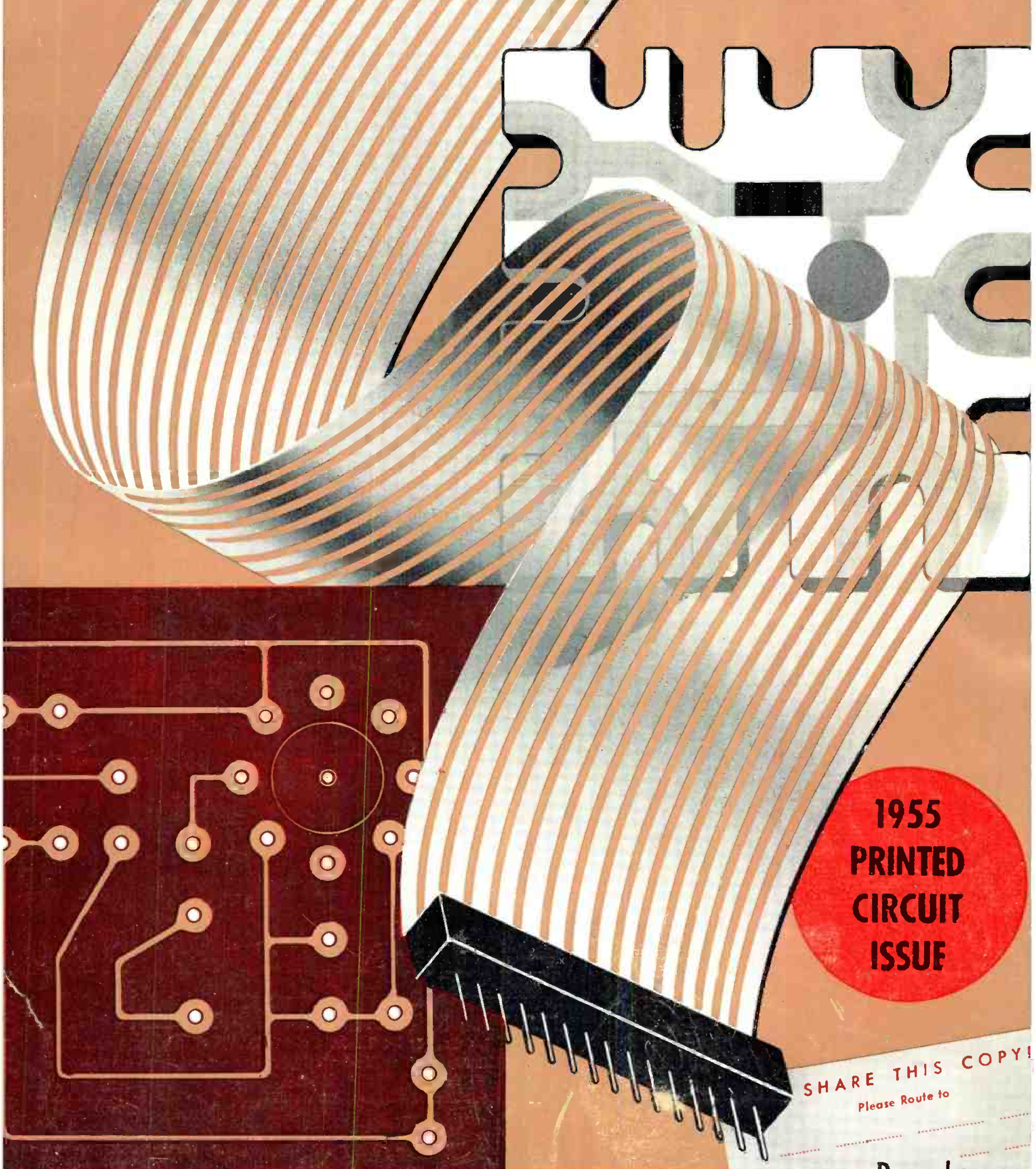
TELE-TECH

& Electronic Industries



1955 PRINTED CIRCUIT ISSUE

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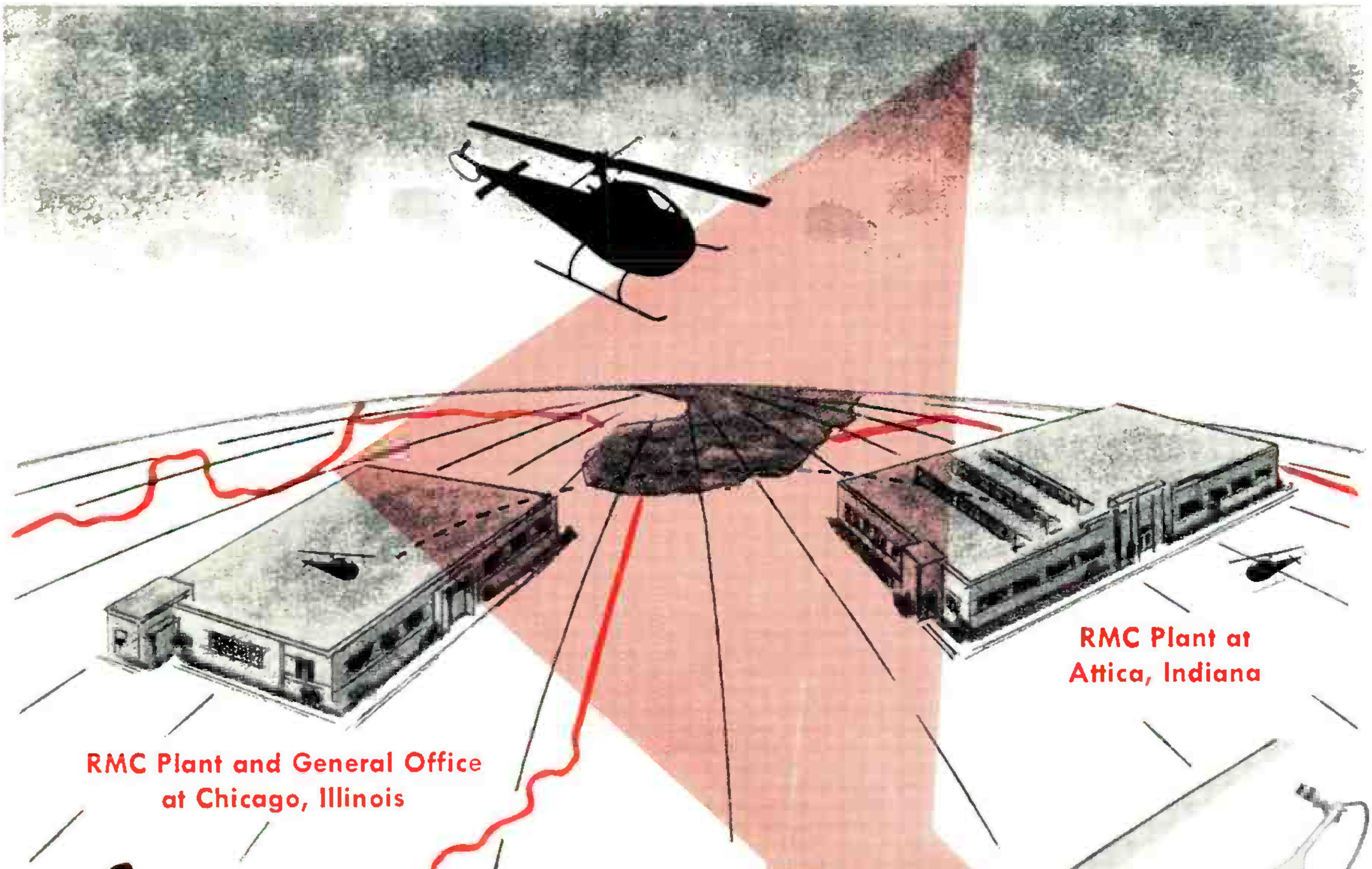


Another RMC *First!*

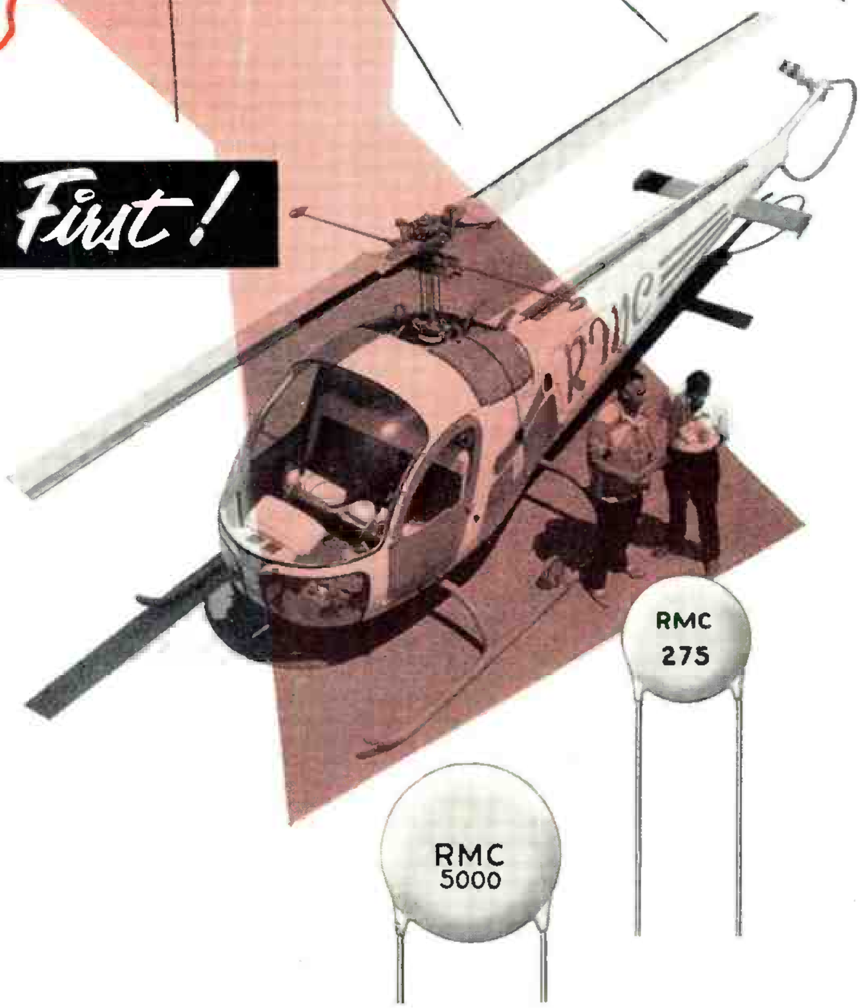
Plant to Plant Helicopter Service

The tempo of RMC service has always been geared to the needs of important customer production schedules. Now RMC's modern manufacturing facilities at Chicago, Illinois and Attica, Indiana are provided with fast, dependable helicopter flights, enabling executive and engineering personnel to travel door to door in slightly more than one hour as compared to a previous four hours.

The new Bell 47H helicopter makes regular flights unhampered by weather and traffic. RMC is the first in the electronics industry to use this new mode of travel.

Now you, as an RMC customer, are assured of even faster service on your production and engineering requirements.

If you are now using any type of ceramic capacitor in the manufacture of your products, it will pay you to investigate DISCAPS...and the many other advantages offered by RMC.



DISCAP
CERAMIC
CAPACITORS

RMC

RADIO MATERIALS CORPORATION
GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.
Two RMC Plants Devoted Exclusively to Ceramic Capacitors

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

TELE-TECH
& Electronic Industries

DECEMBER, 1955

FRONT COVER: This symbolic printed circuit illustration heralds our third annual round-up of feature articles, in this most important and fast developing field. Used as cover symbols are a new copper coated laminate suitable for cold punching operations; a flexible printed circuit connector harness; and a new ceramic module onto which specific printed circuits can be fired. Printed circuits have made automation possible in the electronic industries and the latter in turn is life-blood to large scale electronic equipment producers.

DEPARTMENTS

TELE-TECH & ELECTRONIC INDUSTRIES, December 1955, Vol. 14, No. 12. Published monthly by Caldwell-Clements, Inc. Publishers also of MART and TECHNICIAN. Publication Office, Emmett St., Bristol, Conn. Editorial advertising and executive offices, 480 Lexington Avenue, New York 17. Telephone PLaza 9-7880. M. Clements, President; M. H. Newton, Assistant to President; John J. Borghi, Vice President and Treasurer; M. B. Clements, Secretary. Acceptance under section 34.64 Postal Laws and Regulations authorized at Bristol, Conn., June 9, 1954. Additional acceptance at New York, N. Y. 75¢ a copy. Subscription Rates: United States and U. S. Possessions: 1 year $5.00; 2 years $8.00; 3 years $10.00. Canada. 1 year $7.00; 2 years $11.00; 3 years $14.00. All other countries: 1 year $10.00; 2 years $16.00. Please give title, position and company connections when subscribing. Printed in U.S.A. by Hildreth Press, Inc., Bristol, Conn.

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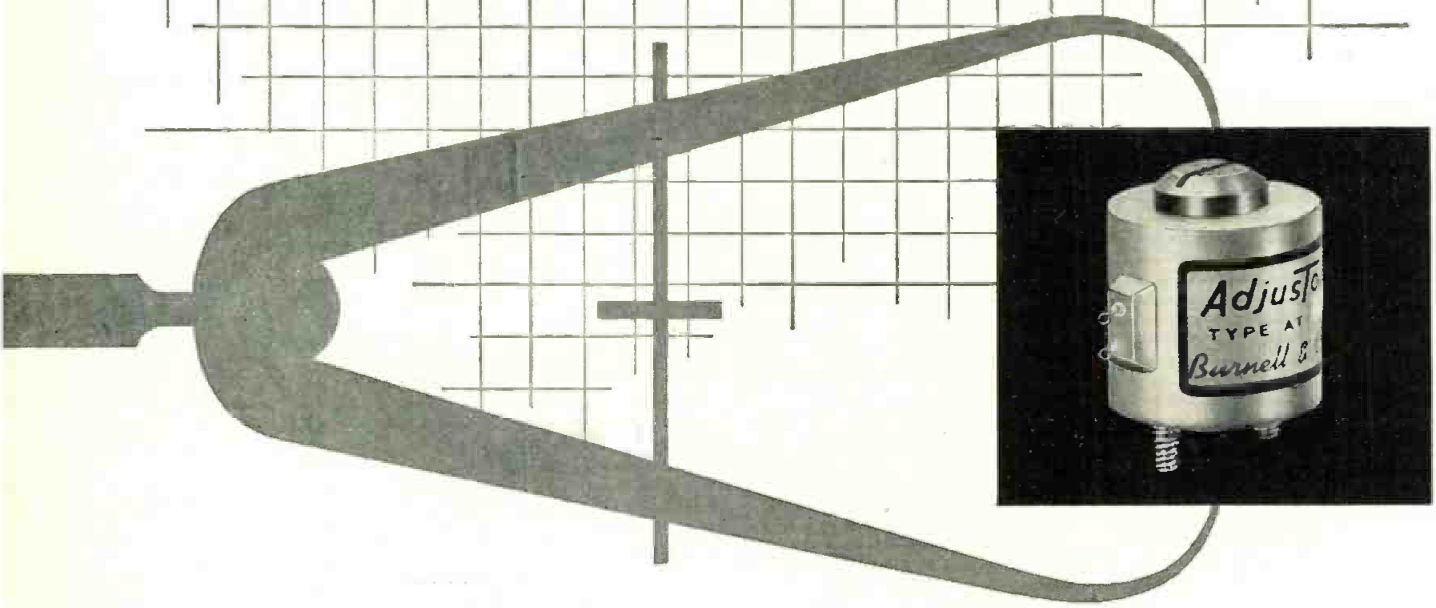

A LOW-COST ADJUSTABLE TOROID

- precise, instant adjustment
- inductance variation of 10%
- eliminates critical close tolerance capacitors
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- temperature coefficients same as fixed toroids
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Write for Adjustoroid Technical Brochure A 55

LET BURNELL ENGINEERS SHOW HOW USE OF ADJUSTOROIDS REDUCES EQUIPMENT COSTS

Many types of Adjustoroids and Rotoroids now available from stock.

Copyright patent applied for

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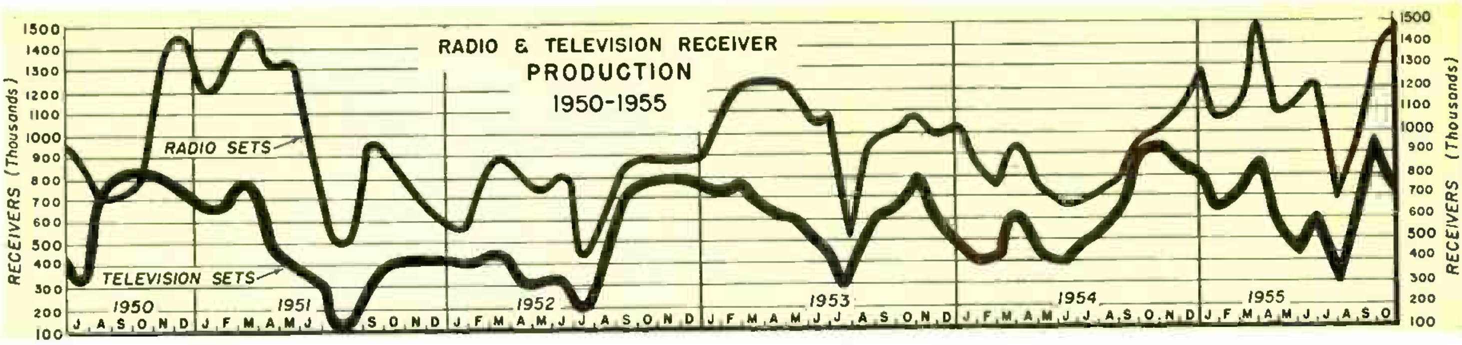
BURNELL & CO., INC.

45 Warburton Avenue
Yonkers 2, New York
Pacific Division: 720 Mission St., S. Pasadena, Calif.

TOTALS



1955 WESCON - CONVENTION REGISTRATION

Fairmont Hotel, San Francisco

INDUSTRY

OCCUPATION		Manufacturer 1 Electronic	Manufacturer 2 Other	3 Mfrs. Rep.	Trade 4 Whsle.	Trade 5 Retail	Trade 6 Publisher	7 Govt.	8 Broadcast Audio Recording	9 Allied Business & Educ.	Unclassified	TOTALS
Management	Owner 10	28	3	11	7	4	0	0	6	9	0	68
Management	Exec. 11	297	18	11	7	0	1	32	14	25	0	405
Production	Eng. 12	248	4	0	0	1	1	13	2	3	0	272
Production	Other 13	32	3	1	0	1	1	7	4	1	0	50
Engineering	Research Design 14	951	169	2	0	3	1	310	20	183	0	1639
Engineering	Operat. 15	48	5	0	0	4	0	37	26	13	0	133
	Purchasing Agent 16	7	0	0	0	0	0	1	0	0	0	8
	Sales or Adv. 17	52	7	9	2	0	1	0	1	2	0	74
	Teach Stud. 19	9	1	1	0	0	0	14	2	134	0	161
	Unclassified											
TOTALS		1672	210	35	16	13	5	414	75	370	0	2810

IRE Members 1397
IRE Students 98
Exhibitors 100
Non-members 831
Speakers or Committee Members 384
TOTAL CONVENTION REGISTRATION 2810

1955 WESCON - SHOW REGISTRATION

Civic Auditorium, San Francisco

INDUSTRY

OCCUPATION		Manufacturer 1 Electronic	Manufacturer 2 Other	3 Mfrs. Rep.	Trade 4 Whsle.	Trade 5 Retail	Trade 6 Publisher	7 Govt.	8 Broadcast Audio Recording	9 Allied Business & Educ.	Unclassified	TOTALS
Management	Owner 10	332	120	119	163	232	9	0	36	150	0	1161
Management	Exec. 11	594	216	82	149	67	17	235	76	276	0	1712
Production	Eng. 12	645	149	23	21	23	1	144	49	94	0	1149
Production	Other 13	580	185	26	27	52	4	347	41	227	0	1489
Engineering	Research Design 14	989	299	15	12	15	0	613	36	339	0	2318
Engineering	Operat. 15	301	88	19	25	52	2	423	228	116	0	1254
	Purchasing Agent 16	155	39	6	32	11	0	47	0	30	0	320
	Sales or Adv. 17	344	156	255	281	135	30	0	34	183	0	1418
	Teach Stud. 18	33	10	3	3	14	6	341	31	1092	0	1533
	Unclassified	0	0	0	0	0	0	0	0	0	113	113
TOTALS		3973	1262	548	713	601	69	2150	531	2507	113	12467

Show Registration 12,467
Exhibitors 3,521
TOTAL SHOW REGISTRATION 15,988

Show Registration 15,988
Convention Registration 2,810

Total 1955 WESCON Show & Convention Registration 18,798

(Note: Guests, Women and Children not Registered)

GOVERNMENT ELECTRONIC CONTRACT AWARDS

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

Actuators	91,834
Amplifiers	108,606
Antennas	73,317
Batteries, Dry	1,564,886
Battery Jars	870,200
Battery Testers	29,669
Cable	190,782
Circuit Breakers	35,626
Communication Equipment	366,812
Connectors	138,299
Control Assemblies	127,298
Data Converters	365,037
Direction Finders	201,705
Discriminators	25,309
Facimile Equipment	483,771
Frequency Changers	1,609,749
Generators	1,043,422
Generators, Signal	441,543
Gyrocompasses	607,284
Indicators	1,930,326
Indicators, Control	419,246
Indicators, Directional	201,705
Indicators, Speed	41,357
Loudspeakers	25,559
Microphone Stations	59,000
Meters, Frequency	415,264
Magnetrons	280,000
Motor, Generator	30,056
Potentiometers	39,024
Power Supplies	76,755
Radar Sets	1,804,678
Radio Sets	9,989,438
Receiver, Transmitters	6,432,831
Recorders, Tape	417,582
Relays	148,269
Resistors	30,225
Servos	352,837
Spectrometers	346,190
Switchboards	84,778
Switches	49,675
Switches and Relays	49,619
Switches, Drum	103,936
Switches, Rotary	46,320
Tape, Magnetic	37,370
Teletypewriter Sets	3,365,805
Transformers, Power	556,868
Tubes	837,991
Valves, Solenoid	41,207
Voltmeters	32,856
Wire, Electric	24,262
X-Ray Apparatus	48,165


New!
PHILCO
COLOR TV
BROADCAST
EQUIPMENT
Catalog
PHILCO CORPORATION
Government and Industrial Division
PHILADELPHIA 44 • PENNSYLVANIA

OVER 100 PAGES

Complete with Illustrations, Diagrams, Planning Information and Prices!

Here is the new Philco Color TV Broadcast Equipment Catalog—over 100 pages, crammed with factual information on Philco Color TV equipment. Carefully cross-indexed, this handy reference volume for TV station engineers, places valuable data at your fingertips. Units are grouped in "building block" sequence to save you precious time in selecting and ordering equipment to meet your requirements.

- *Each unit clearly described, fully illustrated.*
- *Performance specifications conveniently tabulated.*
- *Complete technical information for reference.*
- *System block diagrams included for ease of planning . . . new ideas for simplifying equipment layout and reducing installation floor space required.*

INCLUDES ALL COMPONENTS FOR THESE APPLICATIONS:

- √ Network Color Re-broadcast
- √ Color Slide Origination
- √ CineScanner 16mm and 35mm Film Origination
- √ Color Processing
- √ Color Switching
- √ Color Test and Monitoring
- √ Television S-T-L Relaying
- √ Television Remote Pickup Relaying
- √ Television Network Relaying

A Copy Has Been Reserved for You!

Ask your Philco Broadcast Representative for a free copy or write to Philco, Dept. TT Philadelphia on your station letterhead.

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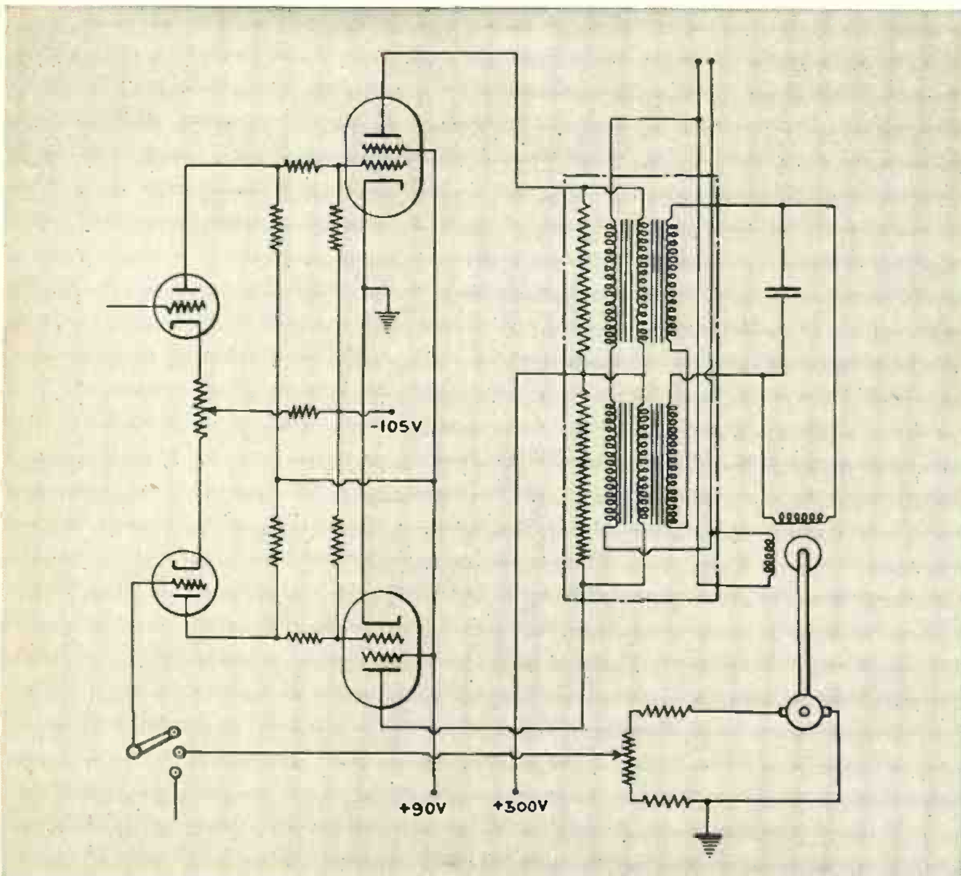
SAN FRANCISCO 3, CALIF. 1355 Market St.	WASHINGTON 6, D.C. 744 Jackson Place, N.W.	DALLAS 1, TEXAS 201 Southland Life Bldg.

PHILCO CORPORATION

Government and Industrial Division

PHILADELPHIA 44 PENNSYLVANIA

For product information, use inquiry card on last page.



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MANUFACTURING														
Automation Equip.	•	•	•	•	•	•	•	•	•		•	•		
Audio & Video	•	•	•	•	•	•	•	•	•		•	•	•	•
Avionics	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Color Television	•	•	•	•	•	•	•	•	•	•	•	•	•	
Components	•	•	•	•	•	•	•	•	•		•	•	•	•
Computers	•	•	•	•	•	•	•	•	•		•	•	•	•
Control Consoles	•	•	•	•	•	•	•	•	•	•	•	•		
Government	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Guided Missiles	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Industrial Elec's	•	•	•	•	•	•	•	•	•		•	•		
Military Elec's	•	•	•	•	•	•	•	•	•		•	•	•	•
Mobile	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Printed Circuits	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Res. & Dev. Labs	•	•	•	•	•	•	•	•		•	•		•	•
Studio Equipment	•	•	•	•	•	•	•	•	•	•	•	•		
Telemetering	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Test Equipment	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Transistors	•	•	•	•	•	•	•	•	•	•	•	•	•	•
TV-Radio-Radar	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Vacuum Tubes	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Xmission Lines	•	•	•	•	•	•	•	•	•	•	•	•	•	•
OPERATION														
Broadcasting	•	•				•	•	•		•	•			
Communications	•	•				•	•	•		•	•			
Consulting Engrs.				•	•			•			•			
Microwave	•	•				•	•	•		•	•	•		
Recording	•	•					•	•	•		•			

Chart shows how TELE-TECH's 27,000 circulation is concentrated among top-level engineers in the electronic industry's principal buying power groups.

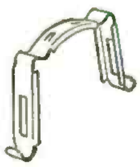
THE ELECTRONIC INDUSTRIES DIRECTORY

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

Engineered by Tinnerman...

NEW SNAP-ON MOTOR CLIP REPLACES 4 PARTS

Cuts Assembly Time and Costs!



If you manufacture or use fractional horsepower motors, this new Tinnerman SPEED CLIP® can lower your parts and assembly costs by eliminating 4-piece screw clamps to hold motors in place.

Made of high-quality spring steel, this SPEED CLIP is quickly snapped into place over the resilient motor-mounting ring, using a simple hand tool. It forms a vibration-proof lock that won't shake free. Assembly time is reduced because of the one-piece construction . . . no loose parts to handle, nothing to tighten. Parts cost and assembly cost are reduced as much as 75%!

These SPEED CLIPS can be provided in sizes to fit any fractional-horsepower motor. They are designed to hold tight even under severest vibration and high starting-torque in any mounting position.

Ask your Tinnerman SPEED NUT sales engineer for more information and arrange for samples to test on your own assembly line.

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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®

IRC

OFFERS MORE TYPES OF 1%

Deposited Carbon

Here's 1% accuracy in an extremely stable non-wire wound resistor at a price low enough to permit its use wherever the characteristics of composition carbon resistors are not fully suited. IRC's unmatched experience in producing film type resistors has led directly to the superior reliability and stability of IRC Deposited Carbons. Outstanding characteristics include load, environmental and age stability and ability to operate at higher temperatures than MIL specification requirements, low wattage coefficient, and low capacitive and inductive reactance in high frequency applications.

3 SMALL SIZES—DCC ½ WATT DCF 1 WATT and DCH 2 WATTS

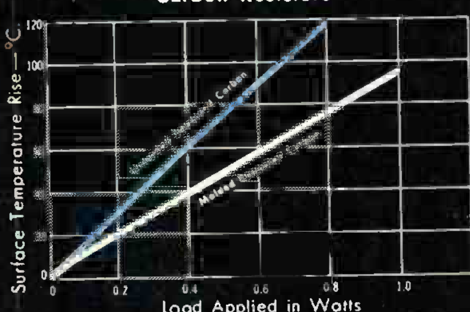
MEET ALL REQUIREMENTS OF MIL-R-10509A SPECIFICATION

Molded Deposited Carbon

Molded Deposited Carbon resistors are now available from IRC in 3 sizes: Types MDA—⅛ watt, MDB—¼ watt and MDC—½ watt. The *molded* plastic housing provides complete mechanical protection, minimizes the effect of moisture and improves load life characteristics. These 1% precision film type units exceed MIL-R-10509A specifications.

COMPARISON SURFACE TEMPERATURE RISE VS. LOAD

Molded vs. Unmolded Deposited Carbon Resistors



Boron Carbon

Where a high degree of accuracy under widely varying temperatures is required, IRC Boron Carbons offer an ideal combination of characteristics. Their superior temperature stability is provided in 3 sizes: Types BOC—½ watt, BOF—1 watt and BOH—2 watts—all 1% accuracy. Considering weight, size and cost factors, plus lower capacitive and inductive reactance, these film type precision resistors can satisfactorily replace wire wounds.

IRC TYPE	BOC	BOF	BOH
Equivalent MIL Style	RN 20R	RN 25R	RN 30R
Wattage (40°C. Ambient)	½	1	2
Max. Continuous Voltage	350 V.	500 V.	750 V.
Minimum Ohms	10	20	30
Maximum Ohms (IRC)	0.5 meg	2.0 meg	5.0 meg

Wherever the Circuit Says

IRC

makes them all . . . can recommend without bias

Subsidiaries:

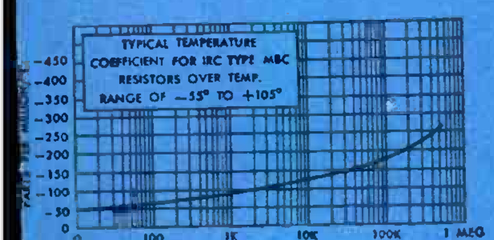
Circuit Instruments Inc., St. Petersburg, Fla. • Hycor Company, Los Angeles, Calif. and Vega Baja, Puerto Rico • IRCAL Industries, Los Angeles, C

TOLERANCE RESISTORS than any supplier in the industry

Molded Boron Carbon

Only from IRC can you obtain Boron Carbon resistors with the protection of a *molded* plastic housing. Any risk of mechanical damage to the coating or of insulation breakdown is overcome. Any need for special handling is eliminated, and moisture and load life characteristics are improved. 3 sizes—Types MBA 1/8 watt, MBB 1/4 watt and MBC 1/2 watt—all exceed MIL-R-10509A specifications.

TYPICAL TEMPERATURE COEFFICIENT



Wire Wound

IRC's winding skills and automatic assembly equipment provide precision windings to exacting standards. Continuous inspections at every stage of manufacture assure maximum reliability in each finished resistor. IRC Mil Type precision wire wounds meet all requirements of MIL-R-93A specification. In addition to 6 Mil sizes, IRC supplies tiny Type WW10J—13/32 x 9/32''. Standard tolerance ±1%; minimum tolerances are shown below.

Minimum Tolerances

Resistance	IRC MIL TYPES	TYPE WW10J
10 ohms & up	0.1%	
5 ohms & up	1.25%	
1 ohm & up	0.5%	
1500 ohms & up		0.1%
200 ohms & up		0.25%
65 ohms & up		0.5%

Encapsulated Wire Wound

Tru-Mite encapsulated wire wound precision resistors are produced to IRC's high standards by its West Coast subsidiary, IRCAL INDUSTRIES. Available in 11 sizes and axial lead or lug types. Standard tolerance ±1%; also ±1/2, 1/4, 1/10 and 1/20% tolerances can be supplied. Tru-Mite core material is the same epoxy resin as is used for the embediment. This eliminates the normal effects of temperature and moisture. Tru-Mite resistors exceed MIL-R-93A specifications.

MANY COMBINATIONS OF CHARACTERISTICS AND OPPORTUNITIES FOR COST REDUCTION ARE INVOLVED WHEN SPECIFYING CLOSE TOLERANCE RESISTORS. NO OTHER SINGLE SOURCE CAN OFFER YOU THE SCOPE OF TECHNICAL GUIDANCE AVAILABLE FROM IRC.

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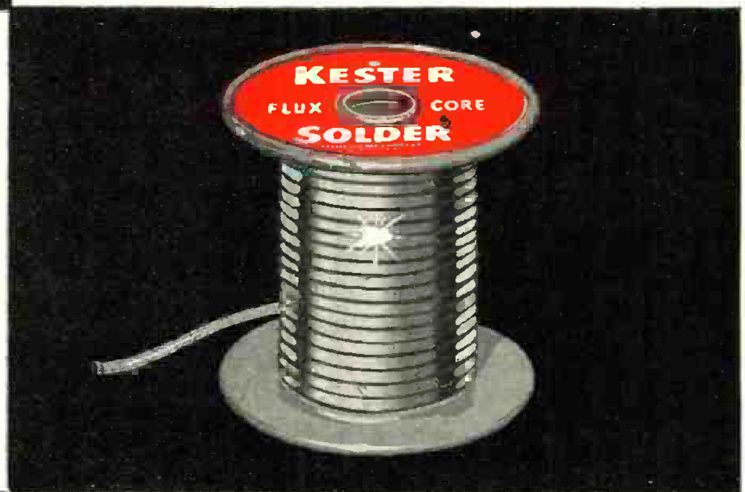

gone!

KESTER "44" RESIN, PLASTIC ROSIN AND "RESIN-FIVE" FLUX-CORE SOLDERS owe their production line popularity to the simple fact that they provide the exactly right solder for every soldering application. It's not difficult to realize why Kester is consumed so rapidly ... because of its great adaptability to so many different soldering operations.

***SEND TODAY** for Kester's new 78-page informative textbook "SOLDER ... Its Fundamentals and Usage."*

KESTER SOLDER

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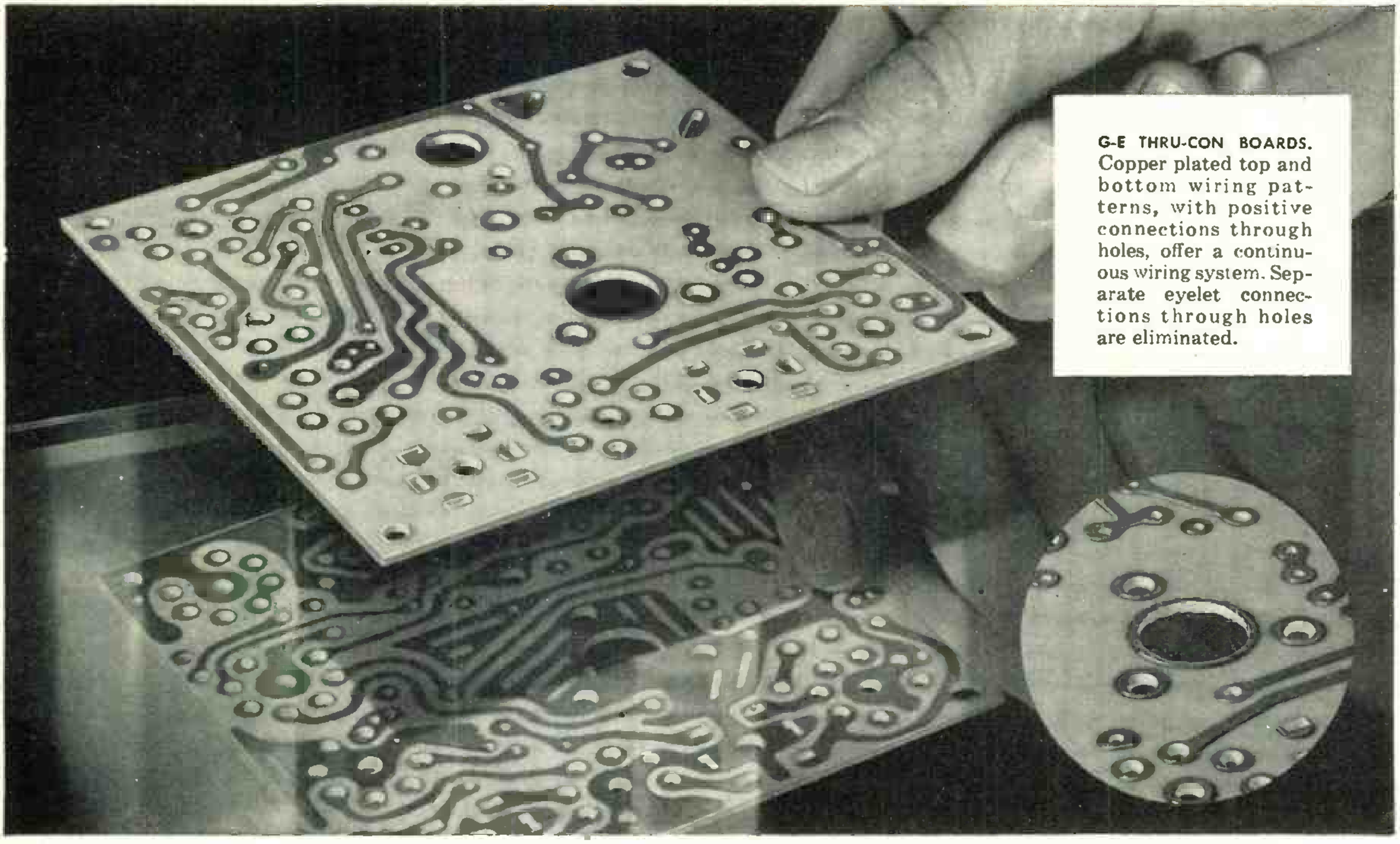


G-E THRU-CON BOARDS. Copper plated top and bottom wiring patterns, with positive connections through holes, offer a continuous wiring system. Separate eyelet connections through holes are eliminated.

G.E.'s Thru-Con Printed Circuit Boards have wiring patterns on two sides, positive connection through the board

Thru-Con Boards for printed circuitry lead to cost reductions, and product improvement in many industries

General Electric Thru-Con Printed Circuit Boards offer manufacturers of radio, television, and electronic equipment new opportunities to reduce production cost and substantially improve quality and performance.

G.E.'s Additive Method of Construction

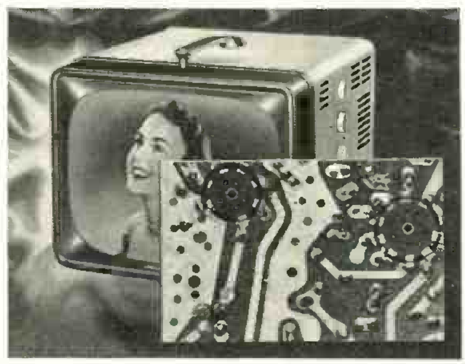
Production techniques developed by G.E. provide two patterns on a single board with a positive through connection—*without staking pins.* Continuous copper plating through the holes insures positive solder filleting top and bottom, extreme strength, and trouble-free assembly.

Thru-Con In Many Industries

Widening usage in radio and TV receivers and street lighting controls has proven the advantages of printed circuits. G-E Thru-Con Boards not only offer manufacturing savings, they also make it possible to reduce parts inventories, shorten assembly and inspection time, and save in weight and product size.

Investigate G-E Thru-Con Boards

Your company may be able to profit by using printed circuitry and G.E.'s Thru-Con Boards. The combination of wiring patterns, circuit designs, sizes or shapes, is virtually limitless. Experienced G-E printed circuit engineers and technicians are ready to aid you in developing a printed circuit program. For a discussion of your problem and a sample G-E Thru-Con Board, just call or write today to: *General Electric Company, Electronic Components Department, Section X48125, Auburn, New York.*



PORTABLE TELEVISION. Printed circuit board in this new receiver contains more than 50% of the wiring. Smaller chassis, yet full size screen. G-E Thru-Con Boards reduce assembly costs, slash receiver weight.

COMPACT, LOW COST RADIO. G-E Thru-Con Board permits compact chassis which slips into cabinet and plugs into speaker. Printed circuitry permits savings—cuts retail cost.

Progress Is Our Most Important Product

GENERAL ELECTRIC

fast deliveries!

price savings up to 300%!

SAVE! and IMPROVE with

STACKPOLE "EE" CORES

Leaders in Engineering core Economy

Preferred-type Stackpole "EE" iron cores meet 8 out of 10 engineering needs . . .

They are stocked for immediate delivery in any quantity . . .

Cost savings amount to as much as 300% less than custom-engineered cores that entail set-up charges . . .

Equally important, new Stackpole core types are constantly being added to the "EE" list to keep abreast of new engineering and production requirements.

Write for latest Stackpole "EE" Core list.

Electronic Components Division

STACKPOLE CARBON COMPANY, St. Marys, Pa.

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For product Information, use inquiry card on last page.

A COMPLETE LINE OF DEPENDABLE ENCAPSULATED RESISTORS

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PRECISION WIREWOUND RESISTORS FOR 85C AND 125C AMBIENTS

When you have applications requiring accurate resistance values at 85C and 125C operating temperatures, in units of truly small physical size—you'll find the resistor you want is one of the 46 standard Permaseal designs in tab and axial lead styles.

They meet or exceed requirements for all types of military and industrial electronic apparatus and instruments. They are "extra-protected" by a special Sprague-developed plastic embedding material that performs beyond the severe humidity resistance specifications of MIL-R-93A and Proposed MIL-R-9444 (USAF).

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

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

SPRAGUE

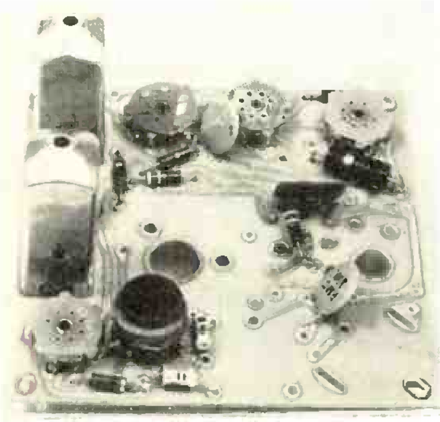
FOR COMPLETE DATA WRITE FOR COPY OF SPRAGUE ENGINEERING BULLETIN NO. 122A

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

As We Go To Press...

GE Plans Volume Output Of Printed Circuit Boards

Production of 1,000,000 sq. ft. of printed wiring boards is being planned for 1956 by the General Electric Electronic Components Dept., Auburn, N.Y. This figure should represent "between five and six million individual boards," according to E. A. Malling, department marketing manager.



G-E "Thru-Con" board for 5-tube radio

The boards will be the G-E "Thru-Con" type, made by a process which plates the copper wiring pattern on plastic boards.

Several current G-E table model radios are already using the "Thru-Con" boards. They are also being used in the company's 14-in. portable TV set and in its transistorized portable radios.

Oversize Radar Indicators Delivered to U. S. Navy

Three of the largest radar indicators ever built to military specifications have been completed by the Stromberg-Carlson Co., division of General Dynamics Corp.

The indicators have 22-in. viewing tubes, with a maximum range of 300 mi. and a minimum range of 4 mi. They can be used with any standard Navy radar equipment.

The indicators, which took 18 months to construct, were completely designed by the company's Electronics Engineering Dept., under chief engineer C. W. Finnigan. A. Zefting was project supervisor, as-

Stromberg-Carlson engineers check radar unit

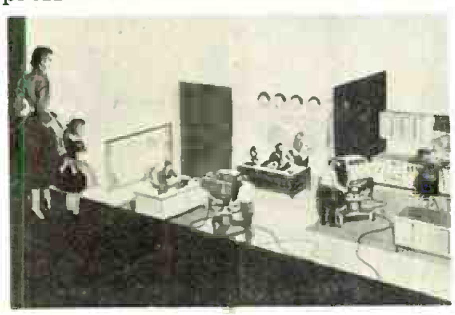
sisted by G. Robertson.

One of the indicators is scheduled to be installed on the battleship USS Mississippi.

WNBQ-Chicago Plans All-Color TV Station

Color television was used for the first time for a closed circuit intercity press conference when Brig. Gen. David Sarnoff announced RCA's plans for converting to color television the entire local live programming of WNBQ, the NBC-owned station in Chicago.

General Sarnoff was seen on color television simultaneously by representatives of the N. Y. press in NYC and by members of the Chicago press who were assembled at the



Visitors will get this view of color studio

WNBQ studios in the Merchandise Mart.

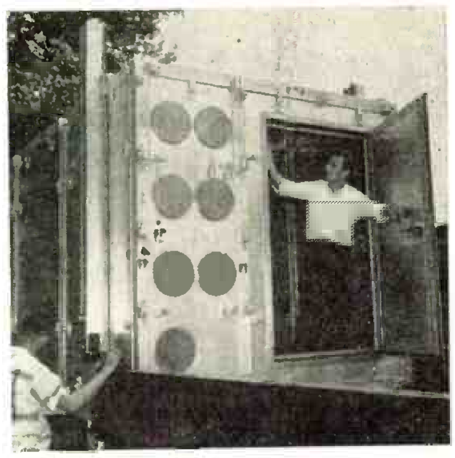
April 15, 1956, is the target date for WNBQ's conversion to color. By then, NBC will have remodeled its facilities to accommodate three color studios with five live cameras and two film cameras.

NBC has leased 50,400 sq. ft. of roof space at the Merchandise Mart.

Mobile Shielded Enclosure Developed For Air Force

A transportable, air-conditioned shelter, to house delicate electronic equipment, has been constructed by N.Y. Univ. research engineers under contract to the Air Research and Development Command.

Resembling a small truck-type van, the cubical aluminum shelter is tightly shielded against outside radio frequency interference. It can be airlifted fully assembled in a C-119 "Flying Boxcar" or on standard Air Force trucks. Assembly and breakdown can be done by four men in less than four hours.



Shelter is transported in aircraft or trucks

Consisting of one aluminum shell within another, the 1½ ton interior working enclosure measures 7 x 7 x 13 ft. The shells are constructed by mounting aluminum panels on extruded beams to form the walls, floor and ceiling.

Sheets of aluminum separated by cores of honeycombed paper of wood or plastic resin furnish insulation. This provides electromagnetic shielding as well as thermal insulation. Shielding is assured up to 100 db in a range of 14 kc to 1000 mc.

U.S.-Africa Phone Link

Telephone service is available now between the U.S. and French Equatorial Africa, reports the Long Lines Dept. of A. T. & T. Rate for 3 min., $15.

MORE NEWS on page 16

As We Go To Press . . . (Continued)

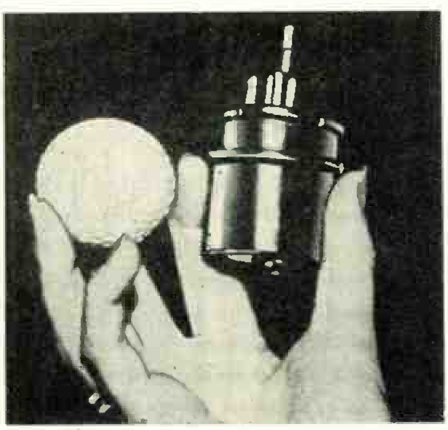
FALL MEETING PLAQUE

1955 Radio Fall Meeting Plaque is awarded to Lewis M. Clement (l.) by Arthur V. Loughren. Presentation was made for Mr. Clement's contributions to the field of reliability of electronic equipment and to the work of the RETMA Engineering Dept.

Miniature Magnetron Tube Developed By Signal Corps

The world's smallest continuous wave, self-contained magnetron tube has been developed by the Signal Corps Engineering Laboratories, Ft. Monmouth, N.J.

The new tube is reportedly 50 times more powerful than the klystron tube it was designed to replace. It physically resembles a standard-type receiving tube and operates from a plate supply of 450 to 500 v. and a heater supply of 6 v. Its operating frequency is approximately 10,000 MC.



Tube is size of golf ball, weighs but 8 oz.

Primary military applications will be in short-range field communications operations, between advance lines and rear echelons. Other commercial uses are also seen, such as in radar speed control systems.

Microwave Associates, Inc. of Boston, is under Signal Corps contract to produce the tubes from laboratory specifications.

A. V. Loughren Elected IRE Pres. for 1956

Arthur V. Loughren, color television expert and vice president in charge of research of the Hazeltine Corp. has been elected President of the Institute of Radio Engineers for 1956. He succeeds John D. Ryder, dean of the School of Engineering of Michigan State Univ., as head of the international society of 44,000 radio engineers and scientists.

Herre Rinia, director of research at Philips Research Laboratories in Endhoven, Holland, will succeed Franz Tank, professor at the Swiss Institute of Technology, Zurich, Switz., as IRE vice president.

Elected as directors for the 1956-58 term are E. W. Herold, director of the Electronic Research Lab., RCA Laboratories, Princeton, N.J. and J. R. Whinnery, Professor of Electrical Engineering, Univ. of California, Berkeley, Calif.

First 2-Megawatt TV For Scranton, Pa.

The present 250,000 watt UHF TV station, WGBI-TV, channel 22, Scranton, Pa., is slated to become the country's first 2-megawatt broadcasting facility and "mother" station to two new associate stations at Williamsport and Sunbury, Pa.

A contract calling for late fall delivery of TV broadcasting equipment for the three stations has been signed between Scranton Broadcasters Inc. and the General Electric Co.'s Electronics Div., Syracuse, N.Y.

With the new installation 750,000 people in the Sunbury and Williamsport areas will have their first local TV stations.

According to Paul L. Chamberlain, G-E general manager of broadcast equipment, the contract, "involving more than a half-million dollars, is by far the largest single order for UHF television broadcasting equipment ever signed."

The WGBI-TV portion of the contract calls for a 45-kw transmitter and a 50-gain helical antenna combination for multiplying effective power output to two-million watts. Automatic switching equipment will provide for push button changing of transmitter and antenna combinations. In addition, the station will be equipped to transmit network color programs.

SPAATZ JOINS LITTON

Gen. Carl A. Spaatz, (ret.), first U.S. Air Force Chief of Staff, has become a member of the Board of Directors of Litton Industries, Beverly Hills, Calif.

New Corporate Structure Planned At Dumont Labs

Stockholders of Allen B. Du Mont Laboratories, Inc. have voted in favor of a program to revise the company's capital and corporate structure and to spin off the stock of the Du Mont Broadcasting Corp.

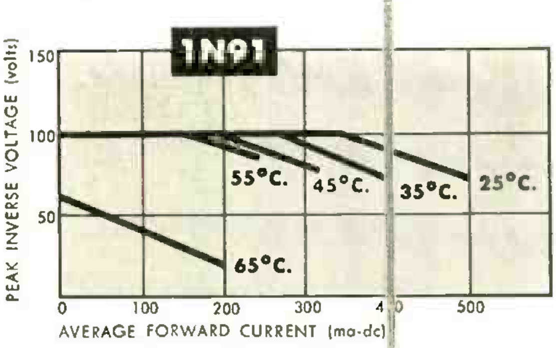
The approved program provides that common stock of the Du Mont Broadcasting Corp. will be distributed to the common stockholders of Allen B. Du Mont Labs, Inc., in a ratio of one to two-and-one-half.

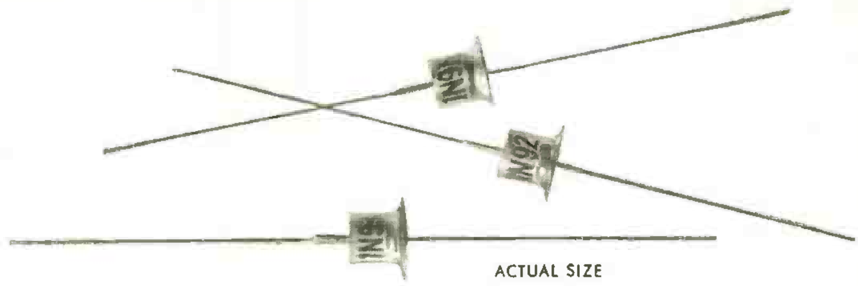
The Du Mont Broadcasting Corp. owns and operates TV stations WABD in N.Y.C. and WTTG in Washington, D.C. and the Du Mont Tele-Centre at 67th St. in N.Y.C.

"HALL OF FAME"

Bust of Guglielmo Marconi, by sculptor Pietro Montana, is presented to the AIEE to be placed in the Engineer's Hall of Fame. Present are (l. to r.) sculptor Montana; Marconi's daughter, Mrs. Gabriel Paresce; Morris D. Hooven, AIEE pres.; Guilio Marconi; and Vittorio Ivella, Secy. of the Italian Embassy.

MORE NEWS on page 22



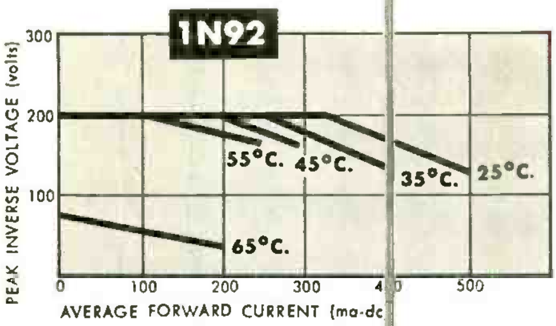


CLEVITE TRANSISTOR PRODUCTS

IMMEDIATE DELIVERY

PRODUCTION QUANTITIES*

POWER DIODES



AN ADVANCE IN ELECTRONICS

Germanium Junction Power Diodes Types 1N91, 1N92, and 1N93 achieve characteristics never before possible in either thermionic or other types of solid state rectifiers. For example:

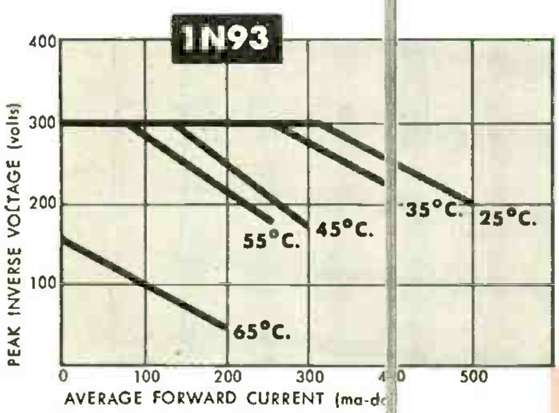
- SMALL SIZE-HIGH POWER—approximately four times the rectified power in the same space as other devices.
- HIGH EFFICIENCY — combines very low forward resistance with high back resistance . . . 100% rectification efficiency is approached.
- LONG LIFE — unlike other semi-conductor metals, Germanium does not age . . . in addition, hermetically sealed construction.

THREE TIMES ACTUAL SIZE

100% RIGID CONFORMANCE TO SPECIFICATIONS

Quality control of Clevite Transistor Products Power Diodes is based on a *100% sampling*. Each and every unit is individually tested for rigid conformance to specifications.

- ELECTRICALLY TESTED — each unit must meet or surpass performance requirements.
- HIGH PRESSURE HUMIDITY TESTED — each unit is checked to assure perfect hermetic sealing.



CLEVITE TRANSISTOR PRODUCTS

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A DIVISION OF THE CLEVITE CORPORATION

TRANSISTORS • DIODES • SEMI-CONDUCTOR DEVICES

ABSOLUTE MAXIMUM RATINGS (for 60 cycle, 55°C. resistive load)

	1N91	1N92	1N93
Peak Inverse Voltage (volts)	100 v. at 2.7 ma	200 v. at 1.9 ma	300 v. at 1.2 ma
Peak Forward Current (amps)	0.47	0.31	0.24
DC Output Current (ma)	150	100	75
DC Surge Current (amps)	25	25	25
Full Load Voltage Drop (volts)	0.5	0.5	0.5
Continuous Reverse Working Voltage (volts)	30	65	100
Operating Frequency (Kc.)	50	50	50
Storage Temperature (°C.)	85	85	85

* ARMED SERVICES and A.E.C. Source Inspection Available

Write for Power Diode Bulletin

For product Information, use inquiry card on last page.

indispensable for measurement and reception

MICROWAVE

MODEL R

with these special features:

EXCELLENT GAIN STABILITY—Equipped with automatic gain control, as well as "signal-lock" Automatic Frequency Control. Performance stable over entire frequency band.

HIGH SENSITIVITY—Achieved with unique double-tuned cavity pre-selector which tracks automatically with local oscillator. Efficient wideband microwave input coupler and crystal mixer maintains sensitivity.

SELF-CONTAINED—Complete with electronically regulated low and high voltage power supplies; signal metering circuits; IF, local oscillator, audio-video, and FM plug-in sub-units. Four interchangeable, plug-in microwave tuning units cover frequency range 950-11,260 mc.

ALL-PURPOSE—Receives AM, FM, CW, MCW and pulse-modulated signals. Equipped with recorder output, trigger output (constant amplitude), video and audio outputs. Meter reads directly in db.

UNI-DIAL CONTROL — Automatically tracks klystron voltages, double tuned pre-selector, oscillator, and linear direct reading frequency dial — all simultaneously.

POLARAD PROVEN RELIABILITY **ELECTRONICS CORPORATION** 43-20 34th STREET, LONG ISLAND CITY 1, N. Y.

BROADBAND
950-11,260 MC

FIELD INTENSITY RECEIVER

UNI-DIAL CONTROL

One of the most complete and versatile measurement instruments ever designed for reception and quantitative analysis of microwave signals in the range 950-11,260 mc.

The Polarad Model R Microwave Receiver is ideal for the reception and monitoring of all types of radio and radar communications within its range. It permits comparative power and frequency measurements, by means of its panel mounted meter, of virtually every type of signal encountered in microwave work.

It is compact and functional, featuring four integrally designed plug-in, interchangeable RF microwave tuning units to cover 950-11,260 mc; non-contacting chokes in pre-selector and microwave oscillator to assure long life and reliability; and large scale indicating meter for fine tuning control.

Call any Polarad representative or direct to the factory for detailed specifications.

SPECIFICATIONS:

Basic Receiver: Model R-B
Tuning Unit Frequency Ranges:
Model RL-T: 950 — 2,040 mc
Model RS-T: 1,890 — 4,320 mc
Model RM-T: 4,190 — 7,720 mc
Model RX-T: 7,260 — 11,260 mc
Signal Capabilities:
AM, FM, CW, MCW, pulse
Sensitivity:
—80 dbm or better throughout range on all models
Frequency Accuracy:
±1%
IF Bandwidth: 3 mc
Video Bandwidth: 1.5 mc
Image Rejection: Greater than 60 db
Gain Stability with AFC: ±2 db
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 v./mc

Skirt Selectivity:
60 db — 6 db bandwidth ratio less than 5:1
IF Rejection: 50 db
Input AC Power:
105-125 v., 60 cps, 440 watts
Input Impedance: (ANT) 50 ohms
VSWR: Less than 4:1 over band
Range of Linearity: 60 db
Receiver Type: Superheterodyne
Maximum Acceptable Input
Signal Amplitude: 0.1 v. rms without external attenuation
Video Response: 20 cps to 1.5 mc
Size: 17" w x 23" d x 19" h
Weight: 180 lbs.
Price:

Model R-B (Basic Unit):	$1,500
Model RL-T:	2,500
Model RS-T:	2,500
Model RM-T:	2,500
Model RX-T:	2,500

Note: To the basic cost of $1,500 add cost of tuning units required.
Prices subject to change without notice

for these applications:

- Broadband receiver for AM, FM, CW, MCW, and Pulse Modulated signals
- Field intensity meter
- Frequency measurements
- Leakage, interference and radiation measurements
- Bandwidth measurements
- Measurement of relative power of fundamental and harmonic signal frequencies
- Trigger pulse amplifier
- Noise figure measurements of r-f amplifiers
- Antenna field patterns
- Attenuation measurements
- Propagation studies
- Microwave relay link site selection
- Direction finding
- Filter measurements
- Standing wave measurements

AVAILABLE ON EQUIPMENT LEASE PLAN
FIELD MAINTENANCE SERVICE AVAILABLE THROUGHOUT THE COUNTRY

CONSULT US ON YOUR MICROWAVE RECEIVER PROBLEMS.

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MALLORY

This capacitor changed designers' ideas about how well... and how long... an electrolytic capacitor could be relied upon to operate

On Electrolytic Capacitors...

Mallory FP is the Sign of Dependability

AUTOMATIC CONTROLS

An example of a field served by Mallory

The long life and uniform high quality of Mallory electrolytic capacitors are particularly valuable, in modern electronic instrumentation, which must deliver consistent and uninterrupted service as the "brainpower" guiding complex production processes.

Also serving the manufacturers of measurement and control equipment are other Mallory precision components . . . contacts, resistors, controls, switches, rectifiers, vibrators and mercury batteries. Because of this wide range of components, Mallory engineers have a unique fund of experience—available to assist you in meeting special requirements and in balancing related circuit elements.

"FP" is the mark of a unique capacitor construction, pioneered and perfected by Mallory, which sets the industry's standards for performance and service life. It signifies these features:

- Ability to operate at ambients of 85° C without derating.
- High ripple current rating; suitable for use with metallic rectifiers and in doubler circuits.
- Exceptional life, in service and on the shelf.
- Compact, standardized case size.
- Quick, economical twist-prong mounting and variety of printed circuit mountings.

For premium performance and reliability . . . without premium price . . . be sure to specify Mallory FP Capacitors. Our capacitor engineers will be glad to consult on your circuit requirements, to assist in effective application and often to aid in simplification of circuitry. For technical data, or for a discussion of your particular requirements, write or call Mallory today.

Serving Industry with These Products:

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

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

Expect more... Get more from

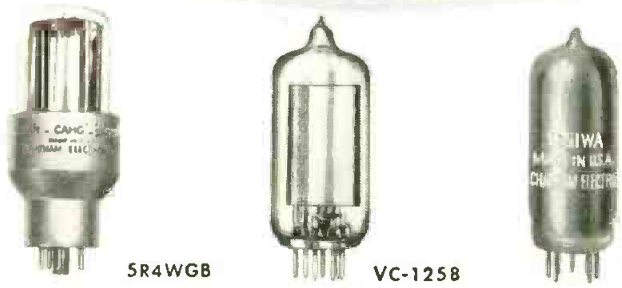
P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

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

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

6336

CHATHAM
SPECIAL-PURPOSE
TUBES



5R4WGB VC-1258 5651-WA

STANDARD TYPES DIRECT FROM STOCK
PLUS SPECIAL DESIGNS BUILT TO REQUIREMENTS

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

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

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

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

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

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

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

CHATHAM ELECTRONICS
Division of Gera Corporation — LIVINGSTON, NEW JERSEY

As We Go To Press (cont.)

First Microwave Photos Transmitted by Motorola

Maps, drawings, photographs and other symbolic matter which cannot be readily communicated in the form of teletype or verbal messages were successfully relayed over microwave between Chicago and Houston, Tex., recently, to demonstrate the feasibility of facsimile transmission over the same radio circuits that carry voice.

The demonstration took place over the private microwave system of the Texas Illinois Natural Gas Pipeline Co., a Motorola installation. Results were reportedly excellent. Experienced facsimile engineers reported the frequency response and differential phase characteristic of the microwave circuits were comparable to or exceeding the best wire circuits used for commercial telephoto service.

New Receiving Tube Plant Announced By Sylvania

Sylvania Electric Products Inc. will construct a multi-million dollar plant at Altoona, Pa. for the production of receiving tubes, it was announced by Matthew D. Burns, vice-pres. for operations, in charge of the company's radio tube and TV picture tube divisions.

The new 110,000 sq. ft. single-story plant will ultimately replace an existing smaller plant and leased warehouse space in Altoona. It will be built on a 15-acre site which has already been acquired by the company. The building will be fully air-conditioned; 100,000 sq. ft. will be for manufacturing and the remainder will contain offices and a cafeteria.

New West Coast Lab

View of the production area of Rototest Laboratories, Lynwood, Calif. Facilities are available for testing a wide variety of electrical and electromechanical components and assemblies for environmental qualification and reliability of performance.

Coming Events

A listing of meetings, conferences, shows, etc., occurring during the period Dec. 1955 through April 19, 1956 that are of special interest to electronic engineers

Dec. 6-7: Sixth SPI Film, Sheeting & Coated Fabrics Div. Conference, Hotel Commodore, New York City.

Dec. 10-16: International Atomic Exposition, Cleveland Public Auditorium, Cleveland, O.

Dec. 12-16: Nuclear Science and Engineering Congress, sponsored by the Engineers Joint Council, Cleveland, O.

Dec. 13: AIEE, N.Y. Sec., 33 W. 39th St., N.Y.C. Discussion of present applications of transistors.

Dec. 14: Joint Symposium on Operations Research, Phila. Sec. IRE; Delaware Valley Sec., SIAM; Pro. Group on Engineering Mgm't., IRE.

Dec. 15-17: URSI Fall Meeting, Gainesville, Fla.

Jan. 9-10, 1956: 2nd National Symposium on Reliability and Quality Control in Electronics, sponsored by the Prof. Gp. on Reliability and Quality Control of IRE, co-sponsored by the American Society for Quality Control and RETMA.

Jan. 19-21, 1956: National Simulation Conference, sponsored by the Dallas Fort Worth Chapter of the IRE Prof. Gp. on Electronic Computers (PGEC), Dallas, Tex.

Jan. 23-26, 1956: Plant Maintenance and Engineering Conference, to be held concurrently with the Plant Maintenance and Engineering Show, at Convention Hall, Phila., Pa.

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

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

Feb. 6-12, 1956: National Electrical Week, sponsored by NEMA.

Feb. 7-9: Eleventh Ann. SPI Reinforced Plastics Div. Conference, Hotel Chalfonte-Haddon Hall, Atlantic City, N.J.

Feb. 15-17: Conference on High-Speed Computers, at Louisiana State Univ., Baton Rouge, La.

Feb. 22-25: RETMA's 1956 Industrial Relations Round Table, Gen. Oglethorpe Hotel, Savannah, Ga.

Feb. 27-March 2, 1956: National Meeting of the ASTM, Committee Week at the Hotel Statler, Buffalo, New York.

Mar. 8-9: Fourteenth Ann. SPI Canadian Conference, Sheraton-Brock Hotel, Niagara Falls, Ontario, Canada.

Mar. 12-16: 1956 Corrosion Show, held in conjunction with the Twelfth Ann. Conference of the NACE, Hotel Statler, New York City.

Mar. 19-22: 1956 IRE National Convention and Radio Engineering Show, Waldorf-Astoria and Kingsbridge Armory, New York City.

April 5-6: Special Technical Conference on Magnetic Amplifiers, co-sponsored by: AIEE Committee on Magnetic Amplifiers, IRE PRO. Group on Industrial Electronics, ISA Central N.Y. Sec. Hotel Syracuse, Syracuse, N.Y.

