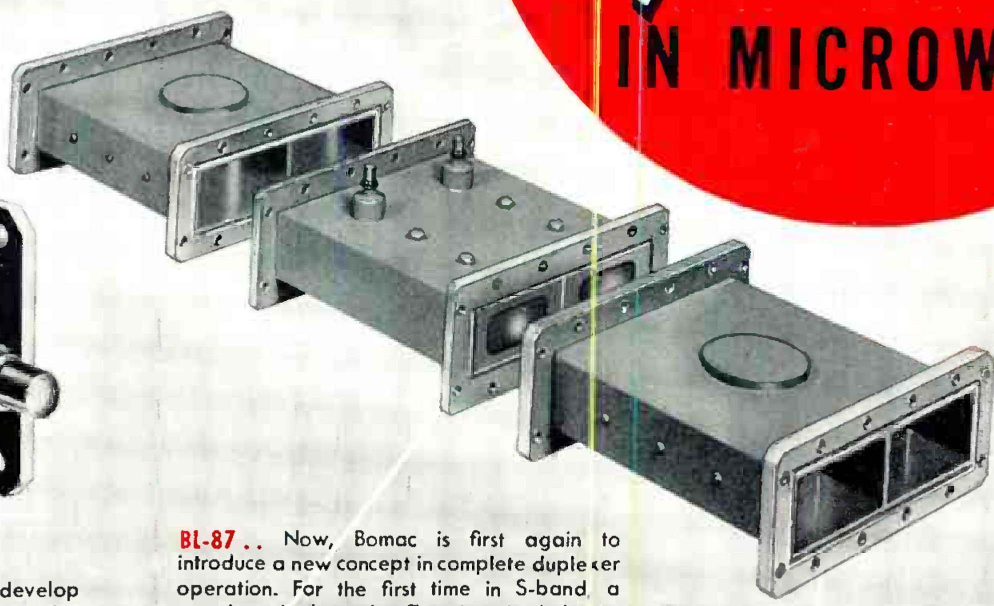


6738 . . . First again in the field of tube miniaturization, Bomac developed a new type TR tube designated the 6378. Designed specifically for airborne radar equipment, the 6378 is a miniaturized version of the 1B24A (another Bomac first), 1B60 and the 1B24. Size was cut in half, and weight was reduced by one fifth with no sacrifice in performance or efficiency.

BL-25 . . The BL-25 TR tube, designed and developed by Bomac, was the first cell-type tube system — engineered to withstand high power levels and maintain recovery time over a long period of life. The BL-25, although originally designed for a specific piece of equipment, has proven its versatility in various applications within the industry.



BL-58 . . . Bomac was the first to develop shutter tubes and integral TR-shutter combinations for continuous crystal protection. The BL-58 was the first integral TR-shutter combination developed by Bomac. With integral TR-shutter operation, bulky waveguide shutters could be eliminated at considerable savings in size and weight. This tube has now been superceded by improved models.

