CALDWELL-CLEMENTS'

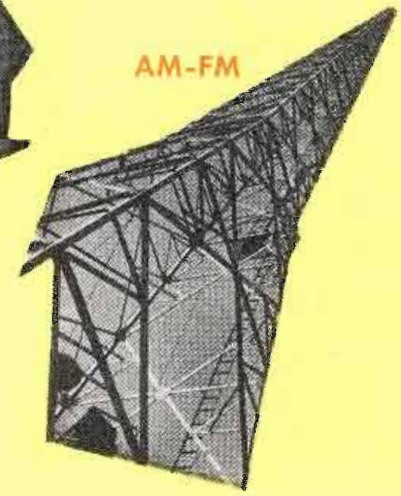
TELE-TECH

RADIO-TELEVISION-ELECTRONIC INDUSTRIES

IN TWO PARTS • PART ONE

MICROWAVE

AUDIO



AM-FM

TV

FILM

BROADCAST ENGINEERS' CONFERENCE

Chicago, March 31-April 2

Subminiature Electrostatic Relays

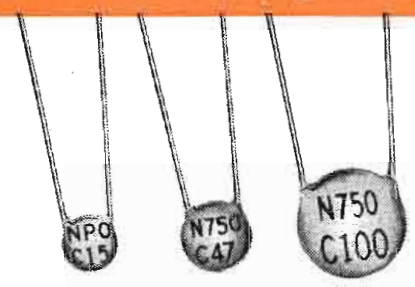
Germanium Diodes for Indicating Instruments

April • 1952

SHARE THIS COPY!

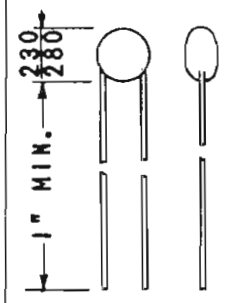
Please Route to

RMC Temperature Compensating and General Purpose DISCAPS



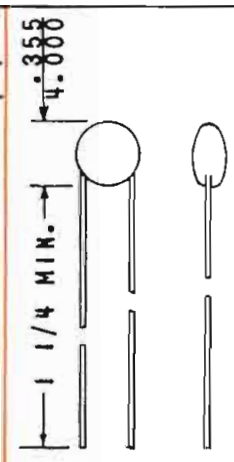
Designed to Replace Tubular Ceramic and Mica Condensers at **LOWER COST**

Type C DISCAPS are available in a wide range of capacities and temperature coefficients. They conform to the RMA specifications for Class 1 ceramic capacitors. Their capacity will not change under voltage.



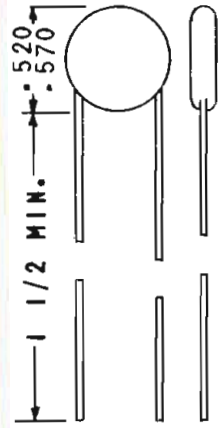
Size A

Available Range	
UUF	TC
— —	—
2 to 12	NP0
2 to 15	N33
2 to 15	N80
2 to 15	N150
2 to 15	N220
2 to 15	N330
2 to 20	N470
5 to 25	N750
15 to 50	N1400
50 to 75	N2200



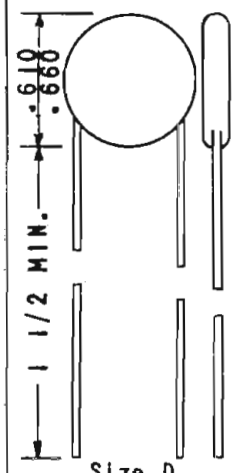
Size B

Available Range	
UUF	TC
2 to 9	P-100
13 to 27	NP0
16 to 27	N33
16 to 27	N80
16 to 30	N150
16 to 30	N220
16 to 30	N330
21 to 40	N470
26 to 50	N750
51 to 80	N1400
76 to 150	N2200



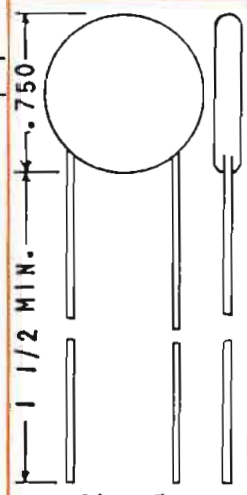
Size C

Available Range	
UUF	TC
10 to 30	P100
28 to 60	NP0
28 to 60	N33
28 to 60	N80
31 to 60	N150
31 to 75	N220
31 to 75	N330
41 to 80	N470
51 to 150	N750
81 to 200	N1400
151 to 250	N2200



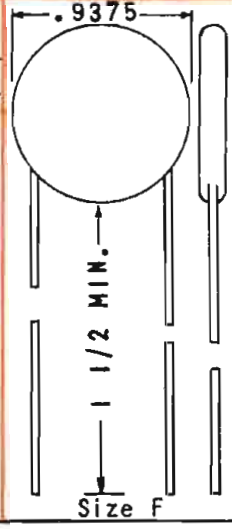
Size D

Available Range	
UUF	TC
61 to 75	NP0
61 to 75	N33
61 to 75	N80
61 to 75	N150
76 to 100	N220
76 to 100	N330
80 to 120	N470
151 to 200	N750
201 to 250	N1400
250 to 300	N2200



Size E

Available Range	
UUF	TC
76 to 110	NP0
76 to 110	N33
76 to 110	N80
76 to 110	N150
101 to 140	N220
101 to 140	N330
121 to 170	N470
201 to 290	N750
251 to 470	N1400
301 to 500	N2200



Size F

Available Range	
UUF	TC
111 to 150	NP0
111 to 150	N33
111 to 150	N80
111 to 150	N150
141 to 190	N220
141 to 190	N330
171 to 240	N470
291 to 350	N750
480 to 560	N1400
501 to 600	N2200

SPECIFICATIONS

POWER FACTOR: LESS THAN .1% AT 1 MEGACYCLE

WORKING VOLTAGE: 600 VDC TEST VOLTAGE 1500 V.D.C.

DIELECTRIC CONSTANT: P-100 14K N-750 88K N-2200 265K NPO 35K N1500 165K

CODING: CAPACITY, TOLERANCE AND TC STAMPED ON DISC

INSULATION: DUREZ PHENOLIC—VACUUM WAXED

LEAKAGE RESISTANCE: INITIAL 7500 MEG OHMS AFTER HUMIDITY 1000 MEG OHMS

LEADS: #22 TINNED COPPER (.026 DIA.)

LEAD LENGTH: ¼" BODY 1", 5/16" BODY 1¼", ½" BODY 1½"

TOLERANCES: ±5%, ±10%, ±20%

SEND FOR SAMPLES AND TECHNICAL DATA

DISCAP CERAMIC CONDENSERS

RMC

RADIO MATERIALS CORPORATION

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

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Two RMC Plants Devoted Exclusively to Ceramic Condensers

TELE-TECH

RADIO-TELEVISION-ELECTRONIC INDUSTRIES

Edited for the 18,000 top influential engineers in the Tele-communications and Electronic Industries, TELE-TECH each month brings clearly written, compact, and authoritative articles and summaries of the latest technological developments to the busy executive. Aside from its engineering articles dealing with manufacture and operation of new communications equipment, TELE-TECH is widely recognized for comprehensive analyses and statistical surveys of trends in the industry. Its timely reports and interpretations of governmental activity with regard to regulation, purchasing, research, and development are sought by the leaders in the many engineering fields listed below.

•

Manufacturing

TELEVISION • FM • ELECTRONIC
LONG & SHORT WAVE RADIO
AUDIO AMPLIFYING EQUIPMENT
SOUND RECORDERS & REPRODUCERS
AUDIO ACCESSORIES
MOBILE • MARINE • COMMERCIAL GOVERNMENT
AMATEUR COMMUNICATION
CARRIER • RADAR • PULSE
MICROWAVE • CONTROL SYSTEMS

Research, design and production of special types

TUBES, AMPLIFIERS, OSCILLATORS, RECTIFIERS, TIMERS, COUNTERS, ETC. FOR
LABORATORY • INDUSTRIAL USE
ATOMIC CONTROL

Operation

Installation, operation and maintenance of telecommunications equipment in the fields of

BROADCASTING • RECORDING
AUDIO & SOUND • MUNICIPAL
MOBILE • AVIATION
COMMERCIAL • GOVERNMENT

APRIL, 1952

PART ONE:

DEPARTMENTS:

PART TWO:

CALDWELL-CLEMENTS, INC., Publication Office, Bristol, Conn., Editorial/Business Offices, 480 Lexington Ave., New York 17, N. Y., Tel. Plaza 9-7880

Publishers also of RADIO & TELEVISION RETAILING

TELE-TECH

RADIO-TELEVISION-ELECTRONIC INDUSTRIES

O. H. CALDWELL, *Editorial Director* — M. CLEMENTS, *Publisher*

BERNARD F. OSBAHR, *Executive Editor* — DR. A. F. MURRAY, *Consulting Editor*

HARRY D. WULFORST, *Production Editor* — CHARLES DREYER, *Art Director*

R. C. DAVIES, *News Editor*
National Press Bldg., Washington, D. C.

LT. COL. STANLEY GERSTIN, *Consulting Editor*
(General Manager, Caldwell-Clements Manual Corp.)

BUSINESS DEPARTMENT

M. H. NEWTON, *Business Manager*
HOWARD A. REED, *Sales Manager*
JOSEPH DRUCKER, *District Manager*
G. A. DILLEN, *Sales Promotion Manager*
N. McALLISTER, *Asst. Business Manager*
480 Lexington Ave., New York 17, N. Y.
Telephone PLaza 9-7880

S. M. GASKINS, *Western Manager*
JOHN D. LUPTON, *District Manager*
201 N. Wells St., Chicago 6, Ill.
Telephone RAndolph 6-9225

CHRIS DUNKLE & ASSOCIATES
California Representative
2506 W. 8th Street, Los Angeles 5, Calif.
Telephone DUnkirk 7-6149

B. V. SPINETTA, *Directory Manager*

WARREN S. BROWN, *Circulation Manager*

M. GROENING, *Subscriptions, Compilations*

JOHN J. BORGHI, *Controller*

MARTHA H. SAVILLE, *Director Reader Service*

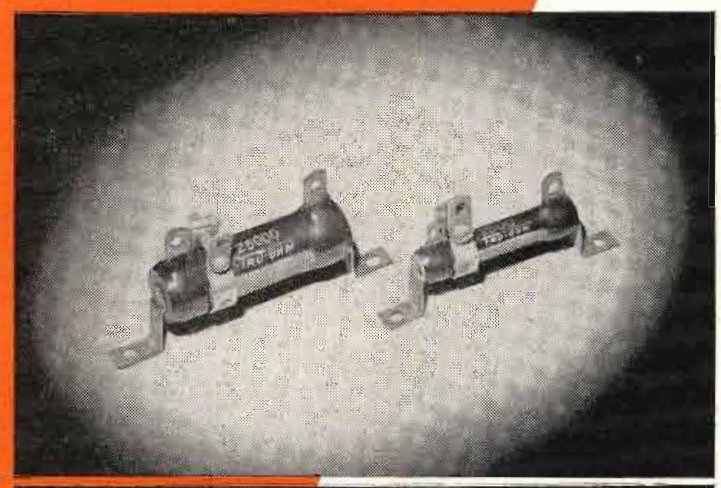
M. IMMEL, *Production Supervisor*

TELE-TECH*, April, 1952, Vol. 11, No. 4. 75 cents a copy. Published Monthly by Caldwell-Clements, Inc. Publication Office, Emmett St., Bristol, Conn. Editorial, Advertising and Executive Offices, 480 Lexington Ave., New York 17, N. Y. Acceptance under Section 34.64 Postal Laws & Regulations authorized at Bristol, Conn., February 8, 1952 with additional entry at New York, N. Y. M. Clements, President; Orestes H. Caldwell, Treasurer. Annual Subscription Rates: United States and Possessions: $7.00; Canada: $8.00; All Other Countries: $10.00. Please give title, position and company connection when subscribing. Copyright by Caldwell-Clements, Inc., 1952. Printed in U.S.A.
***Reg. U. S. Pat. Off.**

TRU-OHM

VITREOUS ENAMELED RESISTORS

The resistor line which is specified by engineers employed by the nation's foremost manufacturers of original equipment.



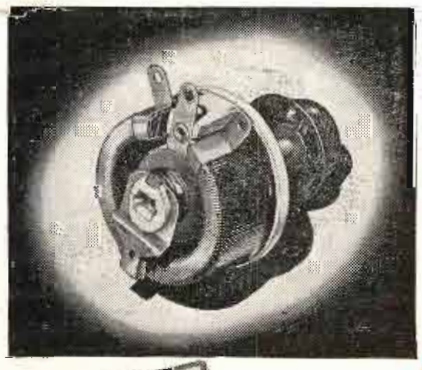
DELIVERY . . . two separate self-contained resistance plants guarantee prompt delivery.

QUALITY . . . as the world's leading manufacturers of wire wound resistors, we assure you that only the finest engineering techniques and material are utilized.

PRICE . . . our tremendous manufacturing capacity enables us to offer resistors . . . in any quantity . . . at exceptionally attractive prices.

ENGINEERING . . . our factories include the most modern machine shops and engineering facilities. Our experienced engineering department is at your service to assist in designing any resistance unit to meet your requirements and to meet JAN Specifications.

We invite your inquiries.



Our new multi-colored catalog, complete with engineering data and illustrations, is yours without obligation. WRITE TODAY!

The New TRU-OHM

Power RHEOSTAT

. . . the practical rheostat in its most exacting form, with a compensating constant pressure contact brush . . . *designed to meet JAN Specifications.*
Write for complete technical literature.

TRU-OHM **PRODUCTS** Division of Model Engineering & Mfg., Inc.

General Sales Office: 2800 N. Milwaukee Avenue, Chicago 18, Ill.
Factory: Huntington, Indiana

MANUFACTURERS: Power Rheostat, Fixed Resistors, Adjustable Resistors, "Econohm" Resistors

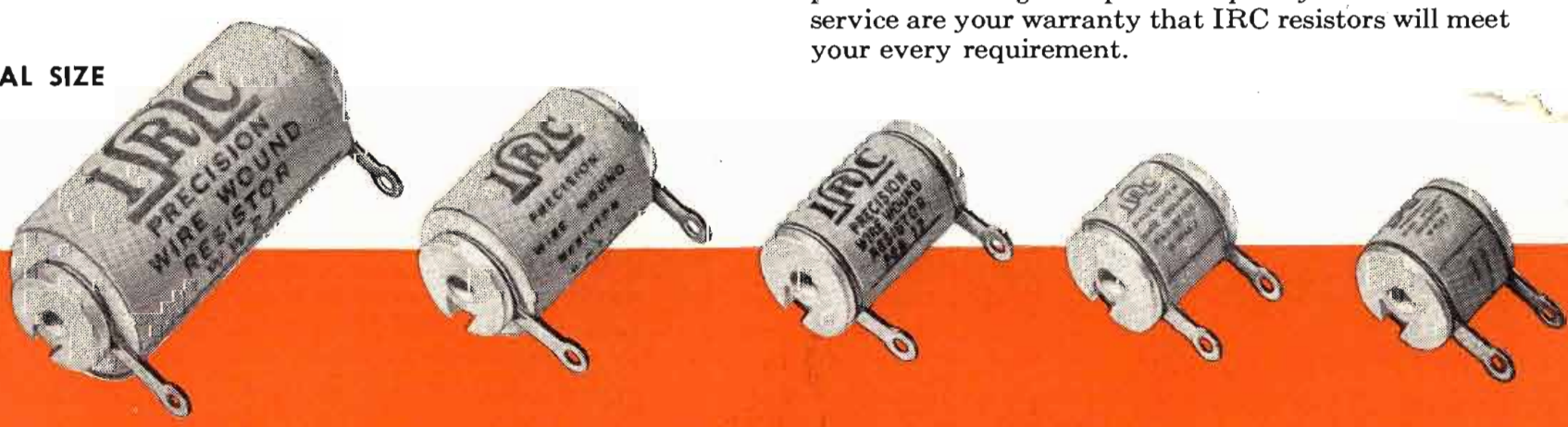
Test data are *in resistors too!*

Rigorous Tests Prove New Precision Wire Wounds Best of All for JAN-R-93 Specifications

No other resistor so far exceeds JAN-R-93 Specifications as IRC's newly developed Precision Wire Wounds! This is the impartial verdict of the most modern electrical and mechanical testing equipment applied to our own and competing resistors.

Largest producers of resistors in the world, IRC makes rigorous, thorough testing a *continuous* job, rather than an intermittent one. Pre-testing proves the design soundness of every IRC product. Tests-in-production safeguard product quality. And tests-in-service are your warranty that IRC resistors will meet your every requirement.

ACTUAL SIZE



ALL NEW Type WW Wire Wound Resistors for JAN Equipment—Industrial Applications—Miniaturization

Specifically designed for close tolerance requirements, new IRC Type WW Wire Wounds offer the finest balance of accuracy and dependability, excel in every significant characteristic under extreme heat and humidity conditions. Choice of leading producers of military equipment, these newly developed Precision Wire Wounds far surpass JAN-R-93 characteristic B Specifications! High stability suits them to a multitude of industrial uses, and compactness and small size make them ideal for miniaturization.

important

NEW WINDING FORMS AND TECHNIQUES— NEW TYPE INSULATION — NEW TERMINATIONS — GIVE NEW CLOSE TOLERANCE EFFICIENCY

New Winding Forms hold more wire—provide higher resistance values. Non-hygroscopic ceramic forms assure high insulation qualities, high mechanical strength, and low coefficient of thermal expansion.

New Winding Technique, developed by IRC engineers, eliminates possibility of shorted turns or winding strains. All wire used receives rigid insulation tests of special enamel coating. Additional production tests assure high quality in the finished resistor.

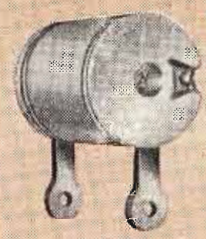
New Type Insulation insures long life under *all* environmental conditions. Winding is multiple vacuum impregnated with a new compound developed by IRC chemists. This has the unique characteristic of retaining the same consistency throughout the entire range of temperatures to which the resistors may be subjected. It is neither glassy hard nor tacky soft under any conditions. Result:—A higher degree of stability and freedom from noise, and much greater resistance to humidity.

Test the IRC Industrial Service Plan and you'll always use it to get maintenance, pilot-run or experimental quantities of standard resistors in a hurry. Your nearby IRC Distributor has these units on his shelf, can make 'round-the-corner delivery without delay. He's a good man to talk with about JAN Specifications, too. Ask for his name and address.

Typical Cycling and Load Tests Show Minimum Change in Resistance of New IRC Precision Wire Wounds

A glance at the adjacent chart will show the negligible resistance change undergone by IRC Precision Wire Wounds subjected to the most stringent and protracted cycling and load tests. Here is your assurance that new IRC Precision Wire Wounds withstand the toughest kind of service without loss of efficiency. This is only one of the many rigid tests applied to IRC Precision Wire Wounds.

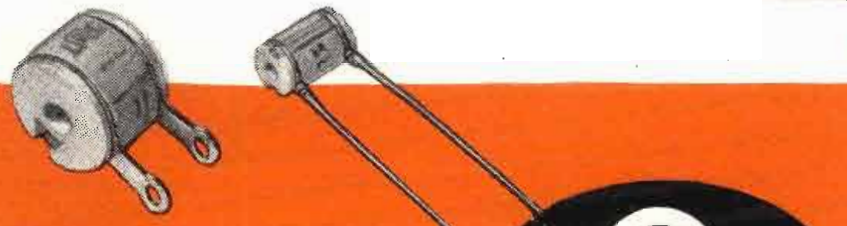
	Original Resist.	1st Cycle % Chge	2nd Cycle % Chge	3rd Cycle % Chge	4th Cycle % Chge	Resist. at End of 100 hrs. load	Total % Chge	% Chge from Last Temp. Cycle to End of 100 hrs. load %	Resistance Chge at End of 100 Hrs. Load only % (no cycling)	
1	100,010	+.04	+.04	+.05	+.05	100,050	+.04	—.01	100,040	—.02
2	100,000	+.03	+.04	+.03	+.05	100,060	+.06	+.01	100,000	0
3	100,000	+.01	+.02	+.02	+.05	100,000	0	+.05	100,050	—.02
4	100,000	+.02	0	+.02	+.02	100,000	0	—.02	100,040	—.01
5	100,010	+.03	+.04	+.04	+.05	100,000	0	—.05	100,030	—.03
6	100,000	0	+.03	+.04	+.04	100,100	+.1	+.06	99,980	0
7	100,000	+.04	+.05	+.04	+.04	100,070	+.07	+.03	100,000	0
8	100,000	+.03	+.05	+.05	+.05	100,050	+.05	0	100,000	0
9	100,000	+.04	+.03	+.05	+.04	100,010	+.01	—.03	100,050	0
10	100,000	+.02	+.02	+.02	+.04	100,010	+.01	—.03	100,000	0
11	100,000	0	+.01	+.01	+.03	100,000	0	—.03		



New Terminations. All precision resistors, with the exception of WW-10, are provided with rugged lug terminals for solder connections. These provide dependable and strain-free winding terminations. WW-10, because of its small size, has wire lead termination 2" long.

SIZES AND RANGES

JAN-R-93.	1 5/32" Max.	29/32" Max.	27/32" Max.	13/16" Max.		3/4" Max.	Dia.
	2 1/8" ± 1/16"	1 1/8" ± 3/16"	1" Max. 7/8" Min.	5/8" ± 1/16"		1 5/32" Max.	Length
	4.00 Meg.	750,000	300,000	300,000		185,000	Max. Range
Style	RB14	RB13	RB12	RB11	RB11	RB10	None
New IRC Style #	WW2J	WW5J	WW4J	WW11J	WW3J	WW8J	WW10J
Dia.	7/8" D	3/4" D	9/16" D	9/16" D	9/16" D	9/16" D	9/32" D
Length	2 1/8" L	1 1/4" L	1" L	21/32" L	9/16" L	29/64" L	13/32" L
No. of Pies	8	4	4	2	2	1	1
J. A. N. .0015" Dia.	4.250 Meg.	1.5 Meg.	0.5 Meg.	0.300 Meg.	0.185 Meg.	0.185 Meg.	40,000 Ohms.
Commercial .0013" Dia.	6.00 Meg.	2.7 Meg.	0.9 Meg.	0.450 Meg.	0.225 Meg.	0.225 Meg.	80,000 Ohms.
.0013" Dia. 1000 Alloy							100,000 Ohms.



Power Resistors • Voltmeter Multipliers • Insulated Composition Resistors • Low Wattage Wire Wounds • Volume Controls • Voltage Dividers • Precision Wire Wounds • Deposited Carbon Precistors • Ultra-HF and High Voltage Resistors • Insulated Chokes.

Wherever the Circuit Says —WW—

INTERNATIONAL RESISTANCE COMPANY

401 N. Broad Street, Philadelphia 8, Pa.

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

Mail Coupon today for Full Details of New IRC Precision Wire Wounds in Technical Data Bulletin 00

INTERNATIONAL RESISTANCE CO.
407 N. Broad St., Philadelphia 8, Pa.

Please send me Technical Data Bulletin (Number) ☐, and/or name and address of nearest IRC Distributor ☐

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

TELE-TIPS

HALF-COLOR TV!—As a rigorous test of the compatibility of the NTSC system, one interested station has made a number of broadcasts of a composite picture, the upper half of which was televised using the color signal and the lower half the standard black-white signal. No one with a home TV set has ever noticed the difference—a striking demonstration of compatibility!

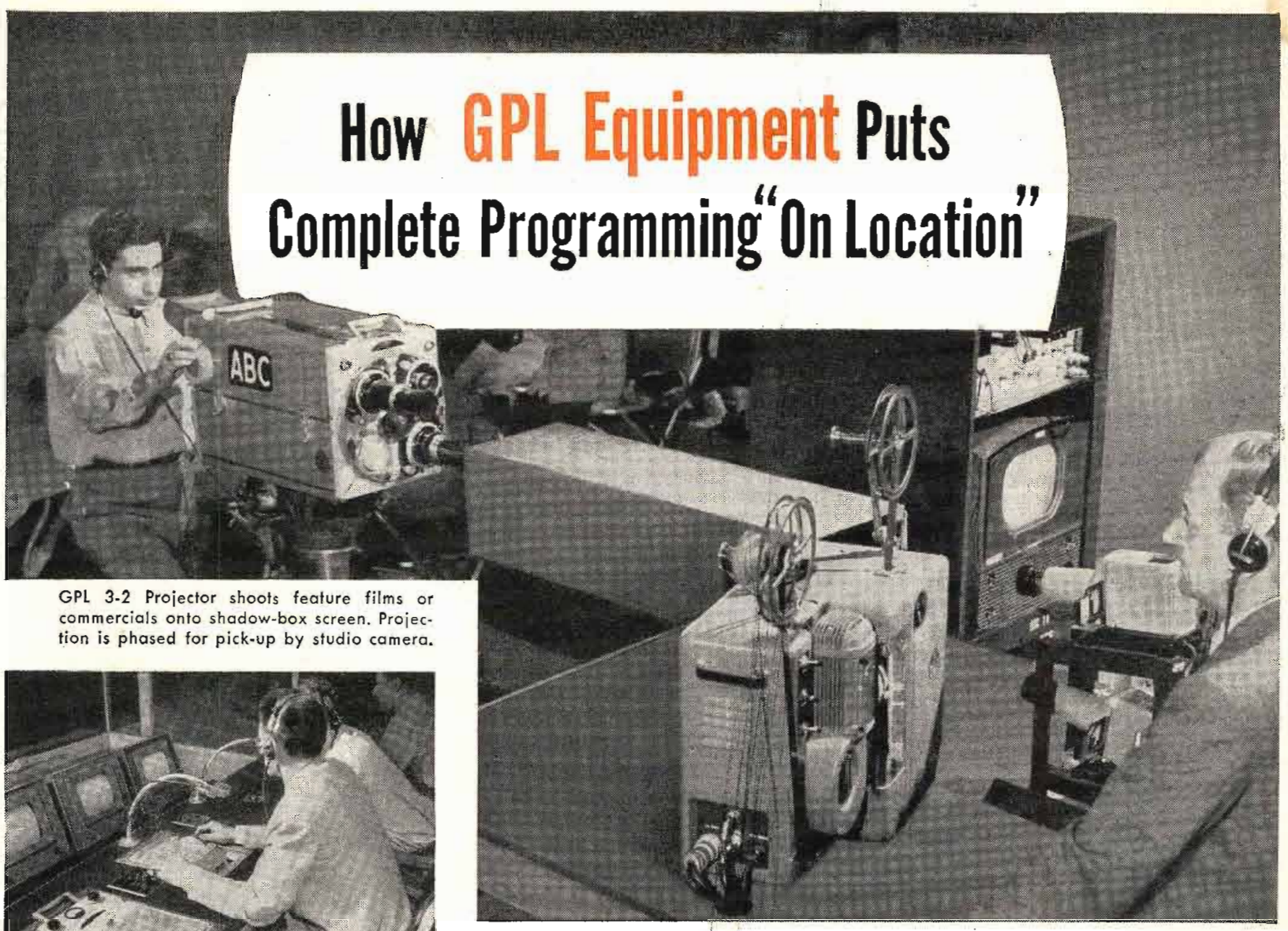
UHF CONVERTERS for customers' sets are being considered as part of the UHF station investment by some UHF applicants who have already contacted TV manufacturers for quantity prices on such converter units. The UHF stations would purchase the UHF converters in quantities and then sell them locally (at one-half or one-third cost) to present TV set-owners, to build UHF audience for the new stations.

CIRCUIT SYMBOLS on rubber stamps, to save draftsmen's time in drawing repetition symbols, have been developed by J. P. Griffin, 2157 James Ave., St. Paul 5, Minn., who is now starting production on an improved similar kit of electronic printing stamps that will be completely transparent. The circuit symbol will be visible from the back of the stamp, thus eliminating all problems of alignment of the stamp to the drawing.

WHAT IS YOUR POTENTIAL? An economically operated device for magnetically recording on tape the tiny electrical impulses originating in the muscles of the body reduces the cost of recording from $9 per minute for film to $.11 per minute for tape. The amplifier and recorder are of the dual channel type, which enables scientists studying electromyography to record both the impulses, and, if they wish, a simultaneous commentary on what a subject is doing to produce variations in the voltage. The new recorder has a flat frequency response from 20 cps to more than 7,000 cps. Before the tiny muscular impulses, which range from 30 μv to three mv, are fed into the amplifier, they are run through a preamplifier which increases their strength about 20,000 times.

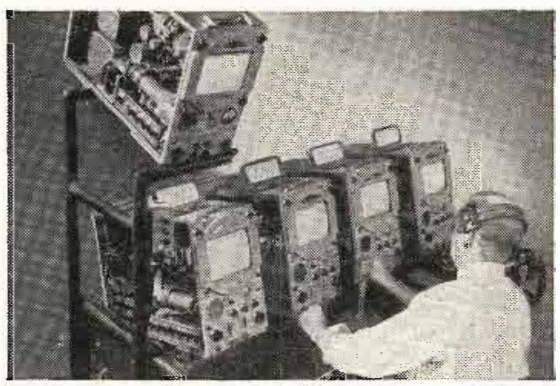
(*Continued on page* 10)

How GPL Equipment Puts Complete Programming "On Location" ...for ABC-TV



GPL 3-2 Projector shoots feature films or commercials onto shadow-box screen. Projection is phased for pick-up by studio camera.

Removable control panel of GPL Video Switcher permits convenient flush-mounting of both sections in control room operating board.



Compact GPL Cameras feature smooth operation, simplified control, (Swing-up and removable chassis permit easy servicing).

GPL Camera Control Units and Master Monitor fit neatly in small booth. Intercom system provides for single or split headphones.

When ABC's two GPL-equipped studios are on the air, there's no need for telecine studio standby. Completely independent and self-contained, each studio can handle live or canned action, feature films, film or slide commercials, or any *combination* of camera work demanded by programming . . . and handle it smoothly, speedily.

Both studios are equipped with 4 GPL cameras, camera control and power units, video switcher, and master monitor—supplemented with a portable 3-2 projector for handling film work independently of the regular film chain. "Human-engineered," the GPL camera chains were developed from motion studies of cameramen. World's most compact broadcast chains, they feature push-button turret and iris controls, right or left hand focus knobs, full range of camera control from CCU or remote location.

Every unit in these GPL-equipped studios is lightweight and portable, so that it may be employed in the field as well as in any studio at a moment's notice.

Learn what GPL TV equipment can do for your operation.
Write, Wire or Phone for Details Today

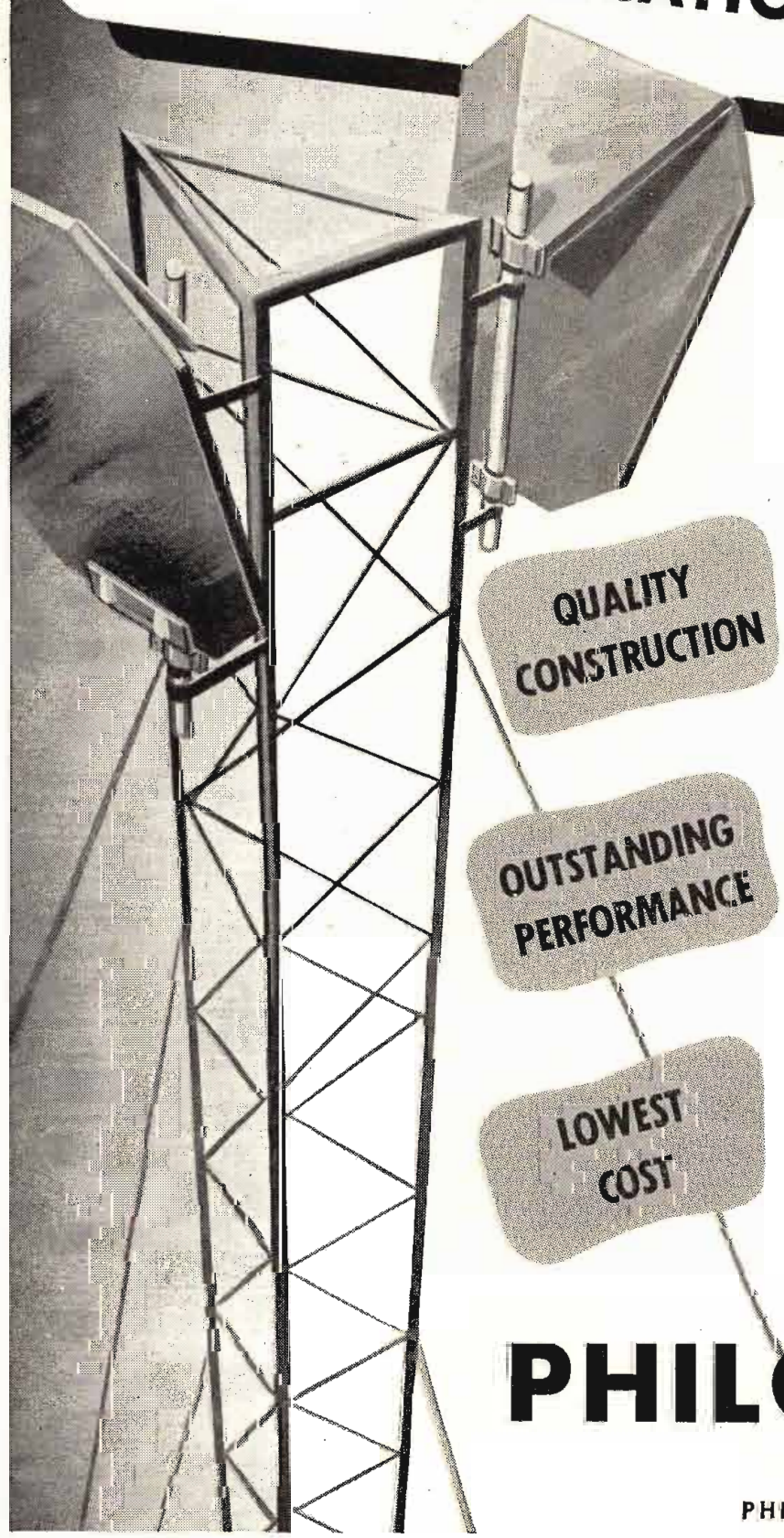
General Precision Laboratory GPL
INCORPORATED
PLEASANTVILLE NEW YORK

TV Camera Chains • TV Film Chains • TV Field and Studio Equipment • Theatre TV Equipment

DON'T SETTLE FOR LESS!

PHILCO

Advanced Design MICROWAVE COMMUNICATIONS SYSTEMS



Again Philco leads the way . . . with Philco *Advanced Design* Microwave Communications Systems. Philco's years of experience in microwave development has produced a system unsurpassed in reliability, performance and economy.

All components are of the finest quality, conservatively rated, insuring long life and economical operation and maintenance.

A signal level 1000 times greater than normally required insures dependable service even under the most adverse conditions. Philco *Advanced Design* Microwave is flexible. The broadband microwave channel may be divided to carry up to 24 simultaneous 2-way telephone conversations . . . or be further divided for telegraph, teletype, telemetering, signaling or supervisory circuits.

Years of production experience enable Philco to produce microwave systems for the lowest possible cost consistent with highest quality. Future expansion can be easily accomplished with no loss of original investment.

For dependable communications service 24 hours a day, every day of the year . . . *don't settle for less* than Philco *Advanced Design* Microwave Communications Systems!

PHILCO CORPORATION

INDUSTRIAL DIVISION

PHILADELPHIA 34, PENNSYLVANIA

10 YEARS!

OF SPECIALIZATION IN MULTIPLE HEADERS AND SEALED LEADS

Ten years specializing in the production of over 100,000,000 precision built, hermetically sealed multiple headers and sealed leads. Simply stated, that is the record of E-I engineers — a record that attests to the quality of these terminals and the ability of E-I designers to meet specifications on the toughest of terminal sealing problems! Currently, E-I offers over 100 standard types, with numerous optional features — for the quick, economical solution of most sealing requirements.

When circuit conditions indicate special types of unusual characteristics, you can depend on E-I to produce terminals to specification at reasonable unit cost. Literature on request.

ELECTRICAL INDUSTRIES • INC

44 SUMMER AVENUE, NEWARK 4, NEW JERSEY

TELE-TIPS

(*Continued from page 6*)

FISHY?—Underwater recordings made in connection with sonar devices have revealed the presence of schools of fish of various types. By studying the individual noises of fish it becomes possible to determine their presence in the composite. Thus fishermen of the future using submarine detectors will know just what types of fish are where and so can select their catches.

FLYING ENTERPRISE A small, twenty-pound ship-to-shore Radiomarine radio-telephone unit, designed for use aboard small pleasure boats, was the only link between Capt. Henrik Kurt Carlsen, master of the ill-fated Flying Enterprise, and the rest of the world for the last two weeks of the vessel's existence. Captain Carlsen had purchased the radiotelephone when the Flying Enterprise stopped at Philadelphia before sailing for Rotterdam, Holland, intending to give it to his father-in-law for use on his motorboat, and had taken it to sea to test its operation. When the 6700-ton freighter was lashed by gales and heavy seas until she appeared doomed, and Captain Carlsen ordered the ship abandoned, electing to remain aboard her alone, he rigged the small radiotelephone unit to a six-volt storage battery and began his two-week vigil aboard the stricken vessel, until she went down and he was rescued.

UHF SEMINARS—Fred King, chief engineer and Rudy Frank, promotion manager of Station WELI, New Haven, Conn., has completed a two-day seminar on UHF television at Hendersonville, N. C., for prospective UHF applicants in North and South Carolina and for servicemen, technicians and engineers of the two states. Arranged by B. M. Middleton, president of AM Station WHKP, Hendersonville, who is applying for UHF channel 26 in that city, over two hundred men participated in the two meetings. Rudy Frank talked about the many advantages of the UHF spectrum, emphasizing absence of man-made interference, stability of transmission, and relatively low cost of getting into operation in the various smaller markets. Fred King discussed propagation characteristics, antennae, converter performance, availability of converters and combination UHF-VHF receivers. Other seminars are planned by WELI as a public service to the industry.

ADLAKE RELAYS AT WORK— One of a series of advertisements on specific ADLAKE applications.

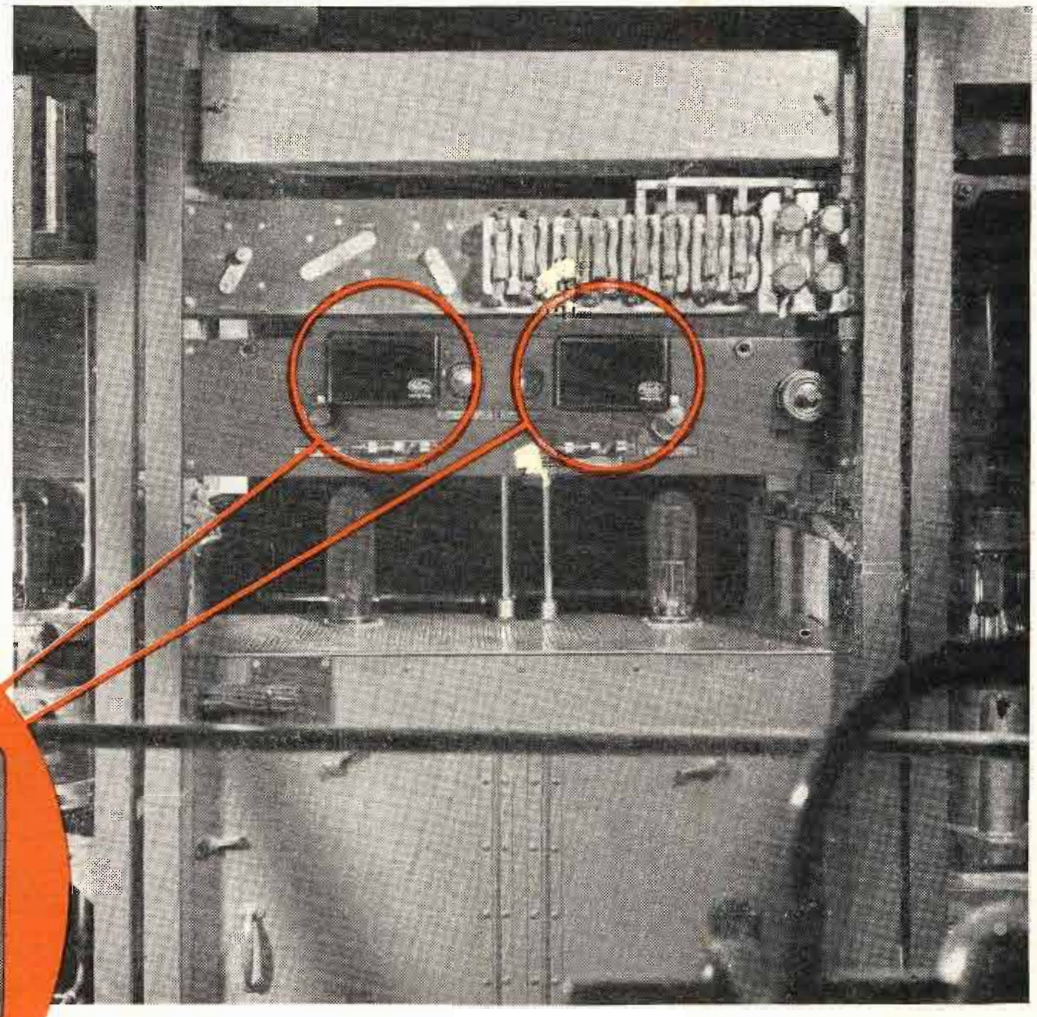
For vital regulation—

Radio Station WAIT uses

Super-Sensitive

Adlake

RELAYS



Operating in conjunction with a thermoregulator, the ADLAKE No. 5000 Relays at Station WAIT control the temperature of the quartz crystals which in turn control the operating frequency of the station.

EVERY ADLAKE RELAY BRINGS YOU THESE ADVANTAGES:

- **HERMETICALLY SEALED—dust, dirt, moisture, oxidation and temperature changes can't interfere with operation.**
- **SILENT AND CHATTERLESS**
- **REQUIRES NO MAINTENANCE**
- **ABSOLUTELY SAFE**
- **MERCURY-TO-MERCURY CONTACT —prevents burning, pitting and sticking.**

ADLAKE'S No. 5000 Relay, which is used by Chicago's Radio Station WAIT in the control of operating frequency, is especially suited to sensitive thermo-regulation. It operates at 115 volts, 60 cycles on only 0.007 ampere—and tests indicate its life to be over 30 million operations!

And, like all ADLAKE Mercury Relays, No. 5000 is hermetically sealed against dust, dirt, moisture, oxidation and temperature changes. Operation is silent and chatterless, and no maintenance whatever is required.

Find out how ADLAKE Mercury Relays can add dependability and reduce costs in *your* business. Write today for your free copy of the illustrated ADLAKE Relay catalog. No obligation, of course. The Adams & Westlake Company, 1130 N. Michigan, Elkhart, Indiana.

Adlake TRADE MARK — *95th year* of serving the transportation and building industries

THE

Adams & Westlake

COMPANY

Established 1857
ELKHART, INDIANA
New York, Chicago
Manufacturers of ADLAKE Hermetically Sealed Mercury Relays

KOLLSMAN

for products of precision and dependability

Aircraft Instruments and Controls • • • Miniature AC Motors for Indicating and Remote Control Applications • • • Optical Parts and Optical Devices Radio Communications and Navigation Equipment

Today, Kollsman works without pause toward the fulfillment of America's defense needs. And to our nation's research scientists, the skill, ingenuity and creative drive of Kollsman Research Laboratories are available for the solution of instrumentation and control problems.

KOLLSMAN INSTRUMENT CORPORATION

ELMHURST, NEW YORK — GLENDALE, CALIFORNIA

SUBSIDIARY OF

Standard COIL PRODUCTS CO. INC.

Sylvania's Consultants in Tube Problems are set to serve your business


R. W. Andrews
Mgr. Factory Sales
Emporium


R. A. Bachhuber
Sales Engineer
Chicago


E. G. Brierty
Sales Representative Mgr
Chicago


G. V. Bureau
Government Sales
New York


T. D. Fuller
Sales Engineer
Los Angeles


F. E. Gilbert
Calif. Div. Sales Mgr.
Los Angeles


H. P. Gilpin
Asst. Gen. Sales Mgr.
New York

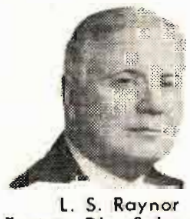

Ben Kievit
Sales Engineer
New York


R. N. Klein
Sales Engineer
New York


J. T. Mallen
E. Cent. Div. Sales Mgr.
Cincinnati


C. E. Marshall
Sales Engineer
Chicago


R. S. Mason
Sales Engineer
New York


L. S. Raynor
Eastern Div. Sales Mgr.
New York


W. O. Spink
Sales Engineer
Chicago


R. A. Starek
Sales Engineer
Cincinnati


D. W. Wachter
Soles Correspondent
New York


L. A. Wheelock
Central Div. Sales Mgr.
Chicago


G. R. Sommers
Gen. Sales Manager, New York


D. W. Gunn
Manager Equipment Sales, New York

Meet the Sylvania team that goes to bat for you

Here's a competent and friendly group . . . 19 experts in radio tube and engineering problems . . . all set to serve you.

In every section of the country you'll find these Sylvania representatives and engineers ready to give you expert advice on circuits, as well as tubes. They know, or can quickly get the information about deliveries, or any other problem that's bothering you. So when you want to know about new tubes, or deliveries, or just want some good practical engineering advice . . . call in your nearest Sylvania representative or write to Sylvania Electric Products Inc., Dept. R-3504, Emporium, Pa.

SYLVANIA

RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS

How Low is a HIGH VACUUM?

You can't measure a working vacuum by *pressure* alone because *time* also is a big factor in any vacuum processing operation. To provide these two essentials of high vacuum — (1) the *required low absolute pressure* (2) in the *shortest possible time* — is the job for fast, dependable Kinney High Vacuum Pumps.

Fast — Kinney High Vacuum Pumps have the ability to save processing time by speeding up the tempo of your vacuum operations.

Dependable — Kinney High Vacuum Pumps have the ability and stamina to produce the vacuum you need, whether it's measured in fractions of an inch of mercury or fractions of a micron.

Remember, there's a Kinney Pump for every vacuum requirement, from the midget 2 cu. ft. per min. pump to the new giant 1600 cu. ft. per min. model. Send coupon today for new Kinney Bulletin V51B. KINNEY MANUFACTURING CO., Boston 30, Mass. Representatives in New York, Chicago, Cleveland, Philadelphia, Houston, New Orleans, San Francisco, Seattle, Los Angeles.

FOREIGN REPRESENTATIVES: Gen'l Engineering Co., Ltd., Radcliffe, Lancs., England • Horrocks, Roxburgh Pty., Ltd., Melbourne, C. I. Australia • W. S. Thomas & Taylor Pty., Ltd., Johannesburg, South Africa • Novelectric, Ltd., Zurich, Switzerland • C.I.R.E. Piazza Cavour 25, Rome, Italy.

KINNEY MANUFACTURING CO.
3568 WASHINGTON ST., BOSTON 30, MASS.

Please send new Bulletin V51B. Our vacuum problem involves:

- ☐ **Vacuum exhausting**
- ☐ **Vacuum dehydration**
- ☐ **Vacuum coating**
- ☐ **Vacuum distillation**
- ☐ **Vacuum metallurgy**
- ☐ **Vacuum research**

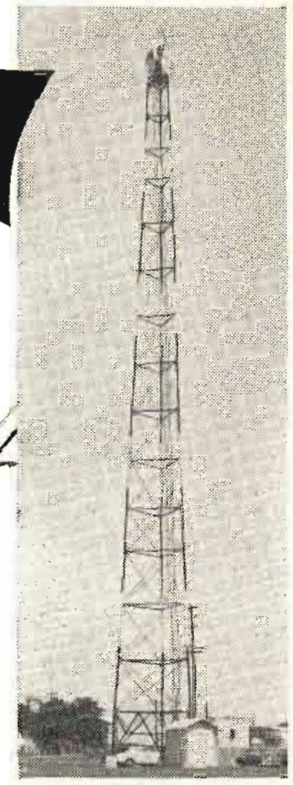
Name..... *Company*.....
Address.....
City..... *State*.....

Kinney
VACUUM PUMPS

FROM TRUSCON

guyed or self-supporting . . . tapered or uniform in cross-section . . . steel towers for every broadcasting purpose

MICROWAVE



Truscon Type H-30 Self-Supporting Tower, at relay station KEB-810, Linden, N. J. (operated by Transcontinental Gas Pipe Line Company, Houston) is 175 feet high.

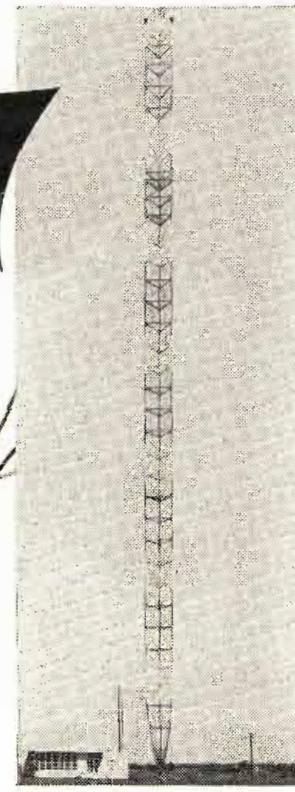
● Take advantage of the great fund of experience which Truscon has acquired in the steel tower field for every broadcasting purpose.

Truscon engineering has encountered and solved many types of problems in tower design and construction. Truscon manufacturing facilities are precise and efficient, assuring economical installation.

Your phone call or letter to any convenient Truscon district office, or to our home office in Youngstown, will bring you immediate, capable engineering assistance. Call or write today.

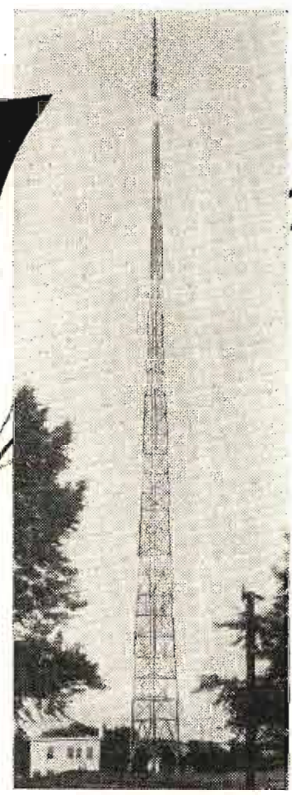
Truscon® Steel Company,
1092 Albert Street,
Youngstown 1, Ohio
Subsidiary of
Republic Steel Corp.

AM



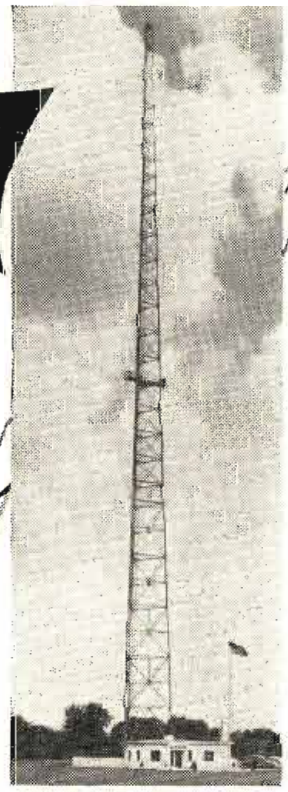
This Guyed Truscon Steel Radio Tower operated by KOCY, Oklahoma City, Okla., is 849 feet above ground, 938 feet high overall to top of General Electric FM antenna.

FM



Truscon Self-Supporting Tower, operated by WEMP-FM, Milwaukee, Wisconsin, is 410 feet high with Western Electric 6 Unit Cloverleaf FM antenna.

TV



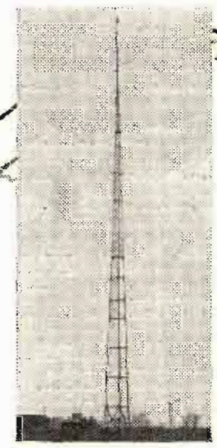
WSAM FM-TV, Saginaw, Michigan, Truscon Self-Supporting Tower, 386 feet high.

TRUSCON
MARK OF MERIT PRODUCTS

TRUSCON a name you can **build** on

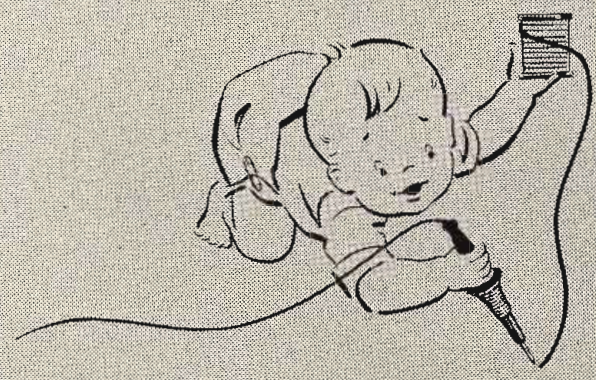
Truscon Type H-30 Self-Supporting Tower, operated by WEXL-FM, Detroit, Mich., supports an 8-bay General Electric F-M antenna and rises to an overall height of 425 feet.

Truscon Guyed Radio Tower, WKY, Oklahoma City, Oklaboma, is 956 feet high to top of FM antenna.

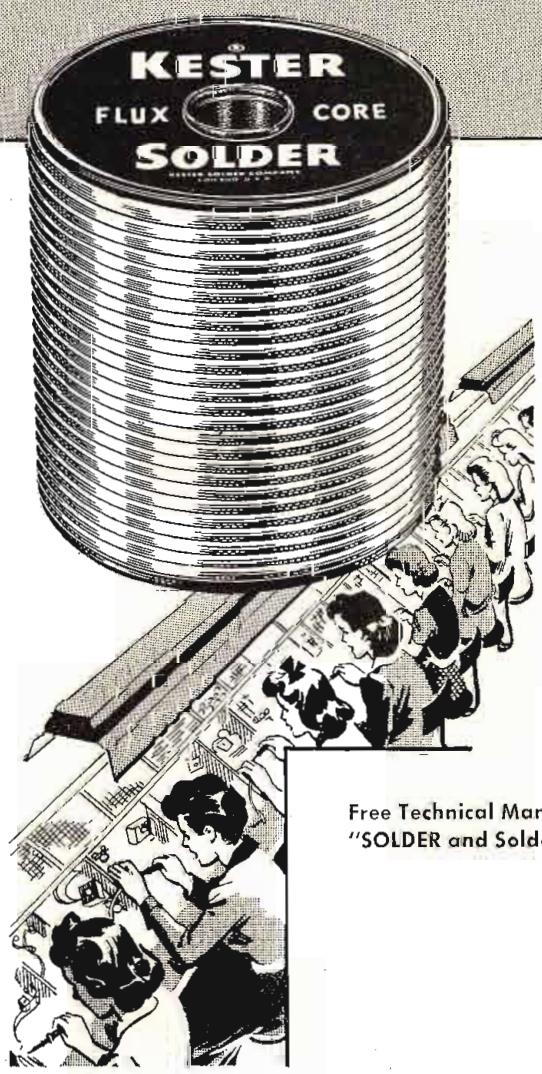


WUSJ-FM, Lockport, N. Y., Truscon Self-Supporting Tower, 135 feet high and supporting a GE 4-bay FM antenna 42 feet high. Overall height 177 feet.

This 240 foot Truscon Tower, operated by WTCH, Shawano, Wisconsin, has 25 x 48 Truscon Ground Screen to assure an excellent signal.



SO SIMPLE...



KESTER FLUX-CORE SOLDER

SO SIMPLE... to solve that Soldering Problem when Kester Solder and Kester's Engineering Service "arrive on the scene."

Flux Control, more or less Flux, the exact predetermined flux-content, is *only* available with Kester's *seven* different Core Sizes (openings) in the solder-strand.

This exclusive Kester feature may be had in eight Flux-Core Solders including the widely accepted "44" Resin, "Resin-Five" and Plastic Rosin, also diameters ranging from nine-thousandths (.009") to one-quarter inch (.250"), and any alloy.

Kester, the "engineered" Flux-Core Solder, meets all applicable Government and Federal Specifications.

Free Technical Manual—write for your copy of "SOLDER and Soldering Technique."

KESTER SOLDER COMPANY

4210 Wrightwood Ave., Chicago 39

Newark 5, New Jersey • Brantford, Canada

KESTER SOLDER

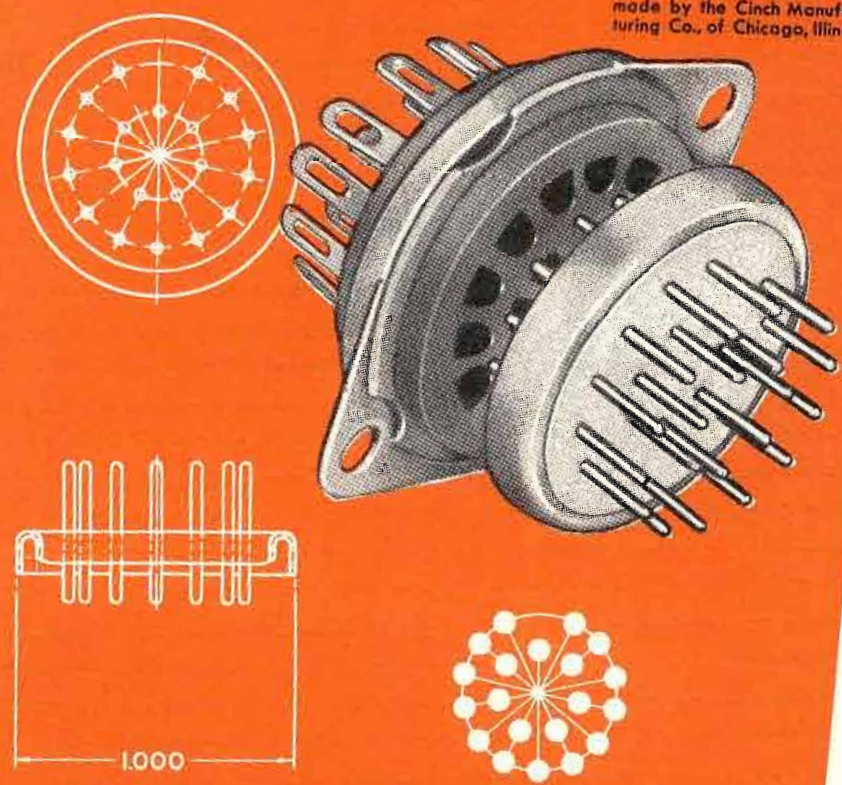
Another Great *Hermetic*

FIRST

in MINIATURIZATION

20-Terminal, Plug-In Header In 1″ Dimension

The socket shown below was made by the Cinch Manufacturing Co., of Chicago, Illinois.



The Electro-Seal Corporation of Des Plaines, Illinois, is an acknowledged leader in the field of hermetically sealed electronic components of exceptional quality. It was natural, therefore, that it should single out HERMETIC SEAL PRODUCTS CO. to develop a needed, polarized 20-terminal, plug-in header in a 1″ maximum dimension. It knew that only HERMETIC, with its vast experience, equipment and engineering staff, could design and develop such a plug . . . one that would be able to withstand the mass spectrometer tests to which it would be subjected for leaks and cracks. Each and every component is thoroughly tested in Electro-Seal's efforts to maintain the quality standard for which it has become famous.

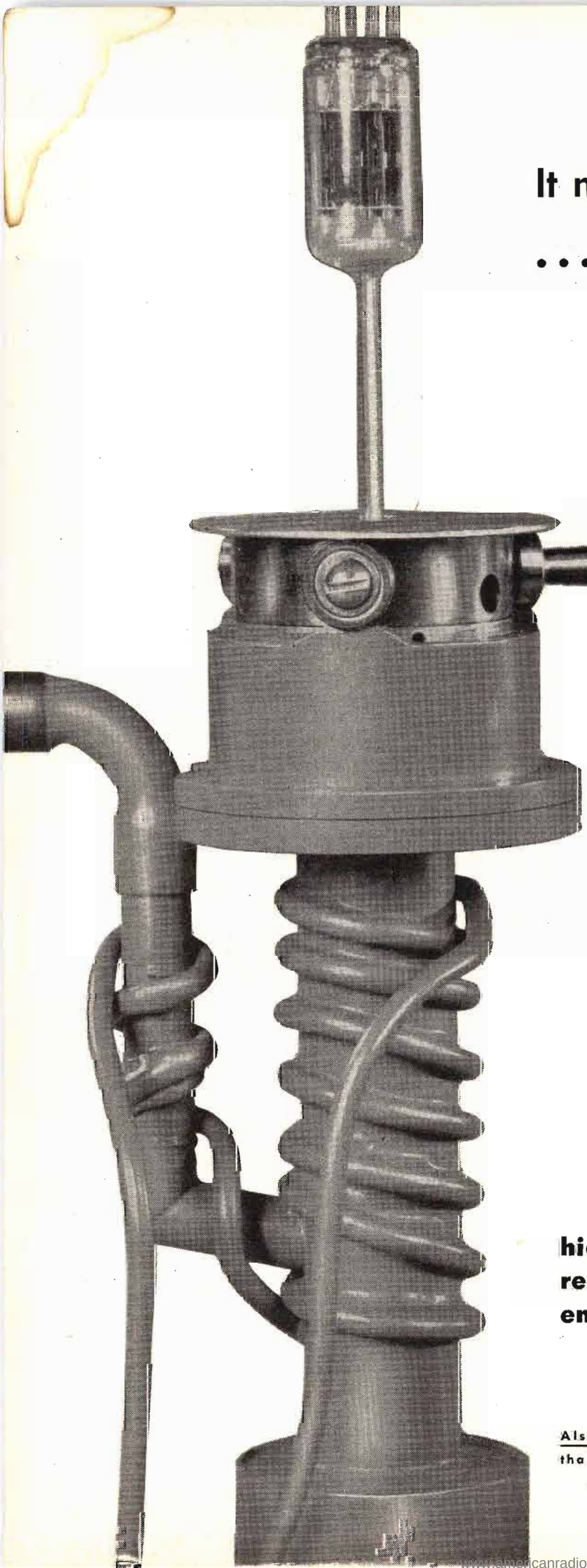
● The 20-terminal, ceramic-metal plug has 7 terminals on the inside circle and 13 in the outer circle. It is also available for other applications as a 14-terminal plug-in with 7 different polarized positions as shown on the print.

Submit your own problems in this highly exacting field to our specialist-engineers. They are eager to be of help.

Write for your copy of our new 32-page brochure, the most complete and informative presentation ever made on hermetic seals.

Hermetic Seal Products Co.

33 South Sixth Street • Newark 7, New Jersey



It makes tubes more reliable

. . . at less cost

SHOWN here, almost natural size, is DPi's new MB-10 Booster Diffusion Pump combined with a new port-and-valve unit. It's compact enough for any rotary exhaust machine, and it gives a big boost in performance—two ways.

1. This pump gives you a vacuum higher than 0.1 micron Hg at the tubulation before getter flash and in less time than other diffusion pumps of comparable size. Results: less residual gas to be gettered, less getter required, less getter deposited to affect operating characteristics, less gas that can be released from the getter to shorten tube life.

2. Despite the high ultimate vacuum, the pump tolerates high enough forepressure so that it can be installed in almost any rotary machine without extensive changes in slide valve and sweeps. For larger tubes, the port-and-valve can be adapted to permit rough pumping independently of the diffusion pump.

The unit is designed for easy installation of a leak detector to check bad seals or machine leaks. Valving is done mechanically, requiring no electrical circuits. The pump jet is specially designed for easy cleaning.

For complete engineering data, write to ***Distillation Products Industries,*** Vacuum Equipment Department, 629 Ridge Road West, Rochester 3, N. Y. (Division of Eastman Kodak Company).

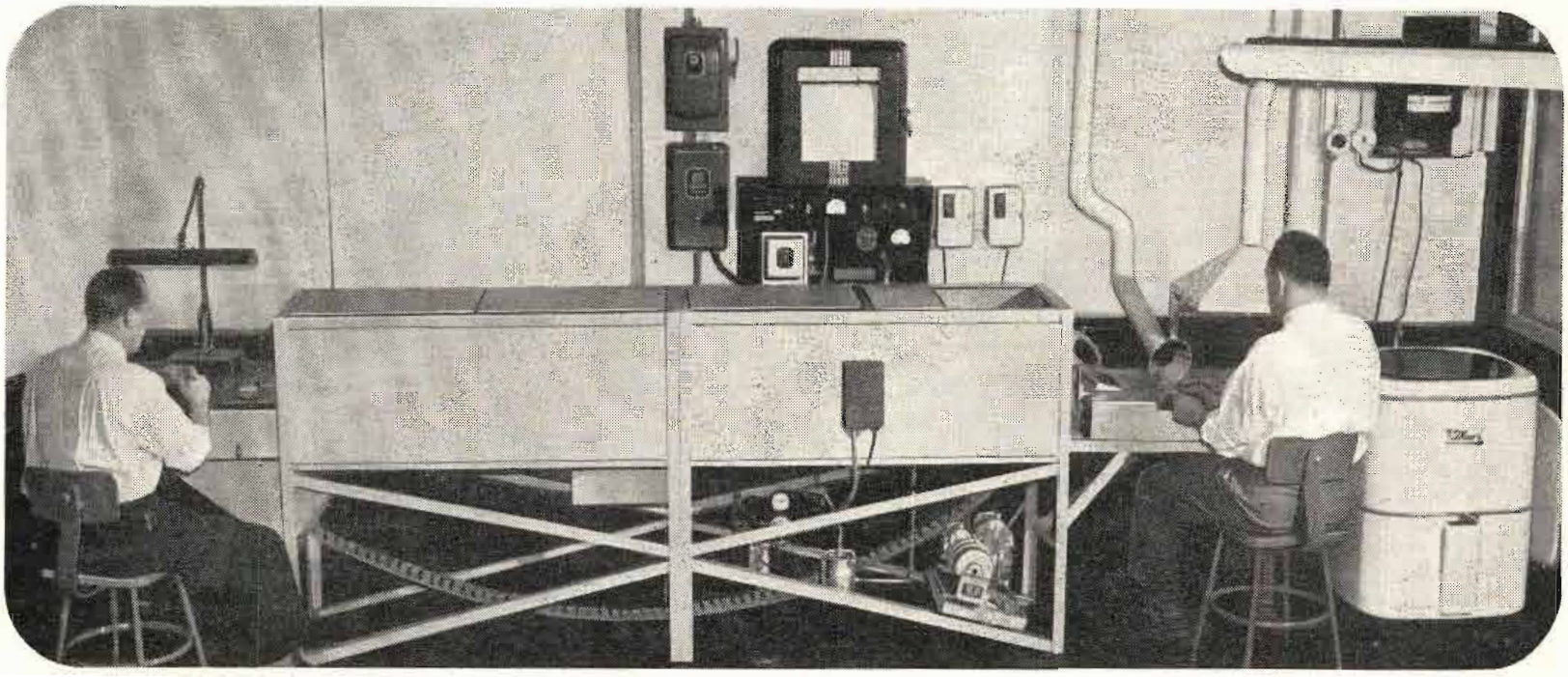
high vacuum research and engineering

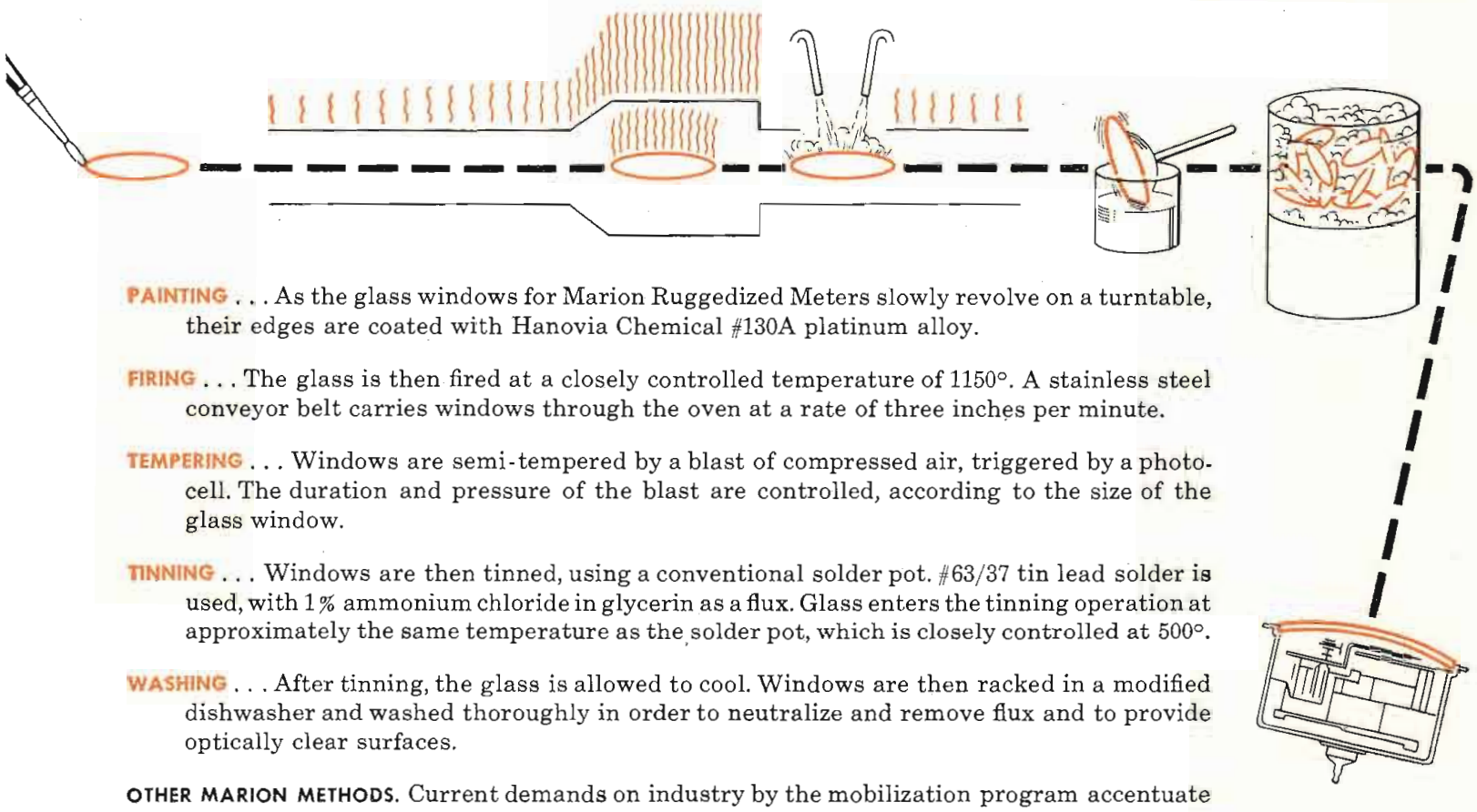
DPi

Also . . . vitamins A and E . . . distilled monoglycerides . . . more than 3500 Eastman Organic Chemicals for science and industry

marion methods

make better hermetic seals for Ruggedized instruments





PAINTING . . . As the glass windows for Marion Ruggedized Meters slowly revolve on a turntable, their edges are coated with Hanovia Chemical #130A platinum alloy.

FIRING . . . The glass is then fired at a closely controlled temperature of 1150°. A stainless steel conveyor belt carries windows through the oven at a rate of three inches per minute.

TEMPERING . . . Windows are semi-tempered by a blast of compressed air, triggered by a photo-cell. The duration and pressure of the blast are controlled, according to the size of the glass window.

TINNING . . . Windows are then tinned, using a conventional solder pot. #63