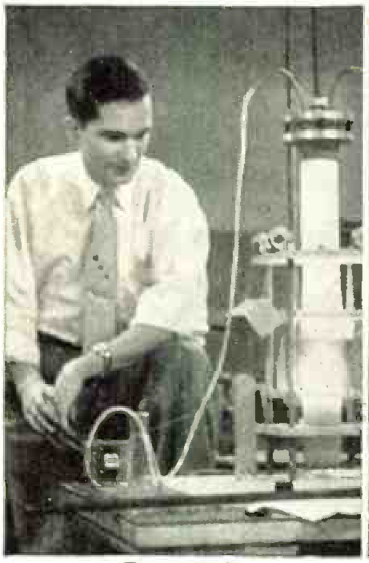
April 13-14, 1956: Tenth Annual Spring Television Conference, sponsored by Cincinnati Sec., IRE, 1349 E. McMillan St., Cincinnati, Ohio.

April 15-19, 1956: 34th annual convention of NARTB, Conrad Hilton Hotel, Chicago, Ill.

Abbreviations:

AIEE: American Institute of Electrical Engineers.
ASTM: American Society for Testing Materials.
IRE: Institute of Radio Engineers.
IAS: Institute of Aeronautical Sciences.
ISA: Instrument Society of America.
NARTB: Nat'l. Assoc. of Radio and TV Broadcasters
NACE: National Assoc. Corrosion Engineers
NEMA: National Electrical Manufacturers Assoc.
RETMA: Radio-Electronics-TV Manufacturers Assoc.
SPI: Society of the Plastics Industry, Inc.
SIAM: Society for Industrial and Applied Mathematics
URSI: International Scientific Radio Union

TUNG-SOL Acknowledged quality leadership . . . in research, design, development and manufacture . . . of all the basic components on which the science of electronics is founded.



Research

Design

Development

Manufacturing

Aluminized Picture Tubes — Color Picture Tubes — Special Purpose Tubes — Radio and TV Tubes — Semiconductors

TUNG-SOL ELECTRIC INC., Newark 4, New Jersey

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For product information, use inquiry card on last page.

Collins 21E PERFORMANCE

WBUY
LEXINGTON, NORTH CAROLINA
5000 WATTS • NON-DIRECTIONAL
1440 KC
FM 94.3 MC
YOUR BEST ADVERTISING BUY

September 26, 1955

Collins Radio Company
Attn: Mr. John F. Stanbery
Dogwood Road
Fountain City (Knoxville), Tenn.

Dear John:

We at WBUY wish to express our complete satisfaction with our new 5 KW Collins 21E which we installed this last spring.

As you know, we previously operated a [redacted] 250 watt. When our 5 KW power increase came through we switched to Collins primarily because of superior performance characteristics and reliability.

When the transmitter arrived we were anxious to check out the actual performance because the final test data report looked to be "too" good. During initial program and subsequent tests we found your advertised specs as well as performance test data to be very much on the conservative side.

In particular, our audio measurements confirm the reasons why the 21E sounds so good on the air. It is really high fidelity.

* Congratulations to Collins engineers for designing what we think is the best 5 KW transmitter on the market today.

With best regards.

Yours very truly,

Omar G. Hilton
Co-owner-Technical Director
Radio Station WBUY

FINEST IN THE FIELD*

Just as many broadcasters have discovered, Omar G. Hilton of WBUY Lexington, North Carolina found his 5 KW Collins 21E performing better than advertised. Those original specs were based on conservative laboratory tests, but actual performance tests show Collins 21E 5 KW transmitters doing an even better job — *outperforming all others in the field!*

NEW SPECIFICATIONS

POWER OUTPUT
5500/1100 Watts

FREQUENCY STABILITY
Deviation less than ±5 cps (Typical — less than ±2 cps.)

AUDIO FREQUENCY RESPONSE
Within ±1½ db from 30 to 15,000 cps (Typical — ±1 db from 30 to 15,000 cps.)

DISTORTION
Less than 3% from 50 to 7500 cps for 95% modulation, including all harmonics up to 16 kc. (Typical — less than 2½ from 50-7500, less than 2% from 100-5000 cps.)

CARRIER SHIFT
Less than 3% (Typical value less than 2%.)

TEMPERATURE RANGE
Up to 45 degrees C.

Your nearest Collins representative will be glad to send you a 21E brochure with complete details plus price and delivery data.

COLLINS RADIO COMPANY CEDAR RAPIDS, IOWA

COLLINS

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COLLINS RADIO COMPANY OF CANADA LTD.
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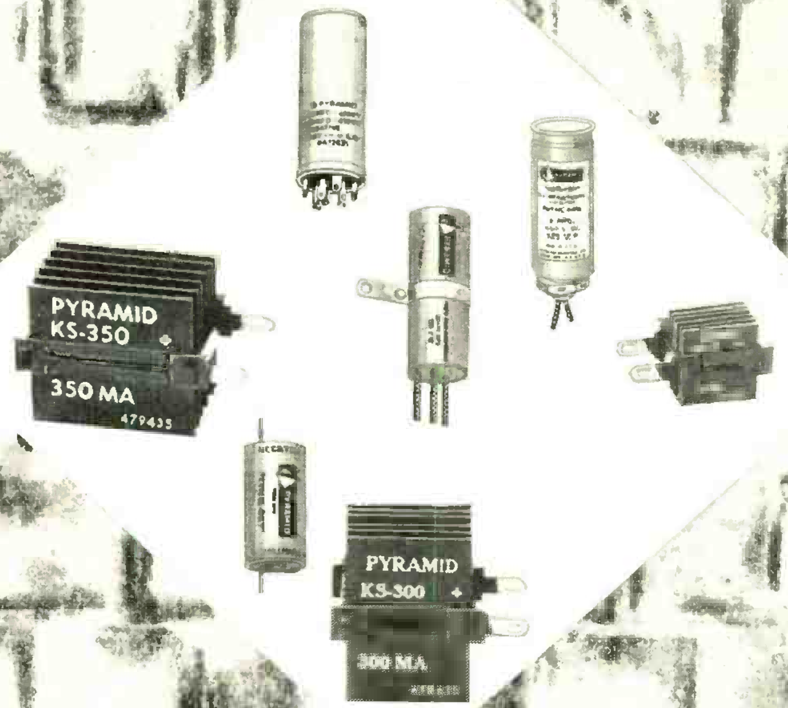


BURTON BROWNE ADVERTISING

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

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

Allied Radio Corporation
100 North Western Avenue, Chicago, Illinois

Arrow Electronics, Inc.
65 Cortlandt Street, New York 7, New York

Art Electronic Supply Co.
145 South Park Street, Tucson, Arizona

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

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

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

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

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

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

Durrell Distributors
222 Mystic Avenue, Medford, Massachusetts

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

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

Electronic Equipment Distributors
1228 Second Avenue, San Diego, California

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

Herbach & Rademan, Inc.
1204 Arch Street, Philadelphia 7, Pennsylvania

Hughes-Peters, Inc.
111 East Long Street, Columbus, Ohio

Interstate Electronics Co.
227 Fulton Street, New York, New York

Kann-Ellert Electronics, Inc.
9 South Howard Street, Baltimore, Maryland

Kierulff Electronics, Inc.
820 West Olympic Boulevard, Los Angeles, California

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

Milgray Electronics, Inc.
120 Liberty Street, New York, New York

Milo Radio & Electronics
200 Greenwich Street, New York, New York

Newark Electric Co.
233 West Madison Street, Chicago, Illinois

Niles Radio & Phonograph Co.
1254 Arapahoe Street, Denver, Colorado

Olive Electronics Supply Corp.
6711 Olive Boulevard, University City 5, Missouri

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

Fred P. Purcell Company
1221-27 N. Washington Ave., Scranton, Pennsylvania

Radio & Electronic Parts Corp.
3235 Prospect Avenue, Cleveland, Ohio

Radio Specialties Company
1946-56 South Figueroa Street, Los Angeles, California

Srepco, Inc.
314 Leo Street, Dayton, Ohio

Standard Electronic Sales Corp.
1505 Main Street, Buffalo 9, New York

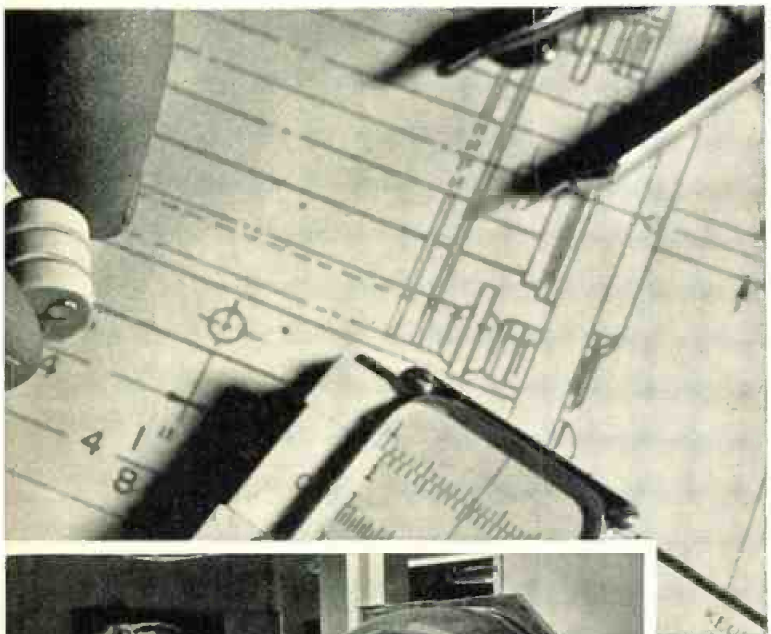
Albert Steinberg & Co.
2520 North Broad Street, Philadelphia, Pennsylvania

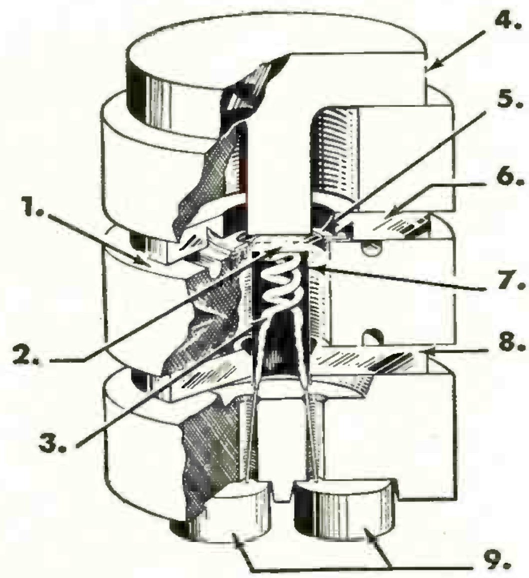
Sterling Radio Products Co.
1616 McKinney Avenue, Houston 1, Texas

Walder Radio & Appliance Co.
1809 North Second Avenue, Miami 32, Florida

PYRAMID ELECTRIC CO.
1445 Hudson Boulevard, North Bergen, New Jersey

ADVANCED DESIGN OF NEW FEATURES METAL-





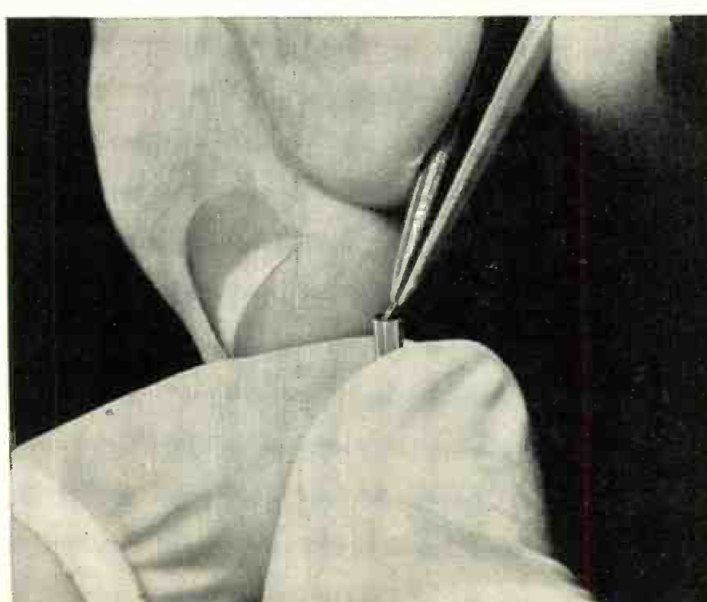
ONLY ⅜" HIGH! THE 6BY4 IS G.E.'S ULTRA-COMPACT NEW METAL-CERAMIC R-F AMPLIFIER TRIODE FOR UHF-VHF TV TUNERS.

Installs in a fraction of the space required by other tuner tubes—yet out-performs them! At 900 mc operation with 10 mc bandwidth, new tube has the low noise factor of approx 8 db, and a power gain of approx 15 db. Filament and plate voltages, 6.3 v and 200 v . . . amplification factor, 100. The metal-ceramic, parallel-plane design as illustrated in the cutaway, gives the new 6BY4 short electron transit time and an extremely low r-f loss; also high structural rigidity. In type 6BY4 this rigidity is employed to attain minimum microphonics rather than maximum tube resistance to shocks and vibration, since TV circuits do not undergo the same physical hazards as military and commercial airborne and mobile equipment.

1. Reference plane
2. Oxide-coated cathode
3. Heater
4. Anode
5. Grid
6. Grid ring
7. Support cylinder
8. Cathode ring
9. Heater buttons

Above: metal parts for G-E micro-miniatures are fired in a high-vacuum furnace. Titanium is employed—this substance has the unique advantage of freeing virtually all its own gases when fired to 700 C. Result of using pre-fired titanium parts: there is no subsequent vacuum contamination from metal-liberated gases when tubes operate at high temperatures. Instead, titanium serves as a gas absorber!

Right: in an operation calling for utmost delicacy, the tube's cathode disc is fitted into the support cylinder. Note rubber finger cots on the fingers holding the tiny cylinder! Changed hourly, these finger cots help ward off dirt and moisture—are worn when handling all micro-miniature tube parts, to keep the parts scrupulously clean. Other G-E aids to cleanliness are air-pressuring, air-conditioning, and lint-free Nylon and Dacron uniforms.



G-E MICRO-MINIATURE TUBES CERAMIC CONSTRUCTION

Heat-resistant! Micro-miniatures will operate up to 500 C!
The new G-E tubes withstand shocks and vibration; have high gain, minimum noise.

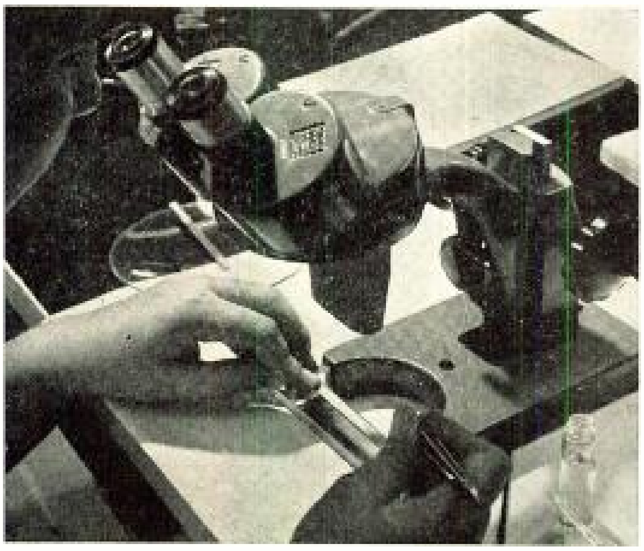
Breaking sharply with traditional concepts of tube design, G-E micro-miniatures are as new as the era of advanced electronic performance that lies directly ahead.

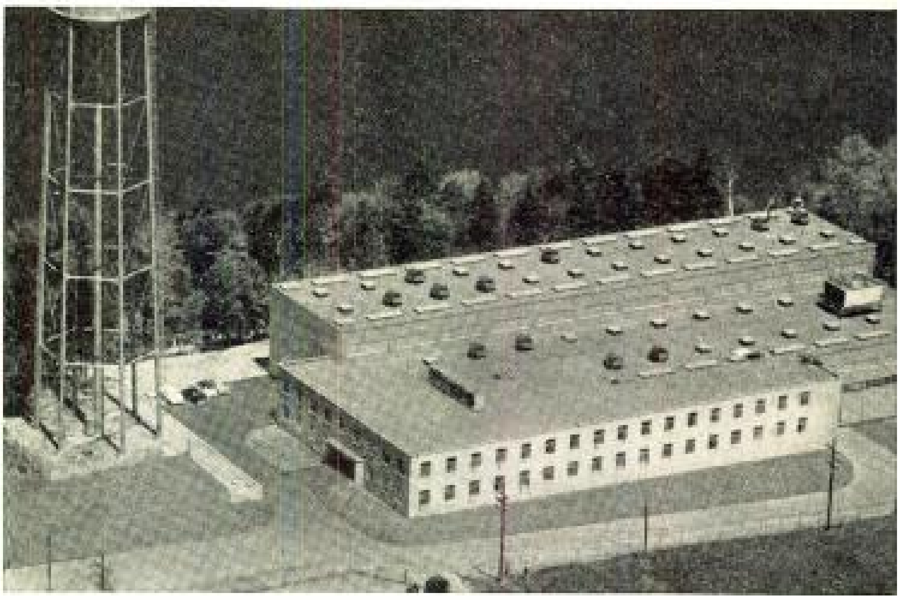
In structure, these extremely small, rugged tubes show a straightforward engineering approach to high electrical efficiency. The materials of tomorrow are used to achieve full-rating operation at high temperatures, with no sacrifice of service life or tube dependability.

Type 6BY4—tuner triode designed expressly for TV, no bigger than a pencil-eraser, amazingly low in microphonics—is the first of an outstanding new series of metal-ceramic micro-miniatures by General Electric. Designers of electronic equipment can meet new, exacting, commercial and military requirements by means of micro-miniature tubes—space-saving, virtually heat-proof.

Ask for full information! If your design problem is one calling for tube analysis . . . if your new circuit needs a special high-performance tube type —G-E tube engineers will be glad to consult with you. *Tube Department, General Electric Company, Schenectady 5, New York.*

Tube grids are carefully micro-inspected. High-power lenses give the necessary magnification to check G-E micro-miniature grids—for the 6BY4, wire only 3/10,000 inch in diameter, wound 1,000 times per inch! Special equipment, new techniques are used at every stage of micro-miniature assembly and inspection. These mark the highest precision standards attained in receiving-tube manufacture.





Importance of metal-ceramic research in the development of electronic tubes and other products, is accented by this new, separate Metals and Ceramics Building at the General Electric Research Laboratory, Schenectady, N. Y. Here G-E scientists, research engineers, and skilled workers investigate and measure metal and ceramic properties and performance under every possible condition that will be encountered.

Progress Is Our Most Important Product

GENERAL ELECTRIC

162-1A5

As We Go To Press (cont.)

Hand-Cranked 50¢ Phono Demonstrated By RCA

The answer to the need for a message carrying device not subject to jamming nor dependent upon electricity has been found in RCA's new hand-cranked phonograph which costs less than 50¢ to make. The little instrument can be dropped by air behind the iron curtain or in the Near East and Asia, where the Russians are doing a lot of propaganda. Weighing less than 10 oz., the 78 RPM machine consists of a base and a turntable with a crank on its axis. A steel needle and the "radiator" it drives pass sound frequencies between 500 and 4000 CPS, permitting voice frequency reproduction without too much background noise and hiss.

The Voice of America has already received a number of these machines for field test, and other federal agencies are reportedly showing considerable interest.

Gen. David Sarnoff, in making the announcement, stated that RCA does not intend to commercially market the instrument, and that it was available to anyone. Toy manufacturers, better equipped to produce the unit, might be able to lower its price to below 20 cents, he said.

The unit was developed by Arthur van Dyke of RCA's design staff.

New 120° Picture Tube Key to "Shallow" TV Set

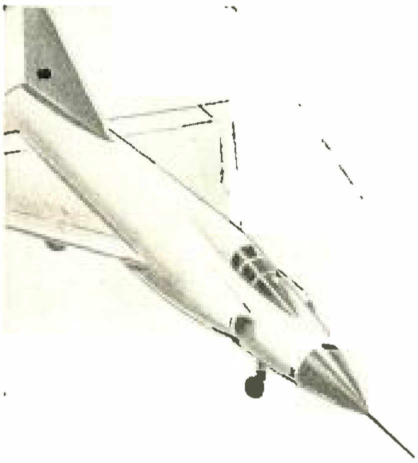
At Westinghouse's Elmira plant last month there was demonstrated an experimental 21-in. 120° TV picture tube which industry officials believe will make possible a new "shallow" look in TV sets, possibly within the next year.

The new tube is more than 5 in. shorter and 2 lbs. lighter than the 90° tube adopted by the industry last year.

While Westinghouse was the first to demonstrate such a tube, there is evidence that virtually all of the major tube manufacturers are working along similar lines, either toward 120° or 110° operation.

Both Westinghouse and National Video Corp. are now sampling the tube to their customers.

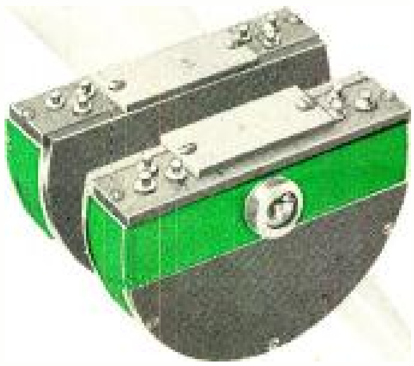
A knotty receiver design problem remains to be solved. To generate the high deflection voltage needed for the tube, a re-designed yoke, flyback, and horizontal output stage and associated circuitry will be needed.



Need a special potentiometer design? Our engineers are specialists in designing sub-miniature potentiometers, sector and open card winding potentiometers, and other combinations of special factors and functions. As the leader in standard precision potentiometer production, Fairchild has all the advanced techniques and facilities to give you fast service on both test models and production runs of potentiometers built to your exacting requirements.

SPECIAL POTENTIOMETERS

for your special needs



This is a special sector potentiometer. It came into being when the Eclipse-Pioneer Division of the Bendix Aviation Corporation needed a potentiometer with gear drive to mount within limited space in the altitude compensator of their Beam Guidance System. Excessive torque would cause inaccurate readings and result in unsatisfactory operation of the system, so a potentiometer with minimum torque was necessary. Since space limitations dictated an unusual configuration, our engineers worked with Eclipse-Pioneer engineers to develop this special design. The critical torque requirements of 0.075 oz.-in. on a 4 gang unit were met by specially designed wipers, windings, and slip rings. This same constructive cooperation can help you when you need a special or a standard potentiometer. So, call Fairchild first. Potentiometer Division, Fairchild Controls Corp., a subsidiary of Fairchild Camera & Instrument Corp., 225 Park Ave., Hicksville, N. Y., Dept. **140-67E1.**

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

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Los Angeles, Cal.

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PRECISION POTENTIOMETERS

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STANDARD PLASTIC-BASE AUDIOTAPE
the standard of quality the world over

"LR" AUDIOTAPE ON 1-MIL MYLAR*
50% more recording time per reel

AUDIOTAPE ON 1½-MIL "MYLAR"
super-strength professional tape

"SUPER-THIN" AUDIOTAPE ON ½-MIL "MYLAR"
2400 ft on a 7-inch reel

*Trademark, DuPont polyester film

BALANCED FREQUENCY RESPONSE for most life-like reproduction throughout the complete range of audible sound.

MOISTURE-REPELLENT BINDER assures smooth, silent tape travel even under hot, humid conditions.

ANTI-TACK AGENT prevents sticking on hot erase and record heads. Especially important on older type machines.

SPECIAL DRIER-TYPE FORMULA greatly reduces danger of oxide rub-off, even on dirty heads.

MAGNETIC ORIENTATION of oxide particles for higher sensitivity, lower distortion and improved output.

LOWER BACKGROUND NOISE through improved dispersion of finer oxide particles.

These Audiotape features, developed and perfected through years of research and production experience, assure the finest recording and reproduction on any type of machine. It is this performance which has made Audiotape the first choice of so many critical professional recordists throughout the world. Join the trend to Audiotape. IT SPEAKS FOR ITSELF!

For condensed data on all tape recorders, send for your free copy of our 1955-1956 TAPE RECORDER DIRECTORY

AUDIO DEVICES, Inc.

444 MADISON AVE., NEW YORK 22, N. Y.
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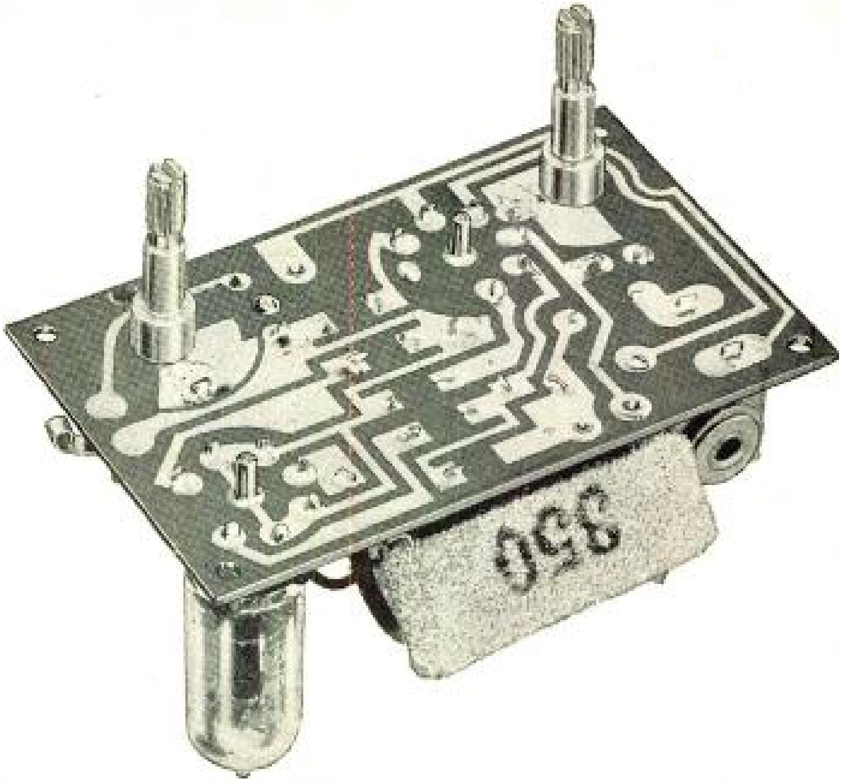
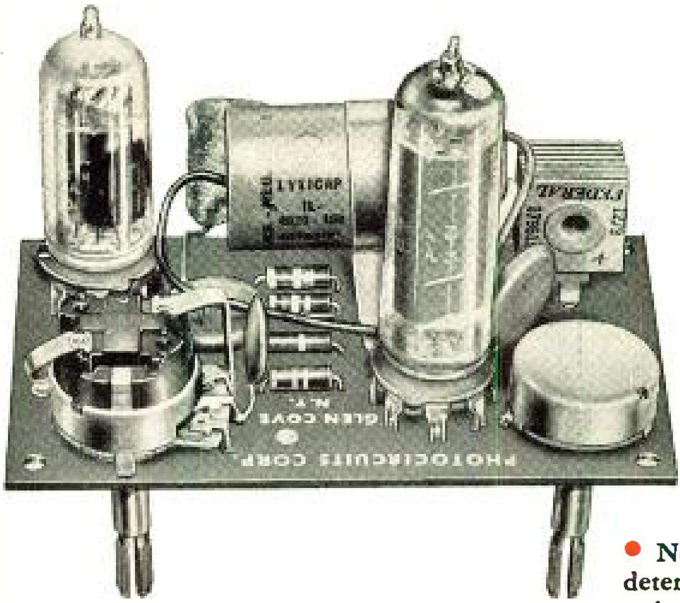
Speed up production with

REVERE ROLLED Printed Circuit Copper





Audio amplifier unit by Photocircuits Corp., Glen Cove, N. Y., using Revere Rolled Printed Circuit Copper.

Available NOW!

● Now that Revere *Rolled* Printed Circuit is available, nothing need deter you from switching to printed circuitry. This copper is supplied to laminators in standard coils of 350 lbs., in widths up to 38″, and in .0015″ and .0027″ gauges, weighing approximately 1 oz. and 2 oz. per square foot.

High in conductivity, uniformly dense through and through and side to side, Revere *Rolled* Printed Circuit Copper is easily etched and soldered.

When ordering blanks from your laminator, specify Revere *Rolled* Printed Circuit Copper.

REVERE

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Founded by Paul Revere in 1801

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Mills: Baltimore, Md.; Brooklyn, N. Y.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Newport, Ark.; Rome, N. Y. Sales Offices in Principal Cities, Distributors Everywhere.

Electronic Industries News Briefs

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

Atomic Instrument Company has acquired controlling interest in Kaye Development Company, Inc., South Norwalk, Conn., maker of electronic color evaluation instruments and related detection devices.

Bogue Electric Manufacturing Company, Paterson, N.J., has built two giant 480 kw Static Rectifier Supplies for the Atomic Energy Commission installation at Paducah, Ky.

Bourns Laboratories, Riverside, Calif., has added a subsidiary plant in Ames, Iowa, devoted to the manufacture of miniature instruments.

Bristol Engineering Corporation has doubled its working area by adding 33,000 sq. ft. with a recently negotiated long term lease of a three-story factory building in Bristol, Pa.

Burroughs Corporation, Detroit, Mich., has established a Defense Contracts Organization responsible for sales, contract administration, and field service of Burroughs Corporation's military business.

Canadian Westinghouse Company, Ltd., will manufacture and distribute Capehart-Farnsworth consumer products in Canada.

CBS-Hytron, Div. of Columbia Broadcasting System, Inc., plans to build a completely modern 55,000 sq. ft. warehouse in Chicago, Ill., for handling of radio and TV receiving tubes, picture tubes, diodes, and transistors.

Controlling interest in **Condenser Manufacturers, Inc.,** Nashville, Tenn., was recently acquired by J. W. Hart and E. W. Carmack.

Consolidated Vacuum Corporation, wholly owned subsidiary of Consolidated Engineering Corporation, Pasadena, Calif., has been merged with the parent organization, and will be known as the ConVac Division of Consolidated.

Frank R. Cook Company, Inc., has been incorporated in Colorado as a new research and manufacturing organization engaging in the development of equipment for the aeronautical and electronic industries. The new company is devoting its first efforts to electronic equipment and automation components to meet the exacting requirements of supersonic and hypersonic flight conditions.

Curtiss-Wright Corp., Wood-Ridge, N.J., has been granted a license to manufacture printed electrical circuits by the Technograph processes, according to an announcement by Hubert L. Shortt, pres. of Technograph Printed Electronics, Inc., Tarrytown, N.Y.

The Electronics Division, Curtiss-Wright Corp., Carlstadt, N.J., has established a West Coast office at 7046 Hollywood Blv'd., Hollywood, Calif.

Dalmo Victor Corp. has merged with its parent company and will henceforth be operated as "Dalmo Victor Company, Div. of Textron American, Inc."

Allen B. Du Mont Laboratories, Inc., Clifton, N. J., has announced the formation of Du Mont National Distributors, Inc., to control distribution in markets where Du Mont is not represented at present.

Dyna Company, at 5142 Master St., Phila., Pa., is a new company specializing in the design and production of electric components and equipment with particular emphasis on audio items for the high fidelity market.

Eitel-McCullough, Inc. is adding a 17,000 sq. ft. building to its main San Bruno, Calif., plant. The new building, scheduled for completion in early Spring, will contain facilities for the production of super klystron amplifier tubes up to twenty ft. long.

Emerson Radio and Phonograph Corp., New York City, has announced its entrance into the tape recorder field.

Federal Telephone and Radio Company, Clifton, N.J., is constructing a new plant, in Los Angeles, Calif., for the production of electronic equipment for the aircraft industry.

The French Government has initiated a broad-gage program affecting that country's educational and atomic energy activities. A major step in this plan is the purchase of three Van de Graaff accelerators from the High Voltage Engineering Corp., Cambridge, Mass.

General Kinetics Inc., 555-23rd St., S. Arlington, Va., is conducting research and development for industrial and government sponsors in the fields of digital computors, special purpose information handling systems, radar techniques, aircraft instruments, and servomechanisms.

General Precision Laboratory, Inc., Pleasantville, N.Y., announced receipt of a $3 million contract from Air Material Command, Wright Patterson A.F. Base, Dayton, Ohio, for the production of airborne electronic navigation equipment Radar Set AN/APN-96.

The Hammel-Dahl Company of Providence, R. I. has opened a new sales office at 310 Thompson Building, Tulsa, Okla.

Houston Technical Laboratories, Texas Instruments' geophysical instrumentation subsidiary, has commenced construction of a new main plant on Buffalo Speedway in Houston, Tex.

International Resistance Company, Phila., Pa., has started construction of a modern one-story building in Sylmar, Los Angeles County, Calif., to house three of its wholly-owned Calif., subsidiary companies.

Kay Lab, San Diego, Calif., has been awarded a $50,000 contract for construction of an industrial closed circuit television system at the Naval Air Station, Alameda, Calif.

The Kuljian Corporation, Phila, Pa., has been awarded a contract calling for design, engineering, procurement, and inspection during construction services for the modernization and expansion of Nicaragua's existing electrical distribution system in Managua.

Lenkurt Electric Co., San Carlos, Calif., has expanded its technical training program for customers to full-time operation, and is now offering one-week courses on the installation and maintenance of 45A carrier and 72B radio.

The Magnavox Company, of Fort Wayne, Ind., has been listed as one of the major sub-contractors participating in the Convair B58 Supersonic Bomber program, by the U.S. Air Force.

Norden-Ketay Corporation has established a Western Division, in Gardena, Calif., to service the firm's customers in the West.

Ohmite Manufacturing Company is now manufacturing Amrecon Relays previously made by American Relay & Controls, Inc. The relays are now known as Ohmite Amrecon Relays, and will continue to be produced at the plant at 3601 Howard St., Skokie, Ill.

Pheoll Mfg. Co., Chicago, Ill., has purchased the Voi-Shan Mfg. Co., Inc., Culver City, Calif., it was announced by Mason Phelps, pres. of Pheoll.

Radiation Instrument Development Laboratory has moved its business offices and engineering department into their new building at 5737 S. Halsted St., Chicago, Ill.

The Radio Receptor Company, Inc., Brooklyn, N.Y.C., has been awarded a $1,225,000 contract by the Signal Corps Supply Agency of the U.S. Army to manufacture 130 AN/TRC-29 radio sets for microwave relay purposes.

The consolidation of all electronic computor and tabulating machine operations into a single unit to be known as the Univac Division has been announced by James H. Rand, pres. **Remington Rand Division of Sperry Rand Corp.**

Seals, Ltd., 1010 Mission Street, S. Pasadena, Calif., is a new source for glass seal connectors for the electronics industry. W. P. Speer is pres. and general manager.

Sensitive Research Instrument Corporation has completed re-location to its new production and engineering laboratories at 310 Main St., New Rochelle, N.Y.

Spencer-Kennedy Laboratories, Inc., Cambridge, Mass., has announced the enlargement of the company's management. Fitzroy Kennedy, as Chairman of the Board of Directors, will be in the senior management position. Donald Spencer, in the office of Pres., will retain financial and business administration, and George W. W. Brewster becomes Chairman of the company's Executive Committee. Samuel L. Gwin has been elected to the firm's Board of Directors.

Sunstein Engineering Company, 464 Conshohocken State Rd., Bala-Cynwyd, Pa., is a new company formed to provide consulting services in the electronics field.

Sylvania Electric Products Inc. has officially begun operations in its new 160,000 sq. ft. incandescent lamp plant at St. Marys, Pa.

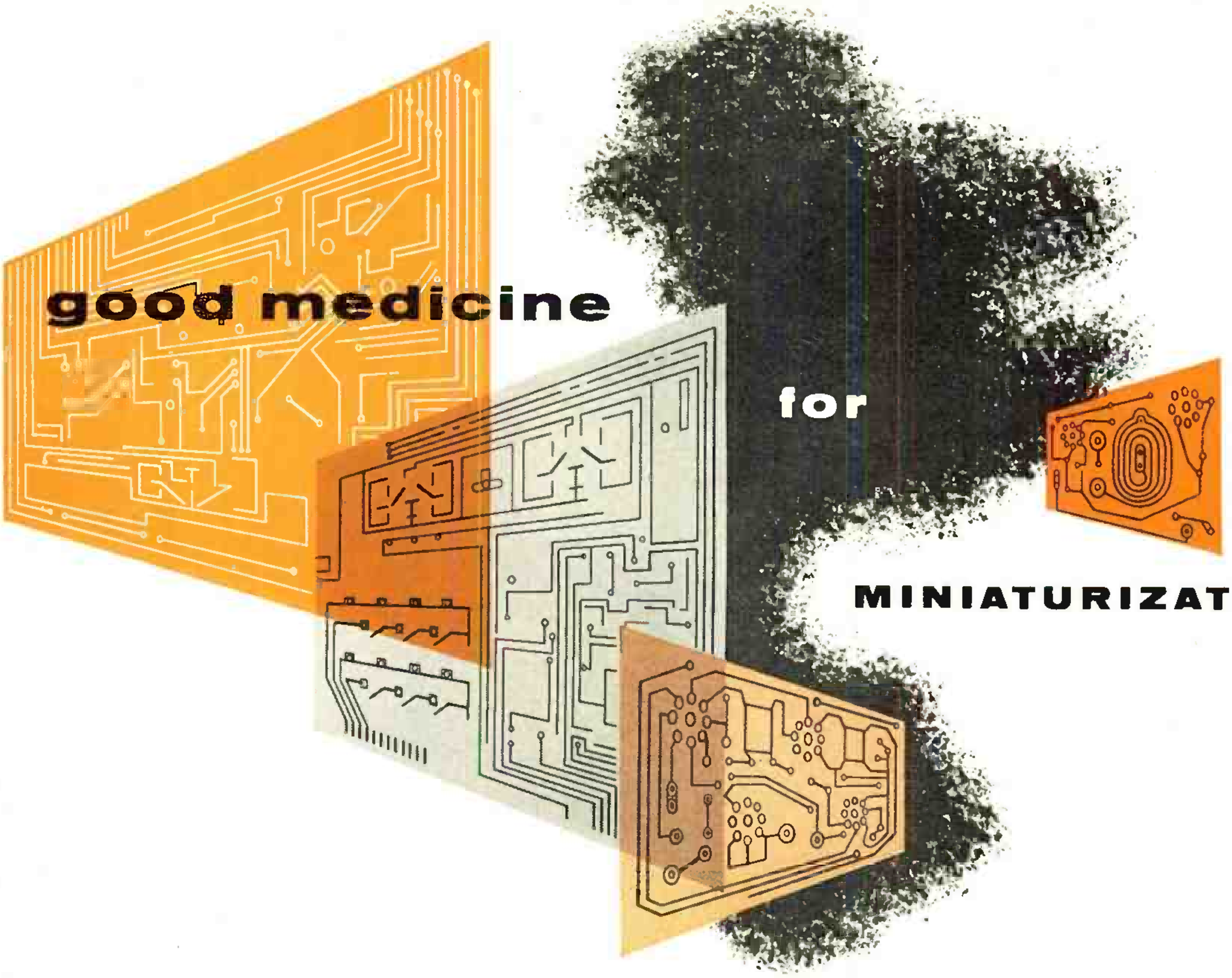
Telerad Manufacturing Corporation, New York City, announced the election of Charles George as President and Chairman of the Board.

Timely Instruments and Controls Corporation has announced the establishment of its new facility at 1645 West 135th St., Gardena, Calif.

Thompson Products, Inc., Cleveland, Ohio, has entered into the atomic energy field. The company has established a central staff department to seek out, investigate, and exploit new developments in the various areas of the nuclear field.

Viking Instruments, Inc. has acquired controlling interest in the Econo Products Co. of East Haddam, Conn.

Vitapix Corp., New York, N.Y. has completed its reorganization pursuant to its recent decision to withdraw from exclusive association with the Guild Films Co., Inc.



New printed circuit material permits mass production cold punching

Versatile printed circuits have opened the door to practical solutions of many complex electric or electronic design problems. Now, a new grade of National's Copper-Clad PHENOLITE permits quality cold punching on a mass production basis. It is called PHENOLITE XXXP-471. Here is a material designed to meet the toughest demands of automatic manufacturing processes. PHENOLITE XXXP-471 is particularly suited where close registration of circuits and holes is required. Improved water absorption and electrical properties combine with good copper bond strength to give you new freedom in selecting the right material for your specific printed circuit application.

PROPERTIES — PHENOLITE XXXP-471

Dielectric Constant	Dissipation Factor	Moisture Absorption	Copper Bond Strength	Flexural Strength	Dip Solder Resistance
10^6 Cycles	10^6 Cycles	% 24 Hrs.	Pounds Per 1 in. Strip	Psi	Seconds at 450° F.
3.75	.0268	0.48	5-6	14,000	> 10

With this new laminate grade, National adds another dimension to a complete range of base materials applicable to the science of printed circuitry. It is also practical evidence of the research program at National aimed at producing better materials for better design. The results of this research are easily available to you. Just call your nearby National Vulcanized Fibre Office, or write to Wilmington, Delaware.

PHENOLITE
Laminated PLASTIC

HERE'S HELP FOR YOU—our new, fact-filled, 12-page bulletin entitled "Mechanize Your Wiring With Copper-Clad Phenolite." Contains full information and application data on Copper-Clad Phenolite and other metal and non-metal clads. Write for it today! Address Dept. K-12.

Also manufacturers of Vulcanized Fibre, Vul-Cot Waste Baskets, Peerless Insulation, Materials Handling Equipment and Textile Bobbins

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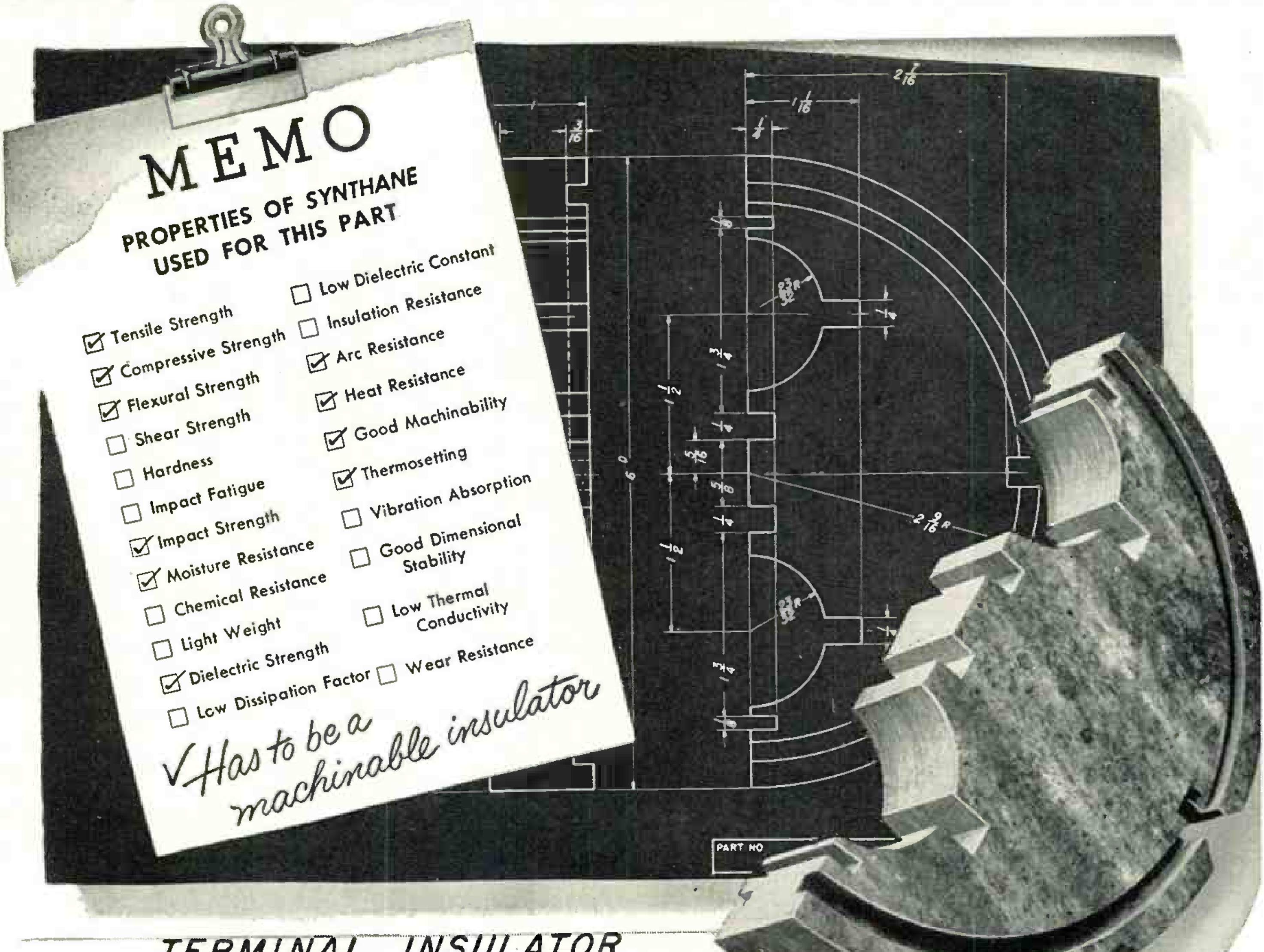

TERMINAL INSULATOR OF SYNTHANE LAMINATED PLASTICS RESISTS MOISTURE, HEAT, ARCING, BREAKAGE

Practically everything made requires a combination of several properties. And this terminal insulator is a shining example. It has to have high dielectric strength in a machinable insulator, good moisture resistance, excellent arc resistance, good heat resistance and mechanical strength. These and other requirements indicate *Synthane* laminated plastics for the job.

Starting with the blueprint, *Synthane* Corporation produces the needed base material with the right combination of properties, machines it with accuracy, and suppli the finished parts, with no waste, to the customer.

Each year *Synthane* turns out thousands of differe finished parts. They are made from the more than different grades of *Synthane* laminated plastics which a also regularly supplied to industry in sheets, rods, tube and molded parts. Good service and quality are chara teristic of *Synthane* fabrication.

If you are looking for parts with many differe properties — physical — mechanical — electrical — a chemical, in combination, *Synthane* may be your answ Mail the coupon for information.

SYNTHANE CORPORATION, 11 River Road, Oaks, Pa.
Please send me more information about Synthane laminated plastics and fabrication service.

Name ____________
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Company ____________
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LAMINATED S PLASTICS

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PROVED!

Because of their proven ability to deliver double the normal life . . . these two AMPEREX heavy duty triodes have already replaced approximately one third of conventional types in existing sockets!

SPECIALLY DESIGNED FOR HEAVY DUTY RF INDUSTRIAL APPLICATIONS

TYPE 6333 (WATER COOLED)

Plate Dissipation 10 kilowatts. Furnished with grid connector for direct interchangeability with type 892 without any equipment modifications. Suitable for communications as well as industrial applications. Available in air-cooled version, Type 6445.

TYPE 6446 (WATER COOLED)

A heavy wall triode capable of dissipating 20 kilowatts continuously. Massive anode (7/16" thick), provides high heat storage capacity for heavy intermittent duty. High dissipation reserve allows extreme mismatch of load to tube impedance. The tube is therefore protected against maladjustment or misuse of equipment. Uses only ½ the water flow required for type 892, for equivalent anode dissipation. Available in air-cooled version, Type 6447.

OPERATING DATA, 6333

RF POWER AMPLIFIER and OSCILLATOR CLASS C TELEGRAPHY

	MAXIMUM RATING per tube	TYPICAL OPERATION one tube	
AC Filament Voltage	—	22	volts
DC Plate Voltage	15000	12000	volts
DC Grid Voltage	3000	1600	volts
Plate Load Resistance	—	3500	ohms
Peak RF Grid Voltage	—	2600	volts
DC Plate Current	2	1.55	amps
Plate Input	30	18.60	kw
Plate Dissipation	10	4.35	kw
DC Grid Current (approx.)	400	165	ma
Driving Power (approx.)	—	420	watts
Plate Power Output	—	14.25	kw
Tube Power Output	—	745	BTU/min.

OPERATING DATA, 6446

RF INDUSTRIAL OSCILLATOR

(3 PHASE, FULL WAVE, UNFILTERED SUPPLY)

Plate Volts and Input—Max.	100	75	50%
For Frequencies Indicated	5	12.5	20(mc.)

	MAXIMUM RATING per tube	TYPICAL OPERATION one tube	
AC Filament Voltage	—	21.8	volts
DC Plate Voltage	15000	1200	volts
DC Grid Voltage	− 3000	− 500	volts
Peak RF Grid Voltage	—	1460	volts
Plate Current	2	2	amps
Plate Input	30	24	kw
Plate Dissipation	20	6.5	kw
DC Grid Current	400	230	ma
Drive Power (approx.)	—	300	watts
Plate Power Output	—	17.5	kw
Tube Output	—	996	BTU/min.

DIRECT INTERELECTRODE CAPACITANCES

Grid to Plate	32 μμf
Grid to Filament	17 μμf
Plate to Filament	1.8 μμf

LIST PRICES:

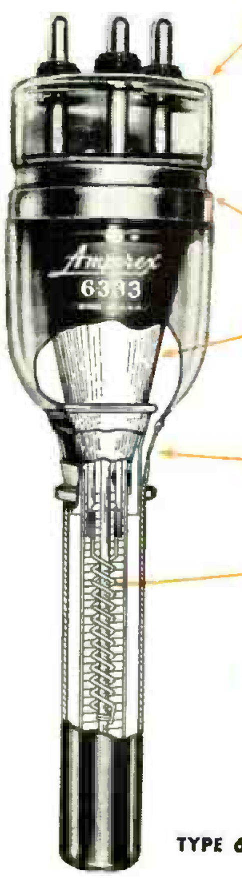
6333 (Water Cooled)	$230.00
6445 (Forced Air Cooled)	375.00
6446 (Water Cooled)	255.00
6447 (Forced Air Cooled)	400.00

ACCESSORIES

Tube Type	Water Jacket	Grid Connector
6333	DW-1580	Y-13326 (Supplied with tube without charge)
6446	S-15096	Y-13326 (Supplied with tube without charge)

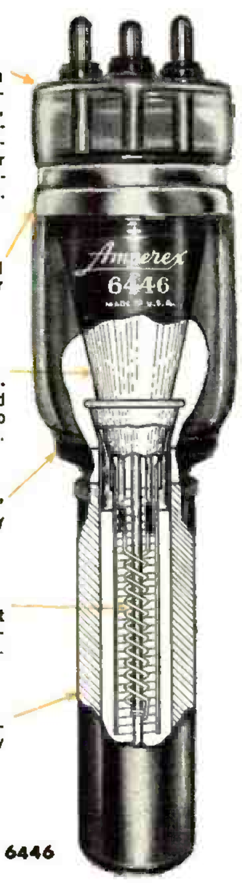
Complete technical data available from our Application Engineering Department

AMPEREX tubes give you better performance and longer life, Physically and Electrically, through these exclusive RUGGEDIZING techniques:

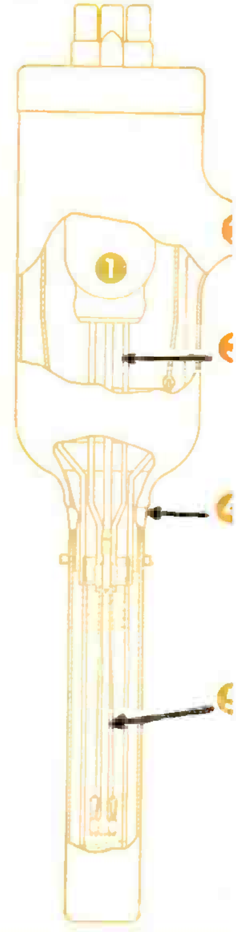


TYPE 6333

1. Rugged, powdered glass stem replaces stem press construction. Runs about 150° cooler, minimizing failure due to thermal shock. Glass matches coefficient of expansion to Kovar over wider temperature ranges minimizing mechanical stress failure.
2. Projecting grid arm eliminated and replaced with strong Kovar ring grid connection.
3. Strong conical internal grid support instead of three-legged riveted construction. This also provides much lower inductance.
4. Fragile copper "feather-edge" glass-to-anode seal replaced by a rugged Kovar seal.
5. New, stronger helical filament provides more uniform heat distribution over the anode surface.
6. 7/16 inch thick, high conductivity copper anode for heavy duty applications.



TYPE 6446



CONVENTIONAL TUBE STRUCTUR

CONDENSED TUBE CATALOG

. . . yours for the asking! Comprehensive, quick-reference guide on all Amperex tubes. Helps you find, in a moment, the tube or tubes that will fit your industrial and communication jobs.

Available At Your Local Parts Distributor

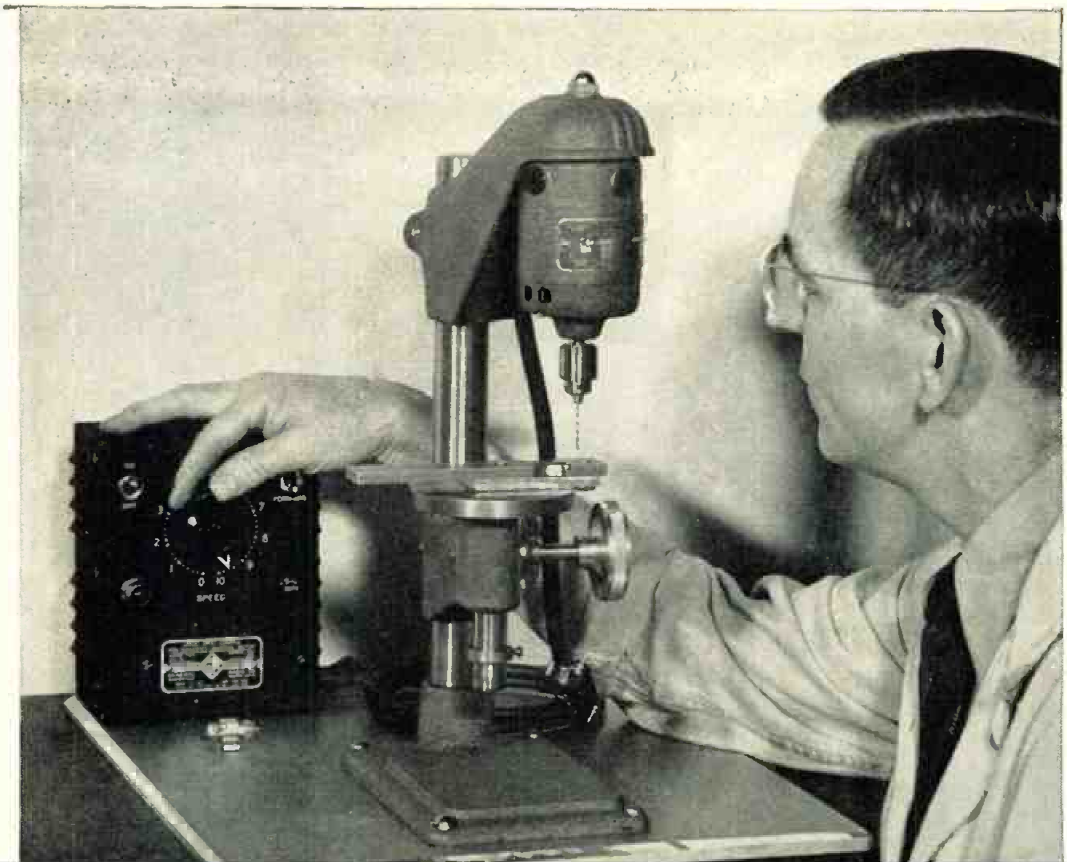
AMPEREX ELECTRONIC CORP.

230 Duffy Ave., Hicksville, Long Island, N. Y.

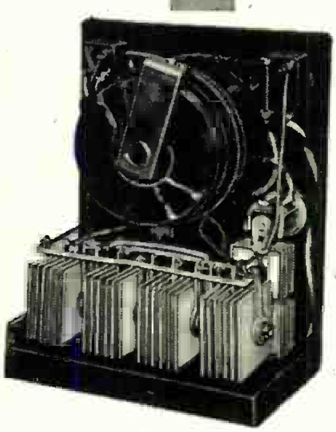
In Canada: Rogers Majestic Electronics Ltd.
11-19 Brentcliffe Road, Leaside (Toronto) 17

Original equipment for over seven years!

Radio Receptor Selenium Rectifiers



....*Deliver Top Performance in Variac Motor Speed Controls*

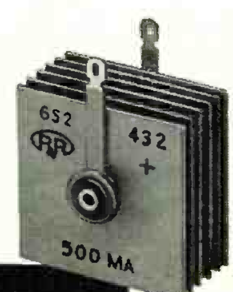


One of General Radio's Variac Motor Speed Controls showing a typical application of Radio Receptor Selenium Rectifiers. Six RRco. units are employed here.

Back in 1948, General Radio Co. of Cambridge, Mass. posed tough rectification problems to us involving their compact new Variac Motor Speed Controls. Working closely with their engineers then and since we have come up with the answers. As a result, Radio Receptor rectifiers have successfully been used in units rated at 1/15, 1/6 and 1/3 hp for field and armature supplies.

General Radio tells us that year after year *for seven years* the service record of these Radio Receptor rectifiers has proved they are worthy components of a fine product—that they are long lived and really reliable in constant use in many diversified applications.

You see, it pays to talk to Radio Receptor specialists when the circuit calls for rectifiers. We'll gladly offer practical suggestions concerning *your* problem, too. Write us now!



Really Reliable

Semiconductor Division

RADIO RECEPTOR COMPANY, INC.

In Radio and Electronics Since 1922

Sales Offices: 251 West 19th Street, New York 11, N. Y., WAtkins 4-3633 • Factories in Brooklyn, N. Y.

RADIO RECEPTOR PRODUCTS FOR INDUSTRY AND GOVERNMENT: SELENIUM RECTIFIERS • GERMANIUM AND SILICON DIODES THERMATRON DIELECTRIC HEATING GENERATORS AND PRESSES • COMMUNICATIONS, RADAR AND NAVIGATION EQUIPMENT

For product information, use inquiry card on last page.

PERFORMANCE-GUARANTEED

Tape Wound Cores

COST NO MORE - WHY TAKE LESS?

You save, because there can be no waste with the industry's only *Performance-Guaranteed* Tape Wound Cores. You also get the widest choice of standard sizes, and for a slight additional cost can specify your tape wound cores in the remarkable Aluminum Core Box* in any size. For complete details, why not write for your copy of Magnetics, Inc. Catalog TWC-100 today?

MAGNETICS inc.

MAGNETICS, INC., DEPT. TT-23, BUTLER, PA.

*patent pending

NOW! the new *Gray telop III*

Eliminates extra manpower requirements

opaque and transparency projector

REMOTE OR LOCAL CONTROL CHECK THESE NEW FEATURES

- Completely automatic . . . utilizing features contained in the now famous Telop and Telojector . . . Slides change by push button control.
- Sequence of up to 50 slides can be handled at one loading . . . additional pre-loaded slide holders easily inserted in unit.
- Remote control of lap dissolves . . . superposition of two slides . . . and slide changes.
- Shutter type dimming permits fades without variation of color temperature . . . opaque copy cooled by heat filters and adequate blowers . . . assembly movable on base which permits easy focus of image.

SCREEN OUT HIGH PRODUCTION COSTS FOR LOCAL SPONSORS

Telop III . . . interior view of automatic slide holder which accommodates 4" x 5" opaque slides . . . One lens . . . no registration problem . . . no keystoning.

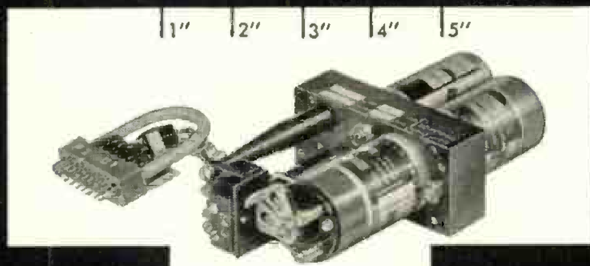
Telop III by the elimination of extra manpower assures the production and projection of low-cost commercials that local sponsors can afford. It can be used with any TV camera including the new Vidicon camera. Telop III projects on single optical axis opaque cards, photographs, art work, transparent 3¼" 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.

WRITE FOR: Illustrated bulletin describing Telop III specifications. Your request will receive prompt response.

GRAY RESEARCH

AND DEVELOPMENT CO., Inc., Hilliard St., Manchester, Conn.
Division of the GRAY MANUFACTURING COMPANY
Originators of the Gray Telephone Pay Station and the Gray Audograph and PhonAudograph.

Type 9 motor-driven induction generator driving two Type 11CT synchros through gear train having ratio of 1500:1. Slip clutch operates to permit one control transformer to be rotated when second control transformer has shaft restrained by stops. Cams close 2 switches during specified degrees of synchro rotation.



big control problem . . . small servo solution

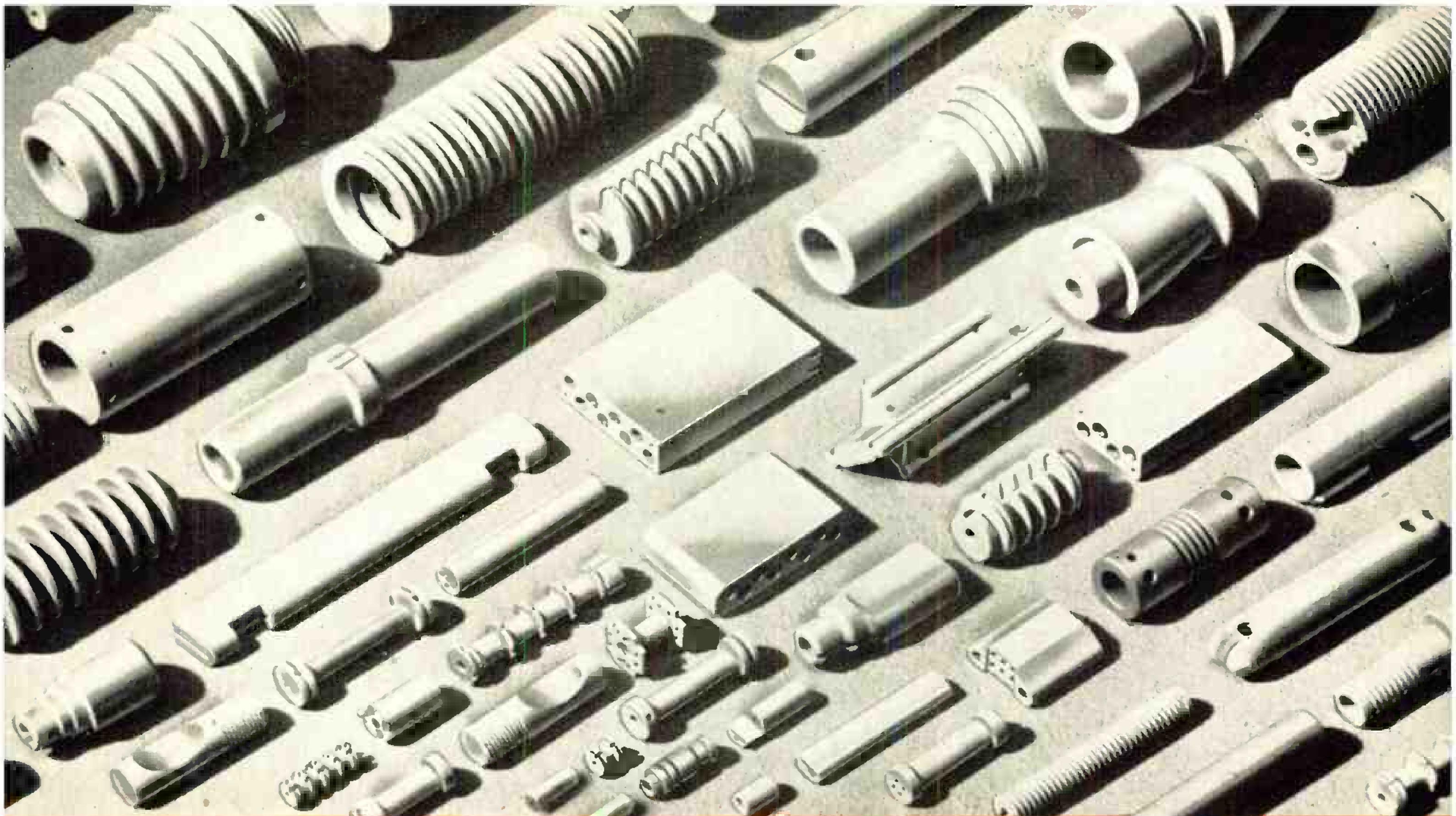
Despite its small size and extreme compactness, this Transicoil plug-in servo assembly always "does the job right". That's because it was especially designed for a single application . . . by a company whose major function is solving individual servo control problems with complete, precisely engineered and manufactured servo assemblies.

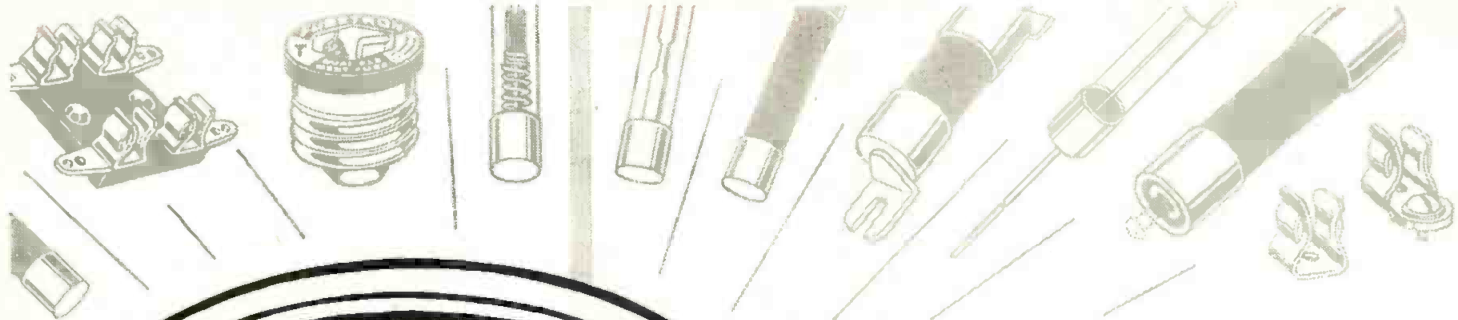
Of course, if you just want servo *components*, Transicoil can provide them to the highest order of precision and accuracy. But it is in the "package" engineering of unique assemblies that Transicoil's experience and creative imagination offer the greatest value. And in most cases, these assemblies cost no more than the individual components would purchased separately. Check your next servo problem with Transicoil first. You'll find it pays — in precision, in space, and in economy. Ask for the new availability guide for precision gear motors at the same time.

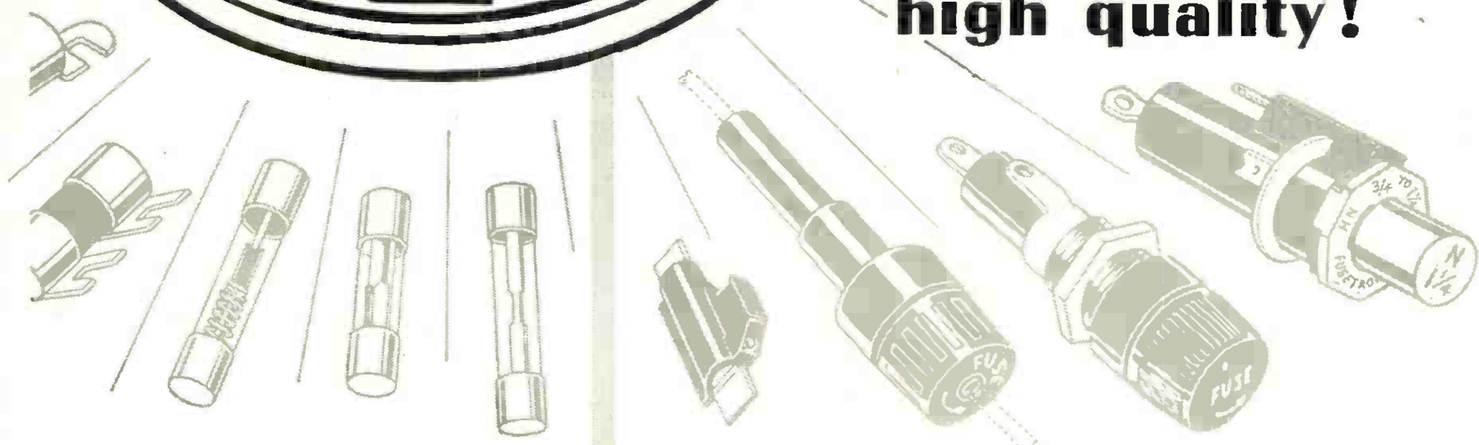
Transicoil

CORPORATION

Worcester • Montgomery County • Pennsylvania

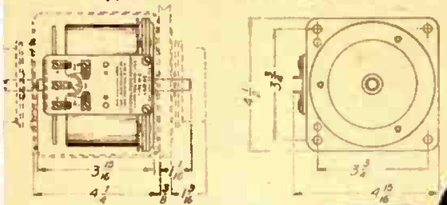






ANNOUNCING NEW W5 VARIACS®

Essential Dimensions
Types W5 and W5M VARIACS



- ★ Higher Rating
- ★ More Rugged Construction
- ★ U-L Approved
- ★ Industrial-Type Cased Models *Completely Enclosed*
- ★ Portable Model *with Overload Protection*

Basic Type W5 VARIAC . . . 6 amperes rated and 7.8 amperes maximum current (0.90 kva)

Type W5MT3 VARIAC . . 6 amperes maximum . . . 5 amperes rated current . . . light weight, provided with carrying handle, overload protection, line switch, convenience outlet, 3-wire grounding cord and plug (W5MT is identical except 2-wire line cord is used)

The new W5 Series VARIACS are another step in General Radio's continuing research and development program to assure users that the VARIAC will always be the best continuously-adjustable auto-transformer available anywhere in the world.

The new W5's have many improvements over the popular Type V-5, electrically and mechanically and in operating convenience.

INPUT Volts	KVA	OUTPUT Volts	Amperes Rated	Amperes Max.	Type	Price	Description
115	0.90	0-115 0-135	6.0 6.0	7.8 6.0	W5	$17.00	Uncased
115	0.75	0-115 0-135	5.0 5.0	6.5 5.0	W5M	21.50	see footnote A
115	0.69	0-115 0-135	5.0 5.0	6.0 5.0	W5MT	26.50	see footnote B
115	0.69	0-115 0-135	5.0 5.0	6.0 5.0	W5MT3	28.50	see footnote C
230*	0.60	0-230 0-270	2.0 2.0	2.6 2.0	W5H	19.00	Uncased
230*	0.60	0-230 0-270	2.0 2.0	2.6 2.0	W5HM	23.50	see footnote A
230*	0.55	0-230 0-270	2.0 2.0	2.4 2.0	W5HMT	28.50	see footnote B

*The 230-volt models can be used on 115-volt lines. When so used, the 0-270 volt output range is limited to a rated and a maximum current of 1 ampere.

A Completely enclosed with conduit knockouts
B Bench model with 2-wire line cord, line switch, outlet, overload breaker and carrying handle
C same as (B) except 3-wire grounding line cord and 3-terminal plug

Type W5M VARIAC, panel mounted . . . four screws in corners of square base

Klixon-type manually reset thermal overload breaker provides protection from prolonged overloads

Type W5M VARIAC . . . 6.5 amps maximum . . . 5.0 amps rated current . . . completely enclosed . . . for wall, bench, panel or behind-panel mounting . . . aluminum gray Hammertone finished cases with four conduit knockouts

Some Features Are:

Basic W5 model has 20% Increased Power Rating

Drawn Wrought-Aluminum Square Base, Designed for Excellent Heat Transfer . . . much more rugged . . . will withstand MIL-T-945A Shock and Vibration Tests

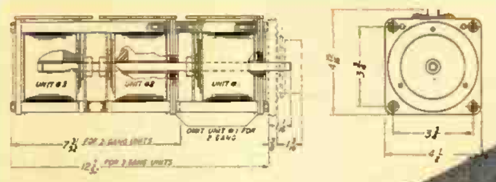
Improved Brush Radiator . . . setting of radiator and brush independent of position of shaft . . . disc-type radiator completely covers and protects Duratrak brush track

Enclosed single and ganged models in industrial-type rectangular cases . . . can be panel, behind panel, wall or table mounted . . . conduit knockouts conveniently located . . . all mounting hardware included

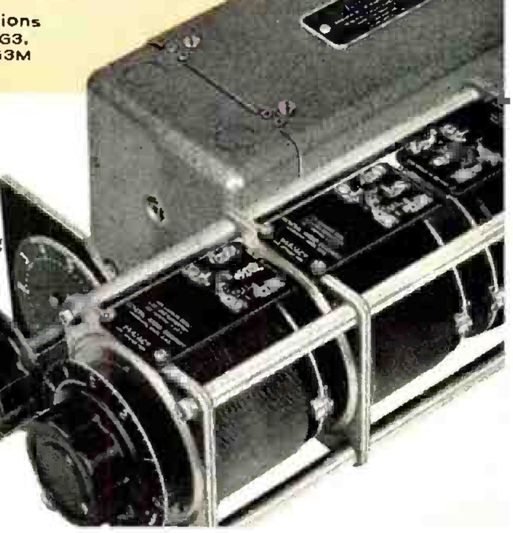
Same mounting holes as all V-5's plus additional mounting holes in each corner of square base for convenience and extra rigidity. In most cases can be substituted directly for V-5's.

Type W-5 VARIAC Assemblies

Type	Description	Price
W5G2	*2-Gang W5*	$41.00
W5G2M	*2-Gang W5 completely enclosed with conduit knockouts*	49.00
W5G3	*3-Gang W5*	61.00
W5G3M	*3-Gang W5 completely enclosed with conduit knockouts*	69.00
W5HG2	*2-Gang W5H*	45.00
W5HG2M	*2-Gang W5H completely enclosed with conduit knockouts*	53.00
W5HG3	*3-Gang W5H*	67.00
W5HG3M	*3-Gang W5H completely enclosed with conduit knockouts*	75.00



Essential Dimensions
Types W5G2, W5G3, W5G2M and W5G3M VARIACS



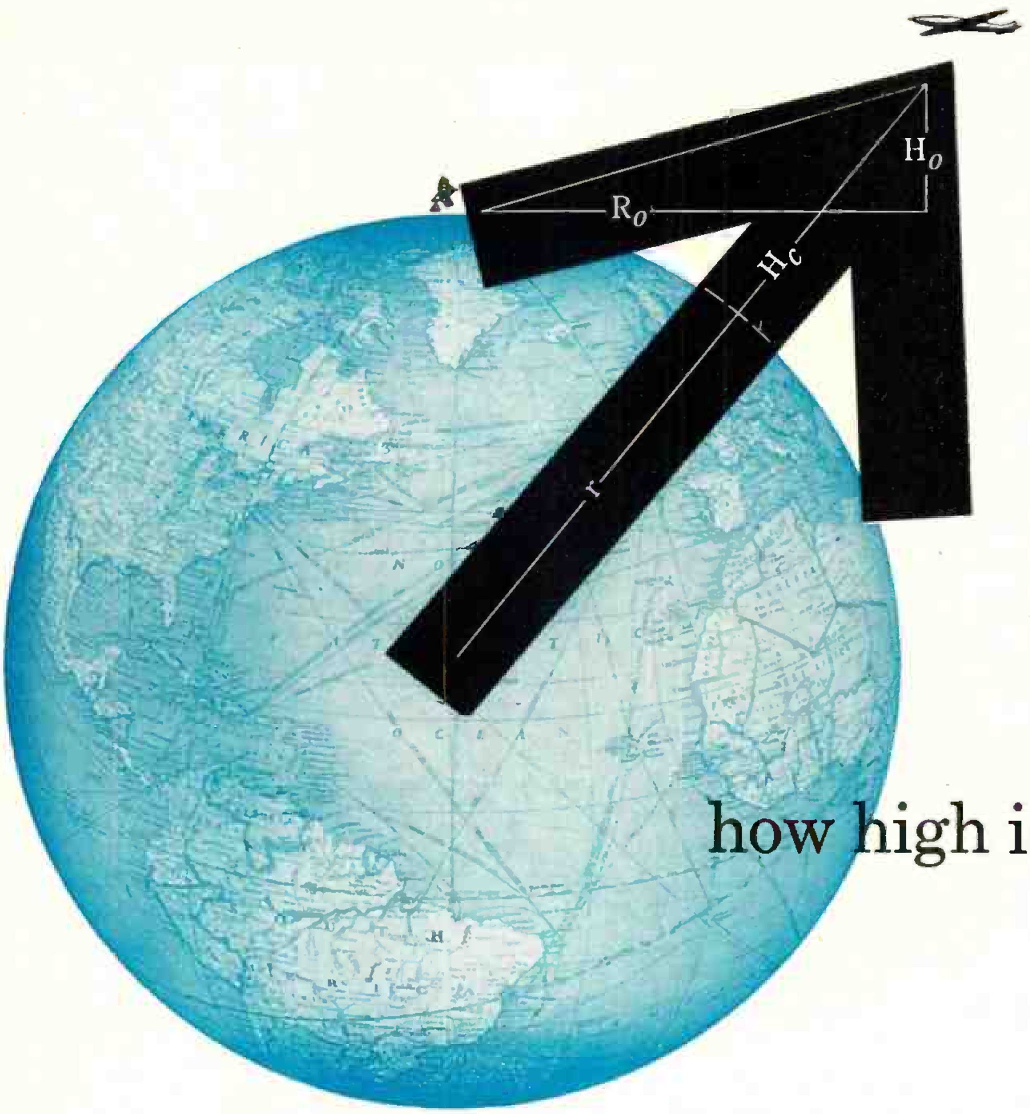
Three-gang cased models showing extra-heavy internal construction . . . can be panel mounted . . . 4 mounting brackets provided for table mounting or vertical wall use . . . 8 conveniently-located conduit knockouts

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Massachusetts

90 West Street NEW YORK 6
8055 13th St., Silver Spring, Md. WASHINGTON, D. C.
1150 York Road, Abington, Pa. PHILADELPHIA
920 S. Michigan Ave. CHICAGO 5
1000 N. Seward St. LOS ANGELES 38

We sell direct. Prices shown are NET, f.o.b. Cambridge or W. Concord, Mass.



how high is up?

A child's conundrum becomes a matter of life and death . . . when radar tells a lie. When our radar tracks attacking aircraft . . . or an incoming missile . . . the lives of all of us on target balance on the pinpoint of a mathematical riddle.

How high is up? It depends on the point-of-viewing.

Because of earth's curvature, radar sees an interloper . . . 100 miles away . . . 6600 feet lower than it really is. Readings must be corrected instantaneously before being fed to our interceptors . . . otherwise, attacker and defender play true or false at twice the speed of sound.

Electronic Engineering Company of California has designed an analog computer that makes this vital correction . . . converting radar observation into true altitude above sea level. The computer continuously solves the equation

$$H_c = H_o + (R_o^2/ 2r)$$

The mathematics are complex. The mechanism, with a two-gang HELIPOT* series A precision potentiometer at its heart, is beautifully simple. Both are fully described in a new application data sheet . . write for Data File 1204.

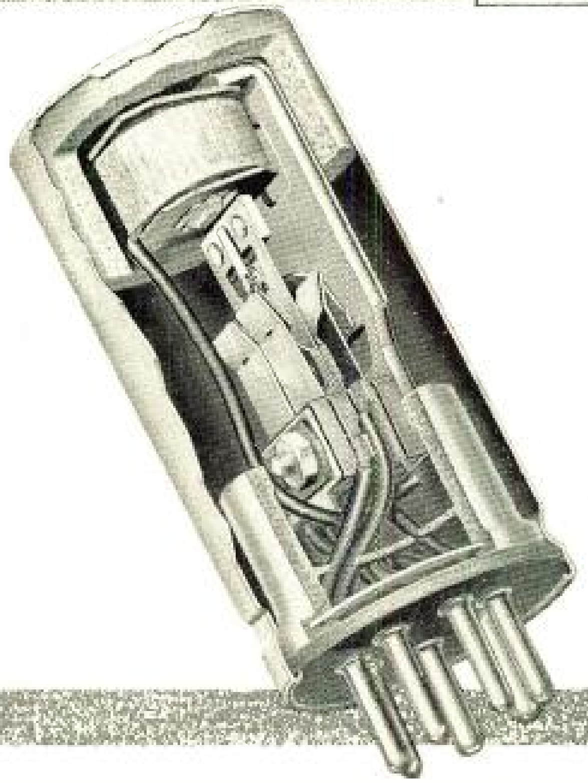
Helipot makes precision potentiometers . . . linear and non-linear . . . in the widest choice of sizes, mounting styles and resistances. Many models are stocked for immediate shipment . . . our engineers will gladly adapt standard models to your requirements . . . or design entirely new HELIPOT *precision potentiometers for you.*

Helipot *first in precision potentiometers*

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

403 *REG. U.S. PAT. OFF.

MALLORY



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

**Patent Applied For*

New Heavy Duty Mallory Vibrator

gives far longer life, constant output

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

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

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

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

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

Minimum Size for heavy duty ratings.

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

COMPLETE POWER SUPPLIES

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

Expect more . . . get more from

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

Serving Industry with These Products:

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

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

For product information, use inquiry card on last page.

ACE

SPECIALIZED SERVICE

..... keeps your Ace enclosure on the job!

Put it up . . . take it down . . . air condition it . . . make it larger—or smaller! Whatever the future demands of your Ace shielded enclosure, *you'll be prepared.* Years from now you'll still benefit from the same sound advice and counsel offered by Ace engineers in the original design of your enclosure. Why? Because Ace—and only Ace—*stands behind the service of your enclosure, as well as the performance.*

Little wonder, then, that laboratories, hospitals, manufacturers of every description, and the military prefer Ace. *It's the one enclosure you can buy today for tomorrow's needs.* Whether you're interested in an entirely new enclosure or modification of your present installation, you'll find it pays to call on Ace.

Detailed information on the complete line of Ace enclosures—featuring highest attentuation, full interchangeability*, inside bolting* . . . and exceeding the performance requirements of MIL-S-4957(ASG)—is given in Bulletin 10 available on letterhead request.

(*Patents Pending)

As an additional feature Ace can now supply shielded enclosures with micro-wave absorber to simulate free space—or can modify existing installations for microwave testing.

ACE ENGINEERING & MACHINE COMPANY

3644 North Lawrence Street • Philadelphia 40, Pennsylvania

TELE-TIPS

A KNOB IS A KNOB IS A KNOB—Sometimes, perhaps, but not in aircraft, says the Office of Technical Services. A large proportion of the errors in operating airplanes, they point out, are caused by confusing one control with another. They tested 31 differently shaped rotary control knobs to find those readily distinguishable by touch alone.

WHAT NEXT?—With Air Associates' new "Talking Beacon" air navigation aid the pilot is informed of his bearings at regular intervals by a soothing female voice.

USAF WEATHER SERVICE is making a plea for the return of radiosonde units. Hundreds of the units are released daily fastened to balloons which carry them up to 100,000 ft. heights to provide weather information. They are parachuted to earth when the balloons burst. The Air Weather Service HQ reports that despite mailing instructions on the container, less than 8% of those launched are returned.

TO CATCH BULLETS fired from the Army's rapid-fire machine guns Potter Instr. Co. designed an "Automatic Chronograph." The device uses two photoelectric detector screens to measure both the number of rounds fired and the individual velocities of each round.

AN ELECTRONIC GRAPHIC RECORDER that will log any changing variable within a quarter of a second has been developed by Minneapolis-Honeywell.

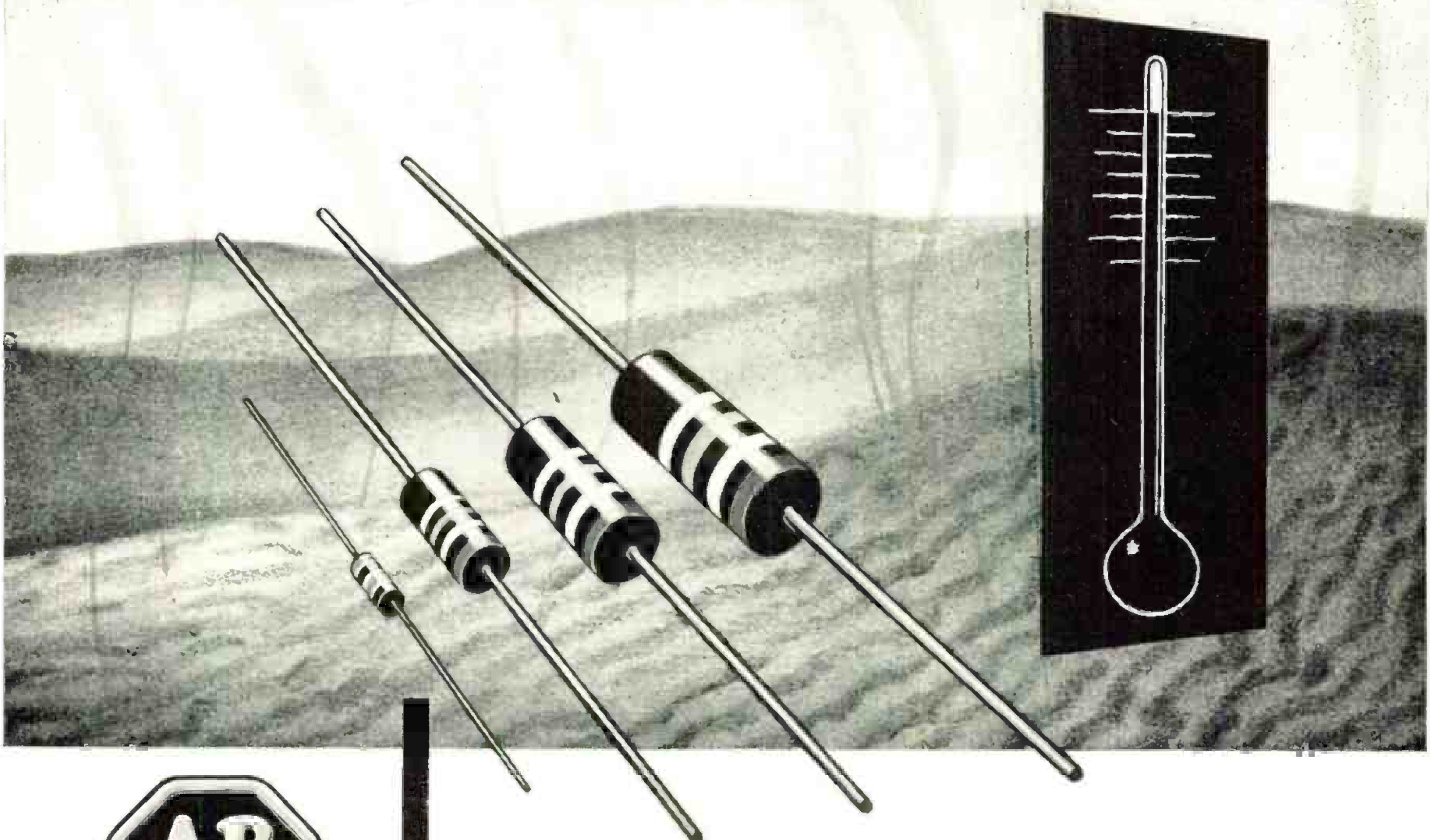
FOR INFORMATION—ONLY. Cunningham & Walsh ad agency reports that afternoon TV viewing by women is increasing rapidly. It is now up to 27%—almost triple the 10% reported in 1951.

THE "WORDWRITER," an experimental device by IBM, can print at the touch of a single key button, any one of forty-two 18 character words or phrases, at a rate of more than 150 words a minute. Key to its operation is the associated "memory" unit in which the typist stores commonly used phrases.

(*Continued on page 48*)

for that

EXTRA MARGIN OF SAFETY



RATED AT 70C AMBIENT... NOT 40C

Allen-Bradley molded composition fixed resistors are so widely recognized for their quality because they can withstand extremes of temperature, pressure, and humidity without deterioration. They are rated to operate continuously at 70C ambient temperature . . . not 40C, as are other resistors.

These reliable, uniform resistors are solid molded. They require no impregnation to pass salt-water immersion tests. For an application where the resistor *must not fail,* use Allen-Bradley. Of course, they are also "the best" for all uses and—they cost no more than ordinary resistors.

Allen-Bradley resistors are made in standard RETMA values, in 1/10, 1/2, 1, and 2-watt ratings from 10 ohms to 22 megohms. Write Allen-Bradley Co., 1342 S. Second St., Milwaukee 4, Wis. In Canada—Allen-Bradley Canada Ltd., Galt, Ont.

Allen-Bradley resistors are packed in patented cartons to prevent the lead wires from becoming bent and tangled.

These Allen-Bradley molded resistors can also be furnished in reels for use in automatic assembly lines.

ALLEN-BRADLEY

FIXED & ADJUSTABLE RADIO RESISTORS

QUALITY

For product information, use inquiry card on last page.

TELE-TIPS

(Continued from page 46)

HOW LOUD IS A JET?—Altec Lansing's John Hilliard reports that 5,000,000 people shouting in unison cannot exceed the roar of one jet engine.

EXECUTIVE MOODS TO ORDER. The "New Look" in executive offices uses adjustable lighting to provide the proper atmosphere—from relaxation to dynamic action.

PLUG-IN MINIATURE RELAY designed for use in printed circuits is being introduced by Automatic Electric Co. Internal loss in conductivity is prevented by having plug-in terminals made integral part of the coil terminals and contact springs.

JUMBO—The new 25 billion electron volt proton synchrotron under construction at Brookhaven National Labs. will have a diameter of 842 ft., and a circumference of half a mile.

BIG FAMILY — Production Resources Agency of the Dept. of Defense estimates that there are in the U.S. 3600 manufacturers of electronic end equipment, components and hardware. The four major centers of electronics production are the N.Y.-Phila. area, the Mid-West, with Chicago as the hub, Southern Calif. and New England, extending out from Boston.

"ELECTRONIC RED FLAG"— that will make small boats highly conspicuous to radar-equipped ships is being marketed by Raytheon. It is a simple folding device of sheet aluminum that can be raised on the mast, or even held aloft on an oar.

ALL COLORS OF THE RAINBOW are now available to aluminum fabricators reports Alcoa. The new color finishes are actually part of the metal itself, a diamond-hard oxide coating that is integral with the metal.

BENDIX-PACIFIC SPECIALIZES IN AIRBORNE RADAR

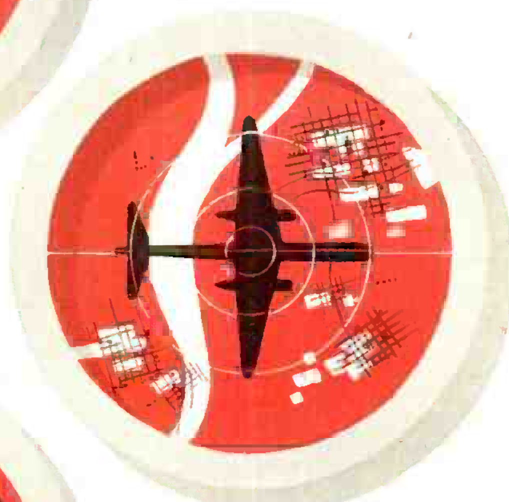
WHICH IS YOUR RADAR REQUIREMENT?

TERRAIN CLEARANCE RADAR

NAVIGATIONAL RADAR

TAIL-WARNING RADAR

MISSILE GUIDANCE



MAPPING RADAR

RADAR BEACONS

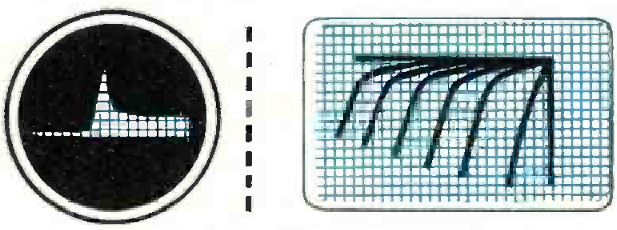
Bendix-Pacific specializes in airborne radar, having design experience and manufacturing ability to develop and produce radar systems to meet your requirements.

Let us send a qualified radar systems engineer to visit you at your convenience.

Bendix
PACIFIC DIVISION
Bendix Aviation Corporation
NORTH HOLLYWOOD, CALIF.

EAST COAST OFFICE: 475 5th AVE., N.Y. 17 • **DAYTON, OHIO**–1207 AMERICAN BLDG., DAYTON 2, OHIO • **WASHINGTON, D.C.**–SUITE 803, 1701 "K" ST., N.W.
CANADIAN DISTRIBUTORS: AVIATION ELECTRIC, LTD., MONTREAL 9 • **EXPORT DIVISION**: BENDIX INTERNATIONAL, 205 E. 42nd ST., NEW YORK 17

For product information, use inquiry card on last page.



Letters . . .

Frequency Standard

Editors, Tele-Tech:

H. S. Knaack, in his interesting article entitled, "Secondary Frequency Standard," in the July 1955 issue of Tele-Tech, suggests that the "sliding" harmonic feature "is not present in any instrument known to the author."

I should like to point out that a sliding harmonic interpolation feature has been included as standard equipment in the Servo Corp. of America Model 1232B Secondary Frequency Standard for many years. This feature is provided by means of a dial calibrated directly in parts/million. The general idea of sliding harmonic interpolation was suggested to us by the writings of J. K. Clapp, of the General Radio Company.

Paul G. Hansel

Servo Corp. of America,
New Hyde Park, N. Y.

"Squelching Commercials"

Editors, Tele-Tech:

I read with interest your editorial "Squelching Commercials" in the October issue of *Tele-Tech*. You said "Better we should make commercials that people don't want to turn off and be more considerate in their application during program time."

No doubt you have hit the nail on the head. A fair-minded public assumes that a sponsor is expected to tell them who is paying for the program and what he is trying to sell. On the other hand, it seems like the very height of stupidity to permit commercials to be given in an hysterical tone of voice, or with artificially sweetened tones, and with the sound volume increased. The masterful pauses that are so disgusting, and singing commercials, are equally objectionable.

Wouldn't it be great if some station or chain had the guts to give commercials only in a natural tone of voice and eliminate the practices that make people want commercial squelchers? Perhaps, because you have the means to be heard, you could carry on a successful campaign of rectifying this situation. How about giving it a whirl?

George D. O'Neill

13-37 212 Street,
Bayside, N. Y.

Editors, Tele-Tech:

Your editoral on Squelching Commercials may not turn out to be as serious as you think.

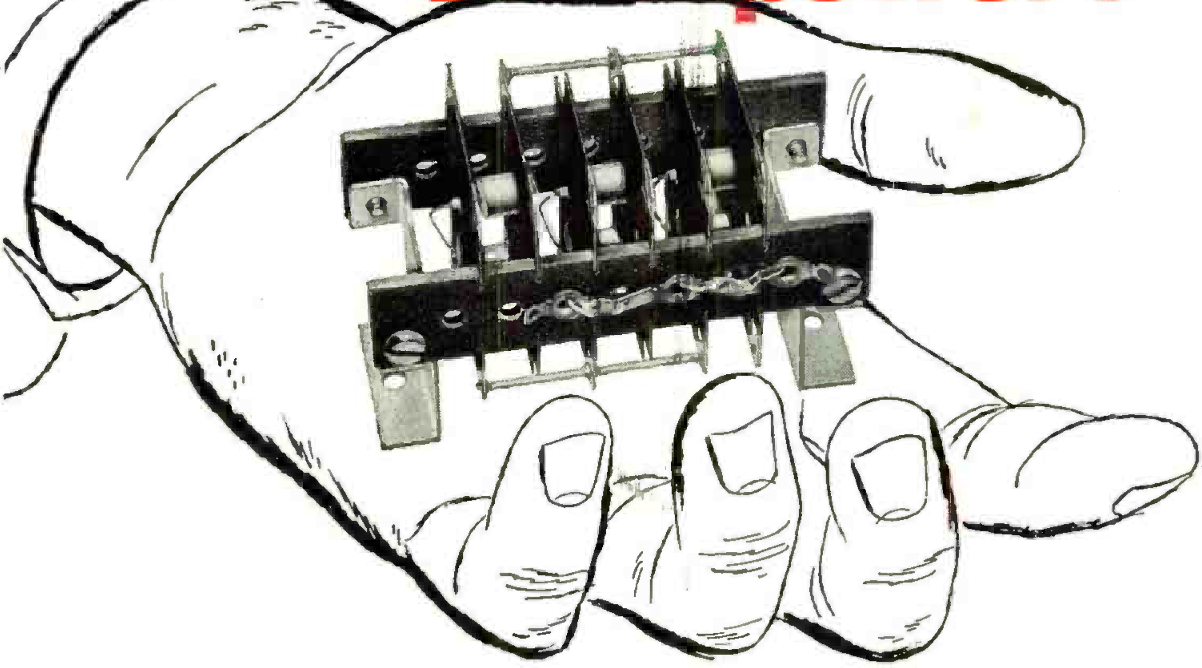
After all, Americans are noted for being sports and if a viewer has to shoot a commercial it may bother his conscience enough to remember the product and buy it.

A. Schmidt

8134 Charmaine Road
Chicago 31, Ill.
(Norwood Park Township)

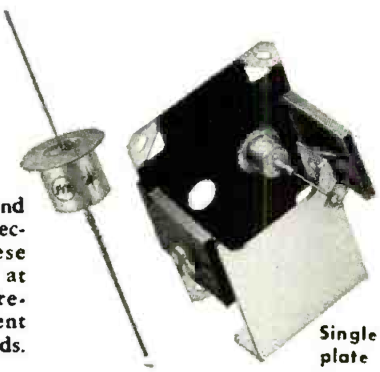
Federal's new germanium rectifier stacks—

a mighty handful of DC power!



Smallest, lightest, most rigid... rated up to 565 volts DC and up to 6 amps...1 to 12 fins

(Over 100 standardized combinations)



The 1N91, 1N92, and 1N93 germanium rectifiers used in these new stacks assure at least 20% lower reverse leakage current than RETMA standards.

Single plate

Once in a while a new design is so good that it sets entirely new standards for an electronic component. The *new* Federal germanium stacks are like that. Here are seven of their most important advantages over existing types . . . advantages that mean a *better* rectifier for *your* equipment:

- **SPACE-SAVING**—The stacks average one-third shorter in length.
- **LIGHTWEIGHT**—Light, strong plastic side strips are used instead of heavy axial assembly bolts and insulators.
- **RIGID CONSTRUCTION**—Interlocking of fins and strips builds a "tight" structure unaffected by vibration.
- **BETTER HEAT DISSIPATION**—Full area of the fin is available for cooling.
- **TERMINAL LUGS ELIMINATED**—Terminals are stamped out as part of the fin corners, so that wires may be soldered directly to the fin.
- **NO PROTRUDING BUS BARS**—Corners of fins are clipped out for passage of bus bars connecting non-adjacent plates.
- **FULLY INTERCHANGEABLE**—Electrically and mechanically interchangeable with types now on the market.

For detailed information, ask for "Federal Germanium Power Stacks" booklet. Phone NUtley 2-3600 or write to Dept. F-266.

Federal

FEDERAL TELEPHONE & RADIO FTR

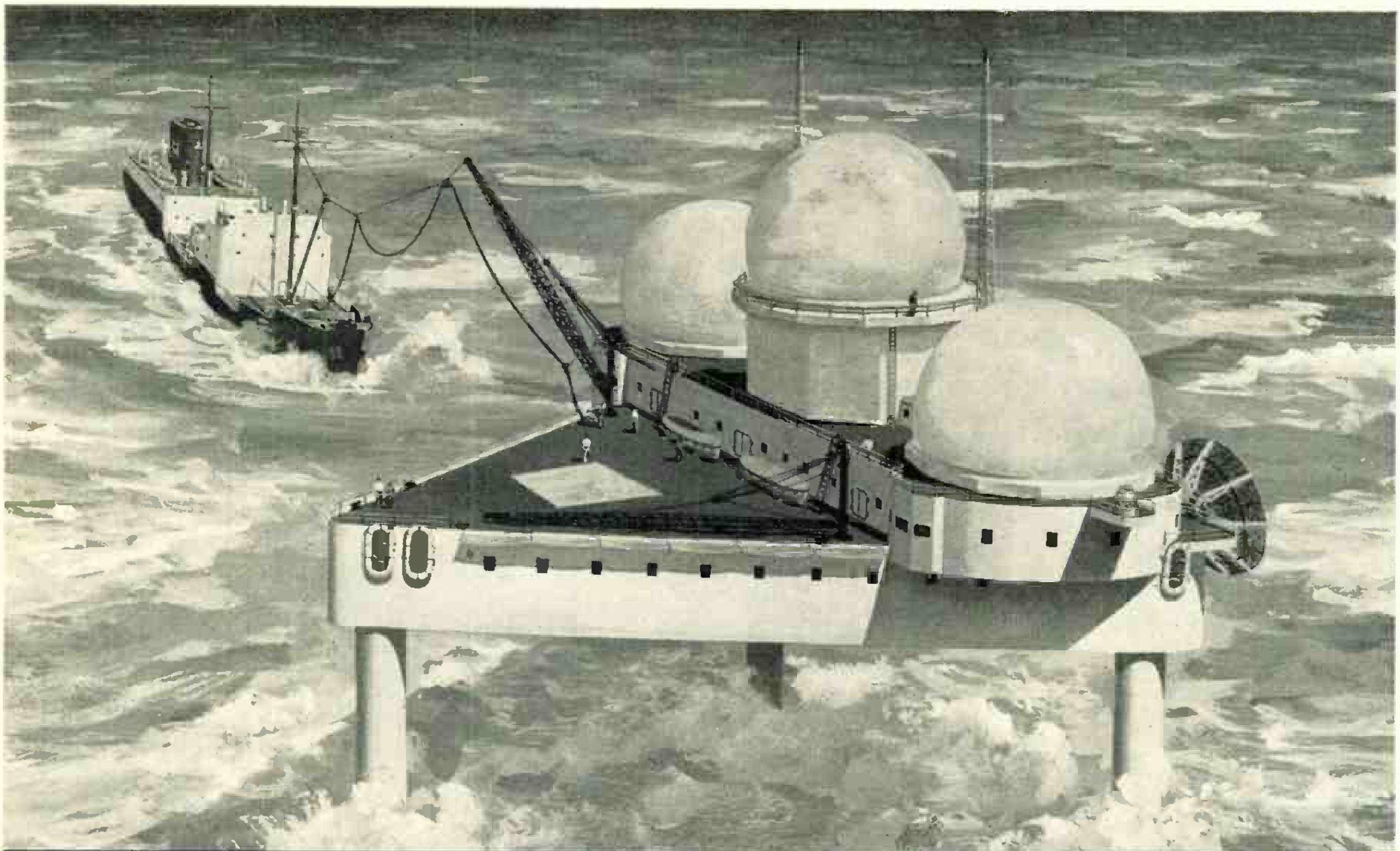
A DIVISION OF IT&T

Federal Telephone and Radio Company

A Division of INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

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

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



EIMAC KLYSTRONS are used in Texas Towers forward-scatter communications system

National Company two, ten and fifty kilowatt transmitters employing Eimac klystrons and circuit components are among the pace-setters in the revolutionary art of forward-scatter propagation.

High power UHF/microwave forward-scatter transmitters by National Company are an example of reliable National equipment designed to meet the most exacting requirements. From the first National Company forward-scatter development link to the advanced Texas Tower communication net, Eimac klystrons have been used exclusively as high power final amplifier tubes. Eimac amplifier klystrons provide the power necessary to make long distance communication through forward-scatter techniques practical at microwave frequencies.

Second in a series of advertisements emphasizing the extensive application of Eimac amplifier klystrons and circuit components by the leading manufacturers of forward-scatter UHF/microwave transmitters.

Eimac — THE POWER FOR FORWARD-SCATTER

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

NOW
...GERMANIUM
FUSED
JUNCTION

- MEDIUM POWER
- LOW NOISE FIGURE
- HIGH GAIN
- AXIAL LEADS
- MINIMUM ALPHA-CROWDING EFFECT AT HIGH CURRENTS
- CLIP-IN STYLE PACKAGE
- HERMETIC SEAL

NPN TRANSISTORS *BY* HUGHES

These devices offer excellent performance characteristics, even up to higher power ratings, together with high gain and low noise figures. The new package is designed to dissipate more heat. This makes it possible to maintain the high performance characteristics.

The low alpha-crowding effect makes the new Hughes transistors particularly adaptable to high current medium power amplifiers, in addition to: Computers...Switching ...Audio Amplifiers...I-F Amplifiers ...Oscillators. For all types, maximum collector current is 100 milliamperes, and collector dissipation is 500 milliwatts. Under certain conditions, or when used with clips or with suitable heat sinks, these ratings can be increased substantially. Detailed specifications for each type are available in pertinent data sheets.

ACTUAL SIZE (photo, transistors in hand).
New Hughes Fused Junction NPN Germanium Transistor, available in (A) Three leads, to fit conventional transistor socket mountings; (B) Clip-in style package.

RATINGS AT 25°C

Type	Alpha		Maximum Collector-to-Base Voltage (V_C)	Collector Cut-Off Current (I_{CO})	Alpha Cut-Off Freq (α cogb)	Rise Time	Noise Figure
	Min.	Max.					
HA5001	0.975	1.0	30V	5µA	2.5	2.5 µsecs	....
HA5002	0.950	0.965	15V	12µA	1.0	....	15.0 db
HA5003	0.975	0.99	20V	10µA	1.5	....	15.0 db

HUGHES
SEMICONDUCTOR DIVISION
Aircraft Company, Culver City, California
New York Chicago Los Angeles

For product information, use inquiry card on last page.

The election of **William P. Maginnis** as President of Kuthe Laboratories, Inc., Newark, N.J., subsidiary of International Telephone and Telegraph Corp., has been announced.

The appointment of **Frederick D. Ogilby** as Vice President—Marketing of Philco Corporation has been announced.

James H. Foster has been appointed General Manager of the Electro-Mechanical Div. of the Erie Resistor Corporation, Erie, Pa.

In his new position as Director of Sales, **George D. Butler** will be responsible for coordinating and heading up all Norden-Ketay Corporation of New York sales.

Robert D. Elbourn has been appointed Chief of the Components and Techniques Section of the National Bureau of Standards.

Herbert W. Cole has been appointed industrial and military tube specialist in the General Electric Tube Dept. regional headquarters at Schenectady, N.Y.

H. D. Kennedy has been appointed Personnel Director of Triad Transformer Corp., Venice, Calif.

Arnold A. Zachow has been appointed vice pres. in charge of operations of El-Tronics, Inc., Phila., Pa.

Robert B. Sampson has been appointed Manager, Market Research, RCA Tube Division, Harrison, N.J.

Dr. W. R. G. Baker has been reappointed chairman of the Special Committee on Spurious Radiation by the Radio-Electronics-Television Manufacturers Association.

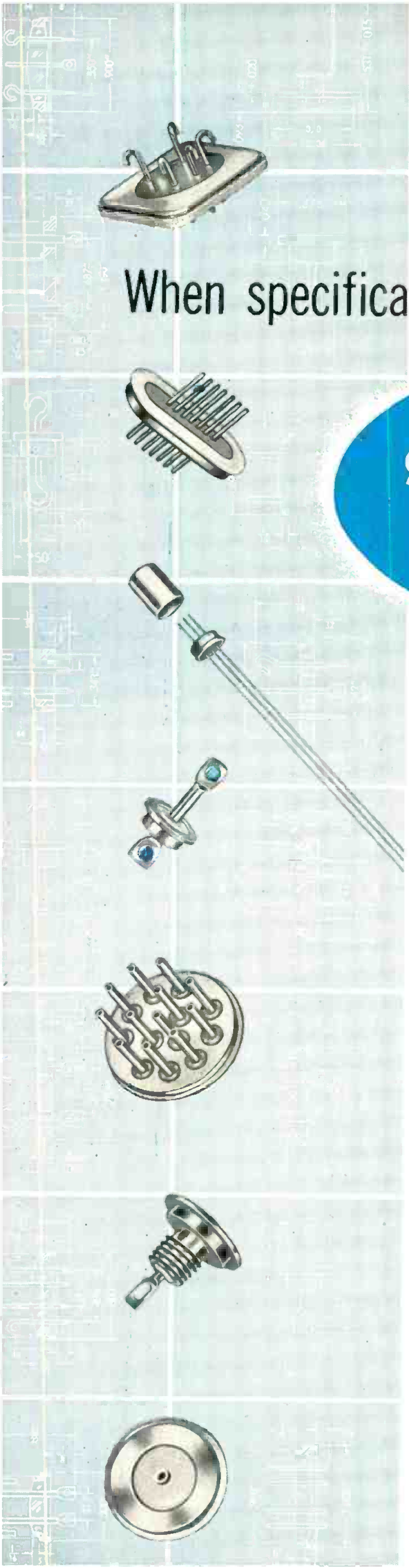
The appointment of **Herbert F. Berg** as Production Control Manager of the Technical Products Div. of Allen B. Du Mont Laboratories, Inc., has been announced.

Robert O. Vaughan has been appointed Vice President of National Aircraft Corp., 3411 Tulare Ave., Burbank, Calif.

Anthony A. Timineri has been appointed Engineering and Sales Representative for the Wac Engineering Co. of Dayton, Ohio.

Dr. Ralph L. Power has been named Editor Emeritus of the Hoffman Transmitter, house organ of Hoffman Electronics Corp., Los Angeles, Calif.

Edward J. Felesina has been named public relations mgr. of Federal Telecommunication Laboratories, Nutley, N. J.



When specifications call for—

glass-to-metal seals*

E-I offers—

9 MAJOR DESIGN ADVANTAGES

❶ CUSHIONED GLASS CONSTRUCTION ❷ DESIGN STANDARDIZATION ❸ HIGH DIELECTRIC STRENGTH ❹ VACUUM TIGHT SEALING ❺ MINIATURIZATION ❻ SUPER DURABILITY ❼ VIBRATION RESISTANCE ❽ MAXIMUM RIGIDITY ❾ ECONOMY AND PROMPT DELIVERY

Check your requirements with sealed terminal specialists! Electrical Industries *specializes* in the design and manufacture of sealed terminations for all types of electronic and electrical components. Both standard and custom terminals can be supplied quickly to meet every design specification and the severest environmental condition. In most cases, specifications can be met with standard types that offer maximum economy and fast delivery!

Consult E-I First

– for Compression Seals, Multiple Headers, Sealed Terminals, Condenser End Seals, Threaded Seals, Transistor Closures, Miniature Closures and Color Coded Terminals – one dependable source for all hermetically sealed terminal requirements!

ELECTRICAL INDUSTRIES

DIVISION OF AMPEREX ELECTRONIC CORPORATION

44 SUMMER AVENUE, NEWARK 4, NEW JERSEY

*PATENT PENDING – ALL RIGHTS RESERVED

NEW—

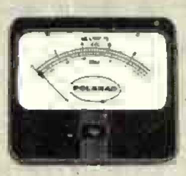
MICRO POWER METER

DC to 11,000 mc

MODEL P-2

- simplified operation
- only one probe
- linear and dbm scale
- self-calibrating

Direct Reading Scale

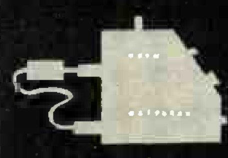


Reads from DC to 11,000 mc with three power ranges: Full scale readings: 1 mw (0 dbm), 10 mw (+10 dbm), and 100 mw (+20 dbm)

Single Broadband Probe

Used for entire frequency range DC to 11,000 mc. Can withstand 150 percent overload without damage or burnout.

Self Calibrating



DC calibrating circuit provided to recalibrate or check meter operation without additional external equipment.

Over the entire frequency range DC to 11,000 mc, Polarad's Micro Power Meter utilizes only one power probe, supplied as an integral part of the instrument. This unique power probe will sustain severe overloads without burnout since it does not contain hot wire barretters or other delicate components.

This new rugged and stable Instrument reduces microwave power readings to the simplicity of everyday low frequency measurements. It is a true rms milliwatt indicating meter accurately measuring CW and pulse power, in milliwatts and dbm. Insensitive to line voltage changes.

Because of its wide band coverage, the Polarad Model P-2 is outstanding as a general lab and field instrument, available for power measurements at all commonly used frequencies. The P-2 can be completely calibrated from its own self-contained regulated DC source.

SPECIFICATIONS

- Single power probe for all frequencies.
- 150% overload without burnout.
- Direct reading.
- Broadband Coverage....DC to 11,000 mc continuous in single mount.
- Multi-Power Range......0-1 mw, 0-10 mw, 0-100 mw; 0 dbm, +10 dbm, +20 dbm.
- Impedance ....50 ohms coaxial.
- VSWR ....Less than 1.4:1 from 0 to 5000 mc. Less than 2:1 from 5000 to 11,000 mc.
- Accuracy ....± 1.0 db.
- Connector ....Type N plug.
- Input Power Required..115v ± 10%, 60 cps.
- Dimensions ....10" x 8" x 8".
- Weight ....14 lbs.

Price: $360

AVAILABLE ON EQUIPMENT LEASE PLAN

FIELD MAINTENANCE SERVICE AVAILABLE THROUGHOUT THE COUNTRY

POLARAD PROVEN RELIABILITY

ELECTRONICS CORPORATION 43-20 34th STREET, LONG ISLAND CITY 1, N. Y.

REPRESENTATIVES • Albuquerque • Atlanta • Baltimore • Boston • Buffalo • Chicago • Dayton • Englewood • Fort Worth • Los Angeles • New York Philadelphia • San Francisco • Syracuse • Washington, D. C. • Westbury • Winston-Salem • Canada, Arnprior, Toronto—Export: Rocke International Corporation

TOP-RATING PICTURE QUALITY CALLS FOR G-E *Broadcast-Designed* CAMERA TUBES!

They help you...in 3 ways...to put finer TV on the air all the time!

1. CLEAR, SHARP IMAGE RESOLUTION. Electron-gun spacings of G-E image orthicons are the most closely controlled in the industry! They give the needle-sharp, cleanly defined beam essential for picture crispness and clarity.

2. UNIFORM, ACCURATE IMAGE REPRODUCTION. Reasons: G-E camera-tube face plates are meticulously pre-cleaned . . . photo-cathode evaporators are precision-placed so as to deposit the light-sensitive film evenly and uniformly on the face plate . . . G-E final inspection methods hold to extremely narrow limits any variations in sensitivity over the scanned area.

3. FULL-MEASURE TUBE LIFE, WITH EFFICIENT PERFORMANCE THROUGHOUT. G.E. is engaged in constant research to (1) further prolong image-orthicon life, (2) extend high-level performance to encompass the whole active life of the tube. With special attention to the image-orthicon target—characteristics of which largely determine tube life—the scope of G-E research and engineering development includes both improved target design and better manufacturing techniques.

* * *

IN ADDITION to these important quality plusses, G-E Broadcast-Designed GL-5820's come to you *safety-packaged*—in square, transparent containers that won't roll off shelves, that show you the tube properly placed inside, that carefully cushion the tube both top and bottom against shocks in handling. A plastic bag covers the face of the tube—prevents scratching. And G-E camera tubes are factory-sealed at the base . . . if the seal's unbroken, you know you're getting a *new* tube!

Phone your G-E tube distributor . . . today! *Tube Department, General Electric Co., Schenectady 5, N.Y.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

161-1C3

BOOKS

Electronic Motion Pictures

By Albert Abramson. Published Nov. 1955 by University of California Press, Berkeley, Cal. 212 pages, price $5.00.

This work was written to fill a need for a compilation of widely scattered material available on the electronic motion picture. Producing a visible image, the electronic television camera is readily adaptable for the production of motion pictures. Beginning with the contributions to early television of the film camera, this book analyzes the development of the television camera. Emphasis is placed on work being done to perfect the electronic camera and the recording process. Limitations of the mechanical camera's performance is explained, as is the difference between the mechanical motion picture camera and electronic camera. Electronic motion pictures and the associated problems involved are covered in detail. A complete list of references is included for those who may wish to check the original source material.

Review of Current Research & Directory of Member Institutions

Edited by Renato Contini, Secretary. Published 1955 by Engineering College Research Council of the American Society for Engineering Education, New York University, University Heights, New York 53, N.Y. 352 pages, price $2.00.

This work, picturing the dynamic research program in our colleges, should be particularly valuable to sponsors wishing to evaluate the work of institutions where they may wish to place their research. 105 institutions, including all major engineering schools in the United States, with approximately 7500 research projects, engaging over 15,000 faculty members, graduate students, and research engineers, and with expenditures of over $75 million are covered. The index lists approximately 5,000 current research project titles. Other information included in the book is: names of responsible administrative officers, policies which govern research projects and contracts, personnel engaged in research activities, annual expenditures for research projects, sources of income for research, and special conferences and short courses of interest to research workers.

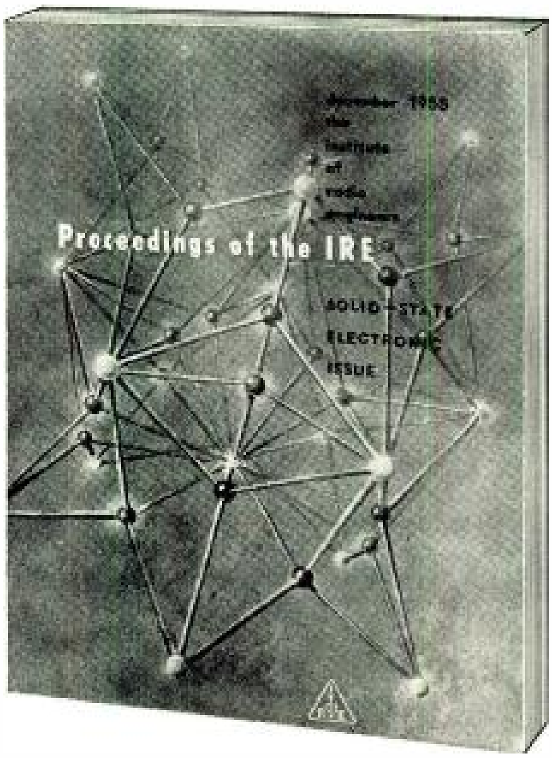
Transistor Electronics

By Lo, Endres, Zawels, Waldhauer, & Cheng of RCA Laboratories. Published by Prentice-Hall, Inc., 70 Fifth Ave., New York, N.Y. 521 pages, price $12.00.

This book is written for students in electrical engineering and associated fields, and as a reference work for the electronics engineer. It is the combined work of five authorities in the field of electronics who are presenting, for the first time, some of the results of their

(Continued on page 60)

What is "solid state electronics"?



You have already received great services from "Solid State Electronics"... but much more is coming your way!

This side of radio science is both old and new. It started with the galena detector which gave you signals you could hear. In phosphers that glow in response to electronic bombardment, it gave you, first, a picture tube—and now, full color television.

Ferrites that store and repeat electronic signals—the memory elements of the computer—are the next stage in this radio engineering. Tomorrow, "steareatronics" (as Cornelius Ryan calls it in Collier's) will provide silicones and other solid state materials which will store heat and power from the sun to serve you.

A working summary of this science is offered to you in the December issue of "Proceedings of the IRE"—from background data to the newest research. This one issue, some 300 pages, is the word count equivalent of a 600-page text book . . . useful, up-to-the minute. It is a history-making issue you will treasure for years.

Price to non-members . . . **$3.00**

(All IRE members will receive this December issue as usual. Extra copies to members, $1.50 each.)

Every Article Is a "Treasure" in this History-Making Issue

"Lead Article," by Dr. Frank Herman, RCA Laboratories, Inc.

"Field of Ferrites," a paper covering the history of the development of ferrites, by Dr. E. W. Gorter, The Philips Co.

"Ferrite Developments," by Dr. Paul N. Russell

"Historical background and current state of the art in dielectric materials," by Dr. E. T. Jaynas, Stanford University

"Future trends and unsolved problems in dielectric materials," by Dr. Gen Shirane, Pennsylvania State University

"History of Semiconductor Research," by G. L. Pearson and W. H. Brattain, Bell Telephone Laboratories, Inc.

"Germanium and Silicon," by G. A. Morton and M. L. Schultz, RCA Laboratories, Inc.

"Conductivity, Hall effect and optical absorption of intermetallic compounds," by Dr. H. P. R. Prederikse, National Bureau of Standards

"Photoconductivity in some of the sulfides and selenides," by Dr. Richard H. Bube, RCA Laboratories, Inc.

"Performance of Photoconductors," by Dr. Albert Rose, RCA Laboratories, Inc.

"Lead Salts or Infra-red Photoconductors," by T. S. Moss

"Design & Performance in a Storage Light Amplifier," by Rosenthal Jennie, Allen B. Dumont Labs.

"An Electroluminescent Light, Amphtyme Picture Panel," by B. Kazan and F. H. Nicoll, RCA Laboratories, Inc.

"Cathodoluminescence," by Dr. G. F. J. Garlick, University of Birmingham

"Electroluminescence," by Prof. Georges Destriau and Dr. Henry F. Ivey, Faculte des Sciences de Paris

"Physical Chemistry of Phosphors," by Dr. F. A. Kroger, The Philips Co.

®

The Institute of Radio Engineers

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PROCEEDINGS OF THE IRE
1 East 79th Street, New York 22, N. Y.

☐ Enclosed is $3.00

☐ Enclosed is company purchase order for the December, 1955 issue on "Solid State Electronics"

Send to:

Name ____________

Company ____________

Address ____________

City & State ____________

For product information, use inquiry card on last page.

BOOKS

(*Continued from page 58*)

original research. Emphasis is placed on a basic understanding of the circuit aspects of the transistor, and, description and analysis of circuits are directed to the principles governing operation of these circuits. The sections on circuit design should provide an effective guide for the design engineer, covering many fields from amplifiers to digital computers. Chapter 1 deals with fundamental transistor physics, Chapters 2 and 3 with operating characteristics. Stabilization of the dc operating point is described in chapter 4. Chapters 5 and 6 treat low frequency amplifiers, and Chapters 7, 8, and 9 discuss transistor high frequency operation. Chapters 10, 11, and 12 deal with non-linear operation, such as oscillators, modulation and demodulation, and pulse circuits. This book supplies all the information required for understanding transistor circuit operation.

Books Received

Quantum Mechanics

By Leonard I. Schiff. Second Edition. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., N.Y. 36, N.Y. 208 pages. Price $6.50.

Government Publications

Liquid Metal Heat Transfer Fluid Problem No. S26

Final Report: American Smelting and Refining Co. for Office of Naval Research—July 1950. 14 pages with bibliography. (Order PB 111662 from OTS, U.S. Dept. of Commerce, Wash. 25, D.C., price 50¢.)

Electro-Plating and Polishing

Catalogue of Gov't. Technical Reports—Oct. 1955. (Order CTR-159 from OTS, U.S. Dept. of Commerce, Wash. 25, D.C., price 10¢.)

Photochemistry & Photoelectricity (Excluding Photography)

Catalogue of Gov't. Technical Reports—Oct. 1955. (Order CTR-311 from OTS, U.S. Dept. of Commerce, Washington 25, D.C., price 10¢.)

The Extrusion of Titanium

Wright Air Development Center—March 1955. 77 pages. (Order PB 111696 from OTS, U.S. Dept. of Commerce, Wash. 25, D.C., price $2.00.)

New Shop Technique and Developments

Second Annual Report, Air Force Cambridge Research Center—Dec. 1954. 23 pages. (Order PB 111668 from OTS, U.S. Dept. of Commerce, Wash. 25, D.C., price 75¢.)

The Application of X-Ray Fluorescence to Trace Analysis

Naval Research Laboratory—April 1955. 5 pages. (Order PB 111685 from OTS, U.S. Dept. of Commerce, Wash. 25, D.C. price 50¢.)

Development of Sand Cast Al. Alloys Having Improved Properties

Final Report: Frankford Arsenal, Battelle Memorial Institute—July 1954. 74 pages. (Order PB 111699 from OTS, U.S. Dept. of Commerce, Wash. 25, D.C., price $2.00.)

MALLORY

ON

OFF

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

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

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

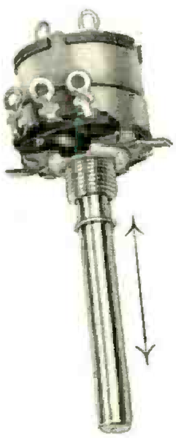
Extremely long service life, proved on actual tests. The floating action spreads wear and arc erosion around the whole circumference of the rings . . . gives cleaner make and break.

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

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

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

NEW CONTROL SWITCH WITH PUSH-PULL ACTION



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

Expect more . . . Get more from

P. R. MALLORY & CO. Inc.
MALLORY

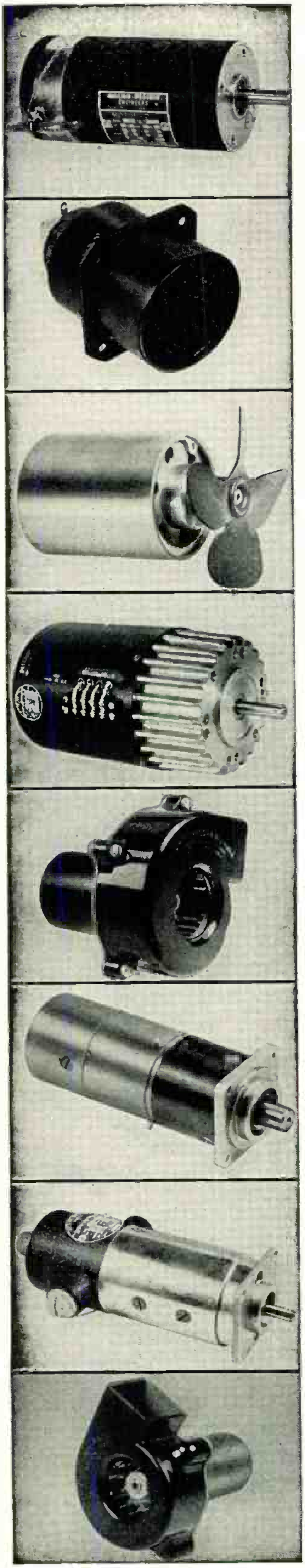
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

Serving Industry with These Products:

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

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

*Patent applied for



BE SURE OF

RELIABILITY!

SPECIFY

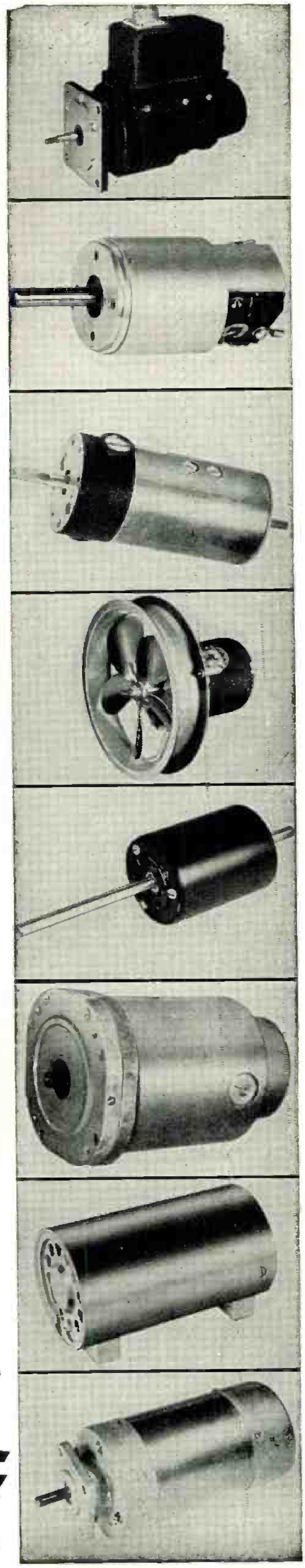
WESTERN GEAR

MINIATURE ELECTRICAL ROTARY EQUIPMENT

HERE ARE 9 REASONS WHY!

- die-cast aluminum housings for rigidity
- ball bearings throughout
- stainless steel through bolts
- bonded stators for greater strength
- full protection against humidity and fungus growth
- meet or exceed all AN specifications
- constant inspection and 100% performance testing
- continuing research program to improve techniques and manufacturing methods
- complete engineering service to insure correct application

More than 50 basic motor designs, including axial and centrifugal blower designs, ranging from .001 to 2 HP, from 50 to 1,000 cycles, any voltage range, to fill virtually any specification. Please detail your requirements. Our engineers will make recommendations promptly. Write Executive Offices, Western Gear (Electro Products Division) P.O. Box 182 Lynwood, California.



"The difference is reliability" ★ *Since 1888* 5568

WESTERN GEAR *Corporation*
ENGINEERS AND MANUFACTURERS

PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.) SEATTLE AND HOUSTON — REPRESENTATIVES IN PRINCIPAL CITIES

A SNAP FOR WIRING BOARD ASSEMBLIES

NEW Sprague Type 28D Push-Lok* Electrolytic Capacitors Give Fast, Fool-Proof Mounting

HERE'S THE BEST APPROACH yet to electrolytic capacitors for printed wiring board assemblies.

It's Sprague's new Type 28D Push-Lok Electrolytic. Just insert the connecting lugs through the slots in the wiring board, and the capacitor is held securely in place until the chassis is ready for dip soldering . . . so securely that solder gaps are eliminated. Spring action of the Push-Lok lugs is strong enough to hold relatively heavy capacitors in place, even when the board is carried sideways, or upside-down on a conveyor. Tab connections are always in close contact with the printed conductors. Yet, unlike other designs, no secondary operations are required for this fast and secure mounting.

Other advantages include:

Fool-Proof Positioning—A Push-Lok can only be inserted the right way. A wide index terminal is provided in the mounting ring to index the assembly on the chassis or other surface if desired.

The Ability to Print Wiring Boards on Both Sides—Shoulders on the Push-Lok lugs plus additional prongs keep the capacitors clear of the chassis.

Safety—Circular shield conforms with suggestions of Underwriters' Laboratories, Inc. Tools cannot be inserted easily between the bottom of the capacitor and the chassis.

FOR COMPLETE INFORMATION on these new Type 28D Push-Lok electrolytic capacitors, write for Engineering Bulletin to Sprague Electric Co., 233 Marshall Street, North Adams, Massachusetts.

**Push-Lok is a Trademark of the Sprague Electric Company*

Sprague, on request, will provide you with complete application engineering service for optimum results in the use of electrolytic capacitors.

SPRAGUE

WORLD'S LARGEST CAPACITOR MANUFACTURER

Export for the Americas: Sprague Electric International Ltd., North Adams, Mass. CABLE: SPREXINT

TELE-TECH
& Electronic Industries

O. H. CALDWELL, Editorial Consultant ★ M. CLEMENTS, Publisher ★ 480 Lexington Ave., New York 17, N. Y.

Education ... Too little too late!

This month the Technical Societies Council of New York sponsors its third annual Scientific and Engineering Career Conference for the benefit of all public and parochial high school students. The aim of this one day gathering is to encourage these students into choosing science and/or engineering as a future career. The conference permits students to study the scope of the art they are interested in and to determine to a degree, the opportunity for creativeness, the financial benefits, and the personal satisfaction that comes to participants. TSCNY, the sponsor, is composed of representatives from some 16 professionally recognized engineering societies. We should like to commend and thank TSCNY members for their efforts to guide youth along the paths that will make for a strong America tomorrow. . . . but for the career decision confronting today's youths we must regretfully add that we think "it's too little . . . too late."

Newspapers and magazines in recent months have been focusing editorial attention on such topics as "Why Johnny Can't Read"; how half of the U.S. schools offer no chemistry and no physics courses, how completely unprepared high school graduates are to pursue engineering courses because of inadequate training in math and other preparatory subjects. Then come reports on how America is losing in the race to the USSR in annual graduations of trained scientific personnel along with a comparison of directed training vs. the permissive. Various reasons are cited for our educational deficiencies, the most notable being of course the lack of competent teaching staffs and the unattractive remuneration arrangements for teachers. It's obvious to all readers however that the time has come when something must be done to assure the continuance of our industry by our sons and daughters. And what's more, we can no longer sit back and "let John do it." We are all individually responsible and concerned.

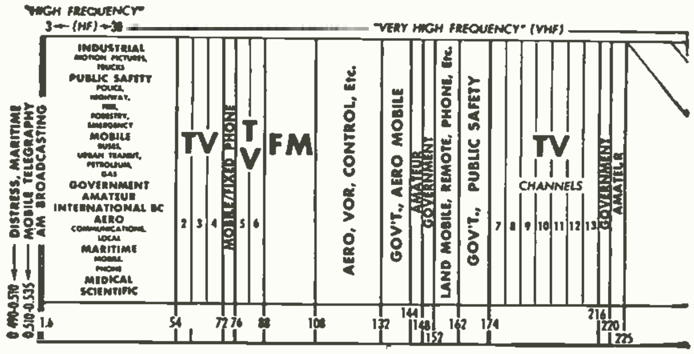
In April 1955 we published a list of 84 Associations Serving the Electronic Industries. The majority of these associations have either direct or indirect interests in electronic engineering. To date none of them have announced any dynamic program for furthering the scientific education of young America. Who but today's scientists and engineers are in a better position to indicate what youth must know when they take over? And what better way than through the cooperation of the educators with the professionally recognized engineering societies could we arrange to have the courses that the students need in the schools? The work of the societies and associations has always been directed to aid today's living. It should now be broadened and expanded to make room for those of tomorrow. In addition, professional societies and associations should make every effort to reach each of today's students personally through books and pamphlets, lecture tours, films, radio and TV to explain the benefits that science and engineering bring to mankind, and to show the comfortable living and self-satisfaction that can come from following such a career.

Electronic Sources

This is the name of a new monthly feature that will appear in Tele-Tech and Electronic Industries starting in January which we feel will be of prime interest to all readers. Now for the first time, in addition to the outstanding engineering design articles of the month, readers will have a bird's-eye view of all important engineering articles appearing in other publications, both foreign and domestic, through the new abstract service we have initiated. Key foreign electronic engineering magazines are being airmailed to us as soon as published in order to assure that Tele-Tech's monthly abstracts are always the most recent. Initially some 15 outstanding English, French and German publications will be abstracted. Later, on a gradual basis and dependent on reader interest, other publications will be added. Electronic Sources will also present other valuable reference data from time to time such as listings of important government engineering reports available, important texts and reference books for engineers, etc. In this growing stage we would appreciate if you the reader would first write and tell us how you like this new feature when it appears and then suggest other publications or reference sources that would provide abstracts of especial interest to engineers. Watch for it in January! . . . Electronic Sources!

RADARSCOPE

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

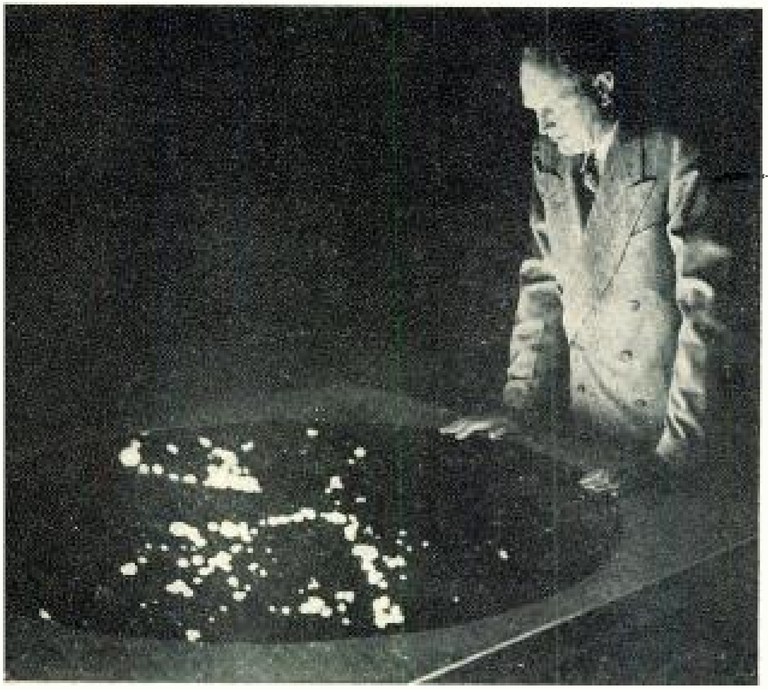


PATTERN FOR THE FUTURE?—One of the largest manufacturers of military aircraft in the East has opened the door to non-citizen engineers. Electronic engineers, in particular, are being sought.

NATIONWIDE SPECIALIZED TV NETWORK, proposed by TelePrompTer Corp., which would connect up to 500 TV stations, ad agencies, station reps and others interested in TV, got FCC classification recently as a common carrier operation. Network would use lines leased from Western Union and would provide five switching centers, at N.Y., Los Angeles, Dallas, Chicago and Atlanta.

FASTER RECORDING OF COLOR TV program material is promised by Eastman Kodak's new film processing system. The system records the color program directly off the kinescope on lenticular—special black-and-white—film. The film can be processed in about an hour, then retelecast in color. It is a special significance to coast-to-coast shows where time delay is a few hours. Previous color recording processes had taken a day or more to complete.

LARGE-SCREEN RADAR



Designed for use in air traffic control and other applications requiring large bright displays, this unique radar system projects the images on a screen 4 ft. in diameter. Here Robert Ayres, Engineering Products Div., RCA checks image of Camden, N. J. locale. Heart of system is new tube developed at RCA. The projection system used is similar to that employed in theater TV image projection.

A NEW TREND IS TAKING SHAPE in the West Coast picture. In the past the W.C. electronic firms have been in the position of having to sell their products locally. Shipping and distribution problems made it difficult to compete with the established Eastern and Midwest manufacturers. An indication that this situation is changing is seen in the fact that two prominent W.C. firms are now opening eastern plants. More W.C. firms can be expected to follow their lead.

ELECTRONIC FIRMS will be prominent among the exhibitors at the Atomic Exposition to be held in Cleveland this month.

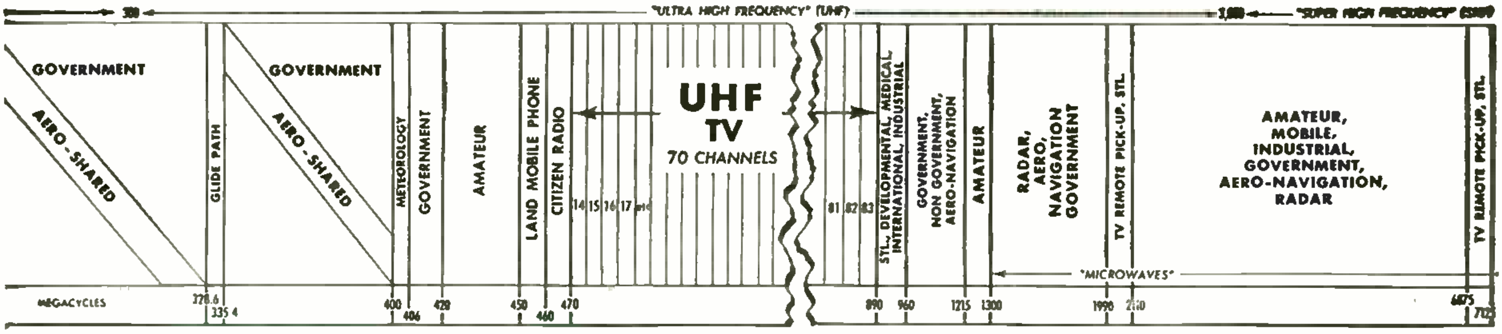
RUMORS PERSIST that 16⅔ rpm phonos are on the way—but with little apparent basis in fact. A TELE-TECH survey of top industry officials found little enthusiasm for the idea at this time. Frequency response at the 16⅔ speed, so far, is rather poor, and also, a tremendous initial investment is called for. However, the threat posed by pre-recorded tape is very much in the industry's mind and a slower record speed may ultimately be the answer. Consensus: some thought, but little developmental work going into 16⅔ operation; no commercial models in the near future. (Special-purpose 16⅔ models continue to be available for automobiles and novelty items.)

NEW ELECTRICAL CONTACTS, of silver-cadmium oxide, are claimed to handle up to twice the current handled by pure silver contacts, without the tendency to weld together.

HOW FAST IS THE ELECTRONICS INDUSTRY GROWING? Philip S. Fogg, pres. of Consolidated Engineering Corp. points out: "Since 1947, the electronics industry has produced one new company each week on the West Coast alone."

THE ENGINEERING SHORTAGE continues to mount. In a recent study of 200 industrial firms one-third admitted that their research and development programs are facing engineering personnel shortages of major proportions. The electronic and aircraft fields are among those hardest hit.

MORE INDUSTRIAL FREQUENCIES will be requested by the mining industry. Mobile radio units have been found particularly useful in tying together the operations of small working teams in the field.



YANKEE ELECTRONIC KNOW-HOW is giving the Japanese industries a shot in the arm. Under technical assistance agreements, American firms are providing engineers to guide the Nipponese in the application of printed circuits to TV and radio construction.

A WAY OUT OF THE CONFUSION over genuine hardwood vs. simulated grain TV and hi-fi cabinets has apparently been found by the National Hardwoods Assoc. At last count, they had pledged seventeen top equipment manufacturers to display their "genuine hardwood" seal on their cabinets. At the same time they are launching a heavy advertising campaign to alert the consumer to the advantages of hardwood over the simulated grains.

BROADCASTING

LOOK FOR A SHARP REDUCTION in the number of "tall" tower permits granted by the FCC. Heavy pressure is being applied by aviation interests. A recent proposal by a joint broadcast-aviation-government committee which would have authorized the FCC to eliminate all tall towers has been watered down to a compromise plan which seeks to confine all towers over 500 ft. to "antenna farm" areas which can be clearly marked on navigation charts. NARTB representatives abstained from voting on the bill, pointing out that their board of directors will not meet until January. They emphasized, however, that their abstention "is not to be construed as either approval or disapproval of the proposed committee report."

MARKETING

THE PROPOSED EXEMPTION from excise tax for UHF and color TV receivers, being considered by the Subcommittee on Excise Tax Technical and Administrative Problems of the Ways and Means Committee, was attacked as a "concealed subsidy" by the Treasury Dept. Dan T. Smith, Special Asst. to the Secy. of the Treasury, told the committee that if tax relief is necessary for these products until they are established "it would be better to have a direct subsidy so that the cost could be known." In quick rebuttal, Sigurd Tranmal of Stromberg-Carlson, representing RETMA, pointed out that Mr. Smith's comment overlooks the fact that the excise tax system is selective and only a relatively few articles are subject to tax. "To say that the omission from taxation constitutes a subsidy is to say that all items not selected for tax are subsidized. This," said Mr. Tranmal, "ignores established canons of selective excise taxation."

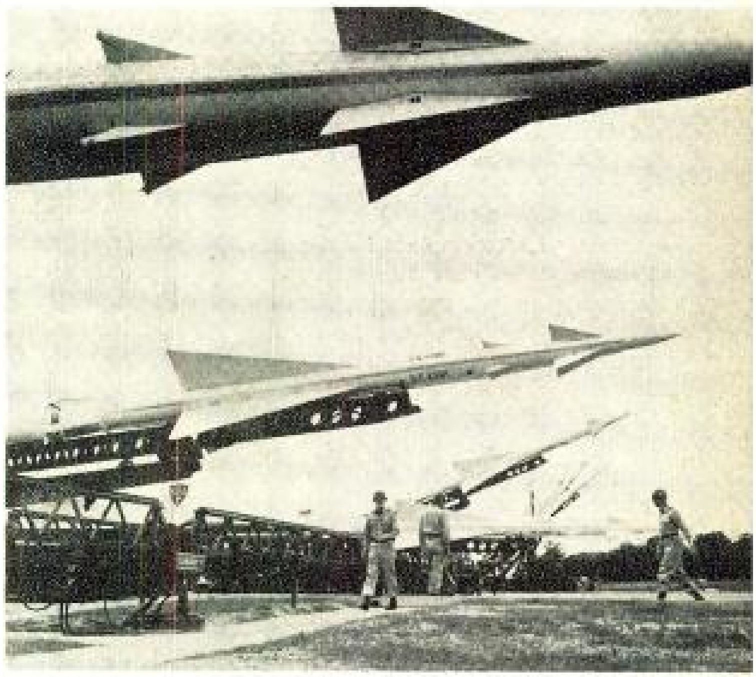
RELIABILITY

CONCERTED EFFORTS WILL BE MADE to improve the reliability of missile weapons systems through improved component reliability. Edwin A. Speakman, chairman of the Aircraft Industries Association's Guided Missiles Committee advises that they will seek to establish new standards for missile equipment—standards that are considerably higher than the most stringent requirements of other industries.

From other quarters, too, comes signs that the reliability program will be tightened up. J. M. Bridges, Director Electronics, Office of the Asst. Secy. of Defense (Applications Engineering) gave the government's view: "The greatest cause of the present unacceptable level of reliability in military electronic equipment is the lack of maturity of product design and failure to evaluate the inherent reliability of design, through realistic engineering tests and service and material evaluation, before major production is undertaken.

". . . demonstration of a company's ability and earnest desire to do a thorough and excellent reliability engineering job is a firm prerequisite for obtaining continued military electronics development and engineering contracts."

MISSILE MARKET



Stepped-up guided missile program, anticipated for '56, will mean more business for the electronics industry. Expenditure for 1955 totalled $1 billion, of which $600 million went for the guidance mechanisms. As year closes, eight missiles are in production: Nike (shown), Corporal, Terrier, Sparrow, Matador, Talos, Regulus and Falcon

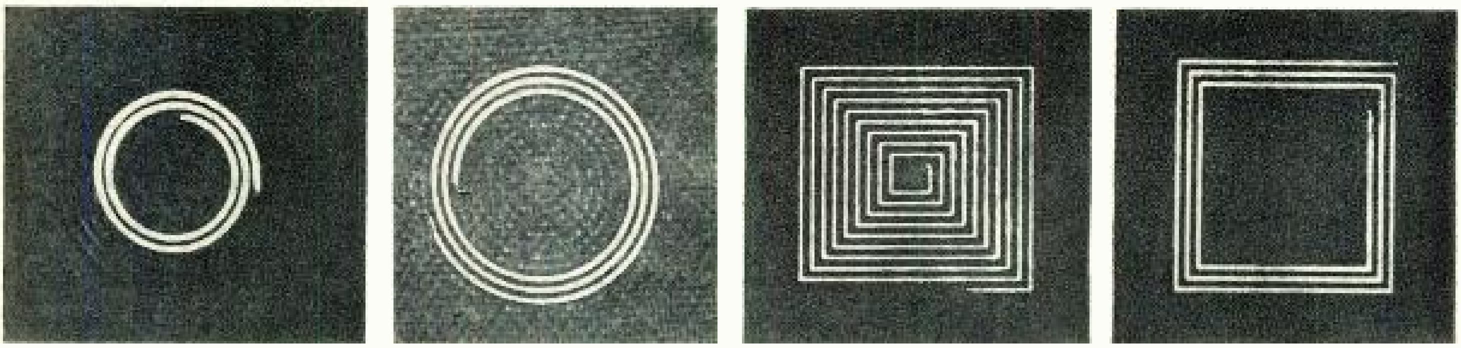


Fig. 1: Typical coils produced by printed wiring techniques. Square coils, produced easier than spirals, are more desirable

Printed Inductors and Capacitors

The manufacturing ease, stability, and reproducibility of printed coils and capacitors make them attractive for printed wiring applications. Empirical design data presented here was obtained from a study of a large number of coils and capacitors of various sizes.

By H. E. BRYAN

A GREAT deal of useful information is available for the design of conventional types of wound coils. Such is not the case with inductors "printed" along with wiring on plastic laminates. Although conventionally wound coils may of course be used in conjunction with printed circuits, the manufacturing ease, stability and reproducibility of the printed variety make them very attractive for many applications.

The formulas found in the handbooks do not perform satisfactorily for printed coils, probably because of the nature of the conductors used. Errors as high as 100% have been experienced in attempting to apply them. In addition, the majority of them are quite time consuming, involving a number of terms and the application of tables and curves.

Information as to the Q which may be expected from printed coils, and the magnitude and the effects of their distributed capacity, is also needed, since these factors will in many applications determine the suitability of printed inductors.

Capacitors may also be formed during the fabrication process by forming plates on each side of the plastic board or through a variety of patterns on one side. Q will be approximately the same in either case. Although these may not be the best capacitors in the world, they can be very useful in many non-critical applications.

H. E. BRYAN, U. S. Navy Electronics Lab., San Diego, Calif.

Because of the general dearth of information on the design of these components a large number of coils and capacitors of various sizes were constructed for study. From the data obtained the information presented here was obtained.

Inductance Calculation

As mentioned above, attempts to apply the formulas found in various handbooks met with failure because of the extreme errors experienced. Derivation of suitable equations was therefore mandatory. Although there are probably an infinite number of possible configurations for such coils, time required that efforts be limited to the two most likely forms—circular and square. The formulas presented here, while not extremely accurate, will be found to be adequate for most if not all practical applications; and, in addition, they are easy to use. The error experienced in using these equations runs within 5% in the majority of cases. However, it must be admitted that coils were constructed in which the error went higher for some unknown reason. This occurred in less than 3% of the coils studied, so is not considered a serious condition and may have been due to errors in measurement of dimensions. (Many coils were made by stripping turns from others, so no chance for rechecking was available in some cases.)

Although a coil is usually thought of as circular, such spirals are difficult to draw. As a result, square coils, being easy to draw, were included. The equations presented below give the true or low frequency inductance in microhenries. The type of base material used makes no difference in this value, although it does affect the Q and distributed capacity, as discussed below.

For circular coils

$$L = 0.126\, a\, n^{5/3} \log 8 \frac{a}{c}$$

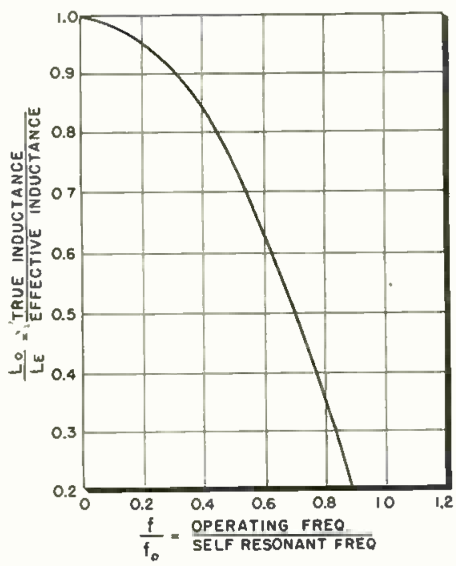
and for square coils

$$L = 0.141\, a\, n^{5/3} \log 8 \frac{a}{c}$$

where

n = number of turns

Fig. 2: Effect of distributed capacitance upon inductance as function of frequency



a = mean radius = $\frac{OD+ID}{4}$ in inches

c = depth of winding = $\frac{OD-ID}{2}$ in inches

ID and OD = inside and outside diameters of circular coil or the corresponding side of square coil.

It will be noted that a square coil gives a somewhat larger inductance than a circular coil of similar dimensions, probably due to the greater length of "wire" involved. Table 1 shows the extent of the correlation between measured and calculated values of some of the inductances constructed. Typical coils are illustrated in Fig. 1.

Alignment Chart

Even though the formulas given above are simple to use, consideration for the weary brain of the hard working engineer made an alignment chart (Fig. 3) seem desirable. The range of the chart has been deliberately limited. A consideration of the magnitude of the magnetic field around these coils, which is extensive, indicates that larger values than those covered by the chart will not be generally practical because of space limitations. Larger coils can of course be constructed where their use is indicated.

An example will illustrate the use of the chart. Suppose it is desired to construct a circular coil of 0.5 microhenry. A ratio of a/c of unity might be chosen as a reasonable value. A line is then drawn through 1 on the a/c scale and 0.5 on the L scale to intersect the central reference line. An additional line from this intersection through the n and a scales will completely define the coil. Space considerations might indicate a medium size coil, with a value of a perhaps 0.3. The number of turns is then indicated as 5. This coil will have outside and inside diameters of 0.9 and 0.3 in., respectively. Of course, other values of the various factors might be chosen to fit particular requirements. A square coil of like inductance would, with the same ratio of a/c, have either fewer turns or smaller dimensions than the circular coil. If a maximum OD is the governing factor, one may work from this in determining useful values of a, c and n.

Distributed Capacity

Any inductance has a certain amount of distributed capacity, which limits its usefulness in certain frequency ranges. If operated above its self-resonant frequency it will of course perform as a capacitor, rather than an inductance. The magnitude of the distributed capacity of printed coils is thus of considerable interest, since most of them will probably be operated at relatively high frequencies.

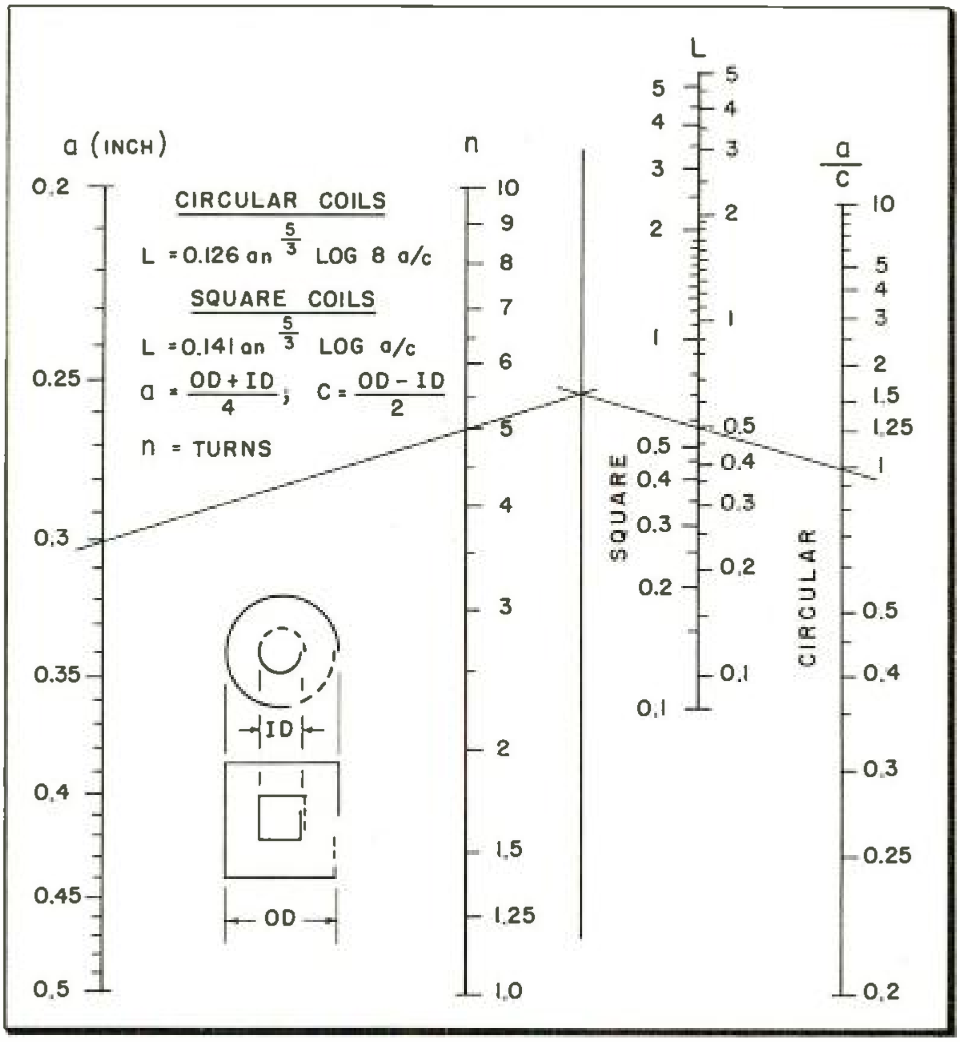


Fig. 3: Alignment chart for designing square and circular coils of specified dimensions

The effective, or apparent, inductance seen by the circuit will differ from the low frequency or true inductance due to the presence of the distributed capacity. This capacity may be considered as a lump shunting of the coil at frequencies up to approximately 80% of the self-resonant frequency. Above this point, the distributed nature of the capacity makes itself apparent.

As the self-resonant frequency is approached from the low side, the effective inductance will increase, always being larger than the true inductance. This relationship is expressed by the equation

$$\frac{L_o}{L_e} = 1 - \left(\frac{f}{f_o}\right)^2$$

where

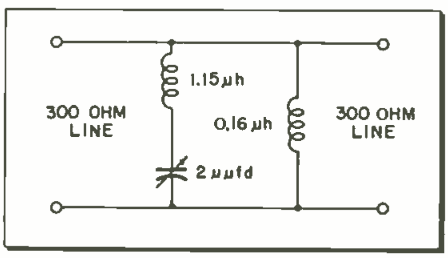
L_o = true inductance
L_e = effective inductance at frequency f
f_o = self-resonant frequency.

This is plotted in Fig. 2 to illustrate the magnitude of the effects to be expected.

In all the coils produced, a remarkable constancy of distributed capacity was found to exist. The number of turns seems to have only small effect, the capacity increasing as the number of turns decreases. The capacity increases as the dielectric constant of the base material increases but not in a direct fashion. Its value seems to be primarily some obscure function of the dielectric constant and the overall dimensions of the coil. Values measured ranged from 0.66 to 1.09 μμf. for all the coils constructed, averaging around 0.8 μμf. It appears from the data that in the absence of other information a value in the vicinity of 0.7 to 0.8 μμf. can be safely assumed for practical purposes when the usual types

(*Continued on page* 120)

Fig. 4: Series resonant rejection filter circuit



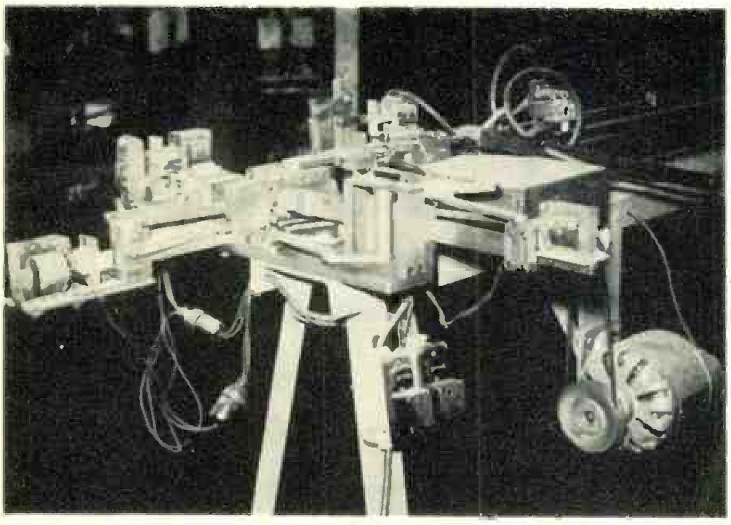


Fig. 1: Automatic feeder section of loading station; showing feeder box and motor drive

Low-Cost Automatic

By A. E. STONES

OVER the past three years Printed Wiring has taken on and progressed remarkably well with the commercial electronic equipment manufacturers. This great popularity is largely due to the alleged mechanical, electrical, and economic favors made possible by intelligent application of a prefabricated wiring unit. Some voices of dissent have been heard, however, and, upon investigating these undercurrents, it was discovered that a large number of the quantity users of printed wiring supported the finding that prefabricated wiring will not replace most conventionally wired units with any economic advantage. Specialty, miniature, and test equipment manufacturers, while also supporting this finding, have indicated that the intangible advantages of printed wiring, such as uniformity and reliability, are so desirable in their products that the economic feature can be secondary in importance. If prefabricated wiring is to continue in its progress, however, there must be economic acceptance by the potential users of large quantity.

This conviction, expressed by some of the large quantity users, arises from the fact that each of the people reporting had taken the most simple item of their products, such as an ac/dc receiver or a phonograph amplifier, converted the wiring to a printed chassis, and inserted this printed chassis into their standard production set-up. This standard set-up was then modified in most cases to include some form of multiple soldering technique, but, in each case, all components were manually mounted. While the application of multiple soldering techniques reduced considerably the direct labor ingredient normally accepted, a cost analysis indicated that this savings was clearly off-set by the price penalty registered by the printed wiring panel. The mechanical and electrical advantages expressed by the specialty equipment manufacturers was recognized and reported, but, in the face of little or no economic advantage in favor of the printed chassis, these people felt that intangible advantages were not enough to justify the expense of a complete conversion program. They concluded with the philosophy that a simple unit, when converted to printed wiring, will break out about even when compared with the identical unit conventionally wired, whereas the more complex unit will show a cost advantage directly proportional to the number of solder connections.

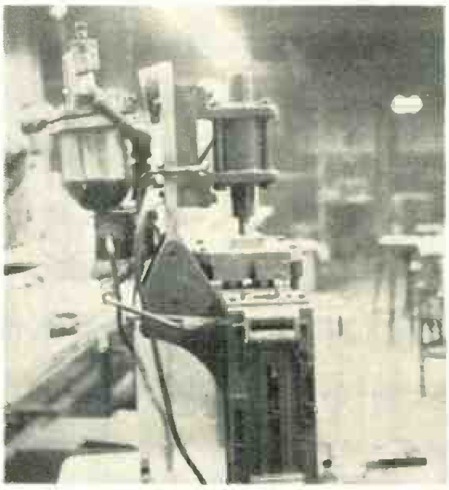
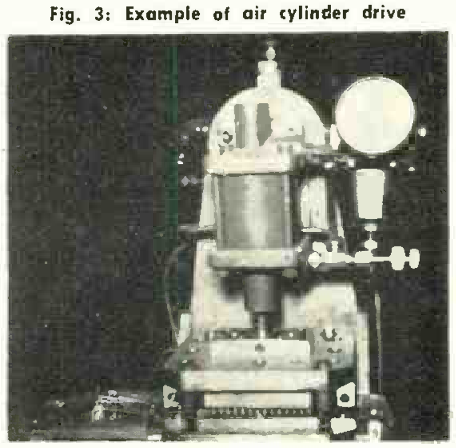


Fig. 2: Component assembly station; view of cutting and forming blocks

In their present stage of development, it seems that printed wiring will not fit into an operation without some means of reducing the cost of the board severely or reducing further the assembly labor. It is possible that with improved processing techniques the cost of the printed board can be reduced, but it becomes apparent that the full production potentialities and cost advantages of printed wiring will only be realized when prefabricated wiring can be integrated into a completely automatic assembly system.

At present, completely automatic assembly systems are being attempted, and some companies are offering, for sale or lease, systems reputed to be designed for the automation of prefabricated wiring. It is noted, however, that most of these systems are employed by the larger companies, due to their initial cost and maintenance burden. Many of these systems require great areas of floor space, involved considerable weight, and demand attention by skilled technicians for their successful operation; also, when once set up, a run of tremendous quantities is required to justify the set-up expense. None of these features make a printed wiring automation system acceptable to the average equipment and set manufacturer.

Fig. 3: Example of air cylinder drive



A. E. STONES, Mandex Manufacturing Co., Inc., 2608 W. 16th St., Chicago 8, Ill.

Assembly System

The economic advantages inherent in printed circuit application are being only partially realized, due to lack of a compact low-cost system which can satisfactorily reduce the assembly labor. A system which meets these requirements is described here.

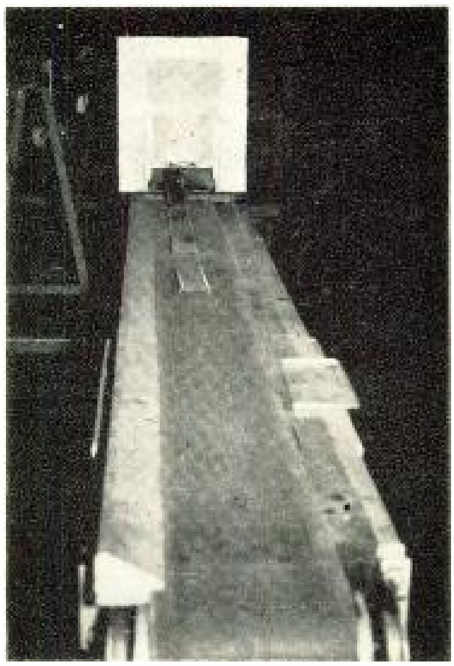


Fig. 6: Discharge conveyor; looking toward Soldering Station hood

The average organization, in order to take full advantage of the production potentialities and cost advantages of printed wiring must have an automatic assembly system that is low cost, that can be easily moved about, that covers very little floor space, and that is infinitely flexible.

Such a system is now being prepared for the electronic industry: it is called the Omnimatic Assembly System. The secret of success with this system is that, wherever possible, only standard equipment and tools are employed. This reduces the capital expenditure, and simplifies each operation to the point where large tolerances are acceptable, thereby reducing the set-up cost and spoilage factor.

In its simplest form, the Omnimatic Assembly System will comprise three sections and four operators, and will be geared to a twenty second cycle. The three sections will be the loading section, the component assembly section, and the soldering section. One operator will be utilized at the loading section to manually place the boards in their jig on the conveyor; one operator will load and attend the component section; one operator will load and attend the soldering section; and one operator will be available to relieve any congestion that may occur. The twenty second cycle will be controlled by the soldering section, as the time required to accomplish a good soldering job must not be economized if trouble free results are to be obtained.

Fig. 4: Socket insertion station

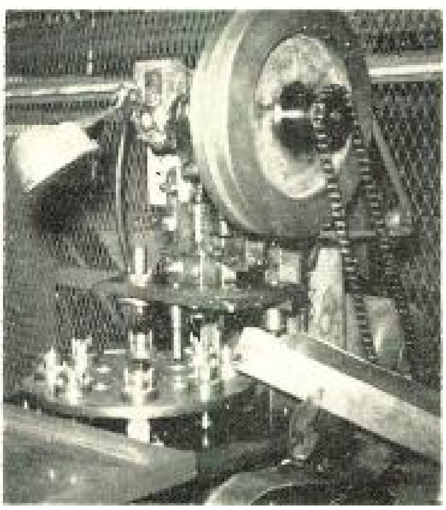


Fig. 5: Engraving machine modified to handle irregular-shaped components

The loading section consists of a conveyor system and a loading system. The loading in the simplest form of Omnimatic Assembly will be a manual placement of each board onto a component template which is mechanically affixed to the conveyor system. The conveyor system will be a metal belt driven by a variable speed electric motor through a gear reduction system. Affixed on this metal belt will be the component templates at a spacing determined by the mounting of the component placing stations. The number of component templates required on the metal belt is equal to the number of components mechanically mounted, as each component assembly station must have a board in position for each stroke. (See Fig. 1)

Each component template is machined to complement the printed wiring panel with a recession at every point where a component lead or lug will be placed. These recessions will take the form of the female part of a staple machine, and be grooved in the direction of the printed conductor running from the fillet at the component termination. Effectively, the component lead is to be stapled outwardly as directed by the template and bent back against the conductor on the printed board. This will provide a mechanical retention feature for the components, and permit more soldering surface for a better solder joint.

The printed wiring panel is held in registration with the template by pins located at the board mounting holes. The stapling feature of the bent component leads provides such good soldering surface and mechanical hold that hole sizes can be made to accept registration tolerances as great as .035 in. This point, plus the mechanically held components, permits the use of undersized pins so that the board may be discharged by gravity at the soldering station as the belt turns under for its trip back to the loading station.

The component assembly section will be made up of one component inserting station for each mounted component; each station will be devised from a feeder channel, a drive source, and a forming head. The feeder channel, in this simplest form,

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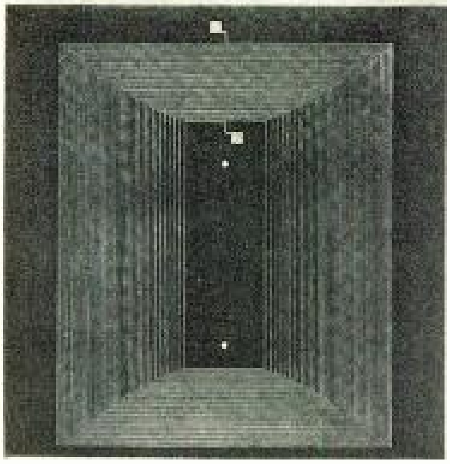

Fig. 1: Coil patterns are mirror images of each other. One pattern is shown above

Describing the construction of a deflection yoke for an image-orthicon color TV camera which was built entirely from printed circuits and operated in a camera. With the exception of resistance, the parameters of a conventional wire wound yoke have been precisely reproduced

By H. J. BENZULY

Printed Deflection Yoke Design

H. J. Benzuly

ONE of the most important considerations in the registration of several television images, such as required in the present RCA color TV camera, is the deflection yoke. Since misregistration is a degradation of picture quality that is quite apparent and annoying to the viewer, it is imperative that errors in registry at the transmitting end of the system be held within very close limits. In present cameras this is done by providing several registration controls and using carefully constructed deflection components. This article describes a different approach to the construction of deflection coil assemblies.

Because variations in geometric distortion rather than geometric distortion per se produce misregistration, the emphasis is primarily on uniformity. While any distortion is undesirable, techniques of field-shaping[1] and focus modulation permit compensation for the symmetrical barrel and pin-cushion variety. Furthermore, a certain amount of symmetrical distortion is tolerable providing it is identical in all of the images superimposed so that no color separation occurs. Thus, while accuracy and low distortion are extremely important, precise reproducibility is of paramount concern.

H. J. BENZULY, Engineering Products Div. Radio Corp. of America, Camden, N.J.

In the camera, distortion can be introduced by optics, tubes or the deflection coil assemblies. But, while the sources of error are known, evaluation of each element's contribution is extremely difficult. The use of high quality optics, carefully adjusted, makes negligible the distortion inserted at this point. Image-orthicons, although made with rigidly controlled accuracy, due to their inherent complexity can contribute some error. However, proper installation and operation reduces nonsymmetrical distortions to a currently irreducible minimum and allows excellent registration to be obtained. Distortions produced in a deflection yoke depend directly on the care and accuracy exercised in its design and manufacture. Thus, the deflection yoke designer, knowing that perfection in his art is not a panacea, is charged with achieving the highest possible precision.

An insight to his problem might be given by a brief description of the procedure used in registering an RCA color camera. Three image-orthicons are used in individual deflection assemblies for the red, blue and green images which have been separated by dichroic mirrors. The two horizontal coils in each yoke (and likewise the vertical coils) are connected in series and the three yokes are then paralleled across the horizontal and vertical output transformers. The green channel has been arbitrarily adopted as the master channel to which the red and blue images are registered. The test pattern normally used consists of wide-spaced horizontal and

Fig. 2: Shield cloth, already formed here, is printed in a continuous strip

vertical lines in a grid pattern, a large circle and test wedges, all thin black lines on a white background. In setting up the green channel, first the mechanical rotation of the yoke is adjusted to make the bottom of the raster parallel to the bottom of the optical image. Then size and linearity are set using master controls which operate on the applied deflection voltage waveforms. The red and blue images are then separately registered to the green using rotation, centering, individual size and linearity controls and a "skew" correction adjustment. "Skew" is a term applied to a distortion causing square shapes on the test pattern to appear as rhombic shapes on the television picture. It can be corrected by applying a variable vertical sawtooth of current to the horizontal deflection coils.

Since a common deflection voltage is applied to all three yokes, individual size and linearity controls are obtained from adjustable resistive and reactive elements in series with the deflection coils. These adjustments permit compensation for production tolerances.

The deflection obtained from a given deflection yoke is a function of the form-factor and ampere-turns. In the so-called form-factor are included the effective length, diameter, turns distribution and efficiency parameters. If the two coils comprising a given yoke (both horizontal and vertical) are connected in series, properly oriented with respect to each other and with the axis of deflection and then fed with a perfect sawtooth current, any asymmetry in the magnetic field (barring disturbing external effects) will be due to construction geometry such as the location of turns in the winding.[2] Since the errors in registration with which we are concerned are on the order of a few percent and since, as mentioned earlier, it is quite difficult to isolate such errors for evaluation, the best approach is to tie down accurately the location of the turns so that no variation is permitted. While several methods are available for accurately locating the turns of a deflection coil winding, it is felt that the application of printed circuit techniques, besides achieving a high degree of precision in this respect, can supply several additional advantages as well.

The use of printed coils permits realization of the ultimate in geometric uniformity between units. It suggests a simple method of fabrication suitable for automation techniques. It should result in cost reduction, size reduction and closer tolerances in electrical characteristics than normally obtained. But, most important from the point of view of this article, a high degree of uniformity in production units should be possible.

Fig. 3: Coils are built up by alternately stacking the formed mirror image patterns

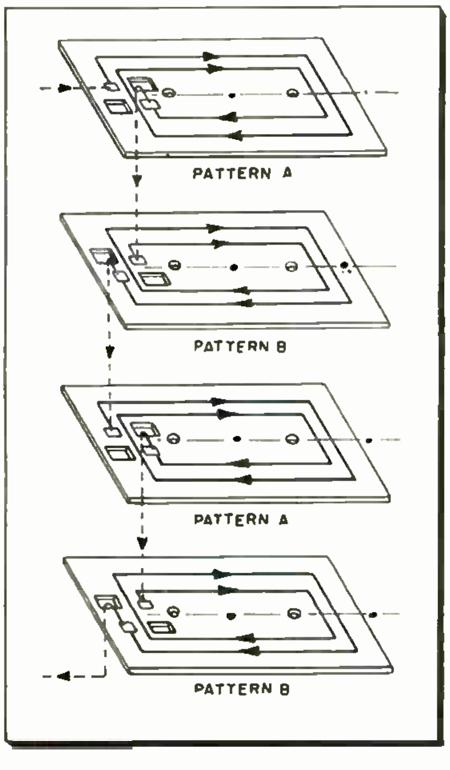

Fig. 4: Single, formed coil pattern alongside completed conventional horizontal coil

The Printed-Circuit Yoke

To explore these possibilities, a deflection yoke for an image-orthicon television camera was constructed entirely from printed circuits. Before describing this printed model, the construction of a conventional yoke will be reviewed.

An image-orthicon deflection yoke is assembled on a long phenolic coil form into which the image-orthicon is inserted. A layer of shield cloth is first wrapped around the form for electrostatic shielding. This cloth consists of thin copper wires woven parallel to each other (in one direction only) through a cloth base. They are all joined together at one end which is grounded. A layer of varnished cloth is then applied for insulation. Next, the horizontal deflection coils, flat wound and preformed are mounted in place. Another layer of varnished cloth, a second layer of shield cloth, more varnished cloth and finally the vertical coils, followed by a last layer of varnished cloth and the iron wire wrap which serves as a return path for the flux.

The coils are wound flat around pins accurately located in a board. They are laid out in six or seven groups of turns, the groups being equally spaced on the ends and approximating a cosine distribution along the major axis. Wooden spacers are provided between groups to maintain their proper relative position. The coils are then shellacked and formed around a cylinder. A finished horizontal coil is shown in Fig. 4.

At the outset it was believed that a printed yoke could be built which would replace directly (mechanically and electrically) the conventional unit. To this end the physical dimensions were predetermined and the electrical parameters set as design objectives. No attempt was made to redesign the standard yoke, but merely to reproduce it using printed coils. Only three different printed patterns were used for the entire yoke, two coil patterns and a shield pattern. The two coil patterns, one of which is shown in Fig. 1, are mirror-images of one another. The third, to be used in place of the shield cloth referred to earlier, was printed in a continuous strip. A section of this pattern, already formed, is shown in Fig. 2.

All patterns were made by an etching process from 2.7 mil copper deposited on a semi-cured melamine glass base material 13 mils thick. The coils have 43 turns per pattern, a conductor width of 10 mils and a minimum turns spacing of 10 mils. The turns are laid out according to a cosine distribution along the major axis and are equally spaced on the ends.

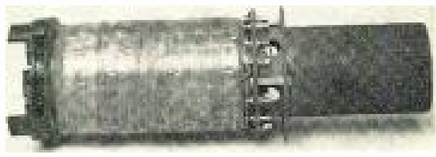

Fig. 5: Completed yoke consists of horizontal and vertical coils, and layers of shielding

The electrostatic shield pattern consists of 15 mils conductors equally spaced at 60 mils, all joined at one end of a bus 3/16" wide.

The deflection coils were built up to the proper inductance by alternately stacking the two preformed mirror-image patterns and interconnecting them as shown diagrammatically in Fig. 3 to provide a continuous current path. Interconnections were made by soldering short pieces of thin copper ribbon between solder pads. An important feature of this scheme is the self-insulating action of the patterns. Consequently no insulating wrappers need be inserted between coils as in the conventional yoke. The two small holes along the center line seen in Figs. 1 and 3 are for accurately indexing the patterns while assembling the coils and later for accurately locating the finished coils on the coil form.

Patterns were preformed by strapping them to a mandrel of the proper size, stacked and indexed in the order in which they would be assembled, and subjecting them to a temperature of 320°F for 1 hr. Fig. 4 shows a single, formed coil pattern alongside a completed conventional

(Continued on page 141)

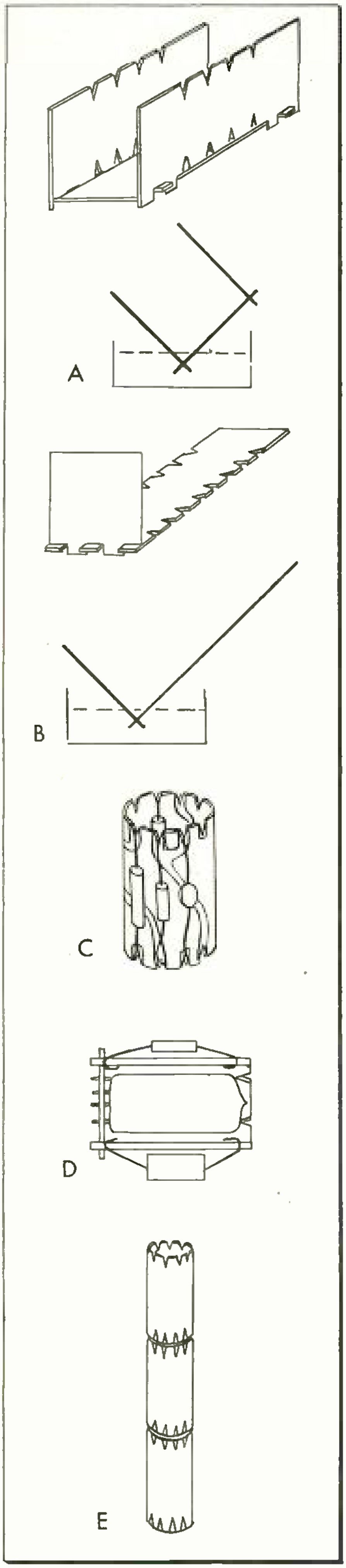

Fig. 1: Different design configurations readily demonstrate flexibility of the system

Edge Dip-Soldering Of Printed Circuits

New approach in printed wiring techniques offers exceptional design flexibility, a minimum of soldering time, and simplified mechanized assembly of electronic units

By M. W. BANG

DURING development work in printed wiring at the DuMont Instrument Div., a design approach was suggested which seems to promise simplification of mechanized assembly of electronic units.

In its simplest form it can be utilized as a terminal board as shown in Fig. 2. A strip of insulation material of 1-2 in. width and the length needed is provided with notches at the edges. The necessary wiring is printed on the strip on one or both sides and has contacts or soldering points at the notches. Resistors and capacitors are placed in a simple fixture, Fig 5, either by hand or fed from a simple feeding machine, and the strip placed on top of the fixture. Hinged parts of the fixture are designed in such a way that by moving same upwards the leads of the components are bent into the notches and around the edge of the board, thus securing the components mechanically to the board.

Next, the strips are fluxed at the edges only and the edges dipped in the solder pot. This way the components are soldered to the printed wiring using a minimum of flux and solder. Small metal clips can be placed in the notches where connections from the wiring on one side of the board to the other are desired. The metal clips solder to the wiring in the dipping process. The component leads can be utilized for the same purpose. As only the edges of the board are dipped in the solder pot, this can be very narrow and thus radiates little heat.

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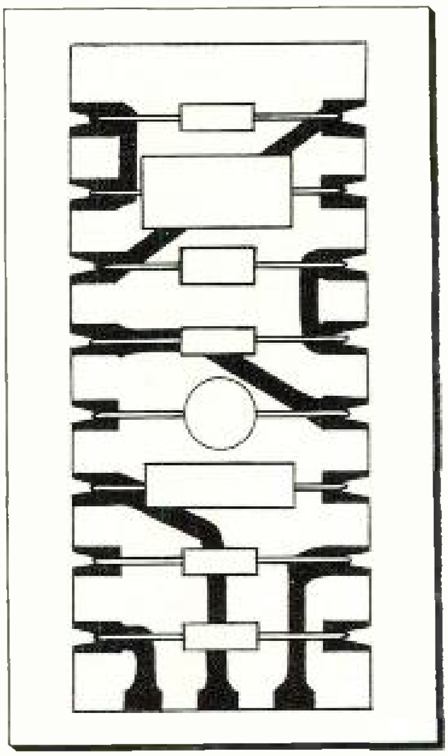
Advantages

The notched edge dip-soldering has several advantages. The space on both sides of the board can be utilized for the mounting of components since only the edges of the

Fig. 2: Wiring board showing component mounting. Parts and wiring may be on both sides.



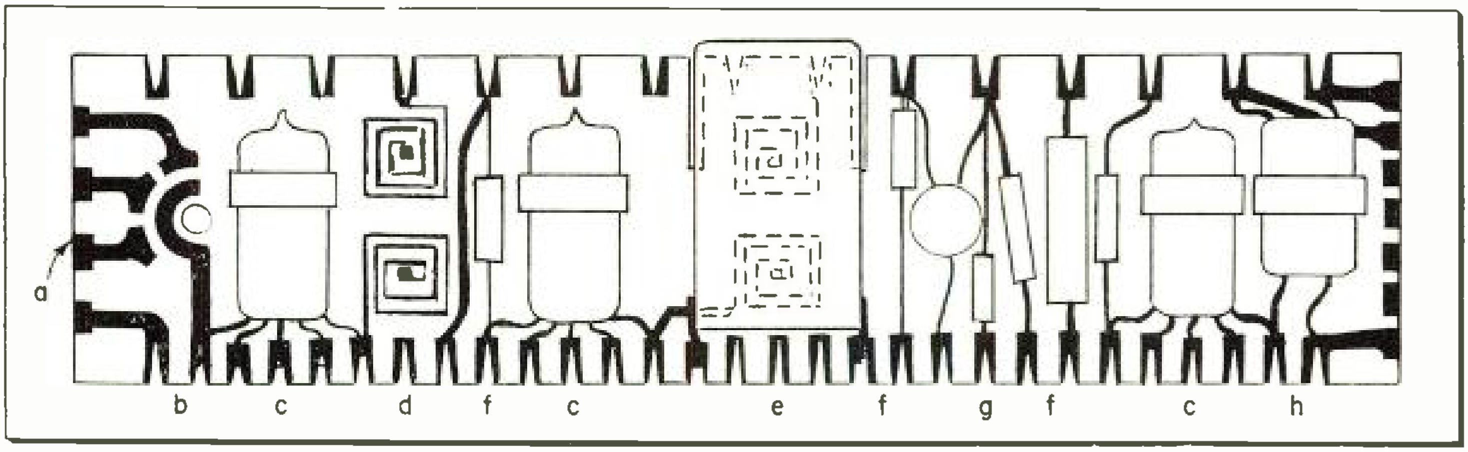


Fig. 3: Complex circuits using coils, transistors, and miniature tubes are easily converted to notched board mechanized assembly

board are dipped in solder. Fluxing and soldering is only necessary at the edges and thus the amount of flux and solder used is kept to a minimum as the wiring itself does not pick up any solder. This also makes it easy to incorporate coils, contacts and switches in the printed wiring, and no masking, as used in ordinary printed wiring chassis manufacture, is needed. Simple jigs and fixtures can be used for semi-automatic production and the method also lends itself to full-automatic production or endless belt automation. Although continuous edge-dipsoldering can easily be applied it is also possible to design continuous welding machines to take care of the electrical connection between components and the printed wiring.

A more complicated strip or chassis is shown in Fig. 3. At a and b are shown the input terminals and a switch, at d and e coils, unshielded and shielded. Since the chassis is kept narrow coils can easily be shielded if necessary. Two slots in the board permit a shield can with two corresponding slots to slip over the coils, and springs mounted on the can will snap into the notches at the bottom of the chassis and provide for grounding, or they can be soldered to the wiring in the dip-soldering process.

Subminiature tubes and transistors with wire leads can be soldered into the assembly as shown at c and *g* or special tube sockets can be snapped into the board and dip-soldered to the wiring. Parts such as resistors and capacitors placed on both sides of the board can be dip-soldered into the wiring with no extra mechanical fastening, as shown at *f*. Tubes and heavier parts, such as transformers shown at *h* and electrolytic capacitors, are fastened to

(*Continued on page* 146)

Modular Assembly System

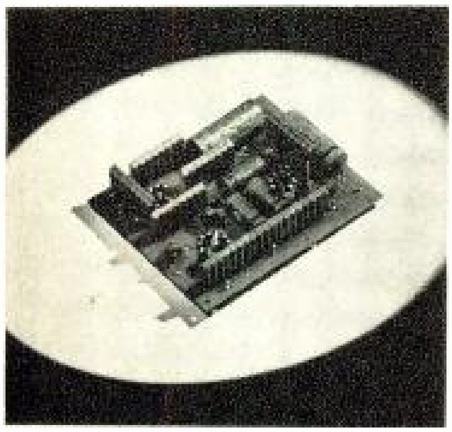


Fig. 1: Printed circuit board containing six pin-assembly modules

THE "PAC", for Pin-Assembly Circuit, system, developed by Erie Resistor Corp., Erie, Pa., simplifies automation for the electronics industry by grouping circuit components together into a unitized package. High speed assembly is simplified by handling these parts at a stage where they have no wires attached and are uniform in size.

First, the wiring pattern for a given circuit is "printed" onto a laminated phenolic base. Component terminal clips are next riveted to appropriate circuit tie points and individual tubular components are automatically assembled into position. Resistor and capacitor "pins" are similar in appearance to cartridge fuses, (See Fig. 2) with electrical contact made in the same manner. Component terminal clips resemble miniature fuse clips. The overall assembly is enclosed in a plastic compound for electrical insulation and moisture seal, and to provide a package of uniform size which can be handled easily by machinery.

Since each circuit element is individually made prior to assembly, compromises in characteristics and tolerances of components are minimized. Different combinations of circuits may be quickly produced without costly setup charges, and, by using uncoated models, development engineers can readily make their own experimental models.

Fig. 2: Pin assembly resistor

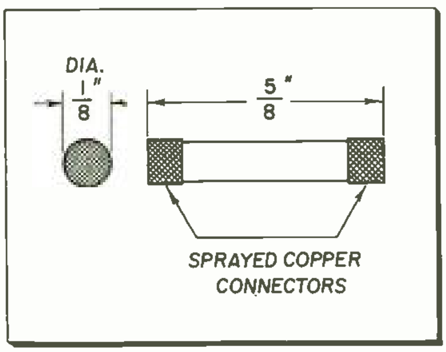


Fig. 3: Components snap into clips as shown, facilitating circuit design

The new system should be of particular interest to equipment manufacturers looking toward automatic assembly of components.

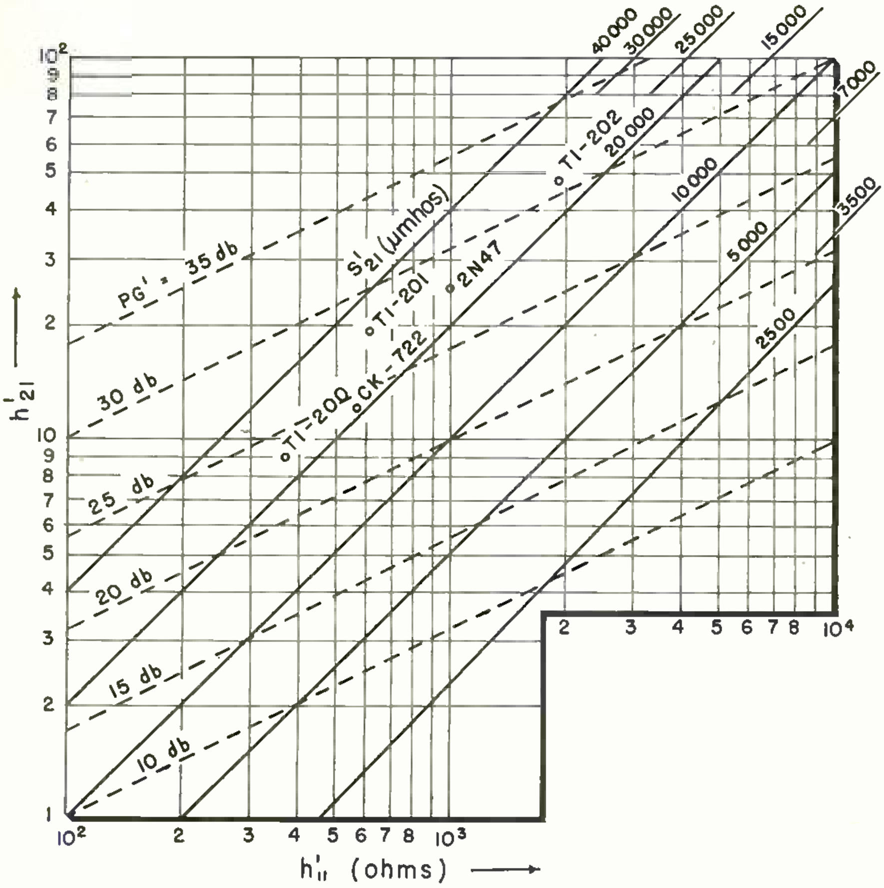


Fig. 1: Transistor Parameter Chart

By W. D. PENN

Hybrid and transconductance parameters are used to determine circuit performance. Expressions for voltage, current and power gain, and power output, are derived for the three transistor configurations in terms of transistor transconductance.

Simplified Transistor Circuit Equations

W. D. Penn

THE rapidly increasing use of the transistor necessitates some means for determining the characteristics required in order to fulfill a given or proposed circuit requirement.

Although the literature is replete with theoretical discussions concerning transistors, relatively little has appeared to help the circuit designer decide what characteristics are necessary in order to achieve a certain power gain, voltage or current gain, or a desired power output.

The purpose of this article is to present in simplified form, certain relations between transistor parameters which should help the circuit designer achieve a specified performance. The treatment is restricted to low frequencies.

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A chart embodying some of the results is also presented.

Transistor Parameters

A transistor can be represented by a four terminal network. The one which has been most commonly used is the tee network of Fig. 2.

The resistances r_e, r_b and r_c are small-signal equivalent resistances and correspond respectively to the emitter, base and collector resistance of the transistor. α is the short-circuit current gain. These parameters are analogous to the variational coefficients of a vacuum tube.

Because of their greater ease of measurement another set of parameters known as the "h" or hybrid parameters, is being used increasingly and it will be helpful to use these and relate them to the tee network resistance parameters.

The hybrid parameters appear in the form shown in Fig. 3.

The equations applying to Fig. 3 are:

$$V_1 = h_{11} I_1 + h_{12} V_2 \qquad (1)$$

$$I_2 = h_{21} I_1 + h_{22} V_2 \qquad (2)$$

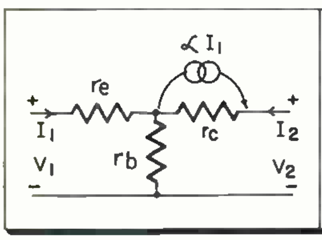
The "h" parameters are defined in the following way:

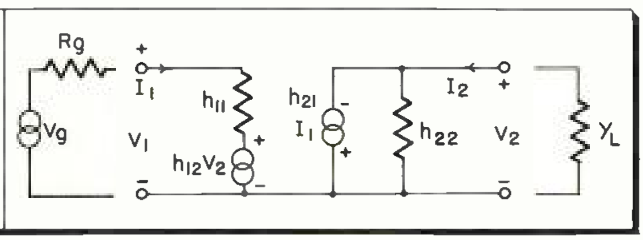
$$h_{11} = \left.\frac{\partial V_1}{\partial I_1}\right]_{V_2=0}$$ = input resistance, output short-circuited.

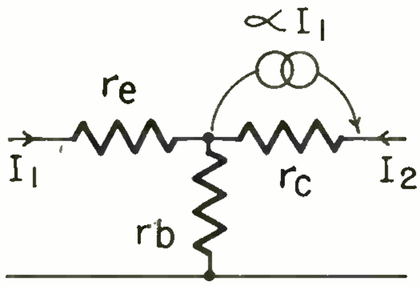
$$h_{12} = \left.\frac{\partial V_1}{\partial V_2}\right]_{I_1=0}$$ = voltage feedback ratio, input open circuited.

$$h_{21} = \left.\frac{\partial I_2}{\partial I_1}\right]_{V_2=0}$$ = short-circuit current gain.

Fig. 2: (l) Tee network representation of transistor. Fig. 3: (r) Hybrid parameters of transistor







$$h_{11} = r_e + r_b\,(1 - \alpha)$$

$$h_{12} = \frac{r_b}{r_b + r_c} \doteq \frac{r_b}{r_c}$$

$$h_{22} = \frac{1}{r_b + r_c} \doteq \frac{1}{r_c}$$

$$-h_{21} = \alpha$$

$$1 - \alpha = \frac{1}{1 + \beta}$$

Fig. 4: Grounded base

$$h_{22} = \left.\frac{\partial I_2}{\partial V_2}\right]_{I_1 = 0} = \text{output admittance, input open-circuited.}$$

Transistors can be used in the grounded base, grounded emitter, or grounded collector configuration. The relation of the small-signal equivalent resistances of the transistor to the hybrid parameters will depend upon the configuration used. Grounded base hybrid parameters will be denoted by small h's, grounded emitter parameters by small h's primed, and grounded collector parameters by small h's double primed. Figs. 4, 5, and 6 show the tee networks corresponding to the three cases. The hybrid parameters are given with each figure in terms of the transistor small-signal resistances.

Simplified expressions for power gain, power output, voltage and current gain, and input resistance will be obtained in terms of the "h" parameters. These can in turn be related to the small-signal transistor resistances if desired. It should be noted that h_{21} is negative for the grounded base and grounded collector configurations.

Circuit Equations

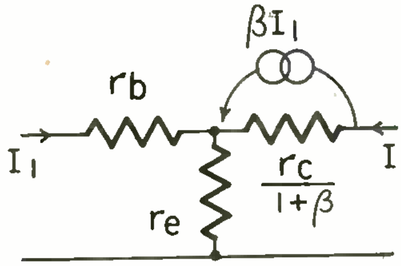
For the circuit of Fig. 3 with a load of admittance $Y_L = 1/R_L$ we have, since $V_2 = -I_2R_L$,

$$I_1 = \frac{V_1}{h_{11} - \dfrac{h_{12}\,h_{21}}{h_{22} + y_L}} = \frac{V_1}{R_{IN}} \qquad (3)$$

$$R_{IN} = \text{Input resistance} \qquad (4)$$

$$= \frac{V_1}{I_1} = h_{11} - \frac{h_{12}\,h_{21}}{h_{22} + y_L}$$

$$I_2 = \frac{h_{21}\,I_1}{1 + h_{22}/y_L} = \frac{h_{21}\,V_1}{R_{IN}\,(1 + h_{22}/y_L)} \qquad (5)$$



$$h_{11}' = r_b + r_e\,(1 + \beta)$$

$$h_{12}' = \frac{r_e\,(1 + \beta)}{r_c}$$

$$h_{22}' = \frac{(1 + \beta)}{r_e + r_c\,(1 + \beta)} \doteq \frac{1 + \beta}{r_c}$$

$$h_{21}' = \frac{\alpha}{1 - \alpha} = \beta$$

$$\alpha = \frac{\beta}{1 + \beta}$$

Fig. 5: Grounded emitter

$$V_2 = \frac{-h_{21}\,V_1\,R_L}{R_{IN}\,(1 + h_{22}/y_L)} \qquad (6)$$

From these the following are obtained. The driving power applied to the input terminals, P_{in}

$$P_{IN} = V_1^2/R_{IN} \qquad (7)$$

The power, P_L, delivered to the load R_L.

$$P_L = I_2^2\,R_L = \frac{(h_{21}\,V_1)^2\,R_L}{[R_{IN}\,(1 + h_{22}/y_L)]^2} \qquad (8)$$

The voltage gain, A_v.

$$A_v = V_2/V_1 = \frac{-h_{21}\,R_L}{R_{IN}\,(1 + h_{22}/y_L)} \qquad (9)$$

The current gain, A_i.

$$A_i = -I_2/I_1 = \frac{-h_{21}}{1 + h_{22}/y_L} \qquad (10)$$

The power gain, PG.

$$PG = \frac{(h_{21})^2}{(1 + h_{22}/y_L)^2}\,\frac{R_L}{R_{IN}} = A_v\,A_i \qquad (11)$$

$$= A_i^2\,\frac{R_L}{R_{IN}} = A_v^2\,\frac{R_{IN}}{R_L}$$

Approximate Equations for Power Gain, Voltage Gain, Current Gain, Input Resistance:

If

$$h_{11} >> \frac{h_{12}\,h_{21}}{h_{22} + y_L} \qquad (12)$$

then

$$R_{IN} = h_{11} \qquad (13)$$

and

$$I_2 = \frac{h_{21}\,V_1}{h_{11}\,(1 + h_{22}/y_L)} \qquad (14)$$

If, in addition $y_L >> h_{22}$, then (15) $I_2/V_1 = h_{21}/h_{11}$ which we will denote by S_{21}, calling S_{21} the forward transconductance. For applications in which

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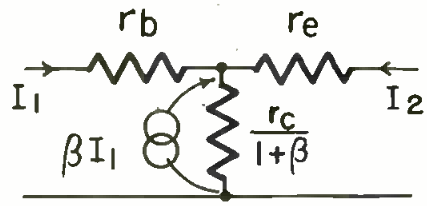

$$h_{11}'' = r_b + r_c\,(1 + \beta)$$

$$h_{12}'' = \frac{r_c}{r_e + r_c\,(1 + \beta)} \doteq 1$$

$$h_{22}'' = \frac{1}{r_c\,(1 - \alpha)} = \frac{1 + \beta}{r_c}$$

$$h_{21}'' = \frac{-1}{1 - \alpha} = -(1 + \beta)$$

Fig. 6: Grounded collector

Table 1: Grounded Base to Grounded Emitter

$$h_{11}' = \frac{h_{11}}{1 + h_{21}}$$

$$h_{12}' = \frac{h_{11}\,h_{22}}{1 + h_{21}} - h_{12}$$

$$h_{21}' = \frac{-h_{21}}{1 + h_{21}}$$

$$h_{22}' = \frac{h_{22}}{1 + h_{21}}$$

Table 2: Grounded Emitter to Grounded Base

$$h_{11} = \frac{h_{11}'}{1 + h_{21}'}$$

$$h_{12} = \frac{-h_{11}'\,h_{22}'}{1 + h_{21}'} - h_{12}'$$

$$h_{21} = \frac{-h_{21}'}{1 + h_{21}'}$$

$$h_{22} = \frac{h_{22}'}{1 + h_{21}'}$$

Table 3: Grounded Base to Grounded Collector

$$h_{11}'' = \frac{h_{11}}{1 + h_{21}}$$

$$h_{12}'' = 1$$

$$h_{21}'' = \frac{-1}{1 + h_{21}}$$

$$h_{22}'' = \frac{h_{22}}{1 + h_{21}}$$

$$h_{21} = -\alpha \qquad h_{21}' = \frac{\alpha}{1 - \alpha}$$

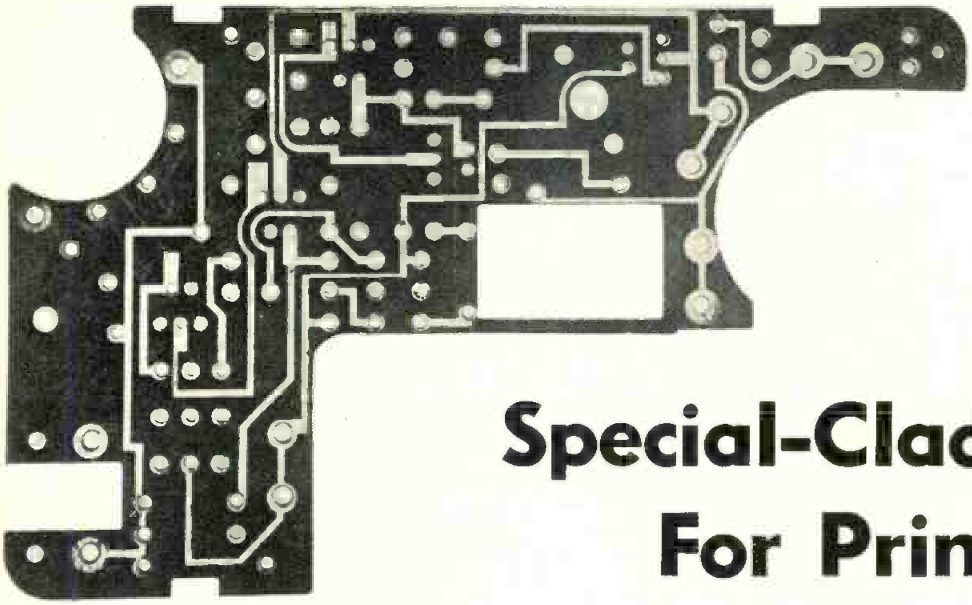

Fig. 1: Intricate hole pattern illustrates superior punching characteristics of this stock

(Photo courtesy of National Vulcanized Fibre Co.)

Special-Clad Laminates For Printed Circuits

Printed circuits are being used under extreme conditions of heat, humidity, shock and stress. To meet these conditions a number of special laminates have been developed. Their technical characteristics and applications are described here.

By W. H. HANNAHS

METAL clad laminate is a comparatively simple material, yet the list of requirements placed upon it is lengthy and also diverse because of the diversity of environment in which we find electrical printed circuits placed. In radio sets we demand a large area at low cost; in TV, the same, with further requirements of non-warpage for larger areas. In missile assemblies high temperature resistance takes precedence and in most military equipment moderately high temperature endurance is expected along with exceptional resistance to moisture, fungus, heat shock and like conditions of exposure to nature.

The endurance of processing and maintenance techniques also enters into the selection of a laminate. The degree of these considerations has been explored in previous reports.[1]

Many of the applications and also the production of printed circuits by the selective etching of copper-clad laminate have been previously described.[2,3] The manufacture of the base stock by laminators is predicated on the use of large presses and continuous coating equipment by which the plastic resins are first applied to craft paper, alpha paper, glass fiber cloth or glass felt (mat).

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After release of solvents from the coated web by drying in a continuous oven, cut sheets are stacked in groups between separator sheets and pressed to the required thickness of laminate, using steam heat. Some laminates are produced by high pressures and some by low (or contact) pressures. In some products the copper sheet, with a coating or separate layer of adhesive film, is included during the first pressing and integrally formed with the laminate, while for other clads the metal surface is adhered by repressing after formation of the base laminate.

Special Phenolic Grades

Since NEMA standard XXXP clad laminate has become the work-horse of etched circuit manufacture, extra price advantages accrue to the user of this material because the volume of production has risen. Emphasizing this trend further is to the economic advantage of both maker and user and consequently manufacturers are pushing improvements in XXXP which will remove some of its limitations and extend its utility.

One prime improvement is toward fabrication; some manufacturers are now offering a cold punching clad XXXP, one significance of which is that hole spacing can be maintained to appreciably closer tolerances since thermal expansions upon preheating before punching need no longer be taken into account. The main advantage, of course, is in lowered costs of tooling and working, and the adaptability to automatically programmed punching equipment.

A typical example of the application of a superior punching grade is shown by the intricate pattern of holes in the sample of Fig. 1. This sample is made from a grade now designated XXXP-471 by the National Vulcanized Fibre Co. The electrical properties of this material are well within NEMA limits and very close to the best electrical grades of XXXP made by this company. This stock is also highly resistant to thermal shock, being rated for 8-13 seconds on 250°C. solder. For a comparison of values, see Table 1. Other companies also offering a cold punching XXXP are Formica and Continental-Diamond.

Fig. 2: Variation of insulation resistance under conditions of 90% relative humidity

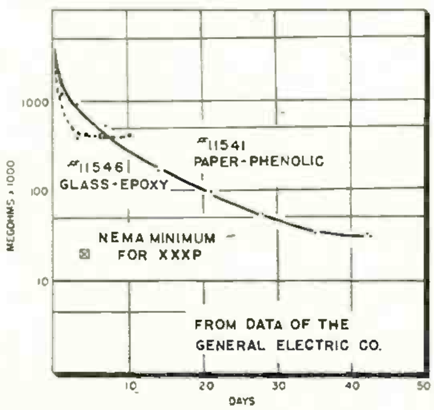


Table 1: Special* (& Standard) Clad XXXP

Base Material Grade	Peel Strength (lbs.) 2 oz. cop.	Max. °C. Temp. Cont.	Dissip. Factor 1 MC	Diel. Const. 1 MC	F.S. psi X 1000	Punching Quality
XXXP-455	6-12	121	.026	4.0	23½	Fair
XXXP-460B	6-12	121	.029	4.2	19	Fair
*XXXP-219C	6-12	121	.030	4.5	15½	Good
*XXXP-471	6-12	121	.027	3.8	14	Excellent

National Vulcanized Fibre Co., Wilmington, Delaware

Table 2: Special Clad-Phenolics

Material	Peel Strength (lbs.) 2 oz. cop.	Max. °C. Temp. Cont.	Water Absorp. % /24 hr.	Dissip. Factor	Diel. Const.	Ins. Resis. (megohms) 96/35/90	F.S. psi X 1000
Canvas CE	2-3.5	*121*	2.2				*17*
Linen L	8.7	*107*	2.5				*15*
Linen LE	*7*	*121*	*1.95*	.055	*5.8*	*30*	*15*
Post Forming XX-Spec.			*4.4*				*15*
Nylon N-1	4-7	74	0.2	.03	3.3	5 x 10^4	16
Glass-Phenolic (modified) Flexible	6-8					10^6	

Note: Bold face are typical commercial values, Italics are NEMA limits for 1/16 in. stock.

Table 3: Special Clad-Laminates

Material	Peel Strength (lbs.) 2 oz. cop.	Max. °C. Temp. Cont.	Water Absorp. % /24 hr.	Dissip. Factor 1 MC	Diel. Const. 1 MC	Ins. Resis. (megohms) 96/35/90	Arc. Resis.
Glass-melamine G-5	5-8	135	.6	.030	6.8	100	Good
Glass-epoxy (MLP-187-77)	6-7	175	.24	.018	4.75	10^5	Good
Glass-silicone G-7	1-4	150	.20	.015	3.9	2,500	Good
Glass-Teflon	5-9	200	0.2	0.0006	2.85	500,000	V. G.
Mycalex	15						Good
XXXP	6-18	125	.7	.028	4.0	7 x 10^4	Poor

Table 4: Epoxy Clad Laminate—Epoglas

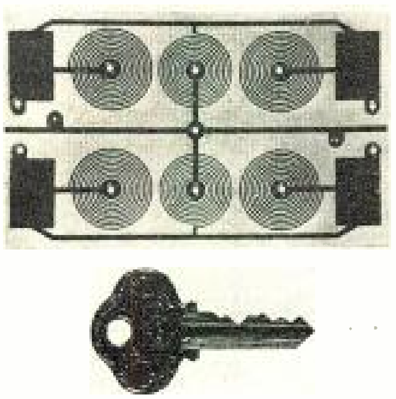
Test	Results
Water Absorption, ⅛ in*	0.03-0.05 %
Flexural Strength, ⅛ in.	66,000-70,000 psi.
Bond Strength, peel on 1 in. strip	min. 10 lbs.
Dielectric Constant, 1 MC	4.95-5.05
Dielectric Strength, kv	45-55
Power Factor, 1 MC	0.022 - 0.028
Insulation Resistance, ½ in., as received	1.8 x 10^6 megs.
Surface Resistivity, ⅛ in., as received	1 x 10^7 megs.
** conditioned	2 x 10^8 megs.
Arc Resistance	100 secs.

*Conditioned for one hour at 105°C. plus 24 hrs in distilled water at 23°C.
**Conditioned for 96 hrs at 35°C. and 90% Relative Humidity.
Rowland Products Inc., Plastilight Div., Kensington, Conn.

In connection with this, it should be mentioned that cold punching varieties of epoxy and polyesters are also available.

An exceptional insulation resistance grade of paper-phenolic, designated Textolite 11541, is produced in clad form by the General Electric Co., Coshocton, O. Just how well this phenolic performs in a 90% Relative Humidity at 35°C. may be seen from the graph of Fig. 2 where this laminate is shown together with that company's glass-epoxy material under ASTM D257 conditions. The measurements were made with the samples remaining in the humidity chamber. For comparison, the permissible NEMA minimum for XXXP insulation after 4 days is shown. While limits for ordinary XXXP out to 40 days exposure are not available, the dropoff is known to be quite steep.

Fig. 3: Printed circuit interference filter
(Photo courtesy of Photocircuits Corp.)



A second variation in phenolic laminates is offered by the clad postforming grades. Generally the facility to hot bend or form a laminate is obtained only by some lowering of both electrical and bond strength requirements from the XXXP level. This naturally results when softer resins must be used for both base and adhesive in order to get bends of reasonably small radius without cracking. Since cloth provides intrinsically more yield than paper, some clad cotton phenolic (C, CE, or preferably LE grade) material is being sold for this application. Removal of copper from the area of inside bends prior to forming is a generally recommended practice to preclude wrinkling. The procedure varies, however, with the individual product. The Formica Co. recommends 2 oz. copper to reduce tearing on bending and also stipulates that both sides be clad to prevent excessive warp. Formica products include a clad postforming stock having two different adhesives on the opposite faces. Forming using this construction can approximate a ½ in. bending radius.

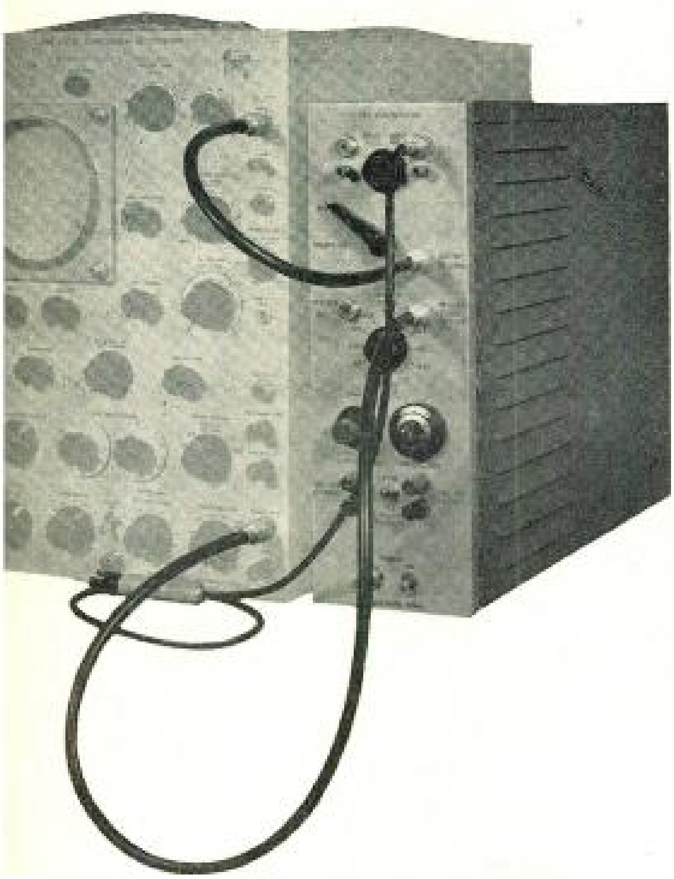
Very little electrical data is obtainable on postforming stocks excepting those shown on Table 2 which are largely NEMA limiting values. Typical commercial values may be expected to be better.

Aside from post forming, the copper clad cloth-phenolics also find usage where exceptional machining or staking operations dictate higher impact or flexural strength rather than the best electrical properties.

The exception to the latter is found in nylon phenolic (Table 2) which has insulation resistance under humid conditions exceeding all other NEMA phenolics. Its limitation lies in a comparatively low temperature limit set by the nylon.

The last item on Table 2 is a very thin flexible clad stock made with a single ply of #116 glass cloth and a phenolic modified for flexibility. This material is supplied by the Photocircuits Corp. in 19 in. x 23 in. sheets in thicknesses of 0.006 in.

(*Continued on page 126*)



Pulse Calibrator

Precise measurement of short-duration pulses is made possible by this easily-constructed line-type calibrator which uses a discharge pulse from a storage line as a calibrating source of known pulse height.

By C. W. SCHULTZ and G. B. SMITH

Fig. 1: Calibrator is designed to stand on input side. Signals are fed through calibrator to scope

THERE are two reasons why the precise measurement of short-duration pulses by oscilloscope is difficult; (1) a difference between deflection obtained from the unknown pulse and that obtained from an equal longer-duration calibrating voltage, and (2) inability to measure the calibrating voltage precisely. The first of these difficulties can be minimized by the use of an oscilloscope with maximum bandwidth, but the observer cannot always recognize distortion of the pulse. There may also be amplitude distortion, especially when the oscilloscope zero line is far off center.

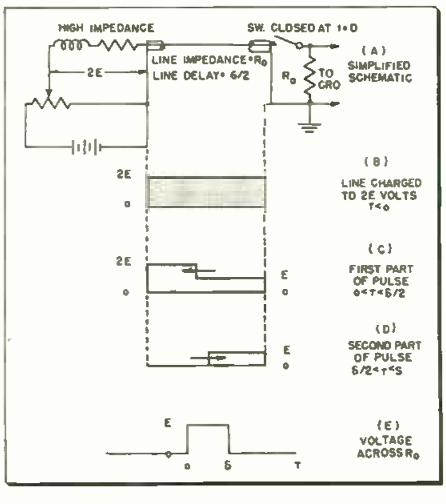
The line-type calibrator shown in Fig. 1 overcomes both of the above difficulties and is relatively simple to construct. Measurement is made by adjusting a short, precise calibrating pulse to obtain deflection equal to that of the unknown with rise time no greater than the unknown. Pulse voltages as low as 10 mv are easily produced with 1% accuracy by a helical potentiometer. All calibrating voltages are obtained from a direct voltage reading.

Calibrator Design

The pulse-forming element of the calibrator is a distributed line which is charged to a precise direct voltage and discharged through its characteristic resistance. The pulse is generated immediately after the terminating resistance is connected to the charged line. A relay with mercury-wetted contacts is suitable for switching, because the contact is established in 0.001 µsec or less and without bounce. A distributed line with low attenuation must be used to obtain a calibrating pulse whose top is "flat"; RG-8/U coaxial cable has been found suitable for lengths up to 100 ft. The spirally-wound type of delay cable appears to have too great attenuation per foot and too small cut-off frequency for the generation of suitable pulses.

The amplitude of the calibrating pulse is exactly one-half of the charging voltage when the line is matched, and the duration of the pulse is twice the transmission time of the line (see Fig. 2). Proper termination is observed by the absence of reflection in the calibrating pulse, and is readily adjusted with high oscilloscope gain. The ideal shape of the pulse in Fig. 2(e) would be vertical sides and a flat top, but physical dimensions of the switching relay limit the rise time to approximately 0.01 µsec. Because the cable from the terminating resistor R_o to the oscilloscope may introduce damped oscillation following the leading and trailing edges of the pulse, the oscilloscope cable should be made short. In addition, a series resistance of 100 ohms inserted in the oscilloscope cable at the R_o- end will reduce the rise time at the oscilloscope to approximately 0.02 µsec and stop the "ringing."

Fig. 2: Simplified diagram of voltage distribution along pulse-forming line



Calibration pulses illustrating the range of pulse heights available are shown in Fig. 3.

Complete Calibrator

Because it was intended for continuous use on every unknown short-duration pulse to be measured, the calibrator, shown in Fig. 1, was designed to stand on the input side of the oscilloscope, and input signals pass through the calibrator to permit switching from "Operate" to "Calibrate" on the calibrator panel. The mercury-wetted relay has overlapping contact time between the

C. W. SCHULTZ and G. B. SMITH, J. P. Seeburg Corp., 1500 N. Dayton St., Chicago 22, Ill.

for Wide Band Oscilloscopes

back and front contacts so that manual selection between "Operate" and "Calibrate" is necessary. Persistence of the trace on the oscilloscope screen permits the observer to compare pulses and adjust the calibrate pulse height (see Fig. 4) until it is equal to the unknown. To permit horizontal alignment of the two pulses, a tapped delay line in the external synchronization (see "Ext. Sync." in Fig. 4) provides delay of the signal sweep. The correct value of delay is selected by observation of the screen. The calibrator is useful for measurement of pulses whose durations lie between 0.1 and 15 µsecs. The reference voltage from which the pulse-forming line is charged must be measured with d-c voltmeter whose precision is at least as good as the pulse measurement required. Below 1v a helical potentiometer is recommended, because direct readings of high precision are not conveniently read on d'Arsonval type meters.

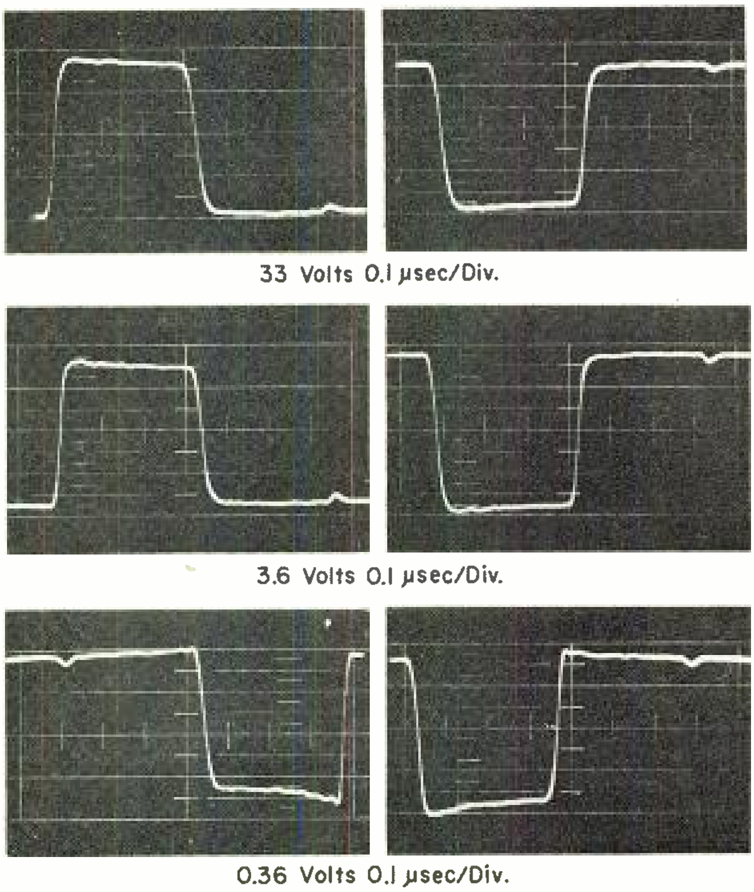
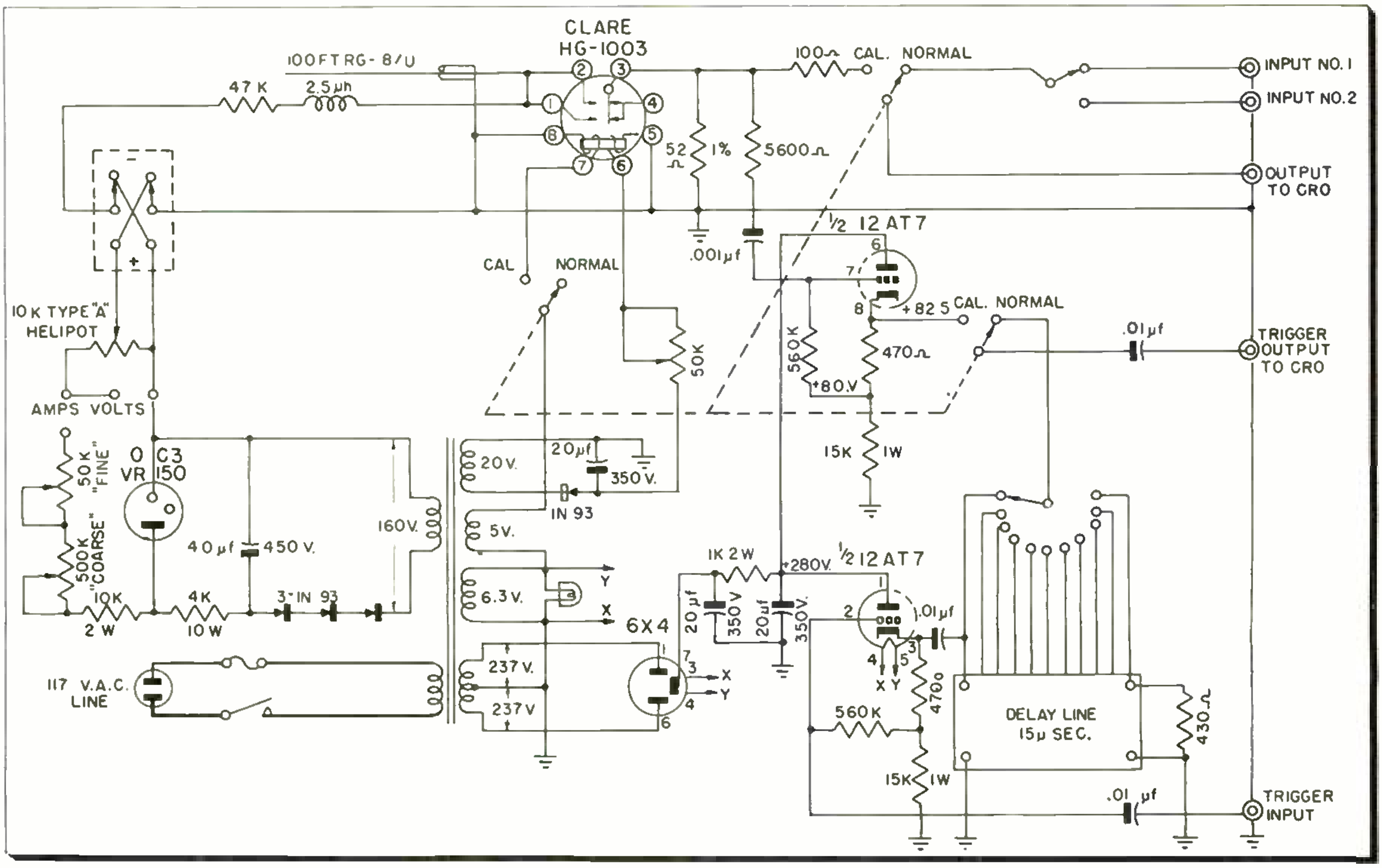


Fig. 3: Wide range of pulse amplitudes is available

Fig. 4: Schematic diagram. Reference voltage for pulse-forming line must be measured to precision required of pulse height measurement



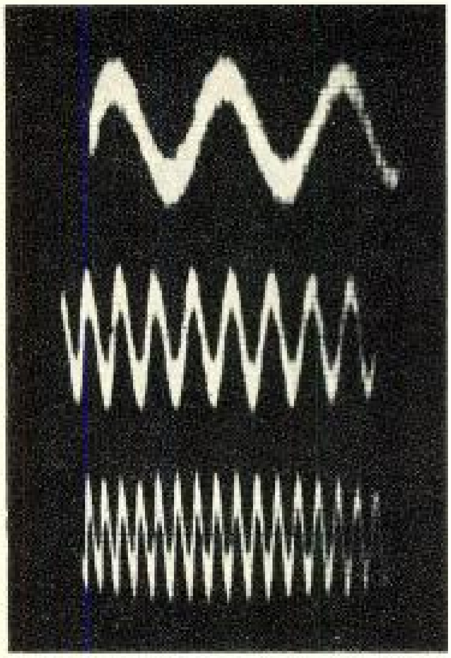


Fig. 1: 1 μv RMS signals observed on screen with preamp. Frequencies: 3.6 KC, 10.8 KC, 21.6 KC. Bandpass: 20 CPS to 60 KC. Input impedance: approx. 1,000 ohms. Generator resistance: 10 ohms. RMS noise voltage, referred to input: 300 mμv.

The "Hushed" Transistor Amplifier

By W. K. VOLKERS and N. E. PEDERSEN

Part One Of Three Parts

Transistors have been considered to be inevitably more noisy than vacuum tubes. This article contends that the fault lies, not with the transistor, but in improper operation. Described is a mode of operation that results in a noise figure lower than that of low-noise triodes.

ALTHOUGH transistors have begun to compete effectively with and to replace vacuum tubes, their advance has been held back noticeably by three unfavorable characteristics which they possess: one is their high noise in comparison with vacuum tubes, the second their unfortunate increase of noise voltage amplitude with decreasing frequency, and the third their low input impedance. In their favor, on the other hand, are such characteristics as small size, small weight, and very small power consumption.

This article will describe the results of a joint development which has brought about a drastic improvement of at least two of the three unfavorable transistor characteristics mentioned, namely: excessive noise and the 1/f noise voltage amplitude characteristic.

As a result of this development, we now have transistor amplifiers which excel the most noise-free vacuum tube amplifiers as far as noise voltage, referred to the input, is concerned. This is even true in the two extreme possible input circuit conditions, shorted input and open circuit. To give you an example, we have measured wide band noise voltages over a 30 KC passband (referred to the input), as low as 250 mμv, with the input shorted, and 500 mμv with the input open, input impedance being 1200 ohms. Obviously, we cannot state noise figures for these two extreme input circuit conditions because, according to its definition, noise figure cannot be expressed for these two conditions. But later we will show noise figure measurements under measurable circuit conditions which assume very low values indeed, particularly under optimum input circuit loading conditions.

In Fig. 1 you see the performance of an average rather than the very best "hushed" transistor amplifier

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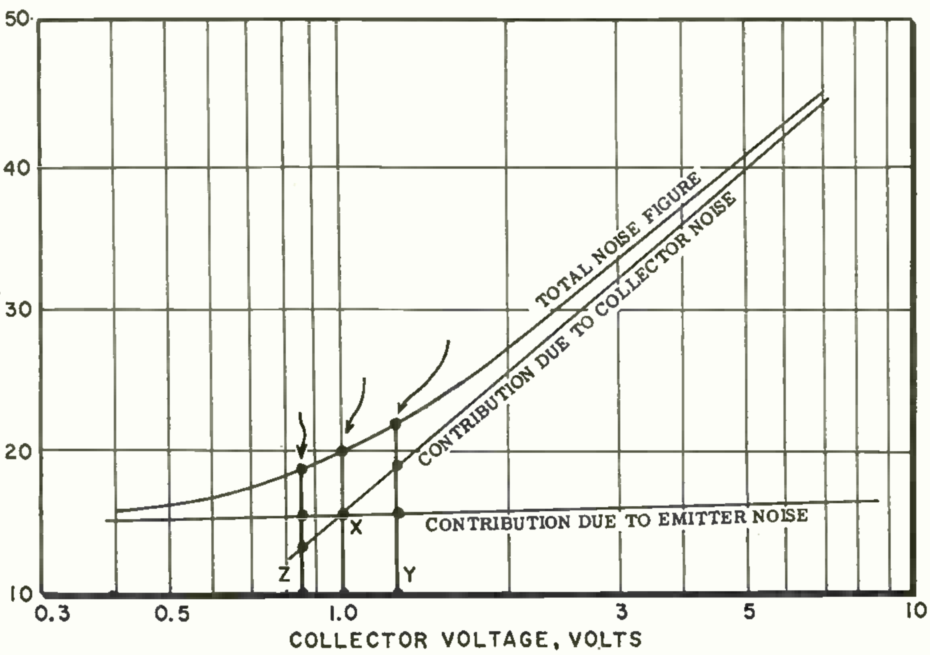
Fig. 2: Contributions of emitter noise and collector noise to total noise figure



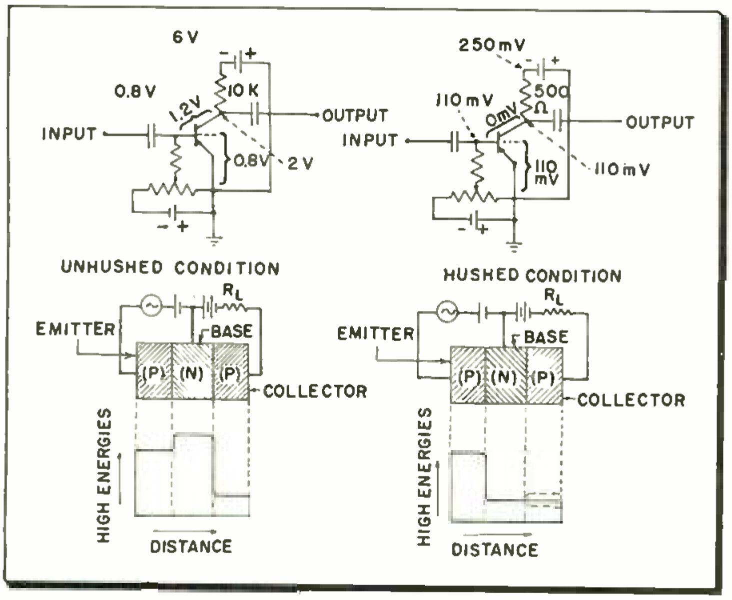


Fig. 3: Voltage distribution between transistor elements for "hushed" and "unhushed" operation

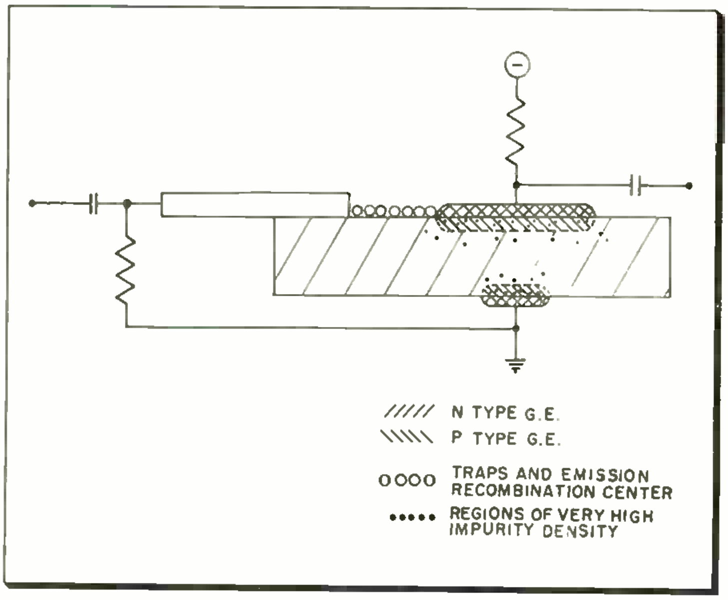


Fig. 4: Locating traps and regions of emission re-combination traps, and high impurity density

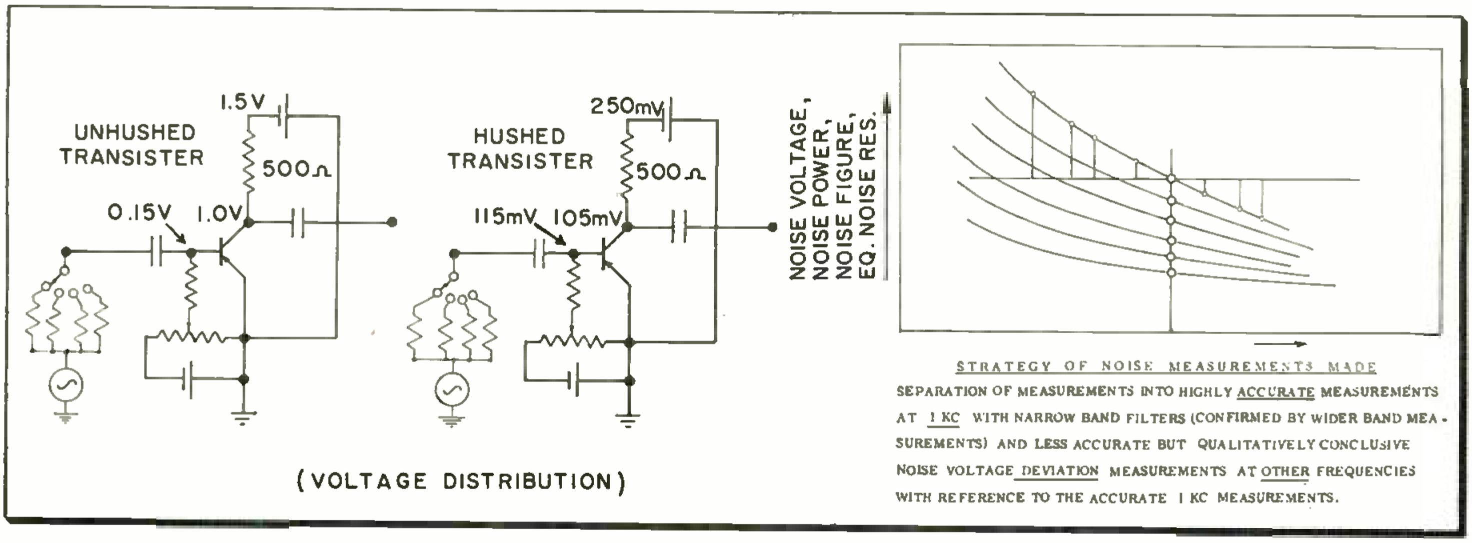
which we have been able to produce; yet, in comparison with vacuum tube performance, it shows a remarkably low noise. Its input here is practically shorted, our generator resistance being only 10 ohms. The passband is 60 KC, input impedance 1000 ohms and the noise voltage, referred to the input terminals, is 330 mμv. The three frequencies reproduced here on the scope screen are 3.6 KC, 10.8 KC, and 21.6 KC.

This is a standard Raytheon CK-721 junction transistor, having a rated noise figure of (max) 22 db. When operated with customary voltage, current and power parameters, its noise voltage would fill the screen completely, making the three 1 μv signals indistinguishable. Yet, here it has been "hushed" below the noise level of the best low-noise vacuum tubes available today. How can we "hush" an ordinary junction transistor?

Most of you are probably familiar with the representation taken from Shea's book[1] of the contributions to transistor noise figure by the two main noise sources within a transistor, namely, emitter noise and collector noise, with reference to collector voltage. We see in Fig. 2 that the contribution of emitter noise toward total noise figure increases very slightly with collector voltage while the contribution due to collector noise increases drastically, for instance between the values of 1 v. and 7 v., where the increase, in this particular instance, is 30 db. The increase of emitter noise contribution over the same collector voltage range of 1 v. to 7 v. is only in the order of 1 db. In analyzing the curves in this illustration, it should be noted that there is an intersection "X" between the steep characteristic representing collector noise contribution and the rather flat characteristic representing emitter noise contribution. This intersection, in this particular case, happens to be at 1 v., although its actual location will vary considerably among individual transistors as well as between different types of transistors. In the latest transistors we find that the intersection is generally well below 1 v. It stands to reason that, in order to reduce transistor noise figure, we should seek a collector voltage operating point (marked "Y" on this slide) at which the contribution, due to collector noise, rises as little as possible above the contribution due to emitter noise . . . in other words, an operating point not much beyond a collector voltage of 1 v. Better still would be an operating point "Z" below the intersection of the steep collector contribution characteristic and the nearly flat emitter noise contribution line . . . in other words, a point below 1 v. collector voltage. To propose such an operating point, and to use it in reality, would be reasonable only if the transistor would still provide a useful voltage or power gain.

In "hushed" transistor operation

Fig. 5: Comparative measurements with same transistor in "hushed" and "unhushed" conditions



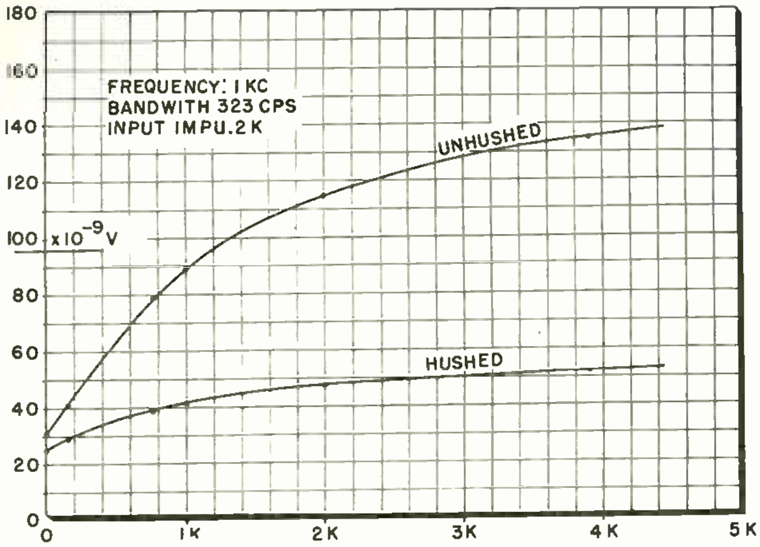


Fig. 6: 1 KC input noise voltage; generator resistance varying between 0 and 3½ X input impedance

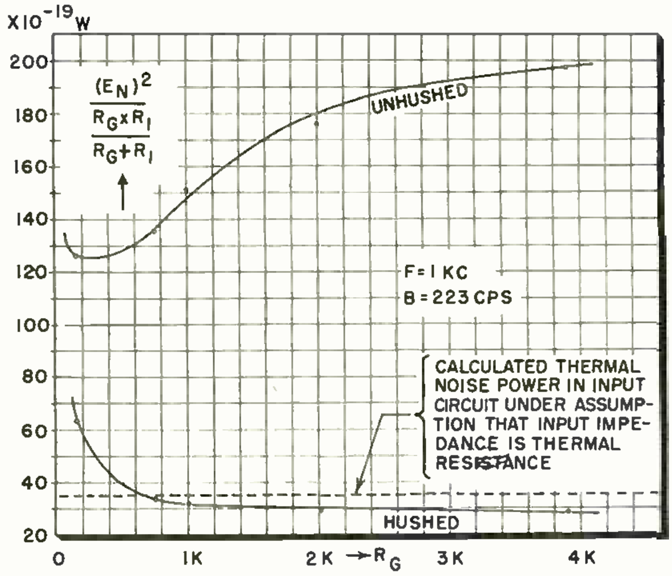


Fig. 7: Total measured noise power, referred to input as function of generator resistance

"Hushed" Amplifier (continued)

this is indeed the case. As a matter of fact, we carry this principle to an extreme which, at first sight might appear senseless, unless the results are known. On the right side of Fig. 3 is shown the voltage distribution between the three transistor elements: base, emitter, and collector, of a typical hushed PNP transistor (in a grounded emitter circuit). On the left you see the corresponding voltage distribution among the elements of an "unhushed," or conventionally operated, PNP transistor.

In the hushed condition, on the right, we have an exceptionally low supply voltage, only 250 mv, also an unusually low load resistance, only 500 ohms. The most unusual aspect of the hushed condition, however, is that the collector voltage, 110 mv, and the base voltage, 110 mv, are identical. In other words, we have a zero voltage drop across the collector junction. The voltage gain of such a hushed transistor, in spite of the low driving voltage of 250 mv and a zero voltage drop across the collector junction was measured to be 2.5 to 10 with various transistors tested by us; in other words, it is definitely a useful voltage gain. Furthermore, since we have measured input impedances ranging anywhere between 500 ohms and 2000 ohms, we also have a very definite power gain.

Turning to the left side of Fig. 3, we see the conventional voltage distribution of a transistor in the unhushed condition. Here we have a 6 v. collector supply, a collector voltage of 2 v. and a base voltage of 0.8 v. The load resistance is 10K. The gain in this normal, or unhushed condition, is, of course, much greater. A typical voltage gain, in this instance, would be 200.

Comparison

In analyzing these two drastically different operating conditions of the same transistor, we can draw several important conclusions:

(a) In the hushed condition, we have now achieved an operating point not only similar to but actually way beyond the point "Z" in Fig. 2; that is, an operating point at which the normally dominating collector noise has been reduced to an extent where it contributes substantially less to the total noise than the naturally low emitter noise. Yet a useful voltage and power gain exists.

(b) Our low load resistance of 500 ohms in the hushed condition assures us of a low stage output impedance. It cannot be more than 500 ohms regardless of collector resistance. If the transistor output impedance is substantially lower than 500 ohms, our stage output impedance would approach the order of such a low transistor impedance. As far as interstage voltage amplification is concerned we are assured of an output impedance of 500 ohms maximum, while our input impedance measurements, in the hushed condition, vary between 500 ohms and 2000 ohms as stated. When cascading hushed transistors, using conventional R/C coupling networks, we can therefore expect a worst voltage loss of 50%. In reality, our experience has shown that it is seldom more than 25%. We therefore begin to approach the usual pattern of impedance ratio encountered in cascaded vacuum tube amplifiers.

Fig. 8: Noise Voltmeter used in measurements

Turning now to the unhushed condition on the left side, the impedance mis-matching situation, for voltage amplification, when cascading, is only too well known to those who have designed cascaded transistor amplifiers in resistance-coupled circuits. It needs no further elaboration.

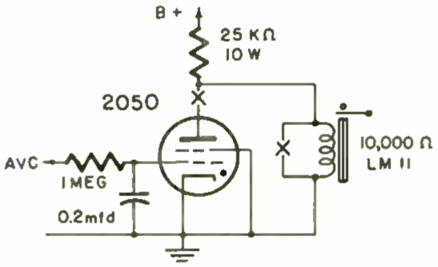
(c) The low output impedance of the hushed transistor favorably influences its upper frequency response limit because unavoidable external shunting capacities and internal shunting capacities will usually not create a frequency cutoff below the possible maximum frequency cutoff set by transit time. In the unhushed condition, at least as far as grounded emitter operation is concerned, severe frequency response limitations, due to capacitive shunting, are often unavoidable.

(d) A noise comparison between

(*Continued on page* 156)

CUES for BROADCASTERS

Practical ways of improving station operation and efficiency



Tube ionizes when carrier is cut

Thyratron Conelrad Alarm

HAROLD E. ALLEN, Ch. Engr.
KGDE, Fergus Falls, Minn.

THE simple circuit arrangement shown, employing a thyratron type 2050 tube, makes a reliable Conelrad alarm control device. It is not so critical to adjust as the twin-triode circuit commonly used. AVC holds the grid negative as long as carrier is received. When the carrier is cut, absence of negative voltage on grid causes tube to ionize. When the tube ionizes anode to cathode voltage drops to about 8v. Once ionized the grid loses control and the relay remains open until reset. Reset may be accomplished either by a normally open push button across relay or a normally closed push button in series with plate lead. The thyratron circuit has all the fail-safe features of the twin-triode circuit save one: removal of tube will not cause relay to open. Lack of sufficient emission in the thyratron or section of dual triode biased to cut-off can render either system inoperative. When used in prolonged service either type should be checked for emission capability periodically to insure complete security.

"Freezing" of 45' Adapter

H. E. HERRON, Ch. Engr.
KCIL, Houma, La.

WE use the Gates CB-11 turntables, equipped with adapters for 45 rpm speed. We found that after the turntable was in use for a short time it was impossible to remove the brass plug-in adaptor from the motor drive pulley, due to the metal expanding from heat friction. Non-technical personnel consistently ruined the adapters by removing them with pliers. The 33 rpm drive pulley was first filed evenly very slightly, being cautious not to file too much and change that speed. The expansion tip on the plug-in adaptor was also filed slightly. Then a small amount of General Cement Lubriplate was placed in the plug cavity of the motor drive pulley. The turntables were placed in operation to allow all excess lubricant to be forced out and removed. This step was repeated until there was no excess lubricant and all associated parts were cleaned with carbon tetrachloride. Since this was done, both turntables have been operated at long periods and the plugs were still removable by hand. The turntable speed was checked with a stroboscope and all speeds checked perfectly.

$$$ 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.

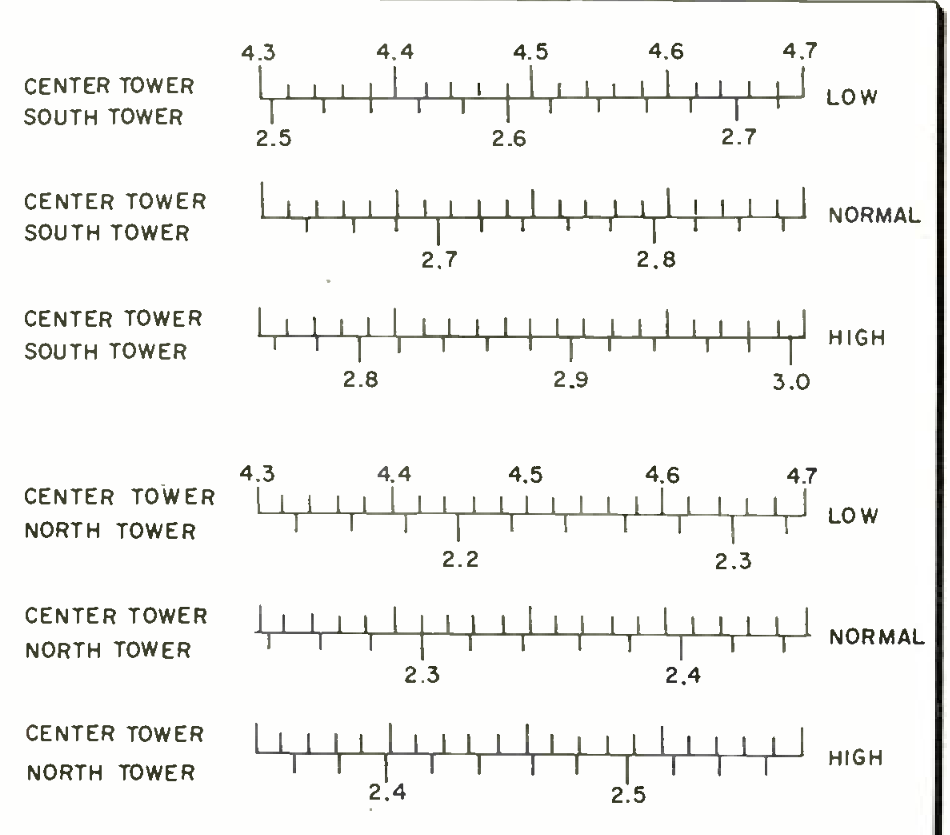
Scales Speed Tower Base Current Readings

MARSHALL W. HUGHES
WISC, Madison, Wis.

IN AM stations employing directional antenna arrays, it is usually specified in the station license that the actual tower base currents be read and logged one or more times daily. Checking the actual base current values for compliance with the required ±5% tolerance is not so simple. It requires reference to a prepared graph, or computation, each time the base currents are read. We have recently prepared a set of scales as shown, which we have found more accurate and easier to use than the graph previously used. It is only necessary to find the value of reference tower current on each of the two scales (high and low),

(*Continued on page 134*)

Daily checks on tower currents are made quickly on this graph



PHASE MONITOR READINGS

	PHASE			RATIO		
	HIGH	NORM.	LOW	HIGH	NORM	LOW
NORTH TOWER	-27.8	-25.5	-23.5	.700	.665	.631
SOUTH TOWER	+22.5	+20.5	+18.5	.720	.685	.650

100 Rules For Improving Man-Machine Effectiveness

By W. WOODSON

To obtain reliable human performance in a man-machine system, the man must be able to work within his characteristic tolerances. The following rules define those conditions under which the man-machine combination will operate with the greatest over-all reliability.

Visual Displays

1. Visual indicators should be mounted as nearly perpendicular to the line of sight as possible.
2. Numerals on fixed visual displays should be mounted so that they do not have to be read upside down.
3. Use numeral and letter designs which have simple configurations similar to Leroy lettering guides. Avoid extra flourishes.
4. Use capital letters for labels but use standard capitalization and lower case type for extended text material.
5. Scale graduation should not be finer than is necessary within the accuracy of the instrument itself.
6. Separation between indices and numerals on a dial should be sufficient for accurate reading.
7. Instrument pointers should be designed to reduce reading parallax. They should not overlap numerals or indices.
8. Irregular scale breakdowns should be avoided.
9. When several instruments must be read at once as in check-reading, orient the instruments so that the "normal" operating positions of all pointers are aligned (preferably at the 9- or 12-o'clock position).
10. Utilize similar numbering and scale progressions for dials which may appear on the same panel.

W. WOODSON, U. S. Naval Electronics Lab., San Diego 52, Calif.

11. Utilize color code techniques to define operating and danger ranges, to simplify check-reading.
12. Use scale breakdowns of units, fives, or tens when possible.
13. Orient scales to make critical ranges appear in the left or upper quadrants so that an increase in reading will progress in the expected direction.
14. For multirevolution dials, orient the zero position at 12 o'clock.
15. Numbering systems should increase from left to right or bottom to top whenever possible.
16. Provide suitable coding or labeling on both the display and control which tells operator which control affects which display.
17. Visual marking on controls should indicate which direction to operate the control.
18. For dials which have a finite scale, provide a definite scale break between the end of the scale and the zero position.
19. Utilize maximum contrast between the color of dial and scale markings and the background of the dial.
20. Dial pointers should be the same color as indices and numbers on the dial.
21. Select counter types in which the numbers "snap" into place.
22. An upward movement of a counter should indicate a numerical increase.
23. Avoid counter designs in which there is an undue amount of space between numerals if the number is to be read as a whole number.
24. Avoid fractions or decimals on dial scales whenever possible.
25. Select counters on which the numbers may be read from left to right.
26. When selecting warning lights, make sure they are compatible with the ambient illumination levels expected. A dim light will not be seen in bright sunlight, and a bright light may be detrimental to dark adaptation. Utilize dimmer controls if necessary.
27. When dark-adaptation is necessary, use red light only (wave-lengths longer than 620 millimicrons).
28. Flash rates for flashing warning lights may vary from 3 to 10 per second, but "duration on" should be at least .05 second.
29. Warning signals should not be obtrusive longer than necessary to attract attention.
30. Critical warning lights should be isolated from other less important lights to be most effective.
31. Ambient illumination surrounding a cathode ray display for detection tasks should be controlled at about 0.1 millilambert.
32. Vibration of visual dispalys should be held to a minimum. Any movement requires simpler display design, higher illumination levels and longer reading time.
33. Counters should be mounted close to the panel so that numbers are not obscured by bezel opening.
34. Don't combine multiple information which does not bear a common relationship.
35. Avoid the use of more than two pointers on a single dial shaft.
36. Provide even illumination of all portions or parts of a dial including the pointer.
37. In dial scale design, the fixed scale with moving pointer is preferred over the fixed index moving scale design.
38. Numeral and scale index designs are dependent upon the reading distance. Use optimum numeral or letter height-width and stroke ratios.
39. Provide a display for showing the operator that the instrument is not operating properly.
40. Up-to-date information is necessary for adequate visual display.

41. Instrument design should minimize mental translations of units and symbols.

42. Changes in visual indications should be easy to detect.

43. When reciprocal readings are necessary from a single pointer, make sure the two ends of the pointer are identifiable.

44. The opening for open-window dial displays should permit viewing at least two numbers at any one time.

45. Keep visual displays as simple as possible within the informational requirement of (1) quantitative, (2) qualitative, or (3) check-type reading.

Control

46. Controls which must be located without visual reference should be positioned in forward areas rather than to the side or behind the operator.

47. Often-used controls should be placed somewhere between elbow and shoulder height.

48. Control movement should be in the "expected" direction; that is, increases should be caused by movement to the right or upward.

49. Control movements and location should be parallel to the axis of the display motion which they affect.

50. Cranks should be designed and positioned with respect to the speed or load which they administer; that is, small cranks at elbow height for fast wrist action, light loads; large cranks oriented for full arm motion.

51. Adjustment-type knobs for electronic equipments should be no more than 2 inches in diameter and should be used only for very light torques.

52. Round knobs should be used for controls requiring smooth continuous movement. Bar- or pointer-type knobs should be used for detent-type switching.

53. Toggle or bat-handle switches should provide at least 30° throw each side of center to give good visual indication of displacement.

54. Brake pedals should be mounted so that the angle between the upper and lower leg of the operator is somewhere between 105° and 135°.

55. Pedals should be pivoted so that control action is similar to the limb or foot motion (near the heel of the foot for ankle motion as for an accelerator pedal, or above the foot for leg motion as in the case of the brake).

56. Control actions should be positive without being sticky or stiff.

57. Joystick movement should be equally free in all directions. Small joysticks on table or desk-top installations should be mounted so that the hand has a resting place for steadying the control movement.

Panel Layout

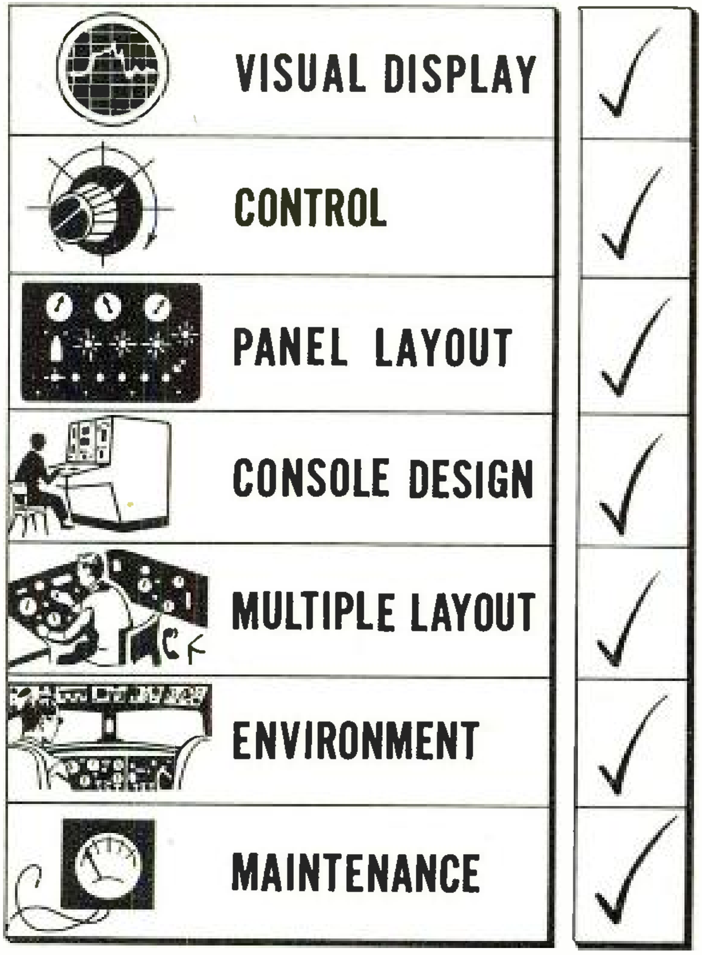
58. Panel layout should be as functionally simple as possible. Compromises of primary position for controls and displays should be considered as a whole in order to see all interactive tasks.

59. Cover those displays and controls which are not absolutely necessary to actual operation.

60. Orient displays at proper eye height and arrange often-used controls near elbow height when possible. Make sure the operator cannot cover a display while manipulating a control.

61. Provide clear legible labels, Use standard abbreviations. Provide illumination where necessary and be consistent in the placement of labels either above or below controls or displays.

This article is the third in TELE-TECH's series on design "Do's" and "Don'ts" for electronic engineers. The previous articles were: "100 Points For Electronic Design Engineers," Nov. 1944; and "27 Rules For Guided Missile Design Engineers," Aug. 1955.



62. Avoid glossy surfaces or highly polished metals. Use anti-glare coating on transparent instrument covers when possible.

Console Design

63. Cabinets, racks, and consoles should be designed with the dimensional statistics of the human operator in mind. Static dimensions are available to the designer, but he must exercise common sense in adjusting these figures to the dynamic situation.

64. Visual displays which are mounted vertically should be between 50 to 70 inches above the floor when they are to be viewed from a standing position.

65. Use a 30-inch seat-to-eye height reference for seated operation relative to location of visual displays, and specify the chair height along with the console dimensions.

66. For a comfortable display mounting angle, use the following rule of thumb: 60° from horizontal for seated operators; 45° for a combination sit or stand and 30° for a straight stand position. These angles provide a good compromise for mounting of displays such as CRT's.

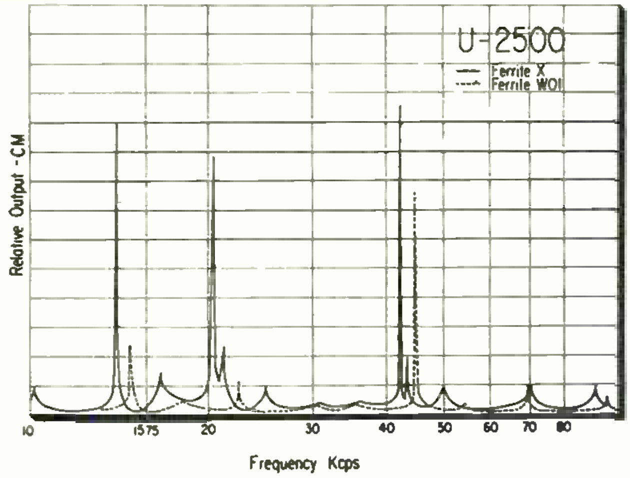
67. Use a 28-inch arm reach, measured from the operator's shoulder, as a limiting figure for the placement of controls which are to be used often.

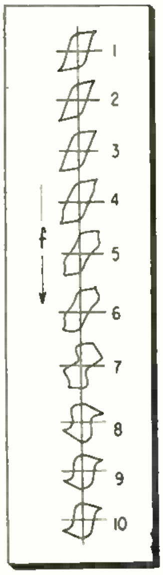
68. Controls should be located near the display which they affect whenever this does not conflict with other manipulatory requirements.

69. Controls should be arranged sequentially with respect to the expected or required order of operation whenever possible. There should be equitable distribution of load or activity for both hands.

70. Control-display organization should be such that visual displays generally occupy central areas, and controls occupy peripheral areas, to avoid hand and arm interference with visual tasks.

(*Continued on page* 137)





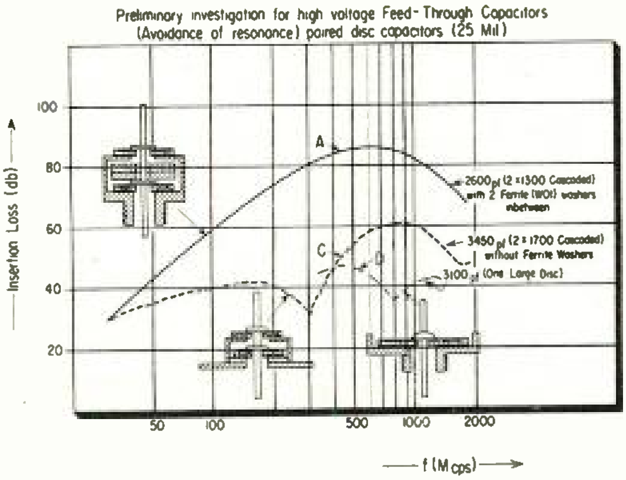


Fig. 1: Magnetostrictive resonance of two U-pieces, U-2500, made of different ferrites

Fig. 2 (r) Warping of hysterisis loops with frequency

Fig. 3: Effect of decoupling ferrite washers in electrically paralleled feed thru caps

By Dr. H. M. SCHLICKE

Design Characteristics of Ferrites

Discussing selected idiosyncrasies of ferrites which are of particular significance to the user. Topics include: magneto- and electro-striction, volume resonance, gyromagnetic resonance and Faraday effect.

THIS article is concerned with high permeativity polycrystalline ceramics—ferrites and ferroelectric dielectrics. It is addressed to engineers already familiar to some degree with these materials. Throughout the article it is easy to see the parallelism between ferroelectrics and ferrimagnetics.

Starting with certain intrinsic mechanisms underlying the behavior of the materials, the possibilities or disadvantages, as the case may be, for practical applications, are considered. In other words, it will deal with certain selected idiosyncrasies of these materials and what they may mean to the user.

Most parameters or apparent parameters of ferrites or high ε dielectrics are complex functions of f, A, T, D, where f stands for frequency, A for amplitude, T for temperature, and D for dimension. Since for most applications several parameters are of interest, and since improving one parameter quite often leads to deterioration of other necessary qualities, arrival at an optimum compromise is often required. A well staffed and equipped manufacturer of ferrites or dielectrics will be extremely curious toward a new request for these materials. He will want to know as much as possible about the operating conditions under which the material will be used, in order to be able to supply the best suitable material. The omission of an apparently insignificant condition may render useless an otherwise highly desirable material. Close cooperation between the manufacturer and the user of the materials is, therefore, indispensable.

Dr. H. M. SCHLICKE, Head, High Frequency Laboratory, Allen-Bradley Co., Milwaukee 4, Wis.

Strictive Resonance

Electrostrictive resonators of bar-

TABLE 1: Ferrites For Medium Frequency, High Flux Density

Average Toroidal Characteristics (Tentative)

Ferrite	μ_m 25°C	μ_m 100°C	B_m 25°C	B_m 100°C	P_h 25°C	P_h 100°C	μ_o 25°C	Cp! °C
W-01	5000	5000	2850	2150	6.2	4.9	850	180
W-02	6300	6000	4200	2950	3.3	3.3	1800	190
W-03	5500	5600	3900	2750	4.0	4.0	1600	180

Spread in Characteristics

	μ_m 25°C	μ_m 100°C	B_m 25°C	B_m 100°C	P_h 25°C	P_h 100°C
W-01						
High	6000	6500	3050	2350	8.0	5.6
Average	5000	5000	2850	2150	6.2	4.9
Low	4100	3800	2650	1950	5.0	3.6
W-02						
High	8000	7200	4450	3250	4.0	4.0
Average	6300	6000	4200	2950	3.3	3.3
Low	5000	5000	3900	2750	2.0	2.0
W-03						
High	6500	6600	4100	3000	5.25	5.25
Average	5500	5600	3900	2750	4.0	4.0
Low	3850	3850	3600	2600	2.5	2.5

Frequency = 4.0 Kc B_m, Gauss, @ 6.0 AT/cm P_h, Core Loss, μW/cm³cps @ 1500 Gauss

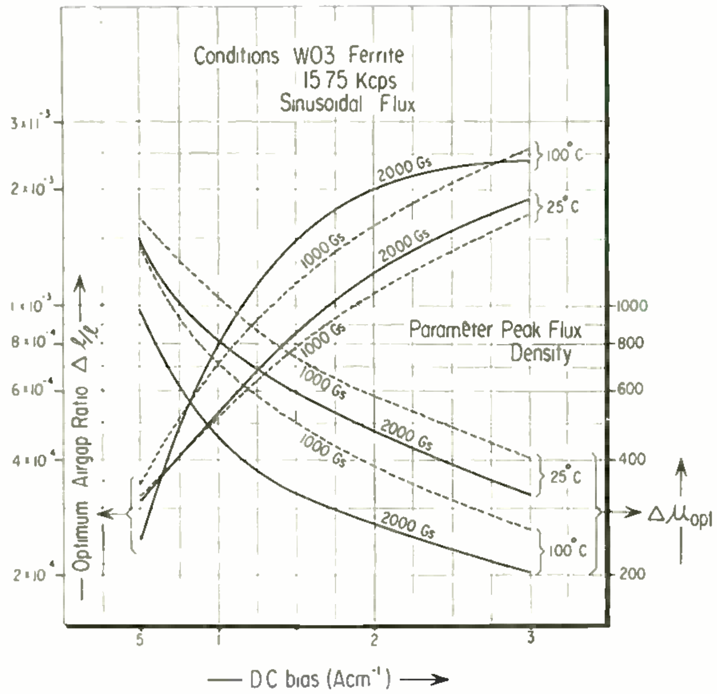


Fig. 5: Optimum air gap and incremental permeability as function of DC bias

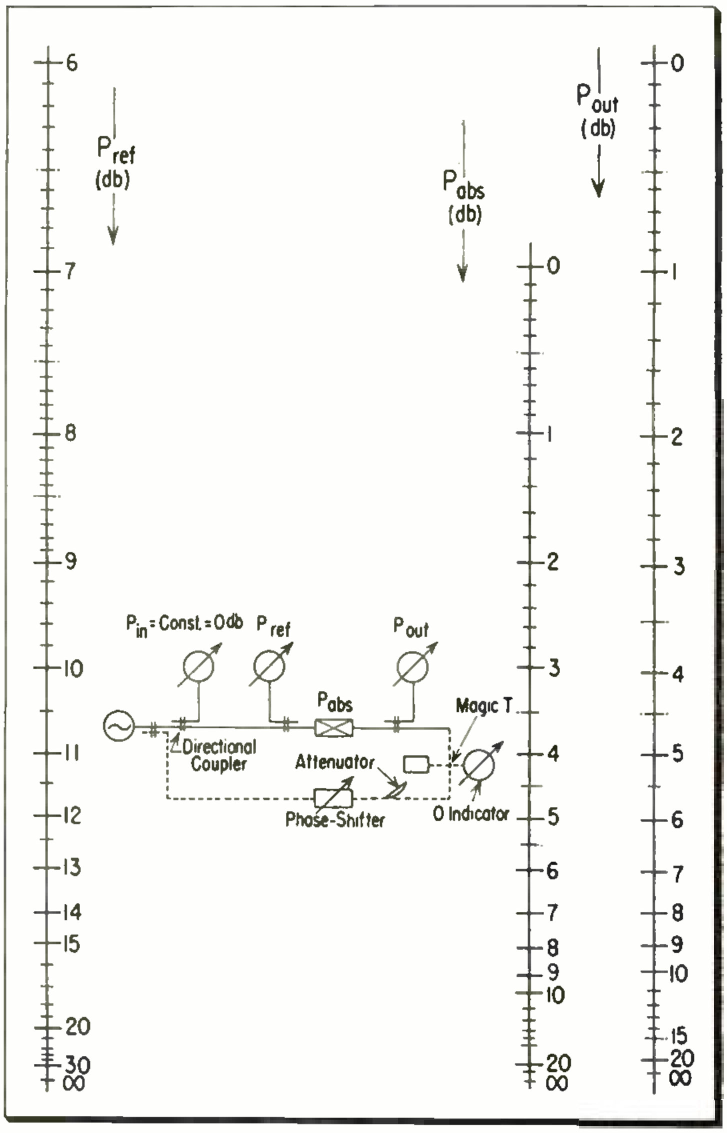


Fig. 6: Determining absorption loss from reflected power and output power (input power = 0 dbs.)

ium titanate are extensively used in the ultrasonics field. The relative mechanical change of the corresponding magnetostrictive effect in ferrites is usually about a decade smaller. Promising efforts are being made to use ferrite toroids as substitutes for quartz crystals up to about 1 MC.[1] By proper damping-free suspension a stable Q of several thousand can be obtained.

In practical cases magnetostriction can become extremely annoying. Fig. 1 shows the magnetostrictive resonances above 10 KC for a typical U-core of a flyback transformer. The ordinate gives the deflection as shown on the oscilloscope. At 15.75 KC, the basic TV sweep frequency, the magnitudes of magnetostriction for Class W-01 ferrite and of a competitive ferrite are about equal. However, at the resonances of the U-piece, the competitive material oscillates much more strongly. With certain shapes of U-cores, a resonance very close to the operating frequency may be encountered resulting in excessive "singing".

Fig. 4: Four configurations of "Ferri-Caps"

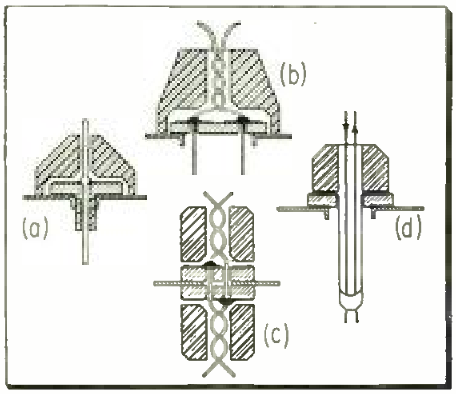


Fig. 2 shows an excerpt from a film depicting the hysteresis loops of a toroid when the frequency is changed (in the talk an actual film is shown, making the warping of the hysteresis loop appear quite real). Here mechanical vibration is reflected into the electrical circuit due to electromechanical interaction. During the change of frequency (28 KC to 30 KC) a pronounced deviation from the normal ω L behavior is therefore observed. (A parallel resonance followed by a series resonance.) Toroids of certain ferrites can easily be fractured when driven through their resonance frequency.

Dimensional Resonance

Another resonance effect, conditioned by dimensions, is purely electromagnetic. Let us say a ferrite has an ε of 9000 and a μ of 1000 (losses disregarded) at 1 MC. Then, for a wavelength in air of 300 m, a dimension of $300\text{ m}/2 \times \sqrt{9{,}000{,}000} = 5\text{ cm}$ corresponds to half a wavelength in the ceramic. In this case ferrite with a critical dimension of about 2 in. would lead to intolerable losses because of cavity resonance effects. Hence, in large power aggregates, such as cosmotrons, lamination of the ferrite material is necessary. Since in ferrite the dielectric constant ($\varepsilon' - j\varepsilon''$) exhibits pronounced dispersion and since the high dielectric and magnetic losses condition a very low Q, cavity effects can be studied with more transparency in high ε dielectrics[2]. Here, the Q's are higher and no appreciable dispersion appears at the frequencies of interest.

As far as partly metallized high ε dielectric cavities are concerned, UHF feed-through capacitors are of particular practical significance. It has been shown that discoidal feed-through capacitors are far superior to tubular feed-through capacitors for filtering purposes[3]. A tubular feed-through capacitor of 1500 pF has undesirable and very detrimental parallel resonances above a few hundred megacycles, whereas a disc type feed-through capacitor of the same capacitance value has its first parallel resonance at about 1800 MC. This will be far above the range of interest as far as TV and many military applications are concerned.

In the tubular capacitor (index

Ferrites (cont'd)

"T") the first parallel resonance occurs at

$$\lambda_T = \frac{2}{K_1'} \cdot \frac{C_T \cdot t}{\sqrt{\epsilon}}$$

where K_1' = Constant
C_T = capacity
t = wall thickness
ε = dielectric constant.

In the case of the discoidal feed-through capacitor, the wave length for the first parallel resonance is

$$\lambda_D = \frac{2\pi}{3.83} \cdot \frac{\sqrt{C_D'}\sqrt{d}}{\sqrt{K_2'}}$$

where K_2' = constant
d = thickness of disc
C_D = capacity

For high voltage discoidal feed-through capacitors, the thickness (d) has to be increased to prevent breakdown. In order to compensate for the loss of capacitance, then, the diameter has to be enlarged. Thus, the first parallel resonance is shifted downward into the UHF range as shown in Fig. 3D, where a ¼-in. diameter disc is replaced by a thicker ⅜-in. diameter disc.

If two small discs are cascaded mechanically and paralleled electrically, as indicated in Fig. 3C, a strong inductive coupling conditions a perceptible parallel resonance at 300 MC or lower.

Fig. 7: Losses/cycle, and induction as function of field strength, of Class W-01 ferrite

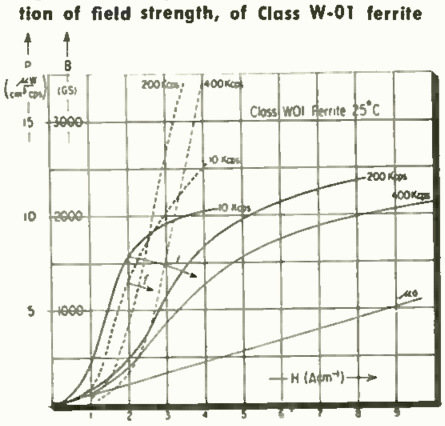
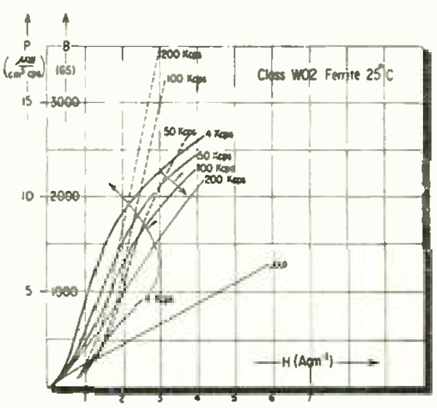


Fig. 8: Same as above, but for Class W-02 stock



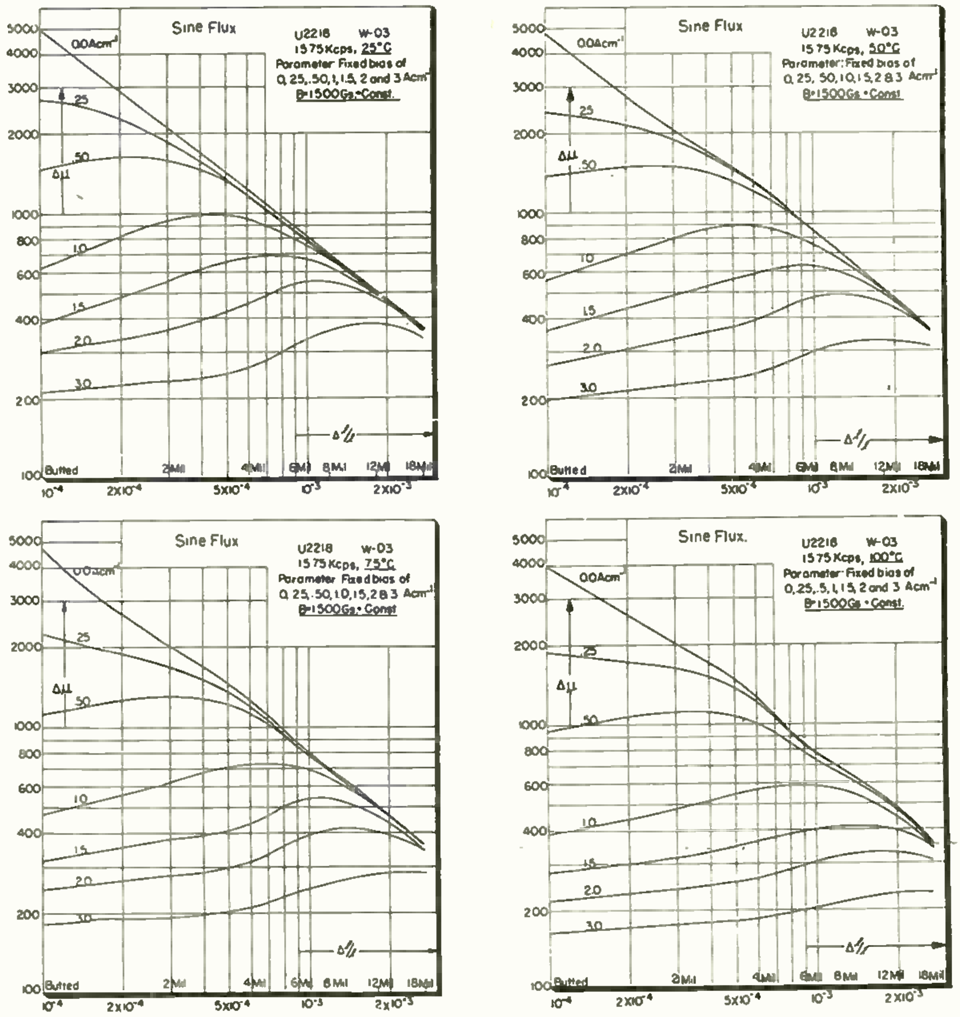


Fig. 9: Incremental permeability of W-03 ferrite for sinusoidal flux, at various temperatures

Interspacing ferrite washers, as shown in Fig. 3A, converts the inductive coupling into a predominantly resistive coupling, thus preventing the two-hump band-filter effect previously observed. With the ferrite washers as resistive decoupling elements, an excellent insertion loss (Fig. 3A) is gained. This extremely beneficial effect of certain ferrites will be explained later in this article when related applications will also be discussed.

Reversible Domain Wall Resonance

At higher frequencies two dispersion mechanisms, responsible for high losses, occur[4], namely, (a) resonance of the reversible domain walls, and (b) gyromagnetic resonance. The following figures may serve as a rough estimate to indicate the order of magnitude of the frequencies involved: case (a) occurs in the 10 MC range; case (b) in the 1000 MC range. The higher the permeability, the lower the corresponding resonance. In the UHF range particularly, permeabilities of less than one, or even negative permeabilities may be encountered, always connected with high losses.

Proper composition and treatment will result in ferrites having either very high or very low losses. An example for an actual very low loss ferrite is given by the following data:

$\mu_0 = 100$; Q at 1 MC = 475
Q at 10 MC = 160
Q at 20 MC = 54

On the other hand, there are very lossy ferrites, so much so that these magnetically induced losses may be utilized advantageously for filter applications[5]. A related application was demonstrated earlier.

Fig. 4 shows four different configurations of "Ferri-Caps" (combination of ferrite and dielectric capacitors in an integrated unit). In this figure the dielectric is designated by even, the ferrite by uneven cross hatching. Fig. 4a depicts the standard "Ferri-Cap."[5] Figs. 4b and c are twin lead "Ferri-Caps," to be used for dc currents above 3 a. to eliminate the decrease of insertion loss due to current biasing. Fig. 4d displays schematically high-voltage coaxial twin lead feed-through capacitors with a ferrite cap. A combination of Fig. 3A and 4a leads to a compact low pass filter of very high insertion loss. The effectiveness and compactness (see Fig. 13) of this

(*Continued on page* 109)

"Preferred Circuits" for the Military

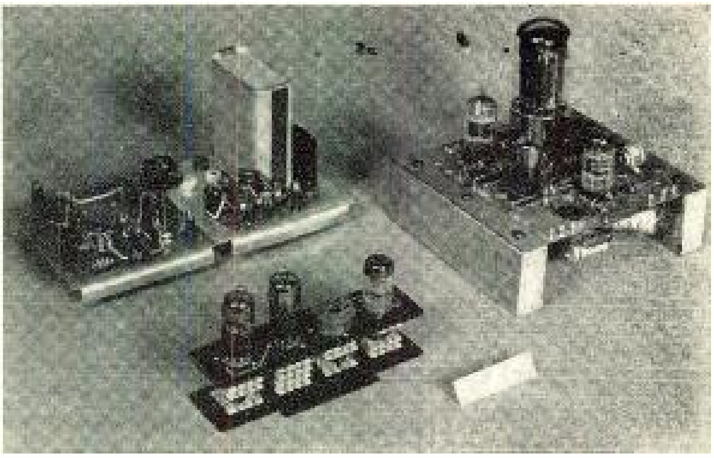
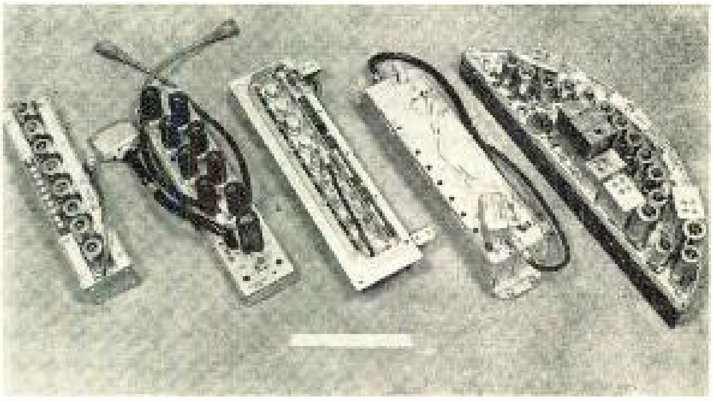


Fig. 1: Pulse-handling video mixers examined in "circuits" program

Fig. 2: Five i-f strips produced for Navy show variation in size, shape



Program being conducted by the National Bureau of Standards seeks to standardize most commonly used circuit configurations. Important economies are anticipated in terms of cost, delivery time and operating reliability.

A standardization program undertaken by the National Bureau of Standards, for the Navy Bureau of Aeronautics, is seeking to determine those well-known circuit configurations that are common to a wide variety of electronic devices but which now differ unnecessarily in detail. Known as the NBS-BuAer "preferred circuits program," this continuing investigation is expected to result in important economies in critical engineering man-hours, in lead time, and by accelerating production. It also should provide the military services with means for: (1) simplifying maintenance training; (2) designing simple "throw-away" units; (3) achieving improved operation reliability; and (4) establishing design standard levels.

The study is being carried out by J. H. Muncy and associates of the NBS engineering electronics laboratories. The Bureau is cooperating with industrial groups engaged in similar programs through exchange of information.

The over-all circuit of any aeronautical electronic equipment is necessarily extremely complex, consisting of hundreds or thousands of individual components. Actually, however, this apparently complex mechanism, is just a composite of many individual smaller circuits, most of which are known and used in different combinations in other equipment having other functions. Some of the circuits may be unique and especially designed for that particular equipment, but the great majority of circuits in any device are of widely used types. Such widely used subcircuits are the essential building blocks of the over-all design. They are recognized as such in the "block diagram" language of electronic circuitry.

No attempt has been made, until now, to standardize the exact circuit configurations of these building blocks. Engineers have recognized that one of the great advantages of electronic techniques is the flexibility of the circuits, both during design and production, since an electronic assembly consists of many parts that may be rather easily replaced by others. Electronic engineers are naturally reluctant to surrender this flexibility except for great compensating advantages. Nevertheless, preliminary consideration by BuAer and a feasibility study by NBS showed that the standardization of circuits used in aeronautical electronic equipment should result in worthwhile advantages.

Military Advantages

To the military services such standardization means lower purchase prices, shorter delivery time, greater operating reliability, fewer spare parts at field installations and simpler maintenance procedures. For the producers, there is the prospect of economies in design and production engineering. Junior engineers, usually assigned the routine work of designing or selecting these well-known circuits, will have their work facilitated, and this in turn will reduce the supervisory burden of senior engineers. Production will benefit from fewer designs and reduced inventories.

Feasibility Study

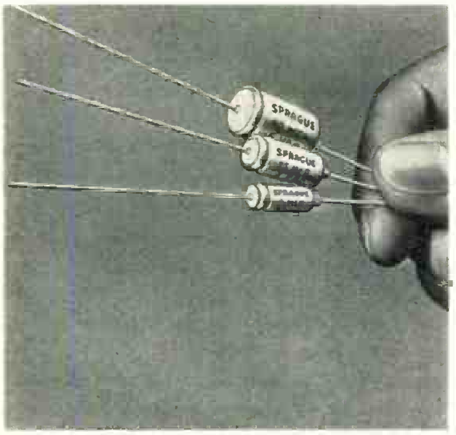
The initial feasibility study, undertaken in 1953, consisted of a detailed examination of 22 carefully selected items of aeronautical electronic equipment. These included several different radar sets, an indicator assembly, radio equipment, and others. Sources of information included instruction manuals, specifications, and the experience and advice of equipment engineers and maintenance personnel. The over-all circuits were divided into functional subcircuits and then subjected to systematic analysis of the detailed circuit differences and of design parameters. Considerable attention was given to establishing a common

(*Continued on page* 124)

New Printed Circuit

ELECTROLYTICS

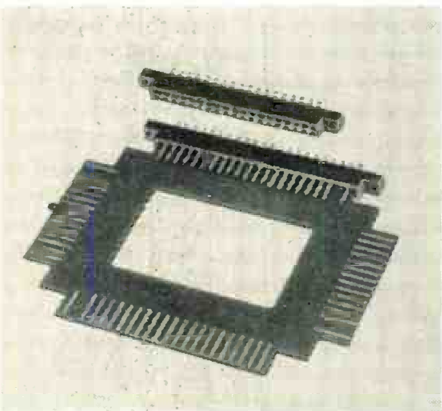
New "Lyttl-Lytics", small hermetically sealed aluminum capacitors, are for use in transistorized pocket radio receivers, wireless microphones, personal style wire recorders, and similar



equipment. Useful in either filtering or coupling operations. Available in capac. ratings from 1 to 110 uf, and working voltages of 1, 3, 6, 12, and 15 vdc. Sizes range from 3/16 in.D. x 1/2 in.L. to 3/8 in.D. x 3/4 in.L. Design lends itself to mechanized assembly on printed wiring boards by machine. Max. operating temp. is 65°C. **Sprague Electric Co.**, 233 Marshall St., North Adams, Mass. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-72)

CONNECTORS

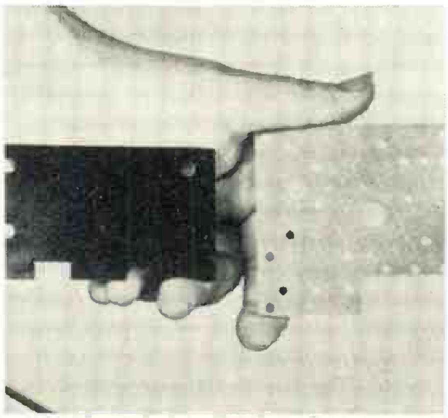
Newly developed connectors with "Bellows Type" contacts are now supplied with Continental Connectors printed wiring circuit receptacles. Connector accepts .054 to .071 in. variation of standard 1/16 in. copper clad printed circuit laminated card (1/8 in. on special order.) Wiring styles include solderless wire wrap, solder lugs or taper pins for "AMP 53". Molding compounds avail-



able include: Mineral filled Melmaline, Plaskon reinforced (glass) Alkyd 440A, and Orlan filled Diallyl Pthalate. **Dejur-Amsco Corp.**, 45-01 Northern Blvd., Long Island City 1, N. Y. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-33)

SPECIAL LAMINATE

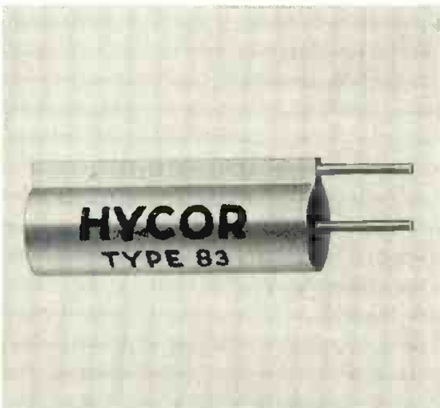
An electrical grade phenolic laminated plastic, punchable at 68° F., is Grade XXXP-470 Phenolite, which is suited for copper clad printed circuits where automatic processes require close



registration of punched mounting holes. Available in the same thickness range, tolerance, and sheet sizes as the company's other XXXP grades, with comparable copper clad bond strength and hot dip solder properties. Has lower flexural strength and higher cold flow than other XXXP grades. **National Vulcanized Fibre Co.**, Wilmington, Del. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-35)

RESISTORS

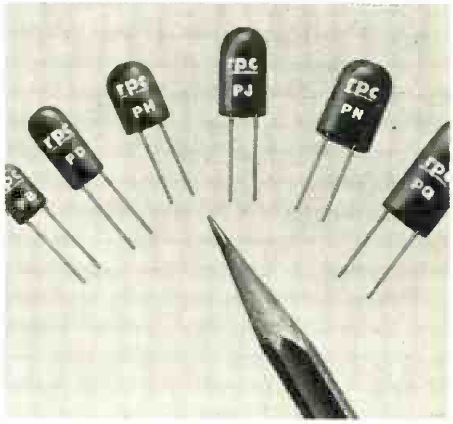
Series "A" encapsulated resistors for use in printed wiring circuits are designed to conform to specifications proposed by RETMA for components to be used in automatic assembly equipment. Epoxy compound protects against extreme humidity, mechanical and electrical shock. Sealed-in terminal connections are welded. Meet requirements of MIL-R-93A and JAN-R-93. Temp.



Coef.: ±0.0022%/°C. Operating Temp.: —65°C. to +125°C. Wattage range from .25 watt to 1 watt; tolerances to 0.1%. Other physical sizes and wattage ranges as desired. **Hycor Co., Inc.**, 11423 Vanowen St., North Hollywood, Calif. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-34)

RESISTORS

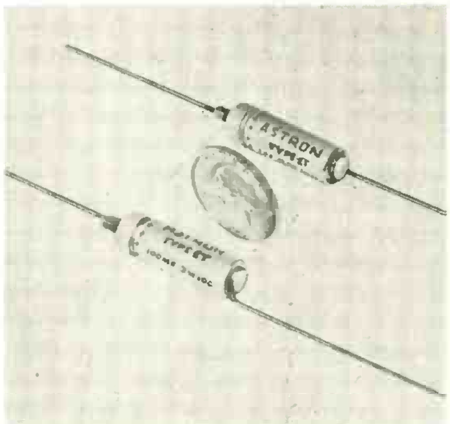
Type P precision wire wound resistors for printed circuits are single ended units made for easy rapid mounting on printed circuit panels. Made with high epoxy resins and resistance wire with



special high temp. insulation, they can be safely operated at full rated load at ambient temps. up to 125°C. Furnished in 6 sizes, resistance values up to 3 megohms are available with low temp. coefficient resistance wire. Resistance tolerances from 1% to .05% are available. Will meet all applicable test requirements of MIL-R-93A, Amendment #3. **Resistance Products Co.**, Harrisburg, N. Y. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-70)

CAPACITORS

New type ET Subminiature Electrolytic Capacitor is designed specifically for printed circuitry and automation applications where space is severely limited, such as: portable TV sets, miniature radios, hearing aids, miniature tape recorders, and other subminiature assemblies with miniaturized tubes and/or transistors. Features include wide range of available values, low

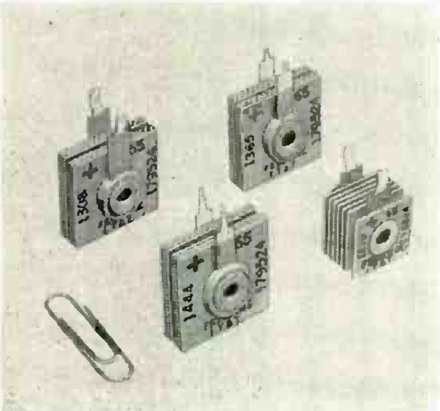


leakage current, and low-resistance terminal tab connection. Hermetically sealed in aluminum. **Astron Corp.**, 255 Grant Ave., East Newark, N. J. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-71)

Components and Equipment

SELENIUM RECTIFIERS

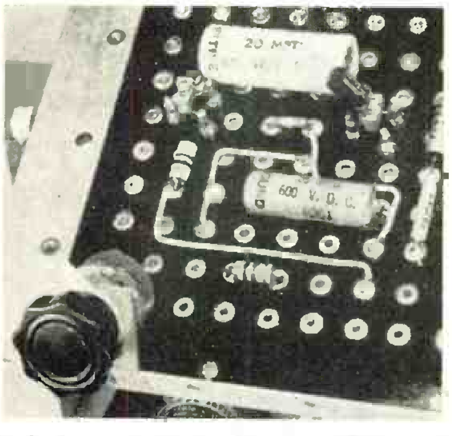
New line of selenium rectifiers is designed for insertion into printed circuits, either automatically or manually, and is particularly suited for the radio and TV industry where automation and



printed circuit techniques are becoming increasingly important. Available in current ratings up to 175 ma. for line voltages up to 175 vac. 12 different rectifiers are available in 11/16, 1, and 1¼ in. cell sizes. Printed circuit rectifiers can be designed up to 600 ma. **Federal Telephone and Radio Co.,** 100 Kingsland Road, Clifton, N.J. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-13)

PRINTED BREADBOARD

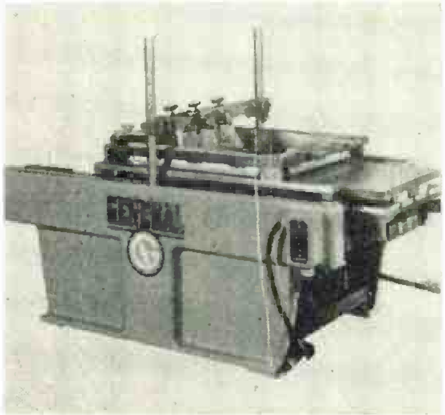
Electronic and electrical design engineers working with printed circuits may now enjoy the advantages of experimentally checking circuit layouts and designs prior to having expensive scale drawings prepared and sample circuit boards etched. New printed circuit breadboard chassis permits the laboratory assembly and test of printed circuit layouts using conventional wiring



techniques and materials. The new printed circuit breadboard chassis is especially well suited to the experimental assembly of transistorized and subminiature circuitry. **The Electratomic Co.,** P. O. Box 827, Wheaton, Md. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-16)

SILK SCREEN PRESS

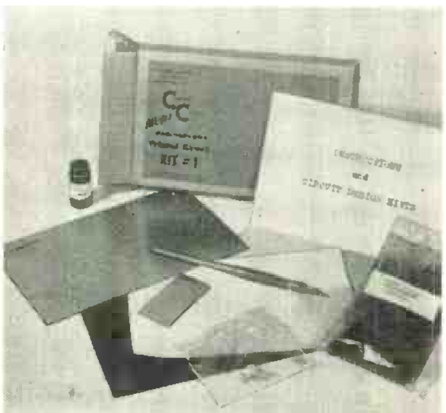
General Decorator Press, Series B, is designed for silk screen preparation of copper laminated plastic panels prior to etching the printed circuits. Press consists of: a reciprocating one piece bed



which supports and carries the work, a reciprocating stencil frame, and a stationary squeegee. Rear delivery (optional) permits straight line operation from feeding through printing, directly into a drying system. Three sizes available with sheet sizes ranging from 13 x 25 in. to 19 x 37 in. **General Research and Supply Co.,** 572 South Division Ave., Grand Rapids 3, Mich. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-14)

PRINTED CIRCUIT KIT

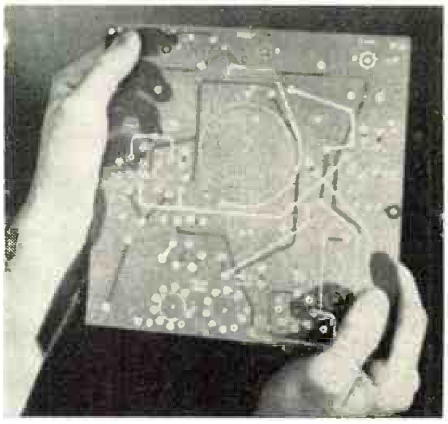
New do-it-yourself printed circuit kit for design engineers is useful in the early stages of development work, as it enables the engineer to evaluate printed circuit designs before passing them along to a production planning department. Package contains a sheet of copper clad laminate measuring 8½ in. by 5 in. and all other materials required to make etched or printed cir-



cuits. Included is helpful booklet of instructions and printed circuit design hints. Kit makes two average size "miniaturization" circuits or one "standard" size circuit. **Control Circuits, Inc.,** Middletown, Conn. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-15)

LAMINATE

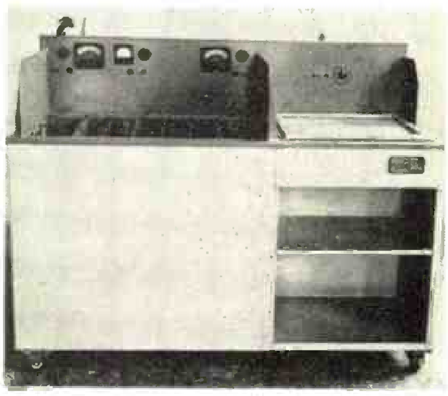
The translucent quality of the new XXXP-36 laminated plastic is demonstrated by the circuit shown. Translucency of the paper base-phenolic impregnated sheet allows a visual check



on the accuracy of printed circuit register. The new grade helps make printed circuits more accurate and provides 10^6 megohms insulation resistance. Punches cold in thicknesses up to 1/16 in. thick. Not subject to dimensional change as in grades which must be heated before punching. Has high dielectric strength, heat resistance, and bonding strength. **The Formica Co.,** Cincinnati, Ohio. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-17)

PRODUCTION EQUIPMENT

"Protomaka," for making production prototypes of printed electronic circuits measures only 60 x 50 x 45½ in., but is capable of producing an average printed circuit in only 30 to 40 mins. Circuits up to 10 in. by 16 in. can be manufactured. Etched wiring is produced by photographic process. Each operation is regulated by controls immediately above its particular section.



Air compressor, vacuum pump, rheostats, etc., are located in the base. Operates on 110 vac. **Printed Electronics Corp.,** 15 Willow St., Natick, Mass. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-18)

New Test Equipment

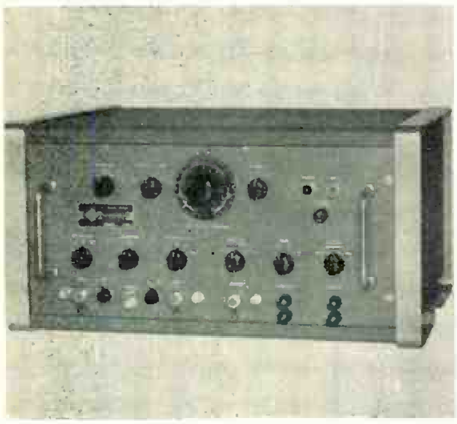
TIME-DELAY GENERATOR

Type 326 is a new instrument which permits accurate measurement of time functions such as duration of waveforms, pulse widths, delay characteristics of oscillograph amplifiers, calibra-

tion of synchroscopes and oscillograph sweep generators, radar and sonar ranges. Unit is equipped with 3 overlapping ranges providing delays from 1.5 μsec to 10,000 μsec. Accuracy is better than 0.1% at delays up to 1000 μsec and 1% on the top range to 10,000 μsec. Jitter is no greater than 1 part in 10,000 at any delay setting. **Allen B. DuMont Laboratories, Inc.**, 750 Bloomfield Ave., Clifton, N.J. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-12)

ELECTRONIC SWITCH

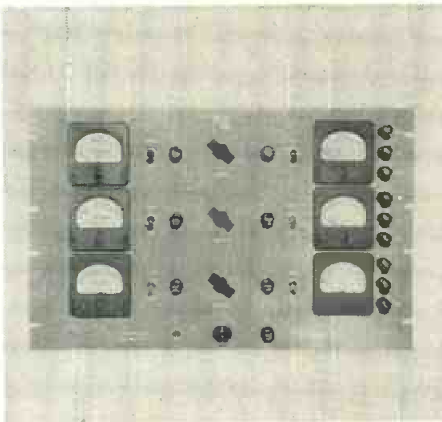
New model ES-180A Wide Band Electronic Switch provides dc to 15 mc dual trace oscilloscope presentations on any conventional oscilloscope at switching rates up to 400 kc. A movable horizontal index and provisions for introducing time markers make extremely rapid and accurate amplitude and time measurements possible. Calibrated control dial allows absolute and relative ampli-



tude measurements to within 2% accuracy. Amplifier rise time is .023 μsec., input impedance 1 megohm, and output impedance 93 ohms. **Teletronics Laboratory, Inc.**, 54 Kinkel St., Westbury, N.Y. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-9)

POWER SUPPLY

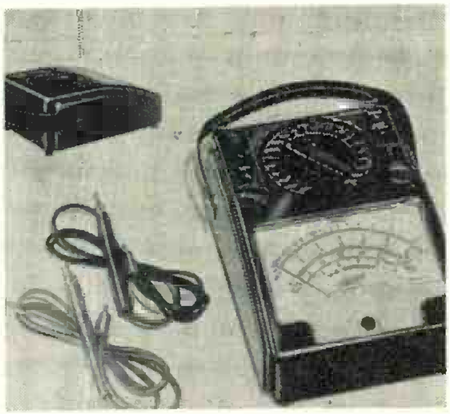
Model CS-3667 is a new laboratory power supply intended for use in transistor circuit development. Completely tubeless, the supply provides 3 regulated, entirely independent "float-



ing" output voltages. Provides 0-50 v. at 0-10 ma., with ripple below 1 mv. Regulation is 0.5% at 50 v. Higher current models are available, up to 1 a. Dual range voltage and current meters are optional for each channel. Enclosed in bench mounted steel cabinet or available for rack mounting. Low ripple and internal impedance simulate battery conditions. **NJE Corp.**, 345 Carnegie Ave., Kenilworth, N.J. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-11)

MULTIMETERS

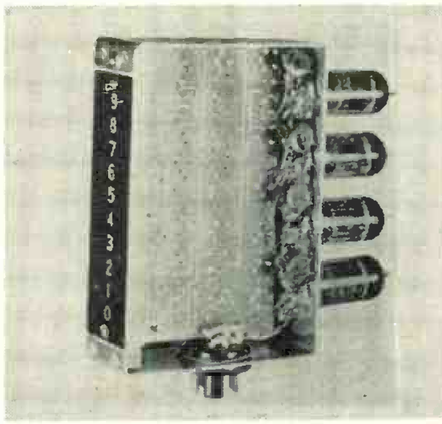
New, portable multimeters feature technique that protects both meter and internal circuit against accidental burnouts. When overload is applied, instrument disconnects itself and raises re-set button on case. High voltage may be applied across any function, including ohms, without danger. Industrial Model 455 has a sensitivity of 20,000 ohms/volt (ac or dc). Audio Model 456 has a sen-



sitivity of 20,000 ohms/volt dc, and 1000 ohms/volt ac. Has db ranges and provisions for output measurements. **Hickok Electrical Instrument Co.**, 10606 Dupont Ave., Cleveland, O. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-8)

DIGITAL COUNTERS

The "Countess," a new digital decade counter designed for 150 v. operation, consumes ¼ the power required by conventional counters (1.2 watts). Staircase voltage output proportional to the



count (to operate Brush Direct Writing Oscillographs) or four line coded output (to operate mechanical printers) is optional. Max. counting speed is 100,000 cps. Units may be cascaded. External switching accessory permits selection of any output pulse from 1 to 9, as desired. **Brush Electronics Co.**, 3405 Perkins Ave., Cleveland 14, Ohio. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-10)

SWEEP GENERATOR

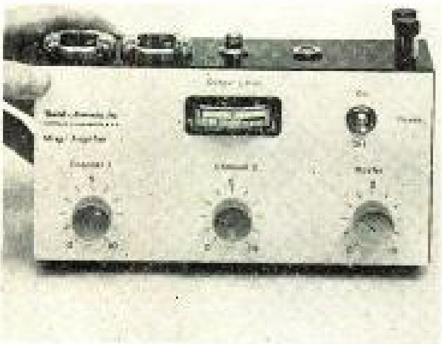
New Microwave Sweep Generator has proven equally valuable in research and development activity, as well as production alignment and testing of microwave components and systems. Supplies a microwave signal swept in frequency across a waveguide range or any portion of it as slowly as 66 mc/sec. or as rapidly as 60 kmc/sec. The unit can also operate as a man-

ually controlled cw source if desired. Simplicity of control and operation permits unskilled personnel to adjust, align, and record performance of waveguide components. **Roger White Electron Devices, Inc.**, 12 West Island Road, Ramsey, N.J. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-7)

New Broadcast Equipment

MIXER-AMPLIFIER

New portable transistorized mixer-amplifier is a self powered field pick-up unit designed primarily for broad-casting and recording use. Input impedance: 50 or 250 ohms, balanced.



Load impedance: 600 ohms, resistive, balanced. Power gain: greater than 90 db. Output level of 1 mw (0 dbm) average, 10 mw peak. Frequency responce: 100-8,500 cps (± 3 db). S/N ratio: 60 db for −60dbm microphone input. Distortion: 1.2% at 0 dbm output and 2.5% at 10 dbm output. Size: 7½ x 2¼ x 3¼ in. Unit weight: 3 lbs. **Baird Associates, Inc.,** 33 University Road, Cambridge 38, Mass. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-26)

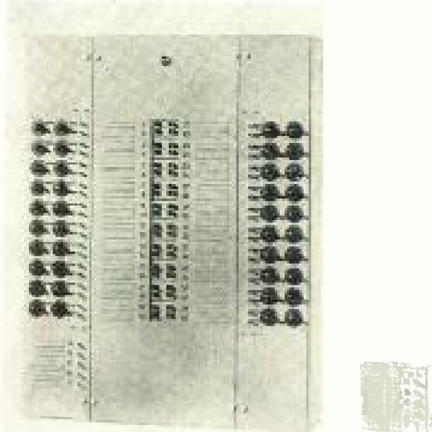
MOBILE RADIOPHONE

New "Twin-V" mobile radio equipment incorporates major innovations improving receiver sensitivity, noise suppression, and voice frequency reproduction. Acoustically designed speaker and enclosure provide improved intelligibility in 2-way radio voice reproduction. Squelch circuit blocks receiver when only noise is present. Line includes 6/12 vdc dynamotor powered

models and all-vibrator models. Operates in the 25-54, 144-174 and 450-470 mc bands. Operates from either 6 or 12 v. **Motorola Communications & Electronics, Inc.,** 4501 W. Augusta Blvd., Chicago, Ill. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-19)

STUDIO CONTROL PANEL

This studio lighting control panel furnishes five preset combinations of 40 lighting circuits from one or more control points. Five preset control positions each accommodate from 1 to 40



circuits. Five master control switches on the lighting panel may be paralleled with as many other remotely-located control units as desired, with a small 11-conductor cable. Low voltage control circuits are completely isolated from power circuits. Designed with forty 20-amp, 120 v circuits for use in 120/208 v 4-wire systems. Price $1090.00. **Rust Industrial Co.,** Manchester, N.H. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-23)

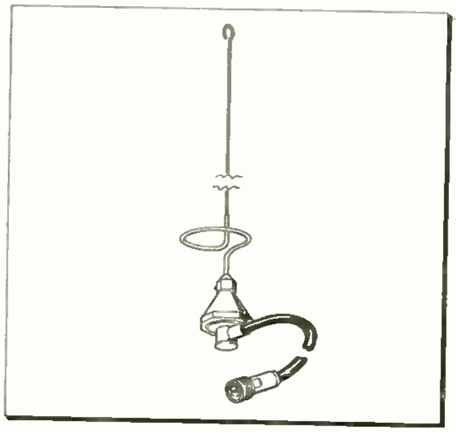
VIDEO EVALUATOR

"Colorscope" combines the functions of seven bulky test units in one compact instrument occupying space of 14 x 16 x 24 in., plus power supply. Can be set up for dolly carry or rack mounted. By means of a function switch, ten displays are seen in sequence on the CRT face: Picture Monitor, Pulse Cross Monitor, Two Line Horizontal Time, Two Fields at Vertical

time, NTSC Vectorscope Presentation, External Vertical Amplifier, Phase Demodulator Scope, Quadrature Phase Demodulator Scope. **Tarc Electronics,** 48 Urban Ave., Westbury, N.Y. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-24)

MOBILE ANTENNA

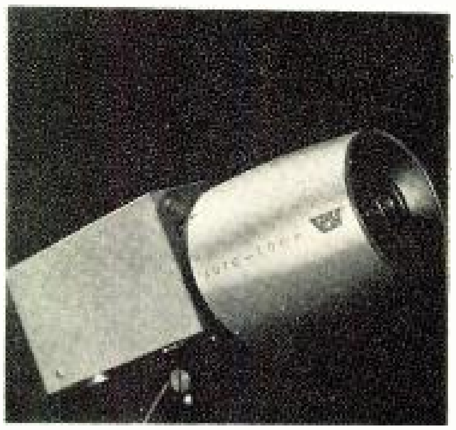
New rooftop antenna for 450-470 mc range effectively multiplies mobile transmitter power by 1.5 without adding cost to the mobile communication unit or increasing battery drain. Inductive-



tuned 9/16 wave radiator has 1.3 db measured gain. Use of RG-8/U feed cable (optional) gives an additional .5 db measured gain, making a total effective gain of 1.8 db (1.5 power gain) compared to conventional quarter-wave rooftop antenna with RG-58/U cable. Unit has stainless steel radiator supported by molded plastic insulator mounted in a single ⅞ in. hole. **Andrew Corp.,** 363 E. 75th St., Chicago 19. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-20)

TV ZOOM LENS

This new lens is designed for use with 16mm TV cameras and the Vidicon tube, with no sacrifice in optical quality. Lens has a 5 to 1 (30-150mm) focal length range, and covers the full Vidicon format. Focuses from 6 ft. to inf., with lens speed varying from f/2.7 at the short focal length and halfway through the range, to f/4.7 at the long focal length. Dimensions, including



motors, are 9 in. l. by 5 in. d. Weight, 16 lbs. Motorless version, weighing less than 3 lbs. is available for hand held cameras. **The Perkin-Elmer Corp.,** Norwalk, Conn. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-22)

New Electronic Products

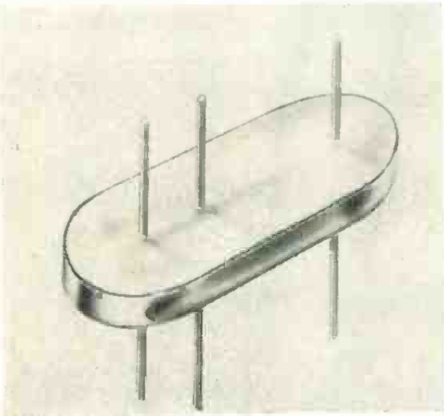
DELAY LINES

Variable from 0 to 10 µsec, Type 611 Variable Delay Lines consist of a continuously variable delay line and a step variable delay line with over 150 sections of m-derived LC networks.

Each section gives linear phase shift beyond 70% of cutoff freq. and has a freq. response curve Gausian in shape. Type 611A has 200 ohms impedance, less than 5 x 10^{-10} sec. resolution time, and either 8 µsec. or 16 µsec. delay. Type 611B has 16 µsec. delay, 0.05 µsec. resolution time, and either 75 or 200 ohms impedance. **Advance Electronics Co., Inc.**, 451 Highland Ave., Passaic, N. J. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-1)

TRANSISTOR BASE

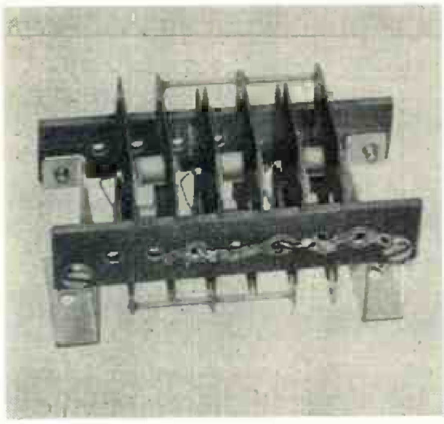
New No. 1619 Transistor Base features all glass construction in the internally exposed portion of the unit. All glass construction prevents contamination of a transistor wafer when closure is made after mounting. Units constructed with all metal internally exposed areas enhance the possibility of contamination and degradation of the wafer during the "buttoning-up" op-



eration. Usually, with metal construction, the "buttoning-up" operation floats solder fluxes right in under the wafer. With the No. 1616 Base, this possibility is eliminated. **Hermetic Seal Products, Co.**, 33 South Sixth Street, Newark 7, N. J. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-2)

POWER RECTIFIER

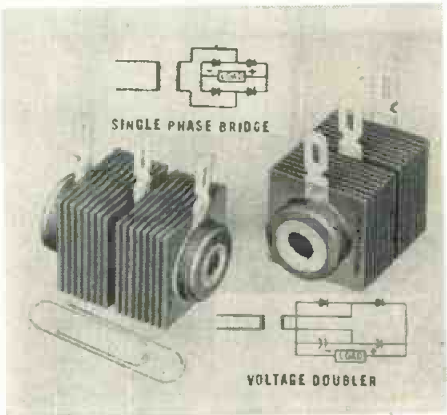
New germanium power rectifier stacks, ⅓ smaller than previous designs are mechanically and electrically interchangeable with present types. Improved heat dissipation is achieved



by eliminating conventional center assembly bolt and insulating doughnuts. Plates are held at sides exposing full area of plate for cooling. Available from 15 v. and 0.35 a. to 888 v. and 2 a. Rectifying elements are Federal 1N91, 1N92, and 1N93 power rectifiers with 20% lower reverse leakage current than RETMA standards. **Federal Telephone & Radio Co.**, 100 Kingsland Rd., Clifton N. J. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-6)

SELENIUM RECTIFIER

Type 60-9150 is basically a voltage doubler stack; one of these units can be used as a doubler and two units can be connected as a single phase full-wave bridge. Ideal for use in dental and professional office equipment where hum is objectionable. Two of these units connected in a single phase full-wave bridge circuit will deliver approximately 180 vdc at 0.10 amps for



an RMS voltage input of 230 v. As a doubler, unit will deliver 50 ma connected to a maximum ac input of 175 v RMS. **International Rectifier Corp.**, 1521 East Grand Ave., El Segundo, Calif. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-5)

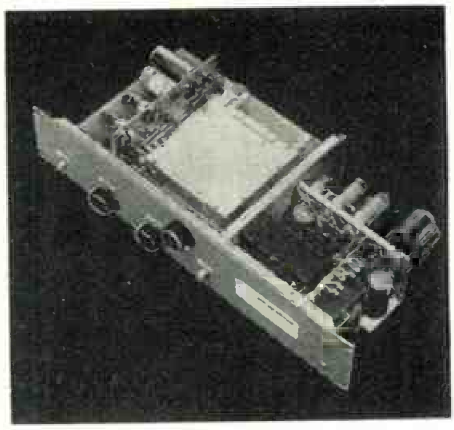
TRANSFORMER

Transistorized dc transformer handles an input of 24 to 30 vdc and produces any dc output. Occupying only 10 cu. in., it is well suited for miniaturization applications. Principle involves the

conversion of dc to square weave ac signal. This is stepped up or down in a transformer, then rectified to give dc output. Normal output variation is 8% no load to full load. Regulation supplied within ±.5%. Efficiency is 85%. Range: +85° C. to —80° C. and lower. Shock and vibration characteristics are excellent. **Nader Mfg. Co.**, 2661 S. Myrtle Ave., Monrovia, Cal. TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 12-3)

DELAY CHANNEL

New concept in delay systems provides complete unit including a compact solid ultrasonic delay line with pre-delay and post delay circuits, and a self-contained, regulated power supply, suiting it for radar, computer, and autocorrelation systems as well as general laboratory use. Model "500" illustrated has a delay of 500 µsec. ±5%. Characteristics response of —3 db be-



tween 10 cps and 4.5 mc and a S/N ratio of 40 db. Units may be cascaded for longer delays. New developments include a 200 µsec. delay operating at 75 mc with a bandwidth of 25 mc. **Sturrup, Inc.**, Middletown, Conn. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-4)

ETCHED CIRCUITRY

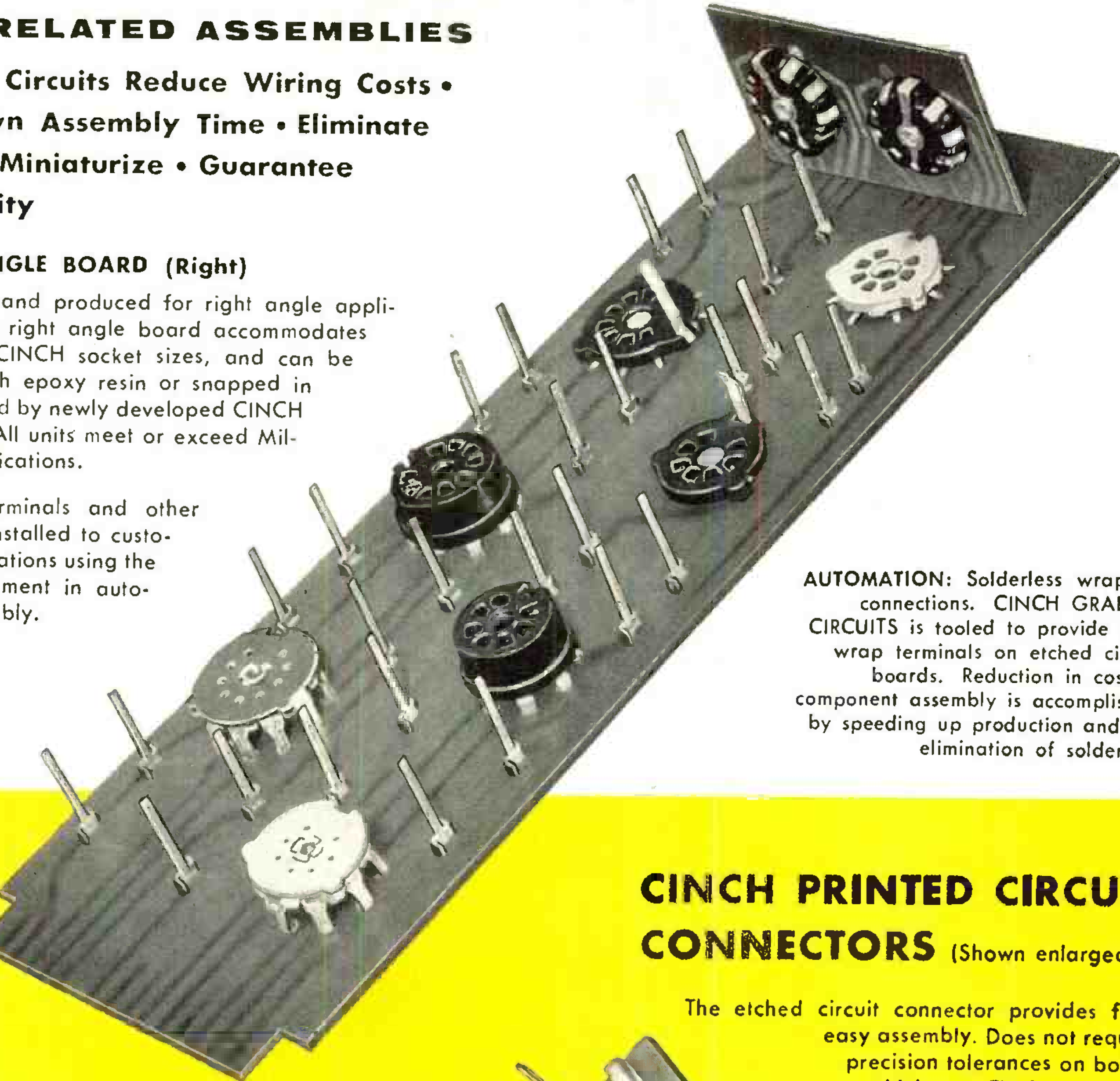
AND RELATED ASSEMBLIES

Graphic Circuits Reduce Wiring Costs • Cut Down Assembly Time • Eliminate Errors • Miniaturize • Guarantee Uniformity

RIGHT ANGLE BOARD (Right)

Developed and produced for right angle application. The right angle board accommodates all of the CINCH socket sizes, and can be bonded with epoxy resin or snapped in and retained by newly developed CINCH hardware. All units meet or exceed Military Specifications.

Sockets, terminals and other hardware installed to customer specifications using the latest equipment in automatic assembly.



AUTOMATION: Solderless wrapped connections. CINCH GRAPHIK CIRCUITS is tooled to provide wire wrap terminals on etched circuit boards. Reduction in cost of component assembly is accomplished by speeding up production and the elimination of soldering.

CINCH PRINTED CIRCUIT CONNECTORS (Shown enlarged)

The etched circuit connector provides fast, easy assembly. Does not require precision tolerances on board thickness. Eliminates moisture trap. Allows greater flexibility of configuration. Lower cost.

Complete facilities for engineering production design, drafting, artwork, development, prototyping and manufacturing photo-printing, silk screen, etching, machining and punching, fabricating, mechanical assembly, electrical assembly, encapsulating, quality control, and fluoroscopic inspection.

CINCH will design new, or re-design parts within the category of their manufacture to fit your particular plans, and will also assist in the introduction in the assembly of CINCH's specially designed component in your radio and TV equipment.

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

CONSULT CINCH

CINCH components are available at leading electronic jobbers—everywhere.

Cinch ELECTRONIC COMPONENTS

GRAPHIK CIRCUITS Division of Cinch Manufacturing Corporation

221 South Arroyo Parkway, Pasadena 1, California

CINCH MANUFACTURING CORPORATION

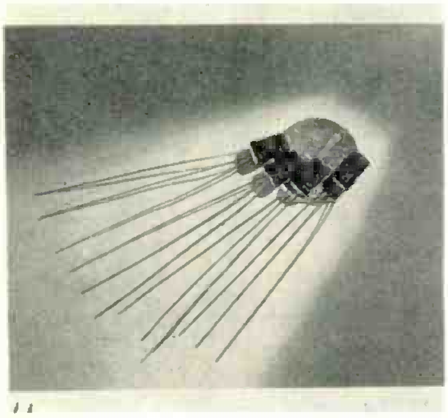
1026 South Homan Ave., Chicago 24, Illinois

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

New Electronic Products

TRANSISTORS

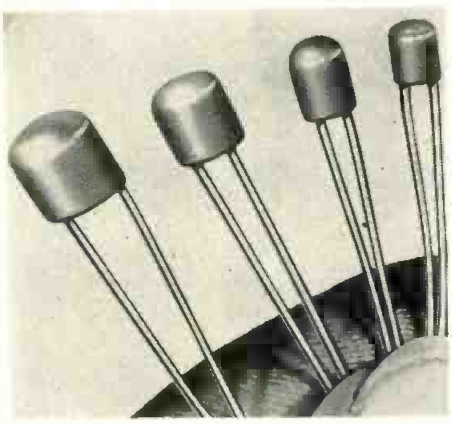
New PNP fused junction germanium transistors have a volume of 0.0087 cu. in. and are designated Types 2N130, 2N131, 2N132, and 2N133. First three are intended for use in audio or low power



radio frequency applications; fourth is a low noise transistor for use in low level audio circuits. The average noise factor of the 2N133 is 6.5 db and will not exceed 10 db. Max. temp. is 85°C. These new transistors are electrically similar to and are designed to replace the CK 721 series. **Raytheon Manufacturing Co., 55 Chapel St., Newton, Mass.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-87)

SELENIUM DIODES

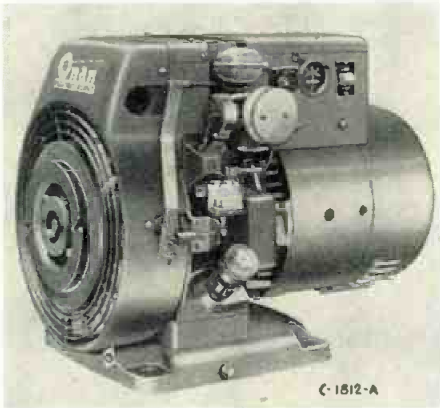
These three sub-miniature selenium diodes are for use in diversified electronic equipment that must withstand severe environmental conditions. Type 6U1 is rated for a max. input of 156 v. rms, type 7U1, 182 v rms and Type 8U1, 203 v rms at 1.5 ma. Temp. range: -50° C. to +100° C. Small and compact in size, units are provided with pigtail leads to facilitate easy wiring into



crowded chassis. Uses include bias supplies, sensitive relays, digital and analog computers, hearing aids, electronic organs and compact airborne electronic equipments. **International Rectifier Corp., 1521 East Grand Ave., El Segundo, Calif.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-88)

ELECTRIC PLANT

Model 2LK heavy duty generating plant produces 2 kw, 60 cycle ac at 1800 rpm (or 1.5 kw in 50 cycle) in all standard frequencies and phases. Unit weighs 235 lbs and is powered by a single-



cylinder, air-cooled, 4-cycle gasoline engine with Stellite-faced rotating exhaust valve and large long-wearing bearings. Available in manual starting models and electrically cranked remote starting models. Optional accessories include: carrying frame, 2-wheel dollies, automatic controls and receptacle plate kit. **D. W. Onan & Sons Inc., 2515 University Ave., S.E., Minneapolis, Minn.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-89)

PLIER, KNIFE

New needle-nose plier, Cat. No. 203-6-H2, designed for telephone and electronics field, has a long, pointed nose for reaching into confined space. Cutting blade has stripping holes for skinning 19 and 22 gauge coated wire. New Skinning Knife, Cat. No. 1550-5, 3¼ in. blade, is of highest quality cutlery steel. Hard wood handle has ring for attaching to snap. **Mathias Klein & Sons, 7200 McCormick Rd., Chicago 45, Ill.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-91)

TRANSMITTING ANTENNAS

"Delta-Tenna," designed for all VHF and UHF applications in 2, 6, and 10-11 meters and commercial frequencies, has an impedance of 50 ohms and does not require use of matching stubs for efficient operation when used with RG8U coax. Engineered for all vertical polarized applications. Handles in excess of 1 kw. Low standing wave ratio, gold anodized elements. One-inch diameter driven elements and a ¾-in. radials. Built-in coaxial fittings and U-bolts permit easy attachment to vertical pole. **Western Gear Corp., Electro Products Div., 132 W. Colorado St., Pasadena 1, Calif.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-92)

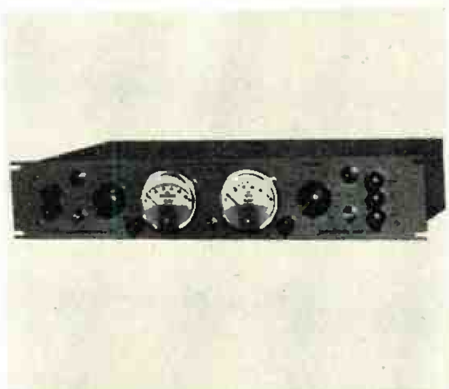
RECEPTACLES

5049 Series Microdot "Hermetically Sealed" Receptacles are designed to mate with 50-ohm screw type Microdot coaxial cable plugs. True hermetic seal ratings of less than 3 x 10^8 standard

cc/sec./in. are obtained. When soft soldering is prohibited, hermetic seal ratings may be obtained with other Microdot receptacles in 50, 70, and 93 ohms. Rating is "no air bubbles for 20 sec. when subjected to 50 psi through one end, with other end immersed in water." Hermetic seal is obtained through Neoprene O-rings. **Microdot, 1826 Fremont Ave., South Pasadena, Calif.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-90)

POWER SUPPLY

Type 212-A Transistor Power Pack provides 0 to 100 vdc at 100 Ma. Modulation input permits measurment of transistor parameters by the small signal method. Provides remote control from a distance by inserting resistance across a two terminal line. Voltage is controlled according to E_o= KR where K is a constant and R is the inserted resistance. A typical application would



be tube testing with automation. Regulation: 0.1%; stability: 0.15%; ripple: ½ mv. Unit is 3½ in. tall and weighs 14 lbs. **Electronic Measurements Co., Lewis St., Eatontown, N. Y.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-86)

New Avionic Products

VOLTAGE SOURCE

The "k-Volt Standard," new high-stability voltage source providing constant dc output through ambient temp. as low as -55°C and up to 100°C, replaces the chemical cell and VR tube

as an absolute reference or precision voltage regulator in airborne, laboratory, etc. instrumentation. Unaffected by position, vibration or mechanical shock. Conforms to MIL-E-5272A. Size 1½ in. H. x 1¼ in. D.; weight: 3 oz. Operates from 26.5 vdc or 117 vac with dc output of 6 v. or 1 v. at 1 ma. or 10 ma. Power consumption: 1.8 w. Life expectancy: above 10,000 hrs. **Avien, Inc., 58-15 Northern Blvd., Woodside, N. Y.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-83)

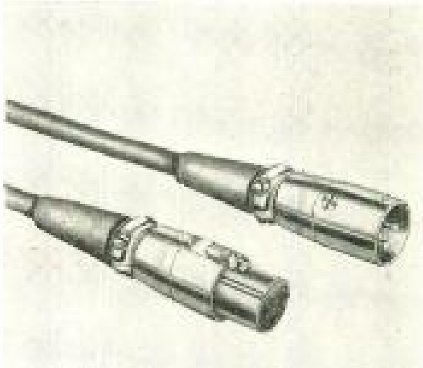
BLOWER

Small, light 2 in. axial blower has high air delivery in relation to volume and weight. Type AXB 2249 puts out 25 to 30 cu. ft. of air/min. at zero static pressure. Weight: 8 oz. Size: 3.375 in. L. x 2.87 in. O.D. Operating temp: -55° C. to +71° C. Other military aircraft environmental requirements met. Consists of an aluminum blower housing, a 2 in. aluminum fan, and a 115 V 400 cycle motor.

A 27 VDC motor is also available. Used for cooling electronic equipment in aircraft and industrial applications. **John Oster Mfg. Co., 1 Main St., Racine, Wis.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-81)

CONNECTOR

XLR audio type cord connectors for quality microphones, aircraft test equipment, instruments and low level sound applications are shock-proofed to provide quiet connection through the



use of polychloroprene. Contacts are brass, silver plated. Two insert arrangements are available, one with 3,15-amp contacts for No. 14 wire; other with 4,10-amp for No.16 wire. One circuit is a grounding means. Panel style rectangular flange receptacle provides closer mounting for crowded installations. **Cannon Electric Co., 3209 Humboldt St., Los Angeles, Calif.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-80)

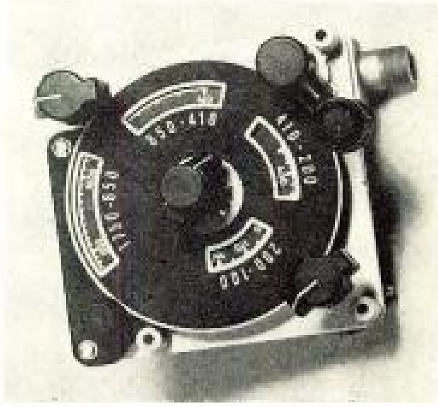
CRYSTALS—OVEN

Model GA-100 Crystal Unit contains a 100 kc GT High Precision Quartz element in an evacuated glass bulb with an octal base. Frequency shift is less than ½ cycle over temp. range of 25°C. to 70°C. Aging: less than 1 part in 10^8 /week. Q's in the order of 10^6 are attainable. Model AM-10 features glass enclosed vacuum sealed crystal unit in a precision oven. Meets Mil. Spec. 3098A environmental conditions. Freq. Range: 4 kc to 200 kc. Stability: 5 parts/

million. Miniature crystal oven Model AB-200 features heater design eliminating need for 2 thermostats. Operates at 27 or 110 v. **Bulova Watch Co., Valley Stream, N.Y.** TELE-TECH ELECTRONIC INDUSTRIES (Ask for 12-84)

CONTROL HEAD

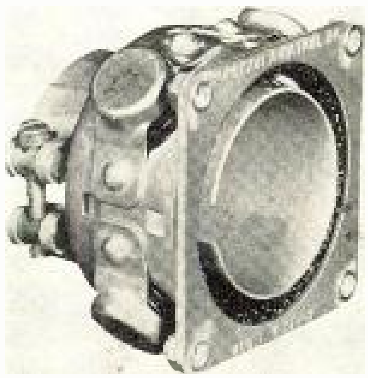
The 150 Series ADF Control Head permits max. utilization of control panel space, retaining a large, accurate, and easily read 4 in. dial face, usable for either straight or 90° tach shaft output.



For use with MN62, R5/ARN7 or BC433 equipment, unit is available in 4 models to meet all requirements. Volume control, left or right switches and knobs and crank, tach shaft outputs straight out of back or 90° to control panel are all optional. Requires a panel depth of 1-3/4 to 2-23/32 in., depending on unit used. **Electronics Equipment Engineering, Inc., 1905 Plantation Rd., Dallas, Texas.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-82

SHOCK MOUNT

Electronic tube protection is now available for delicate components that should not be exposed to shock and vibration. Miniature mounting, as in Model K271, insures against shattered tubes and waveform distortion. Mounting system is a metal sleeve, serving as a brace and support for the tube, and adjustable with a screw clamp. Met-L-Flex spring enclosed cushions, of stain-



less steel, attenuate shock and vibration between sleeve and outer suport. Temp. range: + 375°F. to -130°F. **Robinson Aviation Corp., Teterboro, N. J.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-85)

For product information, use inquiry card on last page.

WASHINGTON

News Letter

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

FAR IN FUTURE—Despite views in some broadcasting quarters, the FCC proposal to "trade" present ultra high frequency TV space to the armed services and other government users for the latter's very high frequency allocations has little chance for success. *TELE-TECH's* Washington Bureau received, from authoritative sources, the view that this plan could not be effectuated, if ever, for a period of a minimum of three to five years. Considerable discussion would be required, the sources emphasized, before the armed services and other government users of VHF space would be able to agree to the complex and expensive frequency changeovers which would be needed. The government sources feel a quicker answer to the TV difficulties could be found in moves such as closer VHF geographical separations.

MOBILE RADIO PLAN—The Bell System is ready to carry through a several million dollar project to provide the nation with broadband common carrier mobile radio service if the FCC allocates sufficient frequency space in the 60-500 MC band to accommodate 200 two-way channels. This proposal was recently presented to the FCC by the American Telephone & Telegraph Co. for the Bell System. The AT&T stated that the Bell System has already "undertaken the preliminary stages and is ready to commit the necessary manpower and funds to carry the project through to completion." The width of the required band would range from a 14.1 MC block in the 100 MC portion of the spectrum to 20.6 MC in the 400 MC band.

AUTOMATION VIEWS—Two leading spokesmen from the electronics industry—President and Chairman Don G. Mitchell of Sylvania Electric Products and Stromberg-Carlson President Robert C. Tait—recently told a Joint Congressional Committee that, without automation, the nation would be faced with a labor shortage. Mr. Mitchell in a constructive presentation stated that even by 1975, if the present rate of automation continues, every available worker would have to work 40 hours a week to meet the national demand for goods and services. He declared that the electronics industry, which has doubled in size in the past ten years, can be doubled again in the next decade if the present trend toward automation is continued and accelerated. Instead of unemployment, he insisted, there is, actually danger of a labor shortage. Mr. Tait likewise felt there was strong possibility of a labor shortage in the electronics field unless automation is carried on "in every conceivable direction." The Stromberg-Carlson President won Congressional attention over his concern about the availability of engineering talent for American industry.

$895.9 MILLION FOR DEFENSE—The Defense Department reported that through the 1955 fiscal year, ended June 30, it had spent $895,960,000 on the procurement of military electronics and communications equipment. At the beginning of the 1956 fiscal year there was available $2,724,780,000. The latter figure included for the current fiscal year $481,242,000 for the Army, $477,725,000 for the Navy, and $1,553,026,000 for the Air Force. The balance of the total available for this fiscal period is to be spent under the mutual defense assistance program.

INFORM CONGRESS—The taxicab industry, one of the larger mobile radio services, is planning to present a strong front to Congress and to the FCC on the proposal for the reallocation of the 152-162 MC band as part of a plan involving frequency exchanges between the military services and non-government users to benefit the television industry to secure additional VHF television channels. The opposition is to be based on the taxicab industry's investment of more than $30 million in 152 MC radio equipment and the fact that the 152 MC band is ideally suited for taxicab radio dispatching.

GO INTO UPPER BANDS—In order to provide interference-free two-way radio-communications for the trucking industry, FCC Safety & Special Radio Services Bureau Chief Curtis B. Plummer, former Commission chief engineer, has recommended that the industry go into the 450 MC band as "a form of insurance against long distance interference." He cited that skip interference from foreign countries due to the coming period of high sunspot activity will create serious problems of interference with their communications operations.

R & D PROJECTS—Wm. H. Martin, the Army's Director of Research and Development reports that as a result of studies made by his office a number of R&D projects have been increased. Guided missile projects, in particular, have found their funds "increased to the amount required to optimize the service availability of the end items."

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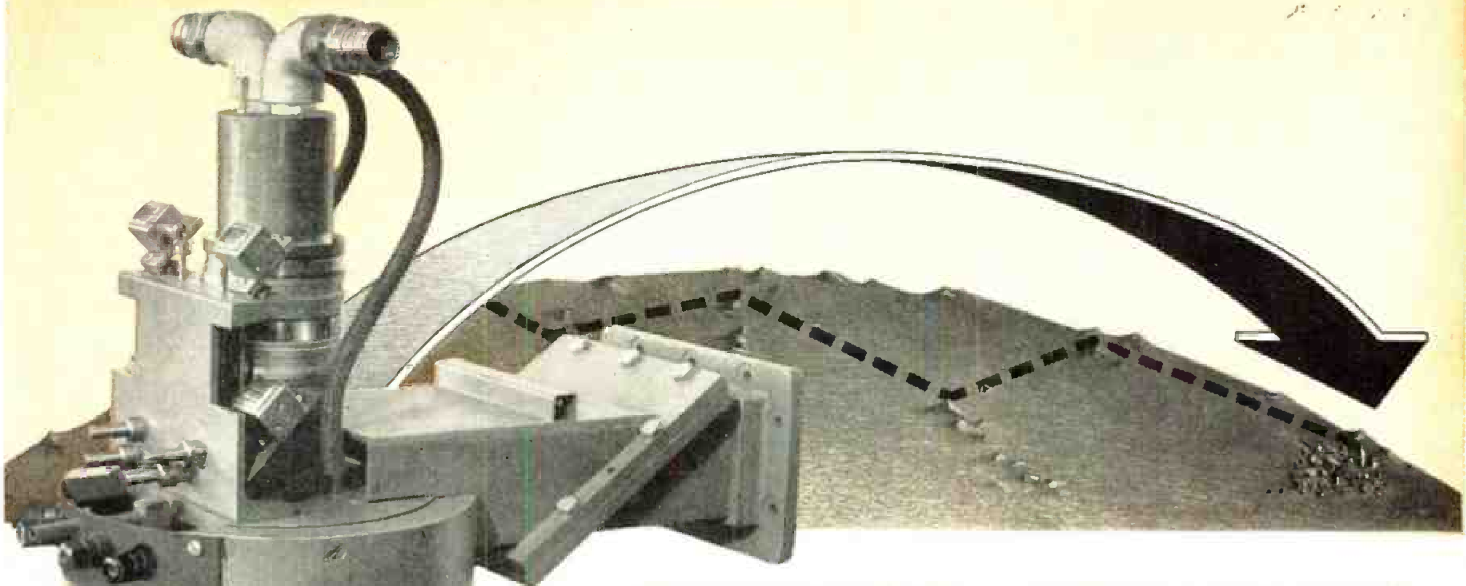
ROLAND C. DAVIES
Washington Editor

NEW VARIAN KLYSTRONS

ADD SEVEN LEAGUE BOOTS

to microwave transmission...



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Meet Varian's newest klystrons . . . a related group of 1 Kw and 10 Kw cw amplifier tubes that extend microwave propagation **far beyond** conventional line-of-sight limits. Designed to exacting Varian quality and performance standards, applications for these versatile klystrons include long range communication and cw radar or illuminator service . . . available in the following types and frequency ranges:

VARIAN TUBE TYPE		FREQUENCY RANGE (MC)	VARIAN TUBE TYPE	FREQUENCY RANGE (MC)
VA-800 (10 Kw)	A	1700-1930	VA-802 (1 Kw) D	2450-2700
	B	1930-2160	VA-803 (1 Kw) B	3700-4200
	C	2160-2400	VA-804 (1 Kw) B	4400-5000
VA-802 (1 Kw)	A	1700-1930	VA-805 (1 Kw) B	5925-6425
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Varian 1 Kw amplifier klystrons offer many advantages for commercial transmitter operation. Rugged, integral-cavity design, air-cooled operation, wide range tuners and conservatively rated, thoriated tungsten buttons provide a life expectancy in excess of 10,000 hours. One power supply design can be used for the entire frequency range . . . no special r.f. equipment is needed. Other outstanding features include:

- Low noise, negligible microphonics.
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For product information, use inquiry card on last page.

1955 Directory of

Printed Circuit Manufacturers

Listed below are the names and addresses of all firms in the U. S. manufacturing printed circuits, printed circuit materials or related items. The firms are listed alphabetically under the product or products they manufacture.

Amplifiers

ACF Electronics, Div. ACF Industries, Inc., 800 N. Pitt St., Alexandria, Va.
Air Associates, Inc., 511 Joyce St., Orange, N. J.
Airborne Instruments Lab., 160 Old Country Rd., Mineola, L. I., N. Y.
Atlantic-Central Mfg. Co., 10 Esplanade Ave., Pitman 9, N. J.
Avion Instrument Corp., 299 State Highway #17, Paramus, N. J.
Bendix Aviation Corp., Pacific Div., 11600 Sherman Way, N. Hollywood, Calif.
Berkeley Div., Beckman Instruments Inc., 2200 Wright Ave., Richmond, Calif.
Bruno-New York Industries, 460 W. 34 St., New York 1, N. Y.
Centralab, Div. Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.
Centronics Corp., 21-04 122 St., College Point 56, N. Y.
Circuitron, Inc., 115 E. Main St., Rockville, Conn.
Computer Control Co., 92 Broad St., Wellesley 57, Mass.
Crown Eng'g., 3821 Commercial N. E., Albuquerque, N. M.
Daystrom Instrument. Archibald, Pa.
Demco Products, P. O. Box 5042, Philadelphia 11, Pa.
Digital Products, Inc., 7643 Fay Ave., LaJolla, Calif.
Dubrow Devel. Co., 235 Penn St., Burlington, N. J.
Dwyer Engineering Co., P. O. Box 483, Nashua, N. H.
Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J.
El Mec Laboratories, 730 Boulevard, Kenilworth, N. J.
Endevco Corp., 689 S. Fair Oaks Ave., Pasadena, Calif.
Eng'g. Research & Devel. Co., Addison, Ill.
Ford Instrument Co., Div. Sperry Corp., 31-10 Thomson Ave., Long Island City 1, N. Y.
Freed Electronics & Controls, 200 Hudson St., New York 13, N. Y.
Gates Radio Co., 123 Hampshire St., Quincy, Ill.
General Precision Lab., 63 Bedford Rd., Pleasantville, N. J.
Goldak Co., 1544 W. Glenoaks Blvd., Glendale 1, Calif.
Hallamore Mfg. Co., 2001 E. Artesia, Long Beach 5, Calif.
Herlec Corp., 6th & Beech St., Grafton 1, Wis.
Insulated Circuits, Inc., 115 Roosevelt Ave., Bellville N. J.
Int'l Testing Service, Div. Jackson & Church, 321 N. Hamilton St., Saginaw, Mich.
iq Industries, 6110 Wilshire Blvd., Los Angeles 36, Calif.
Lear, Inc., 3171 S. Bundy Dr., Santa Monica, Calif.
Magnasync Mfg. Co., 5517 Satsuma Ave., N. Hollywood, Calif.
Mohowk Business Machines Corp., 944 Halsey St., Brooklyn 37, N. Y.
Non-linear Systems, Del Mar Airport, Del Mar, Calif.
Pacific Mercury TV Mfg. Corp., 5955 Van Nuys, Blvd., Van Nuys, Calif.
Phen-O-Tron, Inc., 455 Main St., New Rochelle, N. Y.
Photocircuits Corp. Glen Cove, N. Y.
Plastics & Electronics Corp., 272 Northland Ave., Buffalo 8, N. Y.
Qualitone Co., 4318 Upton Ave., S. Minneapolis 10, Minn.
Radionics, Inc., 1040 N. York Rd., Towson 4, Md.
RS Electronics, P. O. Box 368 Sta. A., Palo Alto, Calif.
Sanders Associates Inc., 137 Canal St., Nashua, N. H.
Springfield Enterprises, P. O. Box 54, Springfield Gardens 13, N. Y.
Square Root Mfg. Corp., 391 Saw Mill River Rd., Yonkers, N. Y.
Standard Coil Products Co., 2085 N. Hawthorne St., Melrose Park, Ill.
Techron Corp., 254 Friend St., Boston 14, Mass.
Telephonics Corp., Park Ave., Huntington, L. I., N. Y.
Thompson Clock Co., H. C., 38 Federal St., Bristol, Conn.
Tri-Dex Co., P. O. Box 1207, Lindsay, Calif.
United Geophysical Corp., P. O. Box M, Pasadena 15, Calif.
Virginia Electronics Co., River Rd. at B & O RR, Washington 16, D. C.
Walkirt Co., 145 W. Hazel St., Inglewood 3, Calif.

Capacitors

Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
Ajax Condenser Co., 932 W. Wrightwood Ave., Chicago 14, Ill.
Astron Corp., 255 Grant Ave., E. Newark, N. J.
Beck's Inc., 298 E. 5 St., St. Paul 1, Minn.
Capacitor Corp., 203 S. Main St., Stillwater, Minn
Cardwell Electronics Productions Corp., Allen D., 97 Whiting St., Plainville, Conn.
Centralab Div., Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.
Condenser Products Co., 140 Hamilton St., New Haven 4, Conn.
Cornell-Dubilier Electric Corp., 333 Hamilton Blvd., S. Plainfield, N. J.
Electrical Utilities Co., 2427 St. Vincent's Ave., LaSalle, Ill.
Erie Resistor Corp., 644 W. 12 St., Erie, Pa.
General Electric Co., Apparatus Div., 1 River Rd. Schenectady 5, N. Y.
Glenco Corp., 212 Durham Ave., Metuchen, N. J.
Good-All Electric Mfg. Co., Ogallala, Nebr.
Gudeman Co., 340 W. Huron St., Chicago 10, Ill.
Gulton Mfg. Corp., 212 Durham Ave., Metuchen, N. J.
Hansen Electronics Co., 7117 Santa Monica Blvd., Los Angeles 46, Calif.
Micamold Radio Corp., 1087 Flushing Ave., Brooklyn 37, N. Y.
Mitronics Inc., 232 13 Ave., Newark, N. J.
Mucon Corp., 9 St. Francis St., Newark 5, N. J.
Phen-O-Tron Inc., 455 Main St., New Rochelle, N. Y.
Philco Corp., C. & Tiaga Sts., Philadelphia 34, Pa.
Photocircuits Corp., Glen Cove, N. Y.
Planet Mfg. Corp., 225 Belleville Ave., Bloomfield, N. J.
Pyramid Electric Co., 1445 Hudson Blvd., N. Bergen, N. J.
Sanders Associates, Inc., 137 Canal St., Nashua, N. H.
Sangamo Electric, 9th & Converse Sts., Springfield, Ill.
Skottie Electronics, 204 Bridge St., Peckville, Pa.
Solar Mfg. Corp., E. 46 & Seville, Los Angeles 58, Calif.
Sprague Electric Co., North Adams, Mass.
Stackpole Carbon Co., Tannery St., St. Marys, Pa.
Stupakoff Ceramic & Mfg. Div., Carborundum Co., Latrobe, Pa.
TV Hardware Mfg. Co., 919 Taylor Ave., Rockford, Ill.
United Condenser Corp., 3400 Park Ave., New York 56, N. Y.

Coatings

Beck's Inc., 298 E. 5 St., St. Paul 1, Minn.
Bigelow Chemical Products, 98 Bigelow St., Quincy 69, Mass.
Biggs Co., Carl H., 2255 Barry Ave., Los Angeles 64, Calif.
Borden Co., Chemical Div., 350 Madison Ave., New York 17, N. Y.
Borthig Co., George C., P. O. Box 115, E. Rutherford, N. J.
Central Coil Co., 1720 N. Luett St., Indianapolis 22, Ind.
Dolph Co., John C. Monmouth Junction, N. J.
Dwyer Eng'g. Co., P. O. Box 483, Nashua, N. H.
Electronic Plastic Corp., 130 St. & 90 Ave., Queens 18, N. Y.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
Haynes Laboratories, Inc., C. W., 61 Chandler St., Springfield 4, Mass.
Industrial Accessories, Inc., 77 S. Broadway, Long Branch, N. J.
Insulated Circuits, Inc., 115 Roosevelt Ave., Belleville, N. J.
Javex, Box 646, Redlands, Calif.
Lacquer & Chemical Corp., 214 40th St., Brooklyn 32, N. Y.
London Chemical Co., 1535 N. 31 Ave., Melrose Park, Ill.
Mackay Inc., A. D., 198 Broadway, New York 38, N. Y.
Mallinckrodt Chemical Works, 2nd & Mallinckrodt Sts., St. Louis 7, Mo.
Metz Refining Co., 369 Mulberry St., Newark 2, N. J.
Micro-Circuits Co., New Buffalo, Mich.
Minnesota Mining & Mfg. Co., 900 Fauquier Ave., St. Paul 6, Minn.
PCA Electronics, 2180 Colorado Ave., Santa Monica, Calif.
Sampson Chemical & Pigment Corp., 2830 W. Lake St., Chicago 12, Ill.
Steel Protection & Chemical Co., Bridge St., Mooresville, Ind.
Technic, Inc., 39 Snow St., Providence 3, R. I.
Techron Corp., 254 Friend St., Boston 14, Mass.
Zophar Mills Inc., 112 26 St., Brooklyn 32, N. Y.

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Automatic Mfg. Corp., 65 Gouverneur St., Newark 4, N. J.
Beck's Inc., 298 E. 5 St., St. Paul 1, Minn.
Better Coil & Transformer Corp., 2000 Main St., Goodland, Ind.
Broadway Coil Co., 5638 Broadway, Chicago 40, Ill.
Cardwell Electronics Productions, Allen D., Plainville, Conn.
Centralab Div., Globe-Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.
Central Coil Co., 1720 N. Luett St., Indianapolis 22, Ind.
Ceramet Co., 5905 Broadway, New York 63, N. Y.
Coilcraft, Inc., Jandus Rd., Cary, Ill.
Dwyer Engineering Co., P. O. Box 483, Nashua, N. H.
Electralab, Inc., 76 Atherton St., Boston 30, Mass.
Electrometric, Inc., 106 Olson St., Woodstock, Ill.
Essex Electronics, 550 Springfield Ave., Berkeley Heights, N. J.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
Hansan-Electronics Co., 7117 Santa Monica Blvd., Los Angeles 46, Calif.
Johnson Electronics, Inc., 521 Elwell St., Orlando, Fla.
Keystone Products Co., 904 23 St., Union City, N. J.
Lear, Inc., 3171 S. Bundy Dr., Santa Monica, Calif.
Microtran Div., Crest Labs., 84-11 Rockaway Beach Blvd., Rockaway Beach, L. I., N. Y.
North Hills Electric Co., 203-18 35 Ave., Bayside 61, N. Y.
PCA Electronics, 2180 Colorado Ave., Santa Monica, Calif.
Phen-O-Tron, Inc., 455 Main St., New Rochelle, N. Y.
Photocircuits Corp., New St., Glen Cove, N. Y.
Printed Circuits, Inc., 36 Tunxis Ave., Bloomfield, Conn.
RS Electronics Corp., P. O. Box 368, Sta. A., Palo Alto, Calif.
Sanders Associates, Inc., 137 Canal St., Nashua, N. H.
Techron Corp., 254 Friend St., Boston 14, Mass.
Thordarson-Meissner Mfg. Div., Maguire Industries, Inc., 7th & Bellmont, Mt. Carmel, Ill.
Tri-Dex Co., P. O. Box 1207, Lindsay, Calif.
Union Spring & Mfg. Co., 1057 Summit Ave., Jersey City 7, N. J.
Wheeler Insulated Wire Co., 150 E. Aurora St., Waterbury, Conn.
Wilco Corp., 546 Drover St., Indianapolis 21, Ind.

(Continued on page 104)

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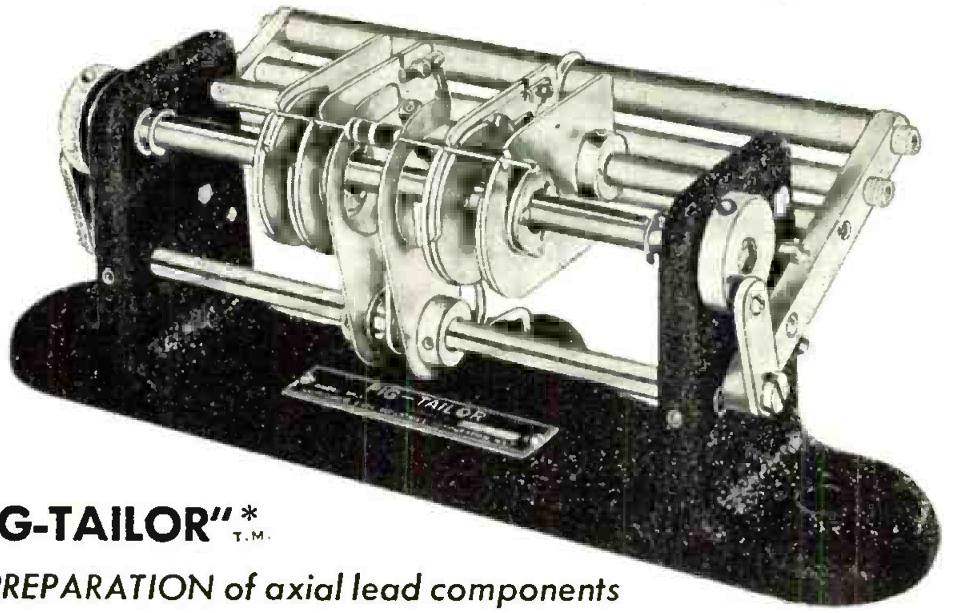

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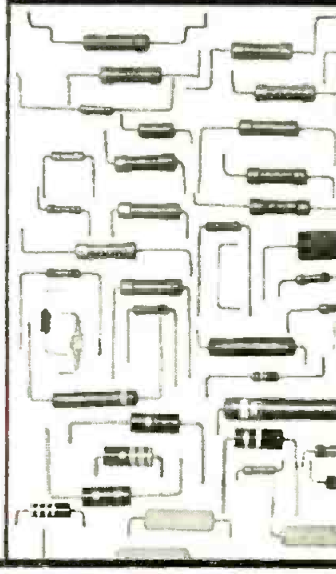
For PREPARATION of axial lead components

PREPARED COMPONENTS IN SECONDS WITH THE "PIG-TAILOR"



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. . . . a revolutionary new mechanical process for higher production at lower costs. Fastest PREPARATION and ASSEMBLY of Resistors, Capacitors, Diodes and all other axial lead components for TERMINAL BOARDS, PRINTED CIRCUITS and MINIATURIZED ASSEMBLIES.

The "PIG-TAILOR" plus "SPIN-PIN"—accurately MEASURES, CUTS, BENDS, EJECTS & ASSEMBLES both leads simultaneously to individual lengths and shapes—3 minute set-up—No accessories—Foot operated—1 hour training time.

PIG-TAILORING provides:

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3. Miniaturization spacing control.
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5. "U" leads for printed circuits.
6. Individual cut and bend lengths.
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PIG-TAILORING eliminates:

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2. Long-nose pliers!
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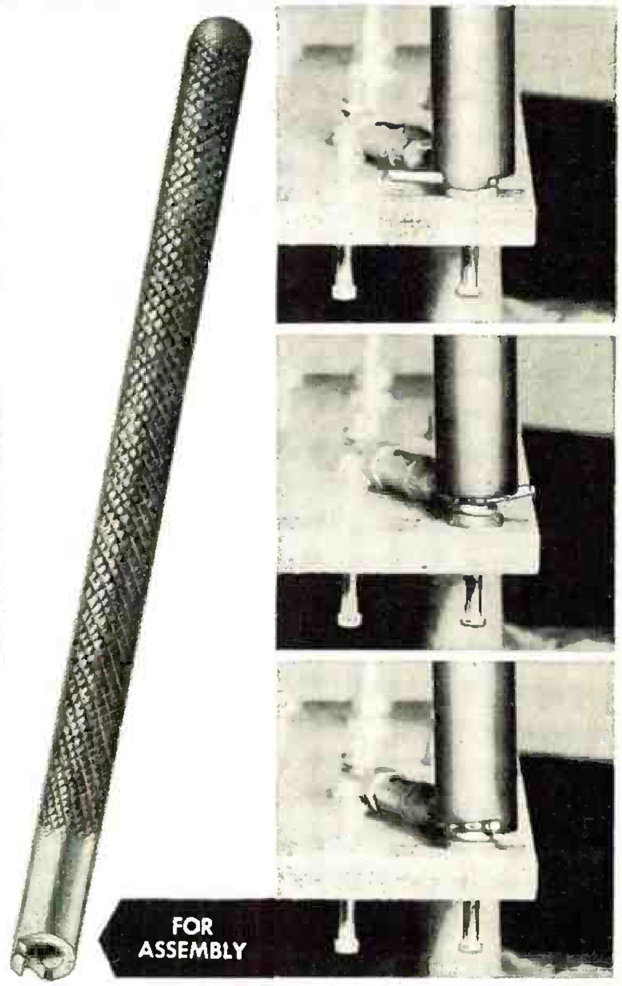

"SPIN-PIN"* T.M.

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* PATENT PENDING

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(Continued from page 102)

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Alden Products Co., 117 N. Main St., Brockton 64, Mass.
American Phenolic Corp., 1830 S. 54 Ave., Chicago 50, Ill.
Beck's Inc., 298 E. 5 St., St. Paul 1, Minn.
British Electronic Sales, 23-03 45 Rd., Long Island City 1, N. Y.
Buggie & Co., H. H., 728 Stanton St., Toledo 4, Ohio.
Cannon Electric Co., 3209 Humboldt St., Los Angeles 31, Calif.
Cinch Mfg. Corp., 1026 S. Haman Ave., Chicago 24 Ill.
Circon Component Co., 17544 Raymer St., Northridge, Calif.
Citation Products Co., 233 E. 146 St., New York 51, N. Y.
Connector Corp., 6025 N. Keystone Ave., Chicago 30, Ill.
Danbury Knudsen, Inc., P. O. Box 170, Danbury, Conn.
DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.
Eby Co., Hugh H., 4700 Stenton Ave., Philadelphia 44, Pa.
Elco Corp., M. St. below Erie Ave., Philadelphia 24, Pa.
Garde Mfg. Co., 588 Eddy St., Providence 3, R. I.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Electric Co., Wiring Device Dept., 95 Hathaway St., Providence 7, R. I.
Gorn Electric Co., 837 Main St., Stamford, Conn.
Herlec Corp., 6th & Beech St., Crafton 1, Wis.
Hermetic Seal Products Co., 37 S. 6 St., Newark 7, N. J.
Hubbell Inc., Harvey, State St. & Bostwick Ave., Bridgeport, Conn.
Insulated Circuits, Inc., 115 Roosevelt Ave., Belleville N. J.
Insuline Corp. of America, 186 Granite St., Manchester, N. H.
Johnson & Hoffman Mfg. Corp., 31 E. 2nd St., Mineola, N. Y.
Lerco, Div. Lynn-Deatrick, Inc., 501 S. Varney St. Burbank, Calif.
National Fabricated Products, Inc., 2650 W. Belden, Chicago 47, Ill.
Precision Metal Products Co., 41 Elm St., Stoneham 80, Mass.
Richardson Co., 2790 Lake St., Melrose Park, Ill.
Sanders Associates, Inc., 137 Canal St., Nashua, N. H.
Ucinite Co., Div., United-Carr Fastener Corp., 459 Watertown St., Newtonville, Mass.
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Viking Electric, 21343 Roscoe Blvd., Canoga Park, Calif.
Volkert Stampings, Inc., 222-34 96th Ave., Queens Village 29, N. Y.
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Winchester Electronics, Willard Rd., Norwalk, Conn.

Copper Laminates

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Allied Photo Engravers, 153 W. Huron St. Chicago 10, Ill.
Beck's Inc., 298 E. 5 St., St. Paul 1, Minn.
Brubaker Mfg. Co., 9151 Exposition Dr., Los Angeles 34, Calif.
California Plasteck, Inc., 225 E. 4 St., Los Angeles 13, Calif.
Continental Diamond Fibre, Newark, Del.
Farley & Loetscher Mfg. Co., Dubuque, Iowa
Farnsworth Electronics Co., Div. IT&T Corp., P. O. Box 810, Fort Wayne, Ind.
Formica Co., 4614 Spring Grove Ave., Cincinnati 32, Ohio.
Glass Products Co., 6911 S. Chicago Ave., Chicago 37, Ill.
Hallamore Mfg. Co., 2001 E. Artesia, Long Beach 5, Calif.
Mica Corp., 4031 Elenda Street, Culver City, Calif.
Murray Plastics Co., 26 Cottage St., Poughkeepsie, N. Y.
National Vulcanized Fibre Co., Maryland Ave. & Beech Sts., Wilmington, Del.
"Q" Circuits., 32 Laskie St., San Francisco 3, Calif.
Revere Copper & Brass Inc., 230 Park Ave., New York 17, N. Y.
Richardson Co., 2790 Lake St., Melrose Park, Ill.
RS Electronics Corp., P. O. Box 368, Sta. A., Palo Alto, Calif.
Sanders Associates, 137 Canal St., Nashua, N. H.
Spaulding Fibre Co., 310 Wheeler St., Tonawanda, N. Y.
Synthane Corp., Oaks, Pa.
Taylor Fibre Co., Norristown, Pa.
Technograph Printed Electronics, Inc., 185 Valley St., Tarrytown, N. Y.
Tingstol Co., 1461 W. Grand Ave., Chicago 22, Ill.
Trimount Plastics Co., 71 Dudley St., Arlington, Mass.

Manufacturing Equipment

Bruno-New York Industries, 460 W. 34 St., New York 1, N. Y.
Eraser Co., Rush Wire Stripper Div., 1068 S. Clinton St., Syracuse 4, N. Y.
General Research & Supply Co., 572 S. Division Ave., Grand Rapids, Mich.
Gundlach Mfg. Co., 38 E. Main St., Fairport, N. Y.
Huppert Co., K. H., 6830 Cottage Grove Ave., Chicago 37, Ill.
Sanders Associates, Inc., 137 Canal St., Nashua, N. H.
Technograph Printed Electronics, 185 Valley St., Tarrytown, N. Y.
U. S. Stoneware Corp., Akron, Ohio
Vemaline Products Co., P. O. Box 222, Hawthorne, N. J.
Waage Electric Inc., 720 Colfax Ave., Kenilworth, N. J.
Wiedemann Machine Co., P. O. Box 6794, Philadelphia 32, Pa.

Printed Circuits

ACF Electronics, Div. ACF Industries, Inc., 800 N. Pitt St., Alexandria, Va.
Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
Airflyte Electronics Co., 21 Cottage St., Bayonne, N. J.
Alden Products Co., 117 N. Main St., Brockton 64, Mass.
American Metaseal Co., 3337 Lincoln Ave., Franklin Park, Ill.
American Printed Circuits Co., Forrest St., Metuchen, N. J.
Austin, O., 128 32 St., Brooklyn 32, N. Y.
Autel Electronics Co., 1947 Farmingdale Rd., Westfield, N. J.
Beck's Inc., 298 E. 5 St., St. Paul 1, Minn.
Brubaker Mfg. Co., 9151 Exposition Dr., Los Angeles 34, Calif.
Buckbee Mears Co., Lindeke Bldg., St. Paul 1, Minn.
California Plasteck, Inc., 225 E. 4 St., Los Angeles 13, Calif.
Cardwell Electronics Productions, Allen D., Plainville, Conn.
Centralab Div., Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.
Centronics Co., 21-04 122 St., College Point 56, N. Y.
Circon Component Co., 17544 Raymer St., Northridge, Calif.
Circuitron, Inc., 115 E. Main St., Rockville, Conn.
Citation Products Co., 233 E. 146 St., New York 51, N. Y.
Cornell-Dubilier Electric Corp., 333 Hamilton Ave., S. Plainfield, N. J.
Cramer Co., 5905 Broadway, New York 63, N. Y.
Davelle Laboratories, Inc., 145-68 228 St., Springfield Gardens 13, N. Y.
Demco Products, P. O. Box 5042, Philadelpha 11, Pa.
Dwyer Engineering Co., P. O. Box 483, Nashua, N. H.
Eby Co., Hugh H., 4700 Stenton Ave., Philadelphia 44, Pa.
Electralab, Inc., 76 Atherton St., Boston 30, Mass.
Electrochemical Industries, Jacques St., Worcester 3, Mass.
Electronic Mechanics, Inc., 101 Clifton Blvd., Clifton, N. J.
Electron-Radar Products, 1041 N. Pulaski Rd., Chicago 51, Ill.
Elm Labs., 18 S. Broadway, Dobbs Ferry, N. Y.
Eng'g. Research & Development Co., Addison, Ill.
Erie Resistor Corp., 644 W. 12th St., Erie, Pa.
Espey Mfg. Co., 528 E. 72 St., New York 21, N. Y.
Farnsworth Electronics Co., Div. IT&T Corp., P. O. Box 810, Fort Wayne, Ind.
Farrington Mfg. Co., 76 Atherton St., Boston, Mass.
Flett Laboratory, 3711 Marshall Rd., Drexell Hill, Pa.
General Electric Co., Broadcast Equip. & Commercial Equip. Div,. Electronics Park., Syracuse, N. Y.
General Electric Co., P. O. Box 1122, Syracuse, N. Y.
General Precision Lab., 63 Bedford Rd., Pleasantville, N. Y.
Glass Products Co., 6911 S. Chicago Ave., Chicago 37, Ill.
Glenco Corp., 212 Durham Ave., Metuchen, N. J.
Goldak Co., 1544 W. Glenoaks Blvd., Glendale 1, Calif.
Hallamore Mfg. Co., 2001 E. Artesia, Long Beach 5, Calif.
Hanson Electronics Co., 7117 Santa Monica Blvd., Los Angeles 46, Calif.
Herlec Corp., 6th & Beach Sts., Grafton, Wis.
Hi-Q Div., Aerovox Corp., Olean, N. Y.
Hubbell Inc., Harvey, State St. & Bostwick Ave., Bridgeport, Conn.
Insulated Circuits, Inc., 115 Roosevelt Ave., Belleville, N. J.
Insulating Fabricators of N. E., 69 Grove St., Watertown 72, Mass.
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International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.
Isolantite Mfg. Corp., Warren Ave., Stirling, N. J.
Javex, Box 646, Redlands, Calif.
Johnson Labs., Willard Rd., Norwalk, Conn.
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British Electronic Sales, 23-03 45 Rd., Long Island City 1, N. Y.
Buckbee Mears Co., Lindeke Bldg., St. Paul 1, Minn.
Centronics Corp., 21-04 122 St., College Point 56, N. Y.
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(*Continued from page 104*)

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Plastics & Electronics Corp., 272 Northland Ave., Buffalo 8, N. Y.
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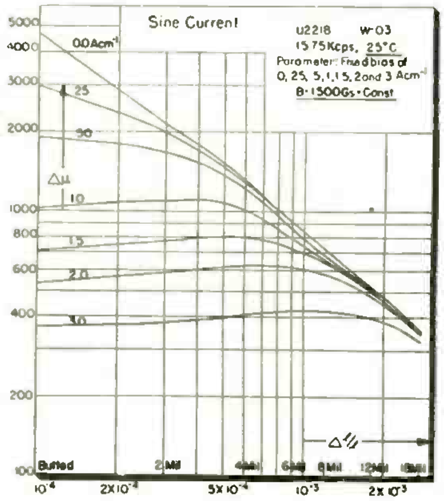
Techron Corp., 254 Friend St., Boston 14, Mass.
Ucinite Co. Div. United-Carr Fastener Corp., 459 Watertown St., Newtonville, Mass.

Ferrites

(*Continued from page* 90)

unit will prove advantageous in military equipment. Work with magnetically induced, resistive decoupling of mechanically cascaded feed-through capacitors is being continued since this new concept looks quite promising.



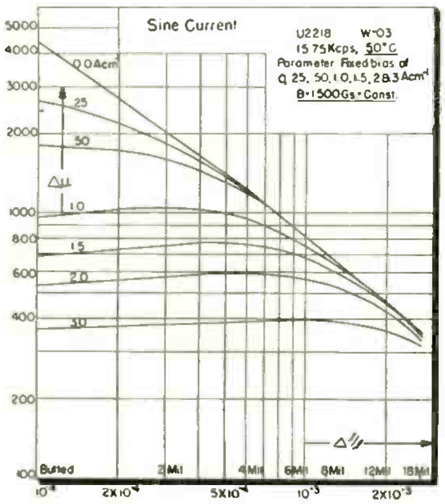


Fig. 10A & 10B: Sinusoidal current distortion

Irreversible Domain Wall Relaxation

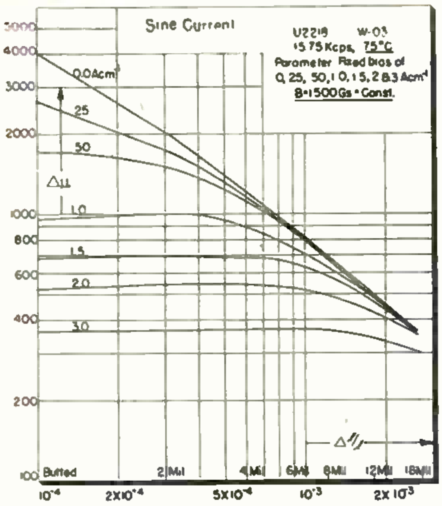
For small exciting amplitudes, the initial dielectric constant of ferroelectrics and the initial permeability of ferrites is independent of the applied electric or magnetic force, respectively. In this so-called Raleaigh range, the domain walls are reversible.

For large driving forces, irreversible domain wall displacements or rotations take place. This orientation of domains occurs in steps (Barkhausen jumps), since a certain amount of energy has to be accumulated to overcome internal friction caused by dislocations and other irregularities in the overall lattice arrangement. In a simplified way,

(*Continued on page* 110)

Ferrites

(*Continued from page 109*)



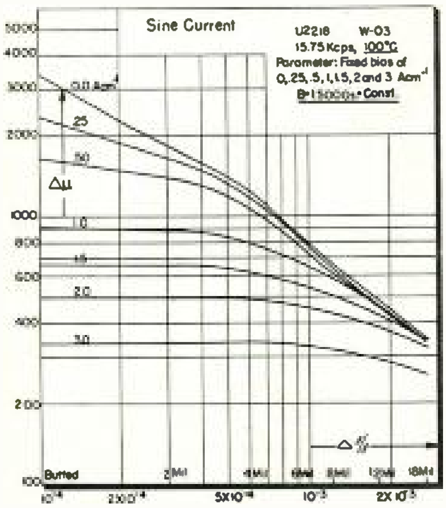


Fig. 10C & 10D: Sinusoidal current distortion

these jerky movements may be compared with moving a body over a rough surface. In certain ferroelectrics, this step-wise response to a smoothly increasing field can be observed as distinct clicks. When using a small increment of field strength, the number of clicks connected with producing a certain change necessitates the same number of clicks to reduce the ferroelectric back to the starting state.

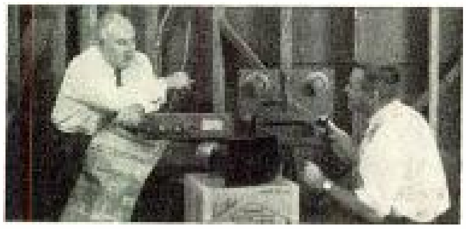
In ferrite a process very much similar to the one just mentioned occurs, but the discrete response steps are much smaller. When the range of reversible domain wall movements is exceeded, the losses increase strongly because of the work required to "grind" the domain wall orientation through the locking obstructions in the structure. This is illustrated in Figs. 7 and 8. Fig. 7 pertains to a NiZn ferrite, Fig. 8 to a MnZn ferrite. The solid lines represent the magnetization curves. With increasing frequency the maximum permeability becomes smaller for both ferrites. This may be explained in terms of the failure of the

(*Continued on page 112*)

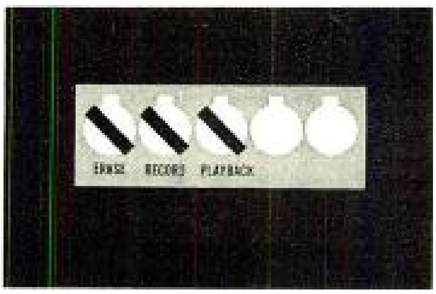
BOB, YOU NEED 5 HEADS!

Meet Bob Stephens, audio pioneer, designer of the first 2-way speaker system, the first high fidelity coaxial speaker and the first wireless microphone. Still experimenting, Stephens is now building a recording laboratory into his Bel-Air home, where he will work on new designs for his world famous Stephens Tru-Sonic speakers. "You're right, Bert," he says to Bert Berlant, as they check the installation plans. "I need a tape recorder that will take up to five recording and playback heads so I can test new stereophonic speaker combinations." Naturally, Bob Stephens is installing a Berlant-Concertone... the personal choice of leading audio manufacturers.

These experts are hard to please. They choose Berlant-Concertone because it is the only recorder made to the highest professional standards plus extra exclusive features that satisfy their special requirements. Bob Stephens needs 5 heads, an



exclusive Berlant-Concertone feature. In addition to the standard erase, record, and playback heads, with 5 heads he can do stereo recording, sound on sound recording and echo effects. He chose Berlant-Concertone because no other recorder offers this remarkable versatility.



"If you want the performance, versatility and dependability of a professional tape recorder, now is the time to trade-up to a Berlant-Concertone See your nearest Berlant-Concertone distributor for news of a special trade-in allowance this month."
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The Concertone TWR-2; $445. A complete Concertone sound system in smartly styled carrying cases with matched 10 watt amplifier and extended range speaker; $595. The Berlant Recorder with hysteresis synchronous motor, designed for broadcast and recording studio use, from $595. Write Department 13-D for detailed literature fully describing Berlant-Concertone recorders.

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Audio Division of American Electronics, Inc.
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Recordata Division· For industrial requirements

Ferrites

(*Continued from page 110*)

irreversible domain wall movement to follow the rapid changes in driving force.[6] The dashed lines in Figs. 7 and 8 represent the specific work per cycle (measured in $\mu Wcm^{-3}cps^{-1}$) with the frequency as parameter. Disregarding the range of saturation, the specific losses per cycle of either ferrite, being very low in the initial μ range, rise very steeply in the neighborhood of the coercive force (H_c). However, there is a distinct difference in the loss behavior of the two ferrites.

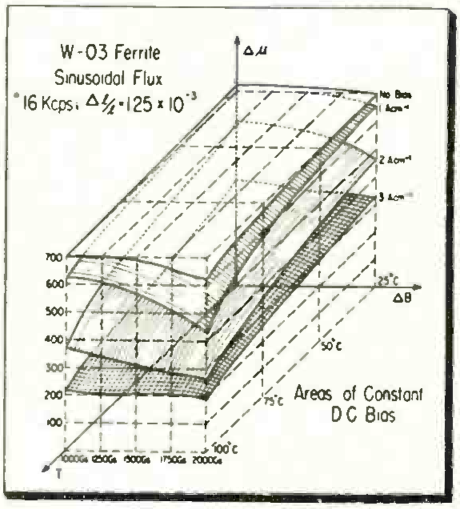


Fig. 11: Interrelation of $\Delta\mu$, B, and T. Bias-K.

In the case of NiZn ferrite (W-01) the two arrows marked "f" (frequency) point in the same direction. With increasing frequencies the loss curves are shifted parallel toward larger H valves.

In the MnZn ferrite (W-02) the nearly straight part of the loss curves pivots roughly about the point H_c and becomes steeper and steeper for increasing frequency. Here the two arrows denoting the frequency trend of P and B are facing in opposite directions.

Only a partly satisfying solution for these different loss mechanisms has been obtained. A clearer explanation hinges on the correlation between corresponding equally distinct differences with respect to Faraday rotation and internal structure. These investigations have not yet been concluded.

In order to prevent any incorrect inference that the ferrites can be used at very high flux densities at high frequencies (as Figs. 7 and 8 might suggest), it should be pointed out that these loss measurements were made with pulsed wave trains having a low duty cycle to avoid masking from heat effects.

W-02, being far less lossy than

(*Continued on page 115*)

SIMPLIFY YOUR DESIGN PROBLEMS WITH

STANDARD *FERRAMIC®* CORES

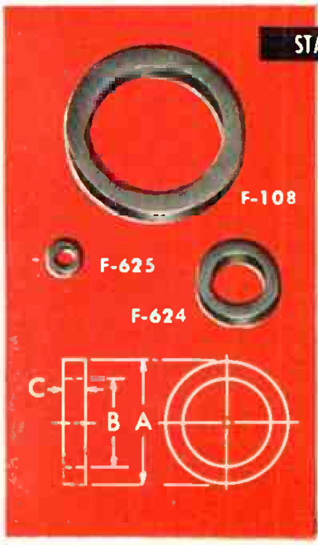
by GENERAL CERAMICS

TABLE OF MAGNETIC PROPERTIES OF FERRAMICS®

PROPERTIES	UNIT	C	E	H	H-I	O-I	Q
Initial Perm. at 1mc/sec.	—	250	750	850	550	1200**	125
*Max. Perm.	—	1100	1710	4300	3800	6000	400
*Sat. Flux Dens.	Gauss	4200	3800	3400	2800	4100	3300
*Residual Mag.	Gauss	2700	1950	1470	1500	2500	1050
*Coercive Force	Oersted	2.1	.65	.18	.35	0.20	2.0
Temp. Coef of Initial Perm.	%/°C	.40	.25	.66	.80	+0.75	.10 max
Curie Point	+°C	330	160	150	125	165	350
Vol. Resistivity	—	Med.	Med.	Med.	Med.	Low	High
Loss Factor:	$\frac{1}{\mu_0 Q}$						
At 1 mcs/sec.	—	.00007	.00008	.00030	.0004	0.000010**	.000024
At 5 mcs/sec.	—	.0008	.0020	.00155	.0010		.00004

*Measurements made on D.C. Ballistic Galvanometer with Hmax = 25 oersteds. Above data is based on nominal values.
**Measurements made at 50 Kcs.

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

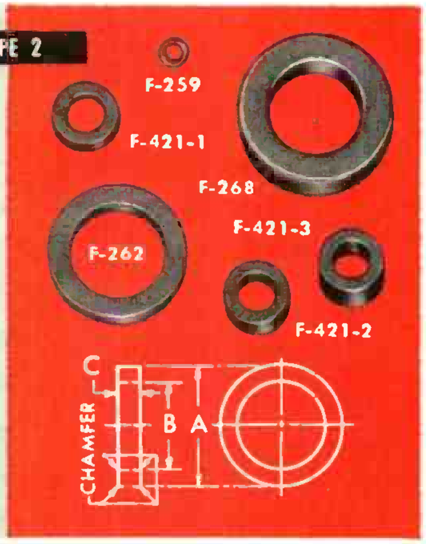


STANDARD TOROID CORES TYPE 1

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

STANDARD TOROID CORES TYPE 2

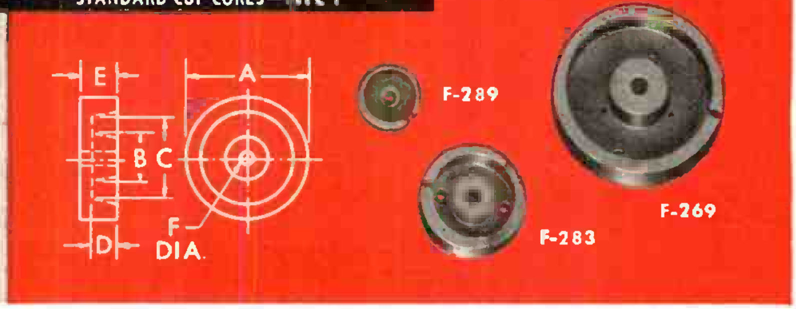
Part No.	A	B	C
F-109-1	.870	.540	.093
F-109-2	.870	.540	.156
F-109-3	.870	.540	.250
F-259	.230	.120	.060
F-262	.375	.187	.125
F-268-1	1.250	.750	.187
F-268-2	1.250	.750	.375
F-268-3	1.250	.750	.250
F-421-1	.500	.281	.093
F-421-2	.500	.281	.156
F-421-3	.500	.281	.250



STANDARD CUP CORES—TYPE 1

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

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



STANDARD CUP CORES—TYPE 2

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

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The "**ELECTRONIC INDUSTRIES DIRECTORY**" is the most complete, accurate, up-to-date directory in the electronic-TV engineering field. It serves the 27,000 top-level engineers who receive **TELE-TECH** regularly each month and have the responsibility to specify and purchase products. Over 4,000 manufacturers are listed, and all editorial listings are FREE.

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Paid listings to provide quick and direct contact between buyer and seller—between the purchaser and the manufacturer's branch office or local representative.

HOW IT WORKS: Immediately under the firm name, listed free in the Alphabetical List of Manufacturers, the firm can list its local representatives, branch or regional offices, executive and engineering personnel, etc. Names, addresses, telephone numbers, representatives arranged alphabetically by cities can be included. Additional localizer listings are available in the Directory of Distributors to show at the end of each state a list of manufacturer's distributors in that state.

LOCALIZER LISTINGS CUT COSTS, INCREASE SALES. They minimize long distance telephone and telegraph charges, reduce time-consuming correspondence, increase the number of inquiries, speed service to the customer.

Listings are available by the inch. All forms of Localizer space are subject to agency commission when ordered by recognized agencies.

TELE-TECH
& Electronic Industries

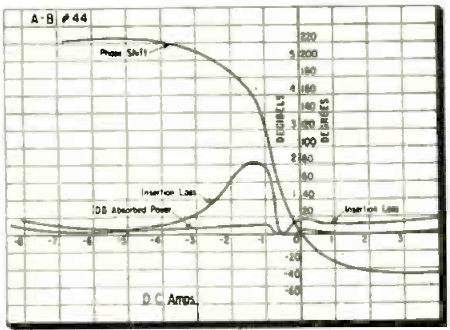
Ferrites

(Continued from page 112)

W-O1 at lower frequencies, equals in losses the W-O1 at about 300 KC to 400 KC.[5] This crossover of high amplitude losses is understandable from the different loss behavior described before. Since the major frequency components are below this crossover point, the ferrite classes W-O2 and W-O3 (a cheaper grade of W-O2) perform more efficiently in television flyback transformers. Table 1 compares pertinent data of ferrite classes W-O1, W-O2, and W-O3. The tolerances of the magnetic data of these mass produced materials are included in the table.

Three quantities form essential criteria for TV flyback transformers:

A) Losses
B) Peak flux density
C) Incremental permeability.



(100 Oe/Amps)

Fig. 12: Faraday rotation, inserting loss and absorption loss vary with magnetized field

It ought to be the responsibility of the ferrite producer to supply all necessary information to flyback transformer manufacturers as transformer steel producers do for power transformer builders. A first attempt in this respect has been made, as described in reference (5). In this article the data presented will be complete enough to be sufficient for practical use, thus eliminating the need for trial and error approaches in the design of flyback transformers.

The losses should be low and the temperature coefficient of the losses should be negative or zero, to avoid one reason for "slumping" of the horizontal drive.[5]

Another reason for "slumping" is the decrease of $\Delta\mu$ with increasing temperatures. Flux density and incremental permeability must be considered concurrently and in conjunction with biasing and temperature conditions. The optimum air-gap afforded for maximum $\Delta\mu$ depends on B, T and the bias.

In measuring these interdependencies, the nonlinearity of the ferrite introduces the need for setting up an

(Continued on page 116)

Ferrites

(*Continued from page* 115)

additional premise, namely, the distribution of distortion between current and flux, depending on the generator impedance. The two limiting cases that should be considered are those of sinusoidal current and sinusoidal flux.

Figs. 9-A to 9-D are based on sinusoidal flux. Figs. 10-A to 10-D are based on sinusoidal current. For a peak flux density of 1500 Gs the incremental permeability of class W-O3 ferrite is plotted over the normalized air gap; the parameter is the bias in A cm^{-1} for the temperatures of 25°C, 50°C, 75°C and 100°C at 16 KC.

Compiled from curves similar to Fig. 9, but conditioned upon a series of different peak flux densities, Fig. 11 shows in a three-dimensional diagram the interrelation of $\Delta\mu$, B and T, with constant bias forming spatial planes as parametric areas, under conditions of sinusoidal flux and for a constant air gap ratio of 1.25×10^{-3}. The drooping of $\Delta\mu$ with B, T and bias and the consequent "slumping" of flyback transformers can be clearly visualized. For the practical design of flyback transformers, the knowledge of the optimum air gap ratio is necessary. In actual cases the peak flux density may vary between 1000 Gs and 2000 Gs. The best air gap ratio for these two limiting cases is plotted in Fig. 5 for 25°C and 100°C. Since the optimum is rather flat, the value of this ratio is not too critical. In the same diagram the corresponding $\Delta\mu$ values are given. The design should be based on the 100°C curves. Upon request the writer will supply diagrams of the type Figs. 9 and 10 for 1000 Gs, 1250 Gs, 1500 Gs, 1750 Gs and 2000 Gs in case of a larger accuracy being required than is obtainable from Fig. 5.

Faraday Rotation and Electro-Optical Effect

The nonreciprocity exhibited by the Faraday effect makes it possible to build passive networks not obtainable with network elements known so far. Low loss networks that allow energy flow in one direction only suggest new concepts for network synthesis. Phaseshifters that can be adjusted by purely electrical means can be made for scanning antenna patterns. Fig. 12 shows the Faraday rotation, insertion loss and absorption loss of a ¼-in. diameter slug (1-in. long) of an experimental ferrite as function of the magnetizing field (1A = 100 Oe). This particular ferrite requires only a small magnetizing field and has no absorption loss for 45° phaseshift that is required for unidirectional lines. The measurements were made at 9375 MC. Fig. 6 is a nomograph for practical convenience since it allows one to determine quickly the absorption loss from the output and reflected power measurements. Output and reflected power are measured at the points shown on the circuit diagram. The nomograph is also helpful for insertion loss measurements made using similar circuits.

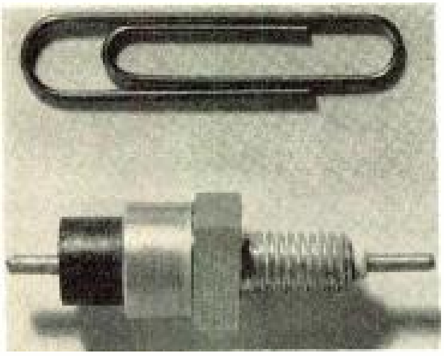


Fig. 13: Low pass, high insertion loss filter

The dielectric analogon to the Faraday effect, namely, the electri-optical effect, can by proper means be transferred from the optical into the microwave range. This effect, on materials investigated so far, is so minute in the microwave range that its utilizability looks hopeless at present.

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4. "Ferromagnetism at Very High Frequencies; III. Two Dispersion Mechanisms in Ferrites," *G. T. Rado et al, Phys. Rev. 80, Oct. 15, 1950.*
5. "Progress in Ferrite Components for Television and Radio Receivers," H. M. Schlicke, *Record of the 1955 National Convention of the IRE,* N. Y.
6. "Relaxationserscheinungen der irreversiblen Magnetisierungsvorgaenge in hochpermeablen Ferriten," T. Einsele, *Zeitschr. Angew. Phys., IV, 2, 1954.*

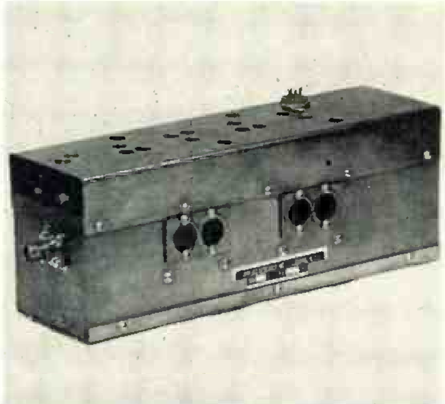
Cardioid Microphone

The article "A New Cardioid Microphone" by Norman Friedman and Cullen H. Macpherson of Electro-Voice, Inc., lacked continuity because of a printing production error. The manuscript was published in the October issue and started on page 70. For those interested readers a corrected reprint has been prepared and will be forwarded upon written request.

New Technical

UHF AMPLIFIER

New wide band, ultra-high-frequency amplifiers have center frequency of 400 mc and bandwidth of 50 mc. Models UH-4(A) and UH-6(A) incorporate the GL 6299 vacuum tube



in lumped constant, triple tuned circuitry. Low Peak to Valley ratio helps preserve phase linearity in the pass band. Power gains of the amplifiers are sufficient to provide for use as either intermediate frequency amplifiers, or as preamplifiers to improve characteristics of existing systems. Available at frequencies and bandwidths as desired. **Applied Research, Inc.**, 163-07 Depot Rd., Flushing, L. I., N. Y. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-25)

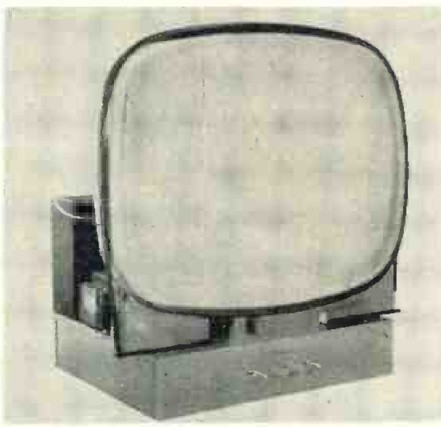
TAPE

A mile of "Plus 100," using Dupont's new "Mylar" polyester film as a base, can be wound on a single 10½ in. reel. Only ½ mil thick, it can be stored indefinitely without deterioration or loss

of sound fidelity. Runs for nearly 19 hours for voice or dictation recording—1⅞ in./sec. on a double track machine. Also available on a 7-in. reel (2400 ft.) and a 5-in. reel (1200 ft.). The 7-in. reel can provide as much as 5 hours of continuous recording at hi-fi speed of 7½ in./sec. on a double track machine. **Reeves Soundcraft Corp.**, 10 E. 52nd St., New York, 22, N. Y. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-29)

TV RECEIVERS

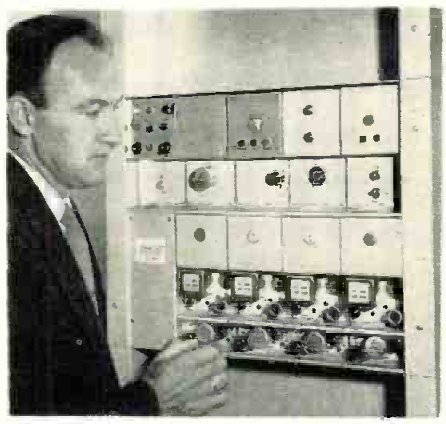
New Fleetwood models include the remote control "800" systems for 21, 24, or 27-in. rectangular 90° picture tubes, the non-remote (or self-contained control) 810 series for the same



size picture tubes, and the non-remote 610B set for 21-in. 70° picture tubes. Definition control permits picture density variation. AGC compensates for overload in strong signal areas and receivers are equipped to supply audio to a high fidelity sound system. Remote systems are fully electronic remote—no motors or ratchet devices. **Conrac, Inc.**, Glendora, California. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-21)

TELEPHONE SYSTEM

Type 45CB is a newly developed miniaturized 4-channel carrier telephone system for open-wire lines. The system uses single-sideband suppressed carrier operating in the frequency

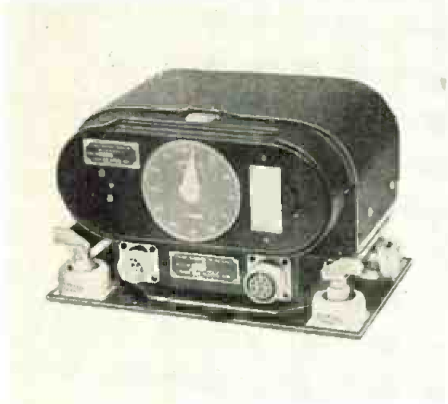


range of 40 to 76 kc and coordinates with Western Electric OB carrier. Designed to permit operation on the same open-wire pair with 3-channel Lenkurt 33A systems or other carrier systems using frequencies below about 35 kc. All 4 channels are compandored and 3 of the units in the 45CB have been transistorized. **Lenkurt Electric Co.**, 1105 Old County Rd., San Carlos, Calif. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 12-28)

Products

RECORDER

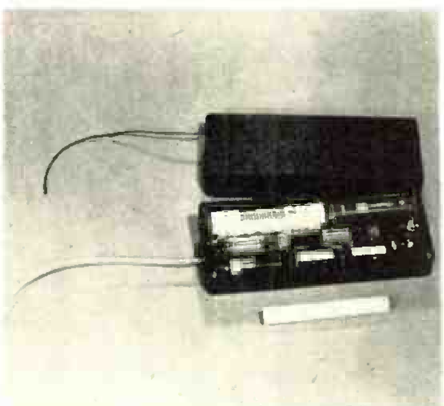
RD-106/ANH-2 sound recorder is intended for making recordings in aircraft from microphones, radio sets and intercommunication systems. Both remote-controlled and local-controlled



equipment for recording complete pilot observations on all flight operations is available. With recording magazine and mounting the unit weighs 8 lbs. 14 oz. Recorder control units are available in 4 variations depending upon application. Shown is the recorder control unit C-1051/ANH-2 (remote) which weighs 2 lbs. Operates on 27 vdc at 2.5 a. **Peirce Wire Recorder Corp.**, 5900 Northwest Highway, Chicago 31. TELE-TECH & ELECTRONICS INDUSTRIES. (Ask for 12-30)

POCKET RECEIVER

Unusual ruggedness is combined with small size and compactness in this Model 15 Pocket Receiver designed especially for one-way radio paging operation. The self contained unit in-



cludes many exclusive features to provide long battery life, good fidelity, and easy maintenance. It is encased in a subdued grey finish, high-impact styrene case. The entire unit measures 7/8 x 2 x 5 1/8 in. and weighs less than 6 ounces. Units are pre-tuned to either 35.58 or 43.58 mc. **West Coast Electronics Co.**, 5873 West Jefferson Blvd., Los Angeles. TELE-TECH & ELECTRONIC INDUSTRIES. (Ask for 12-27)

For product information, use inquiry card on last page.

Printed Inductors and Capacitors

(Continued from page 69)

of base materials are used. If the base material has a relatively high dielectric constant the value should be increased somewhat. These values are for coils on a 1/16 in. thick base. Table 2 shows the variation in distributed capacity with base material.

Q Values

Q measurements were made for the most part at a frequency of 25 MC. While this does not necessarily reflect the maximum Q, it does provide representative values at a

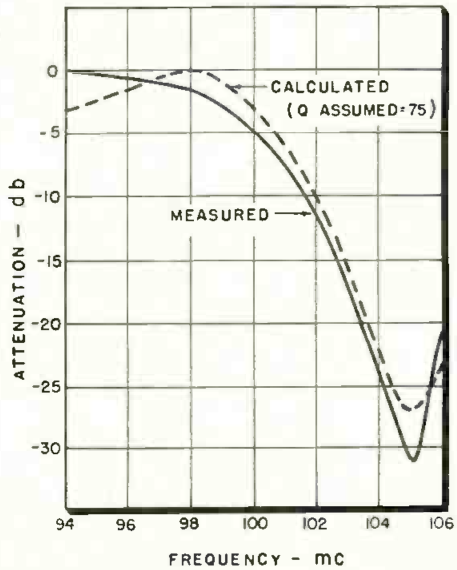


Fig. 5: Comparison of calculated and actual frequency response of filter shown in Fig. 4

"rough mean" operating frequency. Q values as high as 165 to 175 were measured on smaller coils at frequencies in the order of 75 MC.

Table 2 shows the variation in Q with base material on a given size coil at a fixed frequency. As expected, teflon-glass laminate permits the highest Q, while XXXP phenolic results in the lowest. Melamine-glass was included for information, and although it has other less desirable characteristics it nevertheless compares with silicone-glass as to the Q factor of coils constructed on it.

It will also be noted from Table 1

Table 1.

Coils on 1/16-in. Base Material

Turns	Q	f	C_d	Meas. L_o	Calc. L_o	Style
10	104	25	0.765	1.11	1.11	Square
6	105	25	0.845	0.875	0.87	Square
3	85	25	0.876	0.43	0.453	Square
10	110	25	0.66	1.03	0.99	Round
6	117	25	0.675	0.81	0.85	Round
3	90	25	0.86	0.337	0.382	Round
2	72	25	—	0.198	0.197	Round
2	68	25	—	0.21	0.209	Square

that square coils yield slightly lower Q values than circular coils for a given inductance. This was consistently noted and is no doubt due to the sharp corners of the coils used. However, the difference is not great and square coils can be quite generally used.

Printed Capacitors

Capacitors formed in the printing process can be used in many applications. The capacitors so formed will have relatively low Q as compared to more conventional units

Table 2.

Effect of Base Material on Q and C_d

	Q	C_d
Teflon-glass	110	0.67
Silicone-glass	100	0.72
Melamine glass	103	0.965
XXXP	70	0.95

Measured with 1μh coil at 25 mc.

Table 3.

Etched Capacitors

Material	Thickness	$\mu\mu$fd./sq. in.	Q at 14 mc
XXXP	.062	16	30
XXXP	.031	26.5	30
XXXP	.015	35.5	30
Siliglass	.062	15.4	200
Siliglass	.031	34.8	200
Siliglass	.015	49.5	200
Teflon-glass	.062	11.5	1,000

and their stability is probably poor. With these limitations in mind the designer can make his own determination as to their usefulness to him.

Table 3 gives information as to the average capacity/sq. in. to be expected with different materials and thicknesses. It should be emphasized that these values are not absolute and may vary with manufacturers.

In applying such capacitors, fringe effects must be considered when small values of capacity are involved since this may be responsible for an appreciable portion of the total effective capacitance.

Application

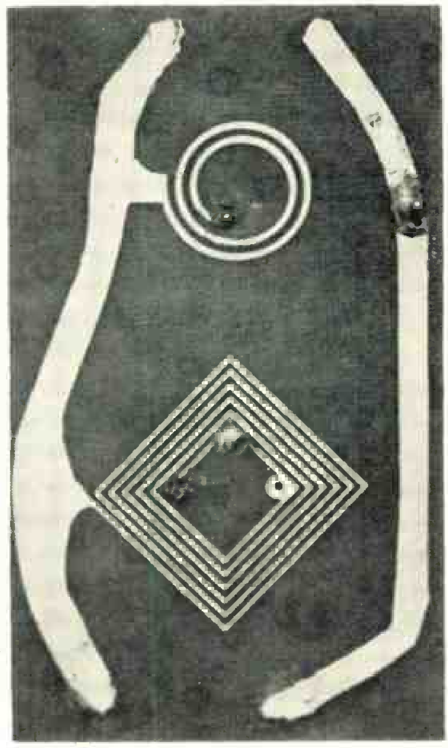
A simple rejection filter was constructed to illustrate the application of this information to a practical circuit. As seen from Fig. 4, this consists of a series resonant circuit shunted by an inductance to bring the impedance up rapidly on the low frequency side. Fig. 5 shows the measured and calculated attenuation of this filter in a 300 ohm line. Q was assumed at 75 for calculation, but apparently is actually nearer 85. A ceramic capacitor was used in the filter for which the curves were drawn.

The filter itself is shown in Fig. 6,
(*Continued on page 122*)

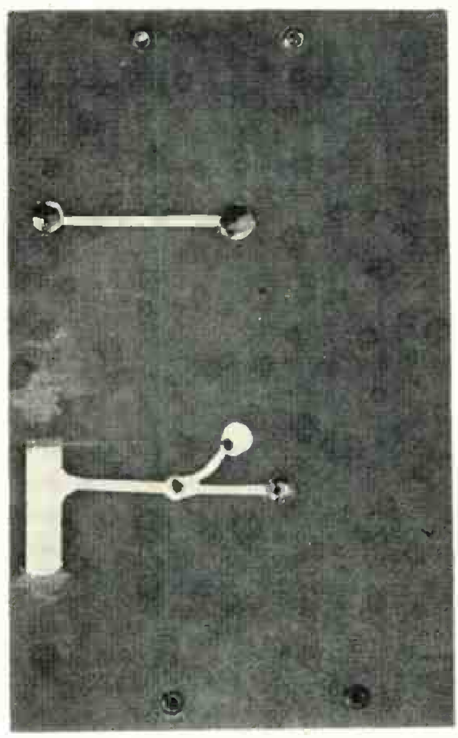
Printed Inductors and Capacitors

(*Continued from page 121*)

together with front and back views of a similar filter in which the capacitor was printed along with the coils. The attenuation of this latter unit is roughly 6 db. less than that using the ceramic capacitor, due to the lower Q of the printed capacitor.

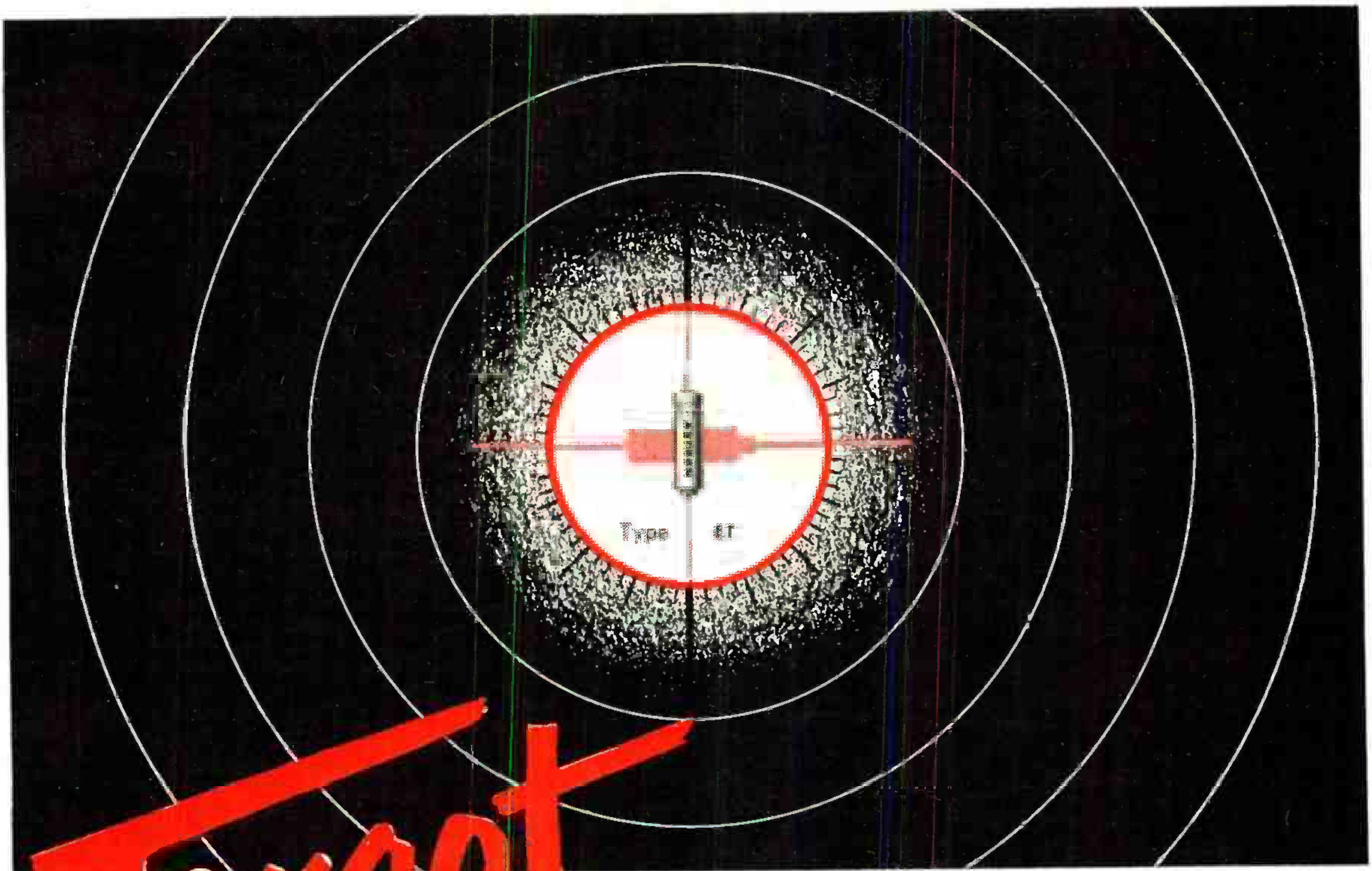


Figs. 6A & 6B: Front and back views of filter similar to that shown in Fig. 4. Here the capacitor was printed along with the coils



The small circles on the inside corners of the square coil were in-

(*Continued on page 124*)



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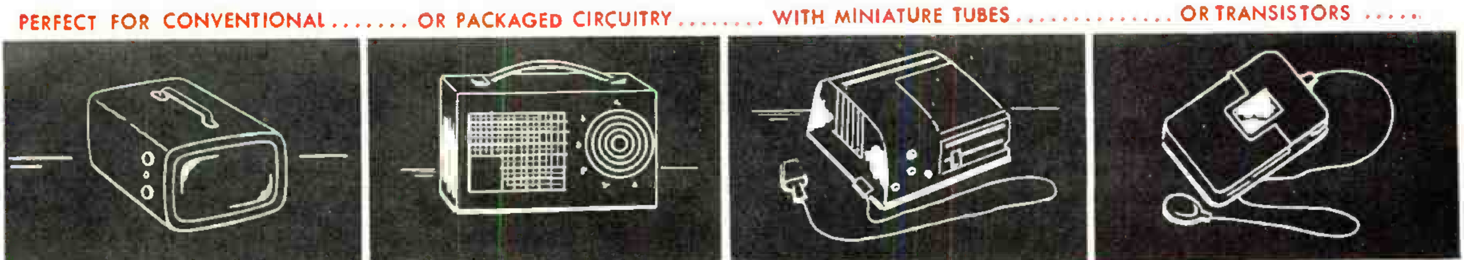

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In Canada: Charles W. Pointon, 6 Alcina Ave., Toronto 10, Ontario

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Printed Inductors and Capacitors

(*Continued from page* 122)

tended to be used as taps, since the actual effective inductance was unknown. These were found unnecessary, indicating that the assumption of 0.8 μμfd. was reasonably close for

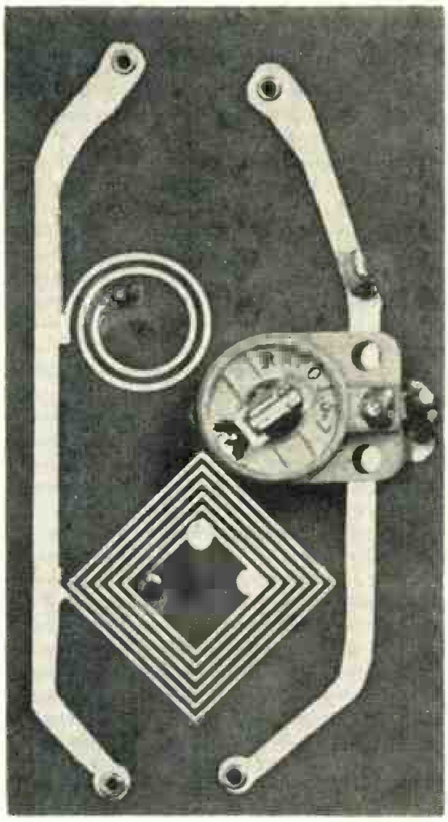


Fig. 6C: Lab model of filter shown in Fig. 4

distributed capacity. It is pointed out that the values of inductance indicated in the circuit are effective values. The true inductance of the larger coil is 0.9 μh.

"Preferred Circuits"

(*Continued from page* 91)

terminology, as different equipment designers may use widely different names for essentially the same circuit.

The results showed that the overall circuits of the 22 equipments essentially were made up of 60 circuit types. Although the circuits falling within a given type were not identical, in many cases examination showed that these circuits were sufficiently similar in their more important aspects so that standardization would be feasible. For example, it was found that certain range marker generator circuits could be identical for many of the radars and for other time-scale indicators.

In expressing the extent to which

a given over-all equipment circuit is standardizable, it has become the practice to use the ratio of the number of vacuum tube cathodes in standardizable portions of the circuit to the number of cathodes in the over-all circuit. Cathodes are counted instead of entire vacuum tubes to avoid ambiguity resulting from such items as double triodes. On this basis, the feasibility study of the 22 pieces of equipment showed that 50 to 70% of the cathodes were standardizable. The remaining cathodes were in circuits too specialized to hold any reasonable prospect of standardization.

The most promising field of standardization was in the power supply circuits, which were considered to be standardizable in all of the equipments. It was also immediately evident that the first step should be the reduction of the unreasonably large number of power supply voltages. For example, it was found that the voltages used in 20 equipments showed 20 different nominal values which appeared readily reducible to four.

As a result of the favorable outcome of the feasibility study, work was immediately started on the preferred circuits program. Priority has been given to the most widely used and readily standardizable items. The work on any given circuit has required both theoretical and experimental studies of the known versions, so that a "least-common-denominator" circuit can be established. The preferred circuit is usually chosen from one of the existing designs, with required variations allowed by prescribed component value changes. As a result, the circuit is capable of equaling the performance while avoiding the faults of a large number of "original" versions. In no case were new circuits created.

For further technical information, see Preferred Circuits Manual, Navy Aeronautical Electronic Equipment, NAVER 16-1-519, published jointly by NBS and Navy Bureau of Aeronautics (in press) Government Printing Office, Washington 25, D. C. Communications concerning the NBS-BuAer preferred circuits program should be addressed to the Office of Technical Information, National Bureau of Standards, Washington 25, D. C.

"Directory of Microwave Equipment Manufacturers"

In this listing of firms manufacturing microwave equipment, which appeared in the Nov. 1955 issue of TELE-TECH, the name of Continental Electronics Manufacturing Co. was inadvertently omitted. Located at 4212 S. Buckner Blvd., Dallas 17, Tex., Continental manufactures complete microwave systems specifically designed for the range of 5925 MC through 7125 MC.

Special Laminates

(*Continued from page 79*)

to 0.010 in. with copper on one or both sides. Insulation resistance is reported good, dry or after 96 hrs. at 90% R.H. While data is not yet available on other electrical properties, dielectric loss may be judged as low by the usage of this material at TV frequencies in the interference filter shown in Fig. 3.

Melamine

In a clad stock, melamine resin with glass fabric is best noted for its use in printed commutators and switching devices where its low tracking under arc conditions and somewhat higher temperature resistance give it advantage over phenolics. The continuous filament fabric used makes for generally good mechanical properties but considerable tool wear. The chief limitation lies in a rather high moisture pickup. Recently, producers have improved somewhat on this characteristic.

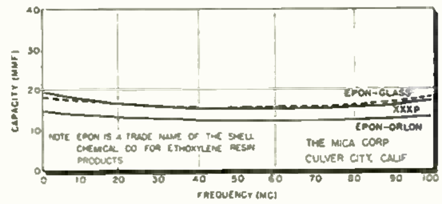


Fig. 4: Capacity vs. frequency

Besides the laminate conforming to NEMA Grade G-5 (Table 3) clads are made with melamine and glass mat as well as some other variations.

Polyester

The polyester laminates lie between the phenolics and epoxies in characteristics. Low moisture absorption results in better resistance qualities and the physicals, including punchability, are generally improved over the phenolics.

Ethoxylene

The promise inherent in epoxy resins for p.c. use has influenced almost all laminators mentioned to bring out a clad laminate with this resin. Epoxy's excellent affinity for metals, together with low moisture absorption, low loss, arc, and heat resistance, make it an excellent etching stock. The insulation resistance is, of course, excellent.

Low pressure clad epoxies have been available for some time, but the newer commercial products are high pressure laminates which will take extensive soldering at 275°C. without blistering. These epoxies can be punched cold, have high mechanical strength and low dimensional change.

Epoxies combine with glass and many synthetic fiber bases to produce laminates of interest. Characteristics of typical clad epoxies, produced by the Mica Corp., are shown in the following three graphs, where it will be seen (Fig. 4) that the capacitance provided by the glass fiber cloth base material over the frequency range does not differ very largely from that of XXXP, while the orlon based material is appreciably lower. (Measurements for these 3 graphs were made on 1 x 1/16 in. square with both sides metallized.) The lower dielectric constant for the orlon material is apparent in Fig. 5.

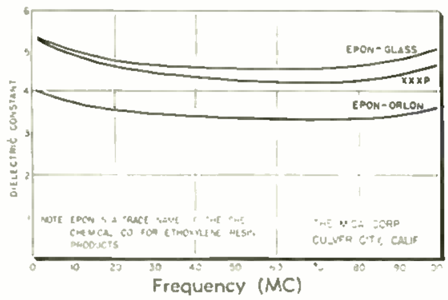


Fig. 5: Dielectric constant vs. frequency

And the advantage of epoxies in terms of very low losses are particularly evident in the power factor at higher frequencies (Fig. 6). Data on another clad epoxy of interest is given in Table 4.

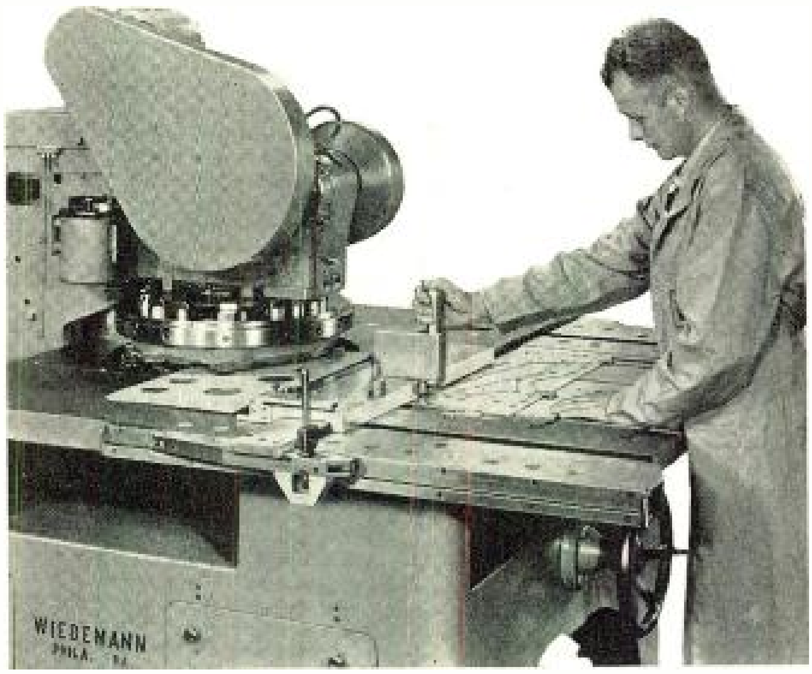
A modified epoxy paper base laminate is produced in copper clad by the American Printed Circuits Co. in sheets up to 18" x 18", with properties characteristic of epoxy materials; a flexural strength of 24,800 psi, a dissipation factor (1 mc) of 0.03 and 24 hr. moisture absorption of 0.27% giving a fair index to this material.

Glass-bonded Mica

Copper clad Mycalex 400 glass-bonded mica provides a unique low-loss, high dielectric strength inorganic stock for etching printed circuits which is characterized by exceptional dimensional stability and high thermal conductivity. The latter property facilitates soldering since heat is dissipated rapidly, which serves to minimize local area heating. (Approved under JAN I-10 as grade L-4A.)

Mycalex 400 is used in many applications where any slight warpage of the etched circuit stock would cause a capacity change. In a typical application, two 14 in. discs are used

(*Continued on page* 128)



Special Laminates

(*Continued from page 127*)

in a capacity commutator with 0.004 in. separation. The capacity surfaces may be applied by silver paste as well as etched copper segments; the surface is finished to an optical flat. These materials are furnished by Mycalex Corp. of America in sheets 1/16 in. up to 1 in., 14 in. x 18 in. in area.

Important present uses include nuclear installations where the organic plastics would be destroyed by the effects of radiation, ultra high frequency microstrip components, capacity commutators and certain types of mechanical commutators. The etched type circuits on Mycalex 400 glass-bonded mica have served many applications for long contact strips where any slight warpage would break the circuit or introduce a very high resistance contact in the circuit.

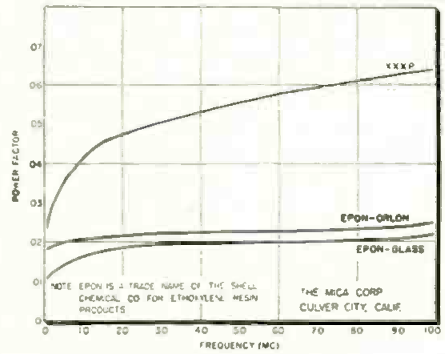


Fig. 6: Power factor vs. frequency

In 1949 the Continental-Diamond Fibre Co. of Newark, Delaware, introduced glass fabric base Teflon (trade-marked name of E. I. duPont for polytetrafluorethylene) in the form of plain or copper clad laminates. Glass fabric base Teflon is characterized by extremely low dielectric loss properties, high insulation resistance, high arc resistance, high temperature resistance (up to 260°C.), as well as a high order of dimensional stability under heat or humidity. This grade is particularly advantageous for use in printed circuits, where the standard 1 oz. or 2 oz. copper may be applied to one or both faces. Bond strength is as good as or better than that obtained with the standard XXXP copper clad, and the blister temperature of this grade is well above 260°C.

Glass fabric base Teflon is finding increasing usage in micro-wave printed circuitry and other exacting applications where superior electrical properties plus heat resistance and dimensional stability are of primary importance.

Of similar application to higher frequency printed circuits is the solid Teflon clad with 1 or 2 oz. copper or silver and an epoxy bond as offered by the U. S. Gasket Co. in sheet sizes from 8 in. x 8 in. to 36 in. x 36 in. MI-443-409 copper clad exhibits a surface resistivity of 27,400 megs, a peel strength of 9 to 11 lbs./in. width and other characteristics expected of solid Teflon.

Silicone

Clads are produced by several manufacturers on glass-silicone resin bases utilizing either NEMA G-6 (staple-fibre) or G-7 (continuous-filament) material and an epoxy resin bond, the G-7 being slightly superior in both electrical and physical properties. Very low dielectric loss and generally superior electricals (Table 3) make this material particularly attractive for inductors at TV frequencies over less stable and less expensive materials.

Temperature resistance, while good, is limited to approximately 150°C. by the epoxy adhesive.

Other Combinations

Almost any laminate or plastic sheet can be obtained clad on order at the present time. Some combinations not discussed, which are rather readily obtained, involve random glass fiber mat with melamine, ethoxylene, or diallylphthalate (DAP) resin. Cloth of various synthetic fibers is also being introduced[4] using these resins, with the prospect of clad-laminates made optimum to every application.

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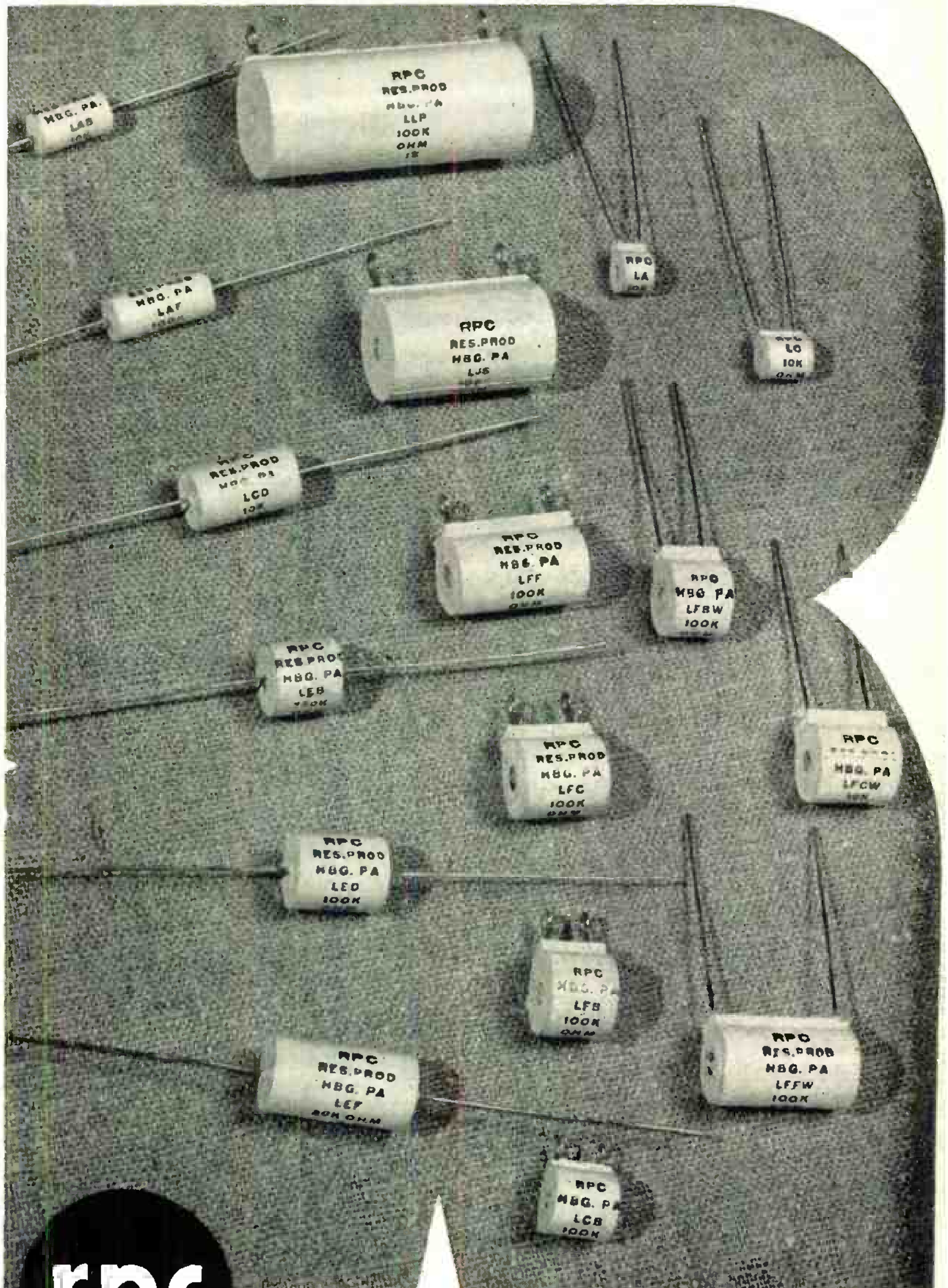
2. W. Hannahs & N. Stein, Printed Unit Assemblies for TV, *Tele-Tech* June 1952 p. 38. See also *Tele-Tech* Mar. 1954 p. 101 and June 55, p. 102.
3. G. Broomhall, Printed Circuit Techniques for the Laboratory, *Tele-Tech* July 1953 p. 36. See also *Tele-Tech* Dec. 1953 p. 78 and p. 62.
4. Anon, Wizardry in Circuitry, *Modern Plastics*, April 1954.

Fabricators of products mentioned in this review are:

1. American Printed Circuits Co., Metuchen, N. J.
2. The Formica Co., Cincinnati 32, O.
3. Continental-Diamond Fibre Co., Newark, Del.
4. General Electric Co., Laminated & Insulating Products Dept., Coshocton, O.
5. The Mica Corporation, 4031 Elenda St., Culver City, Calif.
6. Mica Insulator Co., Schenectady 1, N. Y.
7. National Vulcanized Fibre Co., Wilmington 99, Del.
8. Photocircuits Corporation, Glen Cove, N. Y.
9. Rowland Products Inc., Plastilight Div., Kensington, Conn.
10. The Richardson Co., Melrose Park, Ill.
11. Synthane Corp., Oaks, Pa.
12. Taylor Fibre Co., Norristown, Pa.
13. U. S. Gasket Co., Camden 1, N. J.



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Assembly System

(*Continued from page 71*)

can be an extended metal channel similar to the feed employed on eyeletting machines, which will accept components packaged on cards or in rolls like some of the resistor manufacturers are currently packaging their product. The drive source will be a conventional air cylinder with a maximum stroke of four in. The forming head will be a set of machined cutting and forming blocks designed to pick the components off the feeder channel, clip the leads at the desired length, form the leads at 90°, and support the leads as they are passed through the printed wiring panel component lead holes during the drive against the guide grooves of the template. Those forming heads can be obtained in almost their complete form from a manufacturer of component lead cutting machines. (See Fig. 2 & 3)

For simplicity, it is not necessary to make the forming heads adjustable, as most printed wiring layouts can be designed around $\frac{9}{16}$ in. and $\frac{15}{16}$ in. mounting centers for the components, and, each component assembly station can be equipped with a head for each dimension. It is important however, to support the component leads while they are being driven against the template as the Rockwell hardness of the component leads is very low, and, without support, the leads will collapse before direction and staple is established. The design of the template grooves beneath the lead holes in the printed wiring board will determine the degree of support required to maintain successful assembly as there should be very little friction to overcome in establishing the direction of bend desired for the lead. Caution should be taken not to attempt too long a finished lead length as excess wire length will be difficult to control in bending and directing along the template grooves. The optimum length is that which will provide $\frac{3}{32}$ in. fold back against the printed conductor.

The air cylinder drive unit was selected because of all the variables possible in one package, and because of the portability of its power source. The air cylinder can be infinitely adjusted to provide various ram speeds, ram force, ram travel, and also, to provide various rates of recovery. For this low cost system, the smallest air cylinder consistent with a four in. max. ram travel is selected, as greater ram travel will rarely be desired, and the power required for component insertion is very slight.

This air cylinder type of driving power source, being a common item of commercial use, is readily available as stock order and will perform any insertion operation capable of the Omnimatic Assembly System.

Components, other than condensers and resistors with axial leads, will require feeder channels developed to fit their size and shape. In most cases, such as sockets and hardware, the pieces can be readily fed into the channel by vibrator-hopper feed techniques. (Fig. 4 & 5)

The soldering section is made up of a receiving table to take the boards discharged from the conveyor, a solder pot with an automatic immersion mechanism that is electrically timed, and a carry away, cloth, belt conveyor for transfer of the completed product to shipping or storage. (See Fig. 6)

The completely assembled printed wiring boards is discharged from the metal conveyor as the belt begins its return to the loading section, this discharge being accomplished by gravity as a result of the use of undersize pins on the template. This will furnish the soldering section with one board ready for soldering every twenty seconds. The solder station attendant must then place the board into the soldering jig which triggers the automatic immersion mechanism into action and causes it to proceed through a 5-sec. dip soldering operation. The board is held in place on the underside of the channel soldering jig by beaded teflon pins which, by holding the board against the bottom side of the jig, prevent any tendency of the board to warp during its contact with the surface of the molten solder and provide ease of mounting and removing the board. After the automatic immersion mechanism has completed its cycle, the attendant removes the board to the discharge conveyor and returns his attention to a new cycle. At the rate of one board arriving every twenty seconds there is little possibility of any congestion occurring at the soldering station. While this speed could be increased slightly with no burden being impressed on the soldering station attendant, it is felt that the quality of the end product hinges largely on the quality of the soldering operation, and there would be little to gain by pressing the soldering station.

The automatic immersion mechanism is essentially a step in the direction of quality, as the time required for a dip soldering operation is not largely affected by an auto-

(Continued on page 132)

Assembly System

(*Continued from page* 131)

matic system when compared with a manual system. When employing an automatic immersion system, the dipping cycle can be electronically timed to match exactly the temperature, type, and condition of the solder.

The automatic immersion system is constructed from a standard solder pot, angle iron, a gear reduced electric motor, and a small vibrating unit. The controls consist of microswitches and an electronic timer calibrated in seconds. The solder pot should be a temperature controlled type wtih adjustable temperature range so that solder type and condition may be varied. The object of the vibrating unit is to vibrate the board for a few seconds during the dipping action, assuring that the surface tension of the solder is overcome and complete wetting of the copper surface is accomplished. It is important that the vibrating period be cycled so that all vibration is stopped at least two seconds before removal of the board from the surface of the solder, as it is improbable that a good solder joint can be maintained if any movement is present during the period that the solder has to solidify.

Upon placement of the completed unit on the discharge conveyor, immediate installation in the cabinet, or storage for future installation, is possible as only spot inspection is required due to the reliability, simplicity, and uniformity of a well designed printed wiring chassis. The use of pre-tuned coils will obviate the necessity of alignment as each chassis will reflect electrical characteristics identical to any chassis employing the same printed wiring board. Testing can be accomplished by the use of a jig comparator tester featuring fingers which make contact with the desired points on the conductor side of the printed chassis.

As a result of the attempt made here to take advantage of all adaptable standard pieces of equipment, while keeping the Omnimatic Assembly System as simple as possible, it was found that the total capital expenditure required for this simplest form would be approximately \$8,500.00 in setting up to run a three tube amplifier and approximately \$11,500.00 in setting up to run a five tube receiver. These figures, of course, vary inversely proportional to the degree of utility of standard pieces of equipment. Total floor space required would be about 200 sq. ft. for the three tube amplifier set-up and about 300 sq. ft. for the five tube receiver set-up.

After building and operating the Omnimatic Assembly System in its simplest form, should the volume of production justify greater expenses for more complete automation, you may expand your simple Omnimatic System into a totally self-contained, completely automatic system, requiring only one attendant, by the simple addition of a few standard units of equipment and the construction of integrating pieces. The loading section can be made completely automatic by installing an automatic feeder. The component assembly section can be made completely automatic, eliminating the need for carded components, by the installation of a component preparation machine at each assembly station. The soldering section can be automatized by the installation of a carrier from the metal belt conveyor through the solder pot.

The automatic feeder for the loading section is patterned after the body blank feeders of a body maker used in the can making industry. The printed wiring panels would be stacked in the feeder and slipped off the bottom of the stack one at a time by finders keyed in step with the conveyor belt. The component preparation machine would straighten the component leads and test the component electrically, using a high speed comparator type of test, and ejecting those which are defective or out of tolerance. The machine would then load the component directly into the channel feed of the basic component assembly station. The carrier for the soldering section would be a 4-armed machine positioned at the end of the metal conveyor and keyed to the step of the belt. The arms would each be equipped to pick the boards off the conveyor belt and grip them completely through the soldering section. A standard Geneva movement with arm extenders adapted to handling the printed wiring board or a water wheel type of hook pick-up would be all that is required.

This completely automatic Omnimatic System will be geared to a 10-sec. cycle which, while not quite as fast as possible, will leave a safe margin for a good soldering job.

Total capital expenditure for this completely automatic Omnimatic System should not exceed $16,500.00 for a line equipped to process a three tube amplifier, and should not exceed $24,000.00 for a line equipped to process a five tube receiver. Total

(*Continued on page* 134)

Assembly System

(*Continued from page* 133)

floor space required for these systems should be less than 400 sq. ft.

Initially, it would appear that the most profitable advantage of the Omnimatic System of Automation is the reduction of labor costs, but, it has been noted that many companies could benefit even more from the prospect of tremendously increased production capacity with no increase in factory space required. With the trend toward unitization asserting itself in the TV chassis, and color television presenting sizable increases in wiring complexities, the need for greater production capacities and more simple and foolproof wiring and assembly techniques becomes apparent. The utility of printed wiring will provide the simple and foolproof wiring techniques, while automation will provide the greater production capacities along with simple and foolproof assembly techniques.

Cues for BROADCASTERS

(*Continued from page* 85)

and read the corresponding limits of base current in the tower in question. The middle scale (Normal) is for convenience if retuning of the array should become necessary, as it shows the design center value of current for a range of values of reference tower current.

To prepare such scales, draw a line the length of the desired scale, and divide this line into the range of currents in the reference tower that it is desired to cover. (4.30 to 4.70 a. in the Center scale shown.) Then from the station license, or from the original design data, determine the ratio of current in any other tower under normal operating conditions, and multiply by 0.95. Divide this into some even value of current in the tower, to determine the corresponding value of reference tower current, and divide the space between these values into a number of divisions. This will be the low limit scale for the chosen tower. The use of multiplying factors of 1.0 and 1.05 will construct the normal and high limit scales. Repeat for the rest of the towers, except the reference tower, to complete the set.

Division of a line into fifths for the 0.02 calibration marks is done by drawing two parallel lines the same distance apart as the length of scale to be divided on a separate sheet, and laying a ruler diagonally between them, so that five inches of the ruler are between the intersections with the lines. Make a mark every inch along the ruler, and draw lines parallel to the original two, through these marks. If these lines are carried to the edge of the sheet, they can be matched directly on the scale being calibrated.

Economical 45 RPM Turntable

LEONARD J. SERDAR, Ass't. Chief Engr. KBND, Bend, Ore.

WHEN all major record companies started to supply radio stations with 45 rpm records, we at KBND were not equipped for complete 45 rpm operation. We had one 3-speed turntable which was suitable for 45's. Then we also had two two-speed turntables, which were not capable of 45 rpm. Thus the problem of securing another means of playing 45's presented itself. This, however, was solved with an RCA 45 automatic record changer which wasn't being used at the time.

One of the big complaints of using 45's in broadcast stations is the difficulty in cueing on standard turntables. Our unit in addition to being economical is extremely easy to cue (by grasping the middle stem), extremely fast starting, and one which tracks nicely. We use it often and are very happy with it.

In order to obtain the best possible quality one small modification was made. We removed the crystal pickup and installed a GE reluctance pickup with a 0.001 mil stylus.

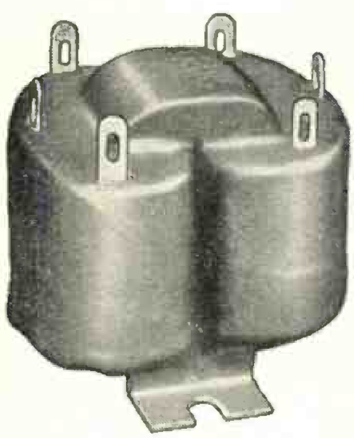
This was accomplished by carving out a small amount of plastic from the inside of the arm around the screw holes. It fitted nicely but only one screw can be used to hold it in place. However, this is ample support. A small amount of weight placed at the rear end of the arm reduces the weight on the pickup and in turn reduces wear on the records and scratching when back cueing.

Plug-In Audio Pads

KEN MAXWELL, Ch. Engr. KLTI, Longview, Tex.

WHEN setting up a broadcast installation or a recording studio where low impedance circuits are used, it is sometimes necessary to provide fixed loss pads between the various pieces of audio equipment. A way to do this so the amount of attenuation may be quickly changed is to install an oc-

(*Continued on page* 136)



Cues

(*Continued from page* 135)

tal socket and wire the input circuit to two of the pins and the output circuit to two other pins. The pads are then constructed by taking the base of an octal base tube, breaking out the glass and soldering the resistors to form an H pad. One-half-watt resistors are used. The leads on the series resistors are pushed through the tube prongs as far as possible. Next the parallel resistor is connected across with very short leads, soldered quickly with little heat and the pig tails clipped. Finally solder the wires that extend through the prongs and cut off the excess.

Type information giving the impedance and loss in decibels on a 3 x 5 in. file card and glue it to the tube base so the information is centered over the top of the tube base. This protects the resistors and identifies the pad.

Values for the resistors may be obtained from engineering texts.

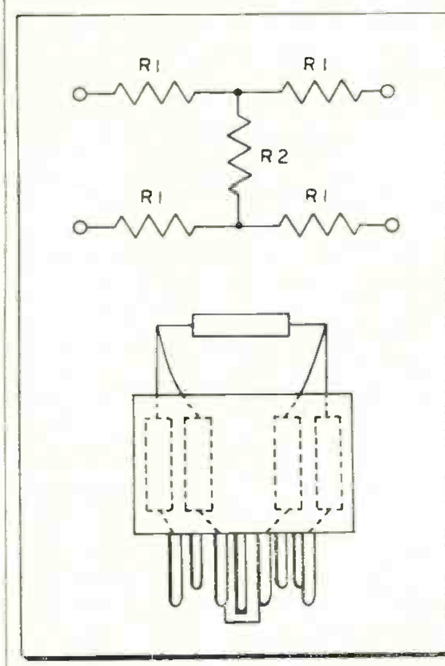


Fig. 1: Schematic & assembly of plug-in H pad

The values of resistance for pads with the impedances 600 to 600 ohms

DB loss	R_1	R_2
5	82	1000
10	160	430
15	200	220
20	240	120

BuRec Engineer Exam.

The U. S. Civil Service Commission has announced a new Engineer examination to fill positions located throughout the western States and Alaska. Entrance salaries are from $4,345 to $5,440 a year.

100 Rules

(*Continued from page* 87)

71. Functional organization of displays and controls should be emphasized by use of such techniques as color coding, marked outline, symmetry of grouping, and/or differential plane of mounting.

72. Where consoles are designed for seated operators, utilize good seating principles such as optimum dimensions with regard to the expected population of users, backrests, armrests, footrests, cushioning, and adjustability.

73. When desk positions are required, consider height of writing surface, working width and depth, knee and foot room, and elbow room if more than one operator is involved.

74. Storage space should be designed with man's physical dimensions in mind; consideration should be given to reach distance, eye height when stored items must be seen, and depth of bin when articles get pushed to the rear of the bin.

Multiple Layout

75. When men and machines are grouped for system or team operations, consider not only the individual needs but also the equitable flow of human traffic and aural and visual communication links.

76. When multiple man-machine combinations are grouped together, make sure that operators are not restricted with respect to their primary control manipulations.

77. When group activity demands use of a central visual display make sure that lines of sight to the display are not blocked by poor arrangement of people or equipments.

78. Corridor and passageway design should consider the space required for people to pass each other and for doors opening into the passageway without hindering the flow of traffic.

79. Special consideration should be given to passageways and doorways to be utilized by personnel who are encumbered by special clothing or equipment.

Environment

80. Good illumination should include the following considerations: (a) suitable brightness for the task at hand, (b) uniform lighting on the task, (c) suitable contrast between task and background, (d) freedom from glare from either the light source or the work surfaces, and (e) suitable quality and color for the illuminants and surfaces.

(*Continued on page* 138)

100 Rules

(Continued from page 137)

81. Consult recommended lighting-level tables for both the ambient lighting and specialized lighting needed for aircraft cockpits or other specialized military applications.

82. Do not assume that general ambient illumination will be adequate for individual tasks. A careful analysis of the entire lighting system will remove the necessity for later makeshift remedies.

83. Consider the environmental conditions under which the man-machine combination must work. If these conditions cannot be controlled directly, it is necessary for the equipment designer to provide other safeguards. Temperature, ventilation, and noise are the major environmental considerations, and use of modern protective measures should be part of the design problem.

Maintenance

84. Design and incorporate displays that will indicate marginal or substandard performance to the maintenance technician. Although normally it is obvious when equipments are not functioning, it is often difficult to determine when the equipment is functioning poorly or below effective levels.

85. Consider the matter of maintenance simplification as well as operational simplification. Utilize unitization techniques, go-no-go indicators, and disposable packages where feasible.

86. Follow good display and control design practices when providing a display or control for the maintenance technician. Poor meter displays, screwdriver controls which are too sensitive, or poor use of color coding hinder the maintenance man.

87. Avoid large cumbersome back-access doors on cabinets or racks. These create a nuisance and a hazard. Utilize quickly removable type doors, or small double hinged doors which do not complicate the space problem.

88. Avoid cable entrances on the front of cabinets.

89. Calibration adjustments with a screwdriver are seldom satisfactory from the standpoint of human manipulation. Use knobs whenever possible, and if these shouldn't be disturbed except in special cases, use a cover over them or provide a special seal or danger code.

90. Provide some type of indexing for adjustment controls. It is difficult to remember positional settings without some marking, and this in-

dexing in turn may be utilized to show a gradual deterioration in performance as settings change from time to time.

91. Keyways for tubes and tube sockets should be suitably marked so that the technician does not rely on "feel" to find the proper position. Tube labels should also be oriented so that they can be seen from the maintenance position.

92. Use care in mounting miniaturized components. Their size often influences the designer toward putting things too closely together. The hand remains the same size.

93. In mounting component parts on chassis and chassis in racks, keep in mind the problem of maintenance. Provide access to both sides of a chassis. Leave sufficient hand room for removing and replacing parts without danger to the technician. Provide hand grips for lifting.

94. Avoid mounting the components so that several intermediate units have to be removed to get to one that requires frequent servicing.

95. When drawer slides are used, make sure they will not stick, that they will hold the unit firmly in the open position, and that the technician does not have to have three hands to manipulate fasteners or guide flexible cables into the cabinet.

96. Reduce the number of types of components required. Utilize common units wherever possible to simplify not only maintenance, but storage as well.

97. Utilize tuning instructions, calibration graphs, and labeling which are legible and permanent. The same ingredients for legible dials are necessary. Separate instructions that get lost hinder good maintenance.

98. Provide adequate illumination for maintenance. Ambient room illumination is seldom satisfactory. Dark colors for cabinet interiors are not recommended since they create shadows by their lack of reflectivity.

99. Provide routine check points which are available to the technician without removing the chassis from the cabinet.

100. Avoid using adjustable components when component values need not change during the life of the equipment.

Uncle Sam Needs . . .

Electronics specialists are needed at the Corps of Engineers Research and Development Labs., Fort Belvoir, Va., to conduct basic and applied research on new devices for military use.

News of MANUFACTURERS' REPS

REPS WANTED

Microwave transmission equipment manufacturer is seeking reps for all terr. except: N.Y., N.J., and Eastern Pa. (Ask for R-12-1)

Erie Resistor Corp., Erie, Pa., has announced the appointment of **Lewis and Trimble, Inc.**, Chicago, Ill., as Manufacturers Reps. in Wisc. and Ill.

W. Burt Knight Co., 10373 W. Pico Blv'd., Los Angeles, Calif., has been appointed Sarkes Tarzian Rectifier Div. Reps. for southern Calif. and Ariz.

Edwin C. Bennett has joined Walter J. Brauer & Associates, Cleveland, O. He will supplement **Tom Miles** in covering distributors in O., Ky., W. Va., and western Pa.

The James M. Pickett Co., 205 E. 66 St., N.Y.C., has been named by the Quam Nichols Co., Chicago, Ill., to represent the Quam line in the N.Y. area.

F. W. Moulthrop, Ed Tilton, and **Rolly Wedemeyer** are representing the Oxford Electric Corp., Chicago, Ill., line in San Francisco, northern Calif., and northern Nev.

General Precision Laboratory Inc., Pleasantville, N.Y., has appointed the **Kittleson Co.**, Los Angeles, Calif., to cover the Calif., Nev., New Mex., and Ariz. terr. **M. P. Odell Co.**, Cleveland, O., will represent GPL in O., eastern Mich., western Pa., and western W. Va.

Todd-Tran Corp., Mt. Vernon, N.Y., has appointed **Jack R. Alshuler** ind. rep. in Ill., and the **Fred W. Falck Co.** as sales rep. in southern Calif.

J. T. Hill Company, San Gabriel, Calif., West Coast selling agent for Allen B. Du Mont Laboratories, Inc., and others has established new and enlarged headquarters at 420 S. Pine St.

James J. Fahy has joined the Morris F. Taylor Co., manufacturers' reps. of Silver Spring, Md., to cover the middle section of Pa.

Maurice Olfman, Montreal, has been appointed factory rep. for eastern Canada by Entron Inc., Bladensburg, Md.

Frank A. Emmet Co., 2837 W. Pico Blv'd., Los Angeles 6, Calif., Southern California rep for the Phaostron Company, announces that they are now maintaining 10,000 sq. ft. of warehouse space to handle immediate sales needs.

Inland Associates, with main offices in Mission, Kan., has been appointed sales rep. for Magnetics, Inc. of Butler, Pa. in Kan., Western Iowa, Mo., and Neb.

Richard D. Brew and Co., Inc., Concord, N.H., has announced the appointment of the following manufacturer's reps: **Electronic Sales Associates**, Los Angeles, Calif., for Calif., Ore., Wash., Ariz., and N.M.; **Thomas B. Hunter**, Chicago, Ill., for Ill., Milwaukee, Wisc., and Cedar Rapids, Iowa; **Mosher & Peyser Co.**, Needham, Mass., for Conn., Mass., N.H., R.I., Me., and Vt.; **William Richter Corp.**, Rochester, N.Y., for N.Y. north and west of Rockland and Westchester Counties, and Canadian provinces of Ontario and Quebec.

Alto Scientific Co., Palo Alto, Calif., has appointed **McCarthy Associates** as sales reps. for Alto instrumentation and test equipment in Calif.

Herbert A. Frankel has been appointed Engineering and Sales Rep. in the N.Y. and N.J. area by the General Ultrasonics Co. of Hartford, Conn.

S. S. Lee Associates, Washington, D.C., have been appointed reps. in Md., D.C., Va., and W. Va., by Color Television Inc. at San Carlos, Calif.

Allen B. Du Mont Laboratories, Inc. has announced the franchising of five corporations to sell Du Mont broadcast equipment in the U.S., Hawaii and Alaska. They are: **Television Transmitter Supply Co., Inc.**, N.Y.C.; **Klindworth-Midwest Co., Inc.**, Minneapolis, Minn.; **Western Transmitter Equipment Co., Inc.**, Los Angeles, Calif., and Portland, Ore.; **Electronic Applications**, Atlanta, Ga., and Rockport, Mass.; **Southern Video Broadcasting Co., Inc.**, Dallas, Tex.

T. Louis Snitzer, 5777 W. Pico Blv'd., Los Angeles, Calif., has been appointed sales rep. for Timely Instruments & Controls Corp., Gardena, Calif., in southern Calif., Ariz., and Nev.

Worthington Corp., Harrison, N.J., Gamon Meter Div., has added three new sales reps. **D. J. Coughlin** will assist in the sale of meters in the met. N.Y. area. **E. A. Curry** will represent the company in the sale of meters in Tex. **A. W. Roddick** will assist in the sale of meters in the Pacific Northwest area.

Payment of commissions to sales reps on gov't. orders does not violate any law providing the gov't. purchasing office is aware of it, according to a quote from a principal recently published in the **REPresenter.**

Deflection Yolk

(*Continued from page 73*)

horizontal coil for comparison.

Experimental Results

The complete deflection yoke (Fig. 5) consisting of horizontal and vertical coils and the two layers of electrostatic shielding was assembled by the techniques just described, inserted in a focus coil and operated in a monochrome image-orthicon television camera. Some modifications were made to the driving circuits because the impedance of the printed yoke was somewhat higher than that of its conventional counterpart but its performance was quite acceptable and the results are certainly encouraging. The major shortcoming encountered was the high resistance. This will be discussed later in detail.

Four patterns were stacked and interconnected for each horizontal coil and eight patterns for each vertical coil. The measured inductance of a single pattern was nominally 189 μh. The completed horizontal coils measured 2.9 mh. each in air and about 3.9 mh. with the iron-wrap in place. DC resistances of these coils were 103 and 97 ohms respectively. The vertical coils had measured dc resistances of 232 ohms and 215 ohms. Matching of the coils with respect to resistance was somewhat restricted by the limited number of patterns available at the time.

In comparison, the conventional wire-wound yoke has horizontal coil inductances of approximately 3.0 mh. each (with the iron-wrap return-path in place) and dc resistances of about 9.5 ohms.

The vertical coils have inductances of approximately 15.5 mh. and dc resistances of about 18.5 ohms.

The horizontal retrace time for the printed yoke was just over 11 μsecs compared to about 9 μsecs for the wire-wound yoke in this circuit. However the inductance, with which the retrace time varies directly as the square root, is 1.3 times larger in the printed yoke.

The radial build of the printed yoke was 0.30 in. compared to 0.43 in. for the conventional yoke.

Uniformity

Quite a large number of the printed coil patterns had "opens" in the windings when received although most of these were repaired and used. The causes of this poor yield explain to a large extent the exceptionally high resistance of the

(*Continued on page 142*)

For product information, use inquiry card on last page.

Deflection Yoke

(*Continued from page* 141)

coils. Fig. 6 shows a plot of the individual pattern dc resistances. The ordinate is in ohms and the abcissa refers to successive numbers assigned to each pattern for identification. White circles denote patterns which required repair. Just over half of the points are grouped in a region between 21 and 25 ohms with an average value of 23.1 ohms; the others, for the most part, are scattered. The calculated resistance per

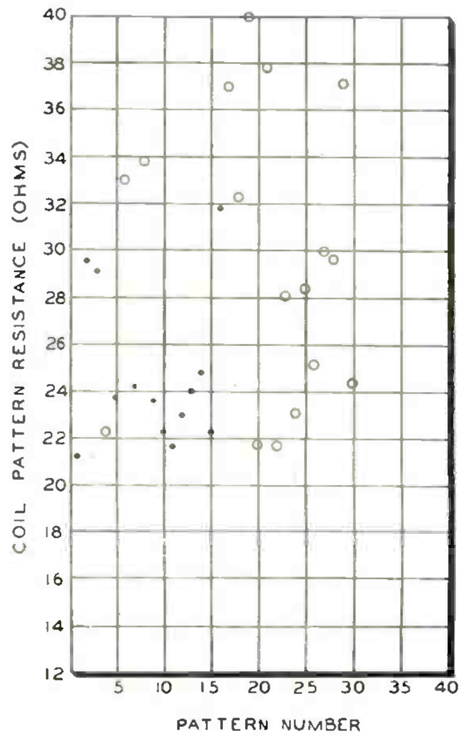


Fig. 6: Scatter diag. of dc coil resistance

pattern based on a .0027 in. x .010 in. cross-section of copper and a measured path length of 43.72 ft. was 13.2 ohms with an expected but unknown percentage increase due to undercutting during etching. Fig. 7 shows the effects of the undercutting. This is a photomicrograph (magnified 60 times) of the cross-section of three conductors. Two things are obvious from this photograph: a reduction in area due to the trapezoidal shape and a variation in conductor width due to non-uniformity in drafting for the printing negative. Measurements from four such photographs taken at different sections indicate an average cross-sectional area 40% less than that calculated resulting in an increase in resistance of 67% over the calculated value. This would bring the 13.2 ohms (calculated) up to 22.2 ohms which is within 4% of the mean value of 23.1 ohms mentioned above. Variations in the etching time and the strength of the bath, imperfections in the copper surface and perhaps some poor repairs would also tend to explain the large number of opens and wide range of resistances.

Uniformity of inductance is inherent with this technique. Tolerances of ± ¼-½% have been achieved with similar types of coils when care has been exercised in etching.

Evaluation

The fabricating technique used in the construction of this yoke appeared to work out very well. Patterns took to the forming process quite readily, the indexing of patterns was precise and, while perhaps

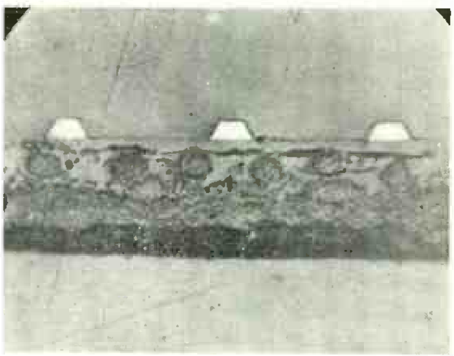


Fig. 7: Photomicrograph cross-section of printed conductors, indicating area variation

a more elegant method of interlayer connection might be devised, the method described was quick and relatively easy.

One of the areas open to question is the expected yield from such printed coil patterns. Although those used were made with considerable care on a laboratory rather than a production basis, several limitations were inherent from the start. First, the specification of 10 mil lines and a minimum spacing of 10 mils is impractical from two standpoints; high resistance and difficulty in etching. Secondly, slight imperfections in the copper surface might cause "opens" with such narrow conductors (particularly if they are "necked-down" by undercutting and drafting irregularities) whereas with wider conductors these imperfections would be less effective. The drafting, done to a 4:1 scale, required that the conductor lines (inked by hand) be drawn in two parts, half above and half below a locating center-line. It is obviously very difficult to achieve uniformity by this method and considerable improvement in the final product is to be expected from an improved drafting technique. With allowances made for undercutting and careful control of the etching process it seems reasonable to assume that resistance can be held to within 10% of the calculated value and still produce a very satisfactory

(*Continued on page* 144)

Deflection Yoke

(*Continued from page* 143)

yield. Although some required repair, over 50% of the coil patterns printed for the yoke came within a ±10% tolerance in resistance.

The inherently high resistance which is limited presently in one dimension by the .0027 in. maximum standard copper thickness can be reduced by using wider conductors. The designer has quite a flexible device with which to work since irregular shapes such as conductors wide along the longitudinal axis and narrowed to reduce the end turn region are quite feasible. Furthermore, the turns distribution, the number of turns per pattern, or the number of patterns stacked can be varied or patterns printed on both sides of the base material might be used. This would, of course, remove the self-insulating property.

Capacity across the coils can be controlled by increasing or decreasing the base material thickness or even changing the material to one with a different dielectric constant. Normal deflection currents should not cause any difficulty with the bond strength, particularly when the coil resistances are reduced to more reasonable values.

Although the end turns cannot be bent up as with wire wound coils, this is not a necessity in many applications.

Summary

A deflection yoke for an image-orthicon was built entirely from printed circuits and operated in a TV camera. With the exception of resistance (which for the printed circuit model was much higher) the parameters of a conventional wire-wound yoke were quite readily reproduced, including inductances per coil of as much as 16 mh. The use of wider conductors, improved drafting techniques and allowances for undercutting will reduce the resistance to an acceptable value. Furthermore, reasonable care in etching should provide good yield from the printed material, correlation between calculated and measured values and close tolerances on electrical characteristics. While the experimental work reported here was rather limited in scope, experience with printed coils in other sections of RCA indicate that a tolerance of better than 1% in inductance can be realized and better than 10% in resistance.

References

1. Soller, Starr, Valley; *Cathode Ray Tube Displays* (Radiation Laboratory Series, Volume 22), McGraw-Hill Book Co., Inc., 1948; pages 338-342.
2. Soller et al; op. cit.; Pages 352-355.

KAY *Mega-Sweep*

Wide Range, Wide Sweep

SWEEPING OSCILLATOR

Widest range of the Kay line of sweeping oscillators, the Kay Mega-Sweep provides continuous frequency coverage up through UHF-TV bands – 50 kc to 1000 mc. Widely used in radar system development and in alignment and testing TV and FM systems and components, as well as wide band IF and RF amplifiers and filters.

SPECIFICATIONS

Freq. Range: 50 kc to 1000 mc.
Freq. Sweep: Sawtooth, adjustable to 40 mc. Repetition rate, 50 to 100 c/s.
RF Output: High, approx. 100 mv max into open circuit. Low, 5 mv into open circuit.
RF Output Control: Microwave attenuator continuously variable to 26 db.
Output Waveform: Less than 5% harmonic distortion at max. output.
Meter: Provides crystal detector current for peak output.
Regulated Power Supply: 105-125 v., 50 to 60 cps. Power input, 100 watts.

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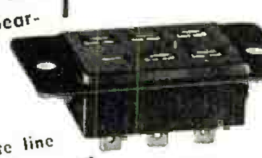

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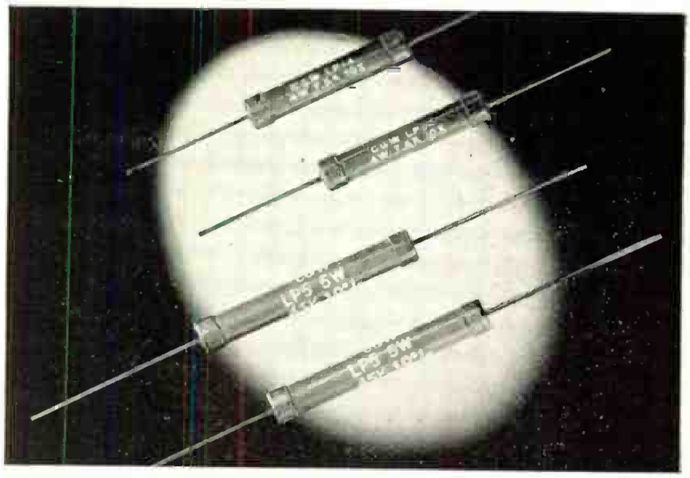

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Dip-Soldering

(*Continued from page 75*)

the chassis by special clips. Only a few printed wires are shown, but both sides of the board can be utilized for wiring and parts.

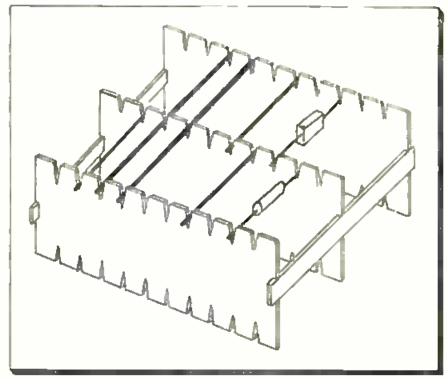

Fig. 4: Bigger assemblies can be formed by ganging chassis units

Chassis units made by the above method can be staggered into bigger assemblies as shown on Fig. 4. Two or more chassis are placed in a fixture or assembled by mechanical means and interconnecting wires or bars placed as shown between the units. The wires can be either hand-soldered or the edges can be dipped once more to solder the interconnecting wires. If desired in some cases components can be hung and soldered between the chassis as shown.

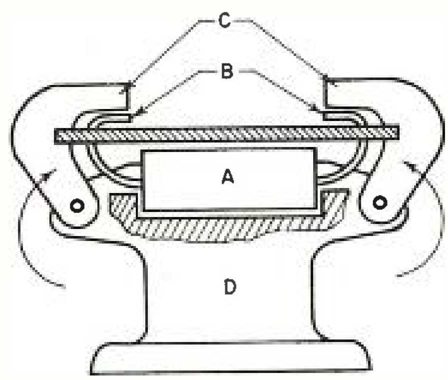

Fig. 5: Fixture bends leads around the notches

Various other configurations of chassis design using the edge-dip-soldering idea are shown on Fig. 1. *A* and *b* show how boards can be mounted at an angle to each other and dipsoldered along the edges. The wiring between the three boards can thus be connected if notches and wiring is properly laid out. Holes for draining excess solder can be provided.

Figs. 1c and 1d show cylindrical versions of the system. Base material can be either flexible sheets or tubing and components can be placed inside and outside the cylin-

(*Continued on page 149*)

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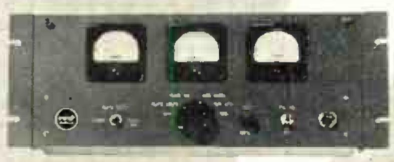

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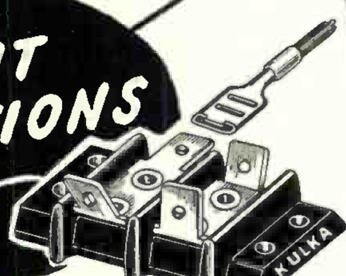

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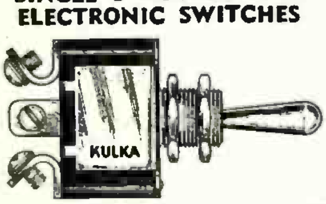

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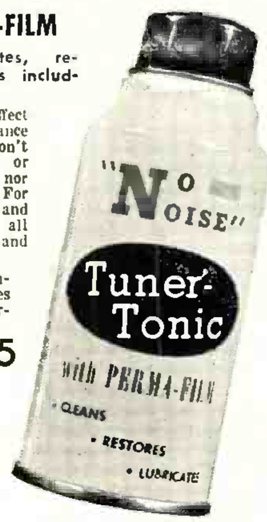

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Dip-Soldering

(*Continued from page* 146)

der or, as in *d*, a tube socket can be mounted inside the tube. The components and the tube socket edge-dipsolder to the wiring in the notches as described above. This version can also be staggered as indicated at *a*.

It is believed that by further development of the system many possible uses in connection with automation of the production of electronic equipment will be apparent.

All U.S. rights to the system described above have been assigned to A. B. DuMont Laborotories, Inc.

Transistor Equations

(*Continued from page* 77)

the inequality (12) is true Eq. (4), (9), (10), and (11) can be written as

$$R_{IN} = h_{11} \quad (16)$$

$$A_v = \frac{-S_{21} R_L}{1 + h_{22}/y_L} \quad (17)$$

$$A_i = \frac{-h_{21}}{1 + h_{22}/y_L} \quad (18)$$

$$PG = \frac{h_{21} S_{21} R_L}{(1 + h_{22}/y_L)^2} \quad (19)$$

If $Y_L >> h_{22}$, (17), (18), and (19) reduce to

$$A_v = -S_{21} R_L \quad (20)$$

$$A_i = -h_{21} \quad (21)$$

$$PG = h_{21} S_{21} R_L = A_v A_i \quad (22)$$

Table 4: Grounded Emitter to Grounded Collector

$$h_{11}'' = \frac{h_{11}'}{1 + h_{21}'}$$

$$h_{12}'' = 1$$

$$h_{21}'' = -(1 + h_{21}')$$

$$h_{22}'' = h_{22}^{1}$$

$$h_{21}'' = -(1 + \beta)$$

Output Impedance

If the input terminals of Fig. 3 are closed through a resistance R_g, we obtain

$$I_1 = \frac{-h_{12} V_2}{h_{11} + R_g} \quad (23)$$

and using the above value of I_1,

$$I_2 = V_2 \left[h_{22} - \frac{h_{12} h_{21}}{h_{11} + R_g} \right] \quad (24)$$

The output impedance R_o, is then obtained as

$$R_o = V_2/I_2 = \frac{1}{h_{22} - \dfrac{h_{12} h_{21}}{h_{11} + R_g}} \quad (25)$$

(*Continued on page* 151)

ANNUAL INDEX—1955

The annual Article Index for Tele-Tech & Electronic Industries has been arranged by subjects for easy reference to related topics. The first figure indicates the month in which the article appeared; the second figure indicates the page number.

AERONAUTICAL RADIO, RADAR

AIRCRAFT, MOBILE AND MARINE COMMUNICATIONS

AIRCRAFT, MOBILE AND MARINE NAVIGATION

AMPLIFIERS

ANTENNAS

AUDIO

BOOKS

BROADCAST STATIONS, STUDIOS

CABLES, TRANSMISSION LINES, WAVEGUIDES, CAVITIES

CHARTS, NOMOGRAPHS, DIRECTORIES

CIRCUITS, NETWORKS AND FILTERS

(Continued on page 152)

Transistor Equations

(*Continued from page* 149)

If it is assumed that

$$h_{22} >> \frac{h_{12}\, h_{21}}{h_{11} + R_g} \qquad (26)$$

Then (25) becomes

$$R_o = \frac{1}{h_{22}} \qquad (27)$$

For the grounded collector stage h_{12}'' and h_{21}'' usually have values such that

$$\frac{h_{12}''\, h_{21}''}{R_g + h_{11}''} > > h_{22}'' \qquad (28)$$

and (25) becomes

$$R_o'' = \frac{R_g + h_{11}''}{1+\beta} = r_e + R_g(1-\alpha) \qquad (29)$$

For convenience in converting the hybrid parameters as obtained for one configuration to their equivalents for the other configurations tables 1 to 4 may be used.

In the grounded collector connection the load resistance is connected in series with the emitter. Hence h_{11}'' is a function of R_L and may be written as

$$h_{11}'' = r_b + (r_e + R_L)\,(1+\beta) \doteq R_L\,(1+\beta) \qquad (30)$$

Transducer Gain

If the transistor is to be driven from a source of specified characteristics the ratio of the output power to the power available from the source is frequently desired. This is known as the transducer gain.

Assuming a generator of open circuit voltage V_g and internal resistance R_g connected to the input terminals of Fig. 3 we can make use of equations (3), (4), (5), (6), (8), (9), and (10) by merely replacing V_1 by V_g and remembering that R_g is to be added in series with h_{11}. In place of the input power given by (7) we use the available power of the source, $P_R = V_g^2 4R_g$. We thus obtain the power delivered to R_L as

$$P_L = \frac{(h_{21}\, V_g)^2\, R_L}{\left[\left(R_g + h_{11} - \frac{h_{12}\, h_{21}}{h_{22}+y_L}\right)(1+h_{22}/y_L)\right]^2} \qquad (31)$$

The transducer gain is

$$(PG)_T = P_L / P_A \qquad (32)$$

$$= \frac{(h_{21})^2\, 4\, R_g\, R_L}{\left[\left(R_g + h_{11} - \frac{h_{12}\, h_{21}}{h_{22}+y_L}\right)(1+h_{22}/y_L)\right]^2}$$

If $\quad R_g + h_{11} > > \frac{h_{12}\, h_{21}}{h_{22} + y_L}\quad$ then (33)

(*Continued on page* 153)

Annual Index *(Continued)*

COMMUNICATION SYSTEMS

COMPONENTS, CHASSIS ELEMENTS

COMPUTERS

CONTROLS

CONVENTIONS AND MEETINGS

CUES FOR BROADCASTERS

CIRCUITS

MAINTENANCE, TESTING

MISCELLANEOUS

RECORDERS, PLAYBACKS

REMOTES

TURNTABLES

DETECTORS AND RECTIFIERS

EDITORIALS

GENERAL

GOVERNMENT ELECTRONIC EQUIPMENT

INSTRUMENTS, MEASUREMENTS, TEST METHODS

(Continued on page 154)

Transistor Equations

(*Continued from page 151*)

$$(PG)_T = \frac{(S_{21})^2 4 R_g R_L}{[(1+R_g/h_{11})(1+h_{22}/y_L)]^2} \quad (34)$$

$$A_v = \frac{-S_{21} R_L}{(1+R_g/h_{11})(1+h_{22}/y_L)} \quad (35)$$

$$A_i = \frac{-h_{21}}{1+h_{22}/y_L}. \quad (36)$$

If in addition $y_L >> h_{22}$

$$(PG)_I = \frac{(S_{21})^2 4 R_g R_L}{(1+R_g h_{11})^2} \quad (37)$$

$$A_v = \frac{-S_{21} R_L}{1+R_g/h_{11}} \quad (38)$$

$$A_i = -h_{21} \quad (39)$$

Transconductance and Operating Point

For junction transistors α may approach unity. If we assume $\alpha = 1$ the expression for transconductance becomes

$$S_{21} = \frac{h_{21}}{h_{11}} = \frac{\alpha}{r_e + r_b(1-\alpha)} = \frac{1}{r_e} \quad (40)$$

The theoretical value of the emitter resistance is kT/qI_e where k is Boltzmann's constant, T is absolute temperature, q is the electronic charge and I_e is emitter current. At room temperature, for I_e in milliamperes we have

$$S_{21} = \frac{1}{r_e} = \frac{I_e}{26} = 38{,}500\ \mu\text{mhos per ma.} \quad (41)$$

The small signal equivalent resistances and hence the h parameters, are functions of the operating point. Their values may be obtained from data supplied by the transistor manufacturers. The small signal parameters are ordinarily given for a collector voltage of 5 v. and emitter current of 1 ma. Correction curves are supplied for determining the parameter values under other conditions of biasing.

Extension to Large Signals

As previously indicated r_e becomes small for large emitter currents. Also the value of R_L for maximum output power is much less than the value required for maximum gain. R_L for maximum output approximates the dc output resistance V_c/I_c. We may therefore assume

$$r_e << r_b/(1+\beta) << R_L \quad (42)$$

$$h_{22} << y_L \quad (43)$$

then since

$$h_{11} = r_b/(1+\beta) \quad (44)$$

$$h_{11}' = r_b \quad (45)$$

$$h_{11}'' = r_b + R_L(1+\beta) \doteq R_L(1+\beta) \quad (46)$$

we get

$$A_i = -h_{21} = \alpha \quad (47)$$

(*Continued on page 155*)

Annual Index *(Continued)*

MAGNETIC MATERIALS & AMPLIFIERS

MATERIALS, PROPERTIES OF

MICROWAVES

PAGE FROM AN ENGINEER'S NOTEBOOK

PRINTED CIRCUITS

PRODUCTION METHODS

RADAR

RECEIVERS

RECORDING AND TRANSCRIBING

TELEVISION, COLOR

TELEVISION, GENERAL

TRANSISTORS

TOTALS

TRANSMITTERS

TUBES, ELECTRON

TUBES, TV PICTURE & CRT

WAVE PROPAGATION

Transistor Equations

(*Continued from page 153*)

$$A_i' = -h_{21}' = -\beta \qquad (48)$$

$$A_i'' = -h_{21}'' = \frac{1}{1-\alpha} = (1+\beta) \qquad (49)$$

and

$$S_{21} = \frac{-\alpha}{r_b\,(1-\alpha)} = -\beta\ r_b \qquad (50)$$

$$S_{21}' = \beta / r_b \qquad (51)$$

$$S_{21}'' = \frac{-(1+\beta)}{R_L\,(1+\beta)} = -1/R_L \qquad (52)$$

The voltage gains for the three configurations are

$$A_v = -S_{21}\,R_L = \frac{\alpha\,R_L}{r_b\,(1-\alpha)} = \beta\,R_L/r_b \qquad (53)$$

$$A_v' = -S_{21}'\,R_L = -\beta\,R_L\ r_b \qquad (54)$$

$$A_v'' = -S_{21}''\,R_L = 1 \qquad (55)$$

From the above equations we obtain

$$PG = h_{21}\,S_{21}\,R_L = \alpha\,\beta\,R_L/r_b \qquad (56)$$

$$PG' = h_{21}'\,S_{21}'\,R_L = \beta^2\,R_L/r_b \qquad (57)$$

$$PG'' = h_{21}''\,S_{21}''\,R_L = 1+\beta \qquad (58)$$

Transistor Parameter Chart

A convenient way for showing transconductance and power gain is by the use of a chart such as shown in Fig. 1.

On the chart, lines of constant transconductance and constant power gain for a 1000 ohm lead are plotted as functions of h_{21}' and h_{11}'. Representative transistors are located on the chart. For comparison purposes the transistor parameters should be evaluated under similar operating conditions. The transistors shown on the chart were evaluated for a collector voltage of 5 v. and emitter current of 1 ma.

For load resistances other than 1000 ohms, the power gain as read from the chart must be modified by adding $10 \log \frac{R_L}{1000} = 10 \log R_L - 30$ where R_L is the actual load resistance.

Example: A transistor with $h_{21}' = 20$ and $h_{11}' = 1000$ ohms is used with a load impedance of 2000 ohms. Determine PG', A'v, A'i. Locating the point $h_{21}'=20$, $h_{11}'=1000$ shows $S'_{21} = 20{,}000$ µmhos and PG' = 26 db. Since $R_L = 2000$ we add 10 log 2000/1000 = 3 db. and obtain 29 db for PG'. These are the values that would be obtained if

$$h_{11}' >> \frac{h_{12}'\,h_{21}'}{h_{22}' + Y_L} \text{ and } Y_L >> h_{22}'.$$

If these inequalities are not satisfied, the exact equations must be used.

BULLETINS

Teflon

A 16 page catalog has been issued covering teflon sheets, rods, and tubes, and teflon-clad material for printed circuits. This comprehensive catalog contains illustrations of machined teflon, complete with specifications, tables, and charts. Continental-Diamond Fibre Products Co., Inc., Newark, Del. (Ask for B-12-40)

Connector

Bulletin describing new male connector for electronic, instrument, and printed circuit use has been released by Circon Component Co., 17544 Raymer St., Northridge, Calif. (Ask for B-12-41)

Test Equipment

Tester Catalog No. 120 describes new Model 310 miniature V-O-M with printed circuits, as well as other test equipment for radio and TV (including color). Triplett Electrical Instrument Co., Bluffton, O. (Ask for B-12-42)

Ceramic Disc Capacitors

Data sheets describing 3 new capacitors intended specifically for automation have been issued by Sprague Electric Co., North Adams, Mass. (Ask for B-12-43)

Modulized Standard Circuits

Aerovox Corp. 1200 Jefferson Davis H'way., Arlington, Va., has issued a 12-page booklet describing their modulized standard circuits. NBS preferred circuits, such as video limiter, amplifier, driver, PRF multivibrator are among the circuits available. (Ask for B-12-1)

Magnetic Tape Manufacture

New folder, "How Magnetic Tape is Made," completely describing the manufacture of magnetic recording tape is available from ORRadio Industries, Inc., 120 Marvyn Road, Opelika, Ala. (Ask for B-12-13)

Carbon Resistors

International Resistance Co., 401 North Broad St., Philadelphia 8, Pa., has made available Bulletin B-4A describing their ½, 1, and 2 watt carbon resistors. (Ask for B-12-14)

Potentiometer Life

Technical Paper No. 573, "Precision Potentiometer Life and Reliability," describing the operating characteristics of precision potentiometers is offered by Helipot Corporation, 916 Meridian Ave., South Pasadena, Cal. (Ask for B-12-11)

Copper-Clad Phenolic

Printed circuit techniques are discussed in a 12-page booklet describing Copper-Clad Phenolite Laminated Plastic, as made available by National Vulcanizing Fibre Co., Wilmington, Del. (Ask for B-12-6)

Microphones

New 32-page Cat. No. 120 describing professional microphones for television and broadcast applications has been released by Electro-Voice, Inc., Buchanan, Michigan. (Ask for B-12-8)

Antennas

Technical Appliance Corp., Sherburne, N. Y. is making available, free of charge, reprints of the article, "Ruggedized Yagi Antennas For Commercial Applications" which appeared in the Oct. 1955 issue of TELE-TECH & Electronic Industries.

"Hushed" Amplifier

(Continued from page 84)

the hushed and unhushed condition, as shown here, discloses a very substantial improvement in the hushed transistor over the unhushed transistor. The hushed transistor shows noise voltages, referred to the input circuit, of 250 to 350 milli-microvolts with the input shorted and 500 mμv to 1000 mμv with the input open. The unhushed transistor shows noise voltages which are much higher with the input shorted and even more drastically higher with it open. In the hushed condition, the 1/f noise component is greatly reduced. In the unhushed condition it is fully rampant. Full details stating noise figure, measured over wide frequency bands, as well as narrow band frequency measurements over wide center frequency ranges, will be given and compared later. However, one rather unusual measurement shall be mentioned now because it very clearly shows the great improvement which the hushed transistor offers with respect to noise reduction. This is an equivalent input noise resistance, with the input shorted, which we measured as low as 60 ohms, at 1 KC. This is remarkably less than vacuum tubes have so far shown (the lowest published measurement, confirmed by test[2] being 385 ohms for the 6AK5 in triode connection).

Physical Interpretation

Before going further into measurements of noise voltage, equivalent noise resistance, and noise figure, the physical aspects of the hushed transistor shall be discussed.

In the lower part of Fig. 3 we have a comparison of electron-energy conditions in the normally operated and in the hushed transistor (that is electron or hole energies, depending upon whether PNP or NPN transistors are discussed). The transistor, incidentally, is shown here in grounded base configuration.

Shockley, Sparks and Teal[3] have shown the essential features of carrier (in our case hole) energy distribution in a normally operated transistor, similar to our diagram here for the unhushed transistor, on the left. We see that the collector junction voltage is substantially higher than emitter junction voltage (since carrier energies in electron volts correspond with applied voltage if we neglect thermal energies). This biasing procedure has been followed more or less as standard practice: and therefore, high noise voltages have consistently been encountered in transistor amplifiers.

On the right side we see the manner of biasing a hushed transistor. The dotted lines qualitatively indicate the range through which collector junction voltages may vary, being small and either forward or reversed. There is a noticeable difference between the right and left displays of electron or hole energy distribution. On the left, almost the entire voltage drop appears across the emitter junction, whereas on the right the situation is reversed: almost the entire drop appears across the collector junction. We should also point out that the voltage or energy scales in our left and right diagrams are quite different by a factor of the order of 10. The scales were selected for qualitative rather than quantitative presentation.

Noise

Noise in semiconductors is of three basic types:

(1) "1/f" noise, where noise power varies approximately inversely with frequency; (2) shot noise; and (3) thermal noise. The power due to shot and thermal noise is proportional to bandwidth and is independent of the center frequency. Under normal high gain operating conditions, the "1/f law" has been applied, generally, to transistors because 1/f noise tends to completely mask the other two types.

In view of the different characteristics of the three noise types, 1/f, shot, and thermal, it would seem reasonable to attribute different physical mechanisms to the sources of the three noise types.

Since 1/f noise has been the most troublesome, most attention has been given to it. Montgomery[4] was the first to observe conductivity modulation, exhibiting the 1/f behavior on germanium surfaces. Shockley[4] proposed that the phenomenon might be explained in the following manner: occluded gases, etc., on the surface manifest themselves electrically as (1) thermal emission - recombination centers which tend to greatly increase surface conductivity, and (2) traps which attract carriers from either the valence or conduction bands and hold them for long times. When a trap is filled, the effectiveness of neighboring emission - recombination centers in their production of carriers is altered, and thus conductivity in this region is changed. If the energy levels of the traps are distributed over a wide energy range, then a noise power spectrum resembling 1/f is qualitatively obtained. This might be interpreted in the following way. Those traps which are further removed from the conduction and valence bands will charge and discharge at wider spaced time-intervals than those closer to these bands. This suggests a direct relation to the 1/f component if it is further hypothesized that the former traps exert a greater influence on the action of the emission-recombination centers.

Recent work at MIT modifies the Shockley[5] model somewhat and brings theoretical and experimental work closer together, but there is still much to be done before the art is replaced by both qualitative and quantitative understanding of the electrical behavior of surface states. In present junction transistors, surface states play an important role in the noise picture whenever an electric field exists between two electrodes—usually between the collector and the base electrodes. However, the trap and emission-recombination center mechanism is not necessarily confined to the surface. It may also operate (but usually to a lesser degree than under normal biasing conditions) in both the emitter and collector junctions.

Shot noise is ideally given by the Schottky formula

$$(i_n)^2 = 2qI_s \qquad (1)$$

where I_s is static current across a junction, q is the electronic charge, and i_n is noise current per unit bandwidth. Unfortunately, in many cases, the observed shot noise is somewhat higher than the Schottky equation predicts. This suggests a model which depends on factors in addition to simply the random nature of charge conduction in semiconductor junctions. Since, once a system is disturbed, the usual tendency of the system will be toward its original steady state condition, such a model is not easy to conceive. However, we would like to offer the following qualitative model for excess shot noise in the hope that it may stimulate further work, or at least further thinking.

Thermal Energy

Charges which are loosely bound to impurity atoms (which may be donors or acceptors), are subject to mean thermal energies which are in the order of .026 electron volts. At room temperature, the total energy of these charges is such that about two-thirds of the impurity atoms are

(*Continued on page* 158)

"Hushed" Amplifier

(*Continued from page 157*)

devoid of their loosely bound charges, while a continuous filling and emptying of the impurity states takes place. Our model is valid only in regions of very high impurity density, such as in the highly "doped" portions of alloyed junctions. (However, the random nature of impurity distribution will allow for an occasional region such as this elsewhere.)

At room temperature, where the mean thermal energy has the same order as the energy required to liberate a loosely bound charge, a secondary effect can become important.

Prohibited Distribution

The energies of liberated carriers have a statistical probability distribution. Those carriers which have several times the energy necessary to exist as free charges will, through lattice scattering in the region, render portions of their surplus energy back to the lattice. These packets of exchanged energy travel through the region. They are commonly referred to as phonons. In a region of high impurity density, there is fair probability that these "secondary phonons" will serve to liberate additional carriers. Thus, at sufficiently high mean energies (at room temperature), in highly doped regions, the mechanism of secondary emission is possible, and the production of "bursts" of carriers becomes qualitatively apparent.

It should be stressed here that our above model would produce noise in addition to that given by the Schottky equation.

Now, if an externally applied field is introduced across the region, for instance by applying an external voltage to a junction, the mean carrier energy is increased. Any surplus charges will be swept out before recombinations can occur. Both of these effects, due to the field, enhance the above noise producing mechanism. Of course, the *pn* product in the region is a function of only its physical parameters and the temperature, but this is an average condition, while ours is a random effect which will balance out over the time-average.

(*To be continued*)

Part 2 of this 3-part article will appear in the forthcoming issue of TELE-TECH & Electronic Industries.

TELE-TECH ADVERTISERS — DECEMBER, 1955

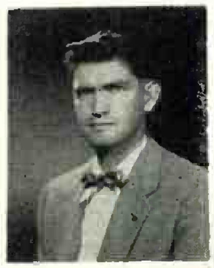
While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

PERSONAL

Robert S. Hood has been appointed Vice-President in charge of manufacturing, Gertsch Products, Inc., Los Angeles, Calif.

James L. Emaus has been named sales engineering mgr., Cathode-Ray Tube Div., Allen B. Du Mont Laboratories, Inc., Clifton, N. J.

James L. Emaus



Robert S. Hood

C. M. Lovell is now Vice-President in Charge of Engineering and Research, Moloney Electric Co., St. Louis, Mo. The co. has also announced the appointment of **David F. Winter** as Vice-President, Chief Engineer and Director of Research.

Kent W. Petty has joined the technical staff of the Guided Missile Laboratory, Hughes Research and Development, Culver City, Calif.

Earl R. Skaggs has been named ass't. General Manager, Associated Missile Products Corp., Pomona, Calif. **Dr. Joseph Tampico** has been made the firm's Director of Engineering.

Dr. W. L. Barrow has been named Vice-President for research and development, and **George A. Richroath** has been named Vice-President for manufacturing, Speery Gyroscope Company.

Dr. Harry G. Romig has been appointed Staff Engineer at Summers Gyroscope Company, Santa Monica, Calif.

Rodrick Yard has been appointed Project Engineer, ESC Corp., Palisades Park, N. J.

Dr. Alan Franklin has been appointed to the staff of the Nat'l. Bureau of Standards, Porcelain and Pottery Section.

Edward Edison has joined the staff of Robert L. Hammett, Consulting Radio Engineer, San Francisco, Calif.

Alfred Vincent Chow, Robert E. Reed, George R. Hokenstad, James Eliades, John A. Johnson, and **Thomas R. Welch** have joined the Weapons Systems Development Laboratories, Hughes Aircraft Co.

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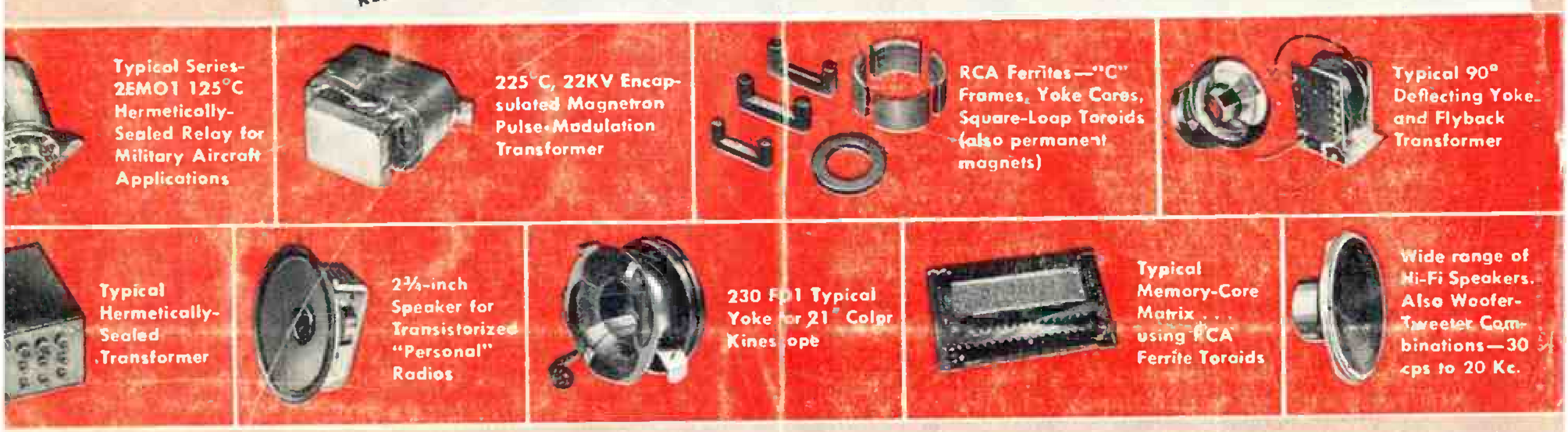

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