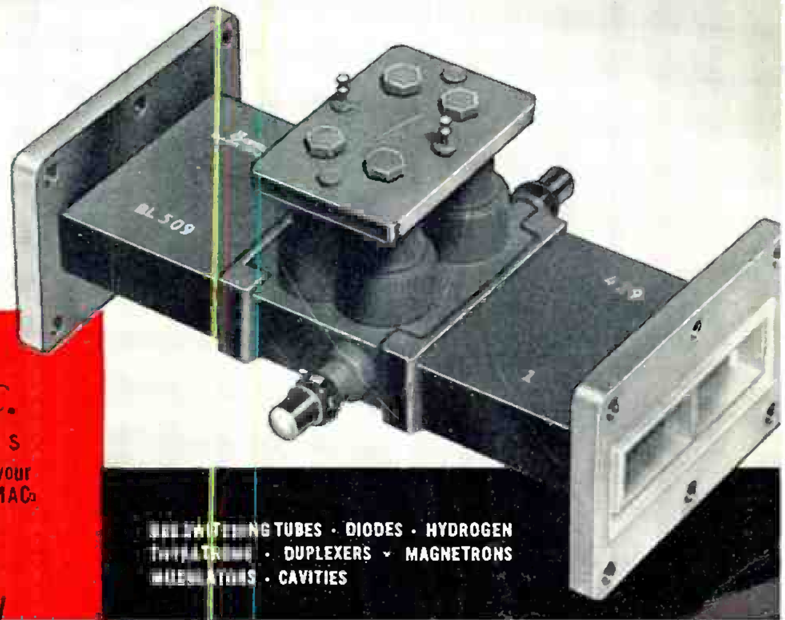


BL-87 . . Now, Bomac is first again to introduce a new concept in complete duplexer operation. For the first time in S-band, a complete duplexer is offered to the industry. The BL-87 is a dual TR tube, complete with perfectly matched hybrids to assure maximum efficiency and long life. Systems designers can now be assured of reliable duplexer operation because Bomac's hybrids are designed specifically for their dual TR tubes. Bomac is first again in design and development of microwave tubes.

BOMAC DUAL TR DUPLEXERS

Tube	Frequency (MC)	Tube	Frequency (MC)
6334 (BL-27)	8490-9578	BL71	8500-9600
BL29	9325-9425	BL78	8490-9578
BL35	15000-17000	BL87	2700-2900
BL47	9325-9425	BL507	8490-9578
BL60	5400-5900	BL600	8490-9578

BL-509 . . . Bomac's BL-509 was the first complete duplexer offered in one compact unit. Combining a Bomac dual TR tube having integral shutters with two perfectly matched hybrid junctions in a single unit, the BL-509 provides duplexer operation and continuous crystal protection in one package. Light weight and compact, the BL-509 assures superior electrical performance and mechanical simplicity.



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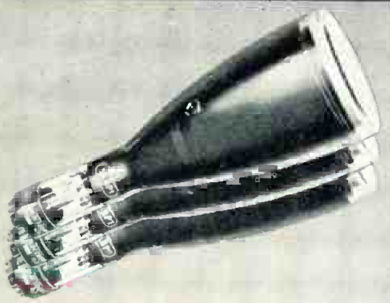

RCA OSCILLOGRAPH TUBES
RCA-5ABP1, 5ABP7 and 5ABP11 flat-faced cathode-ray tubes feature electrostatic focus, electrostatic deflection, and post-deflection acceleration. These 5-inch oscillograph tubes differ only in spectral-energy emission and persistence characteristics of their respective phosphors. Outstanding features: very high deflection sensitivity, high spot intensity, and high grid-modulation sensitivity. The exceptionally high deflection sensitivity and low capacitance of the pair of deflecting electrodes provided for vertical-deflection, make this pair of electrodes especially suited for operation from wide-band amplifiers. The small size and high brilliance of the fluorescent spot give finer detail in oscillographic traces . . . even with high-speed phenomena.

RCA-2D21—a sensitive, four-electrode thyratron, of the indirectly heated cathode type for use in relay applications. It has a high control ratio (essentially independent of ambient temperature over a wide range), extremely small pre-conduction or gas-leakage currents right up to the beginning of conduction, very low grid-anode capacitance and grid current. The 2D21 is not affected appreciably by line-voltage surges and, in a high-sensitivity circuit, can be operated directly from a vacuum phototube.

RCA-5879—is a sharp-cutoff pentode of the 9-pin miniature type intended for use as an audio amplifier in applications requiring reduced microphonics, leakage, noise, and hum. It is especially well-suited for input stages of medium-gain public address systems, home sound recorders, and general-purpose audio systems.

RCA-4X150-A—a very small and compact forced-air-cooled beam power tube for use in power amplifier or oscillator service at frequencies up to 500 megacycles and also as a wideband amplifier in video applications. The 4X150-A has a maximum plate dissipation of 150 watts. Terminal arrangements of this power tube facilitate its use with tank circuits of the coaxial type. Additional features: unipotential cathode . . . integral radiator . . . coaxial-electrode structure. Max. length: 2.468", max. diameter: 1.645"

For technical information, write RCA, Section D-50-R, Commercial Engineering, 415 S. 5th Street, Harrison, N. J. Or call your nearest RCA Field Office:

EAST——HUmboldt 5-3900
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MIDWEST——WHitehall 4-2900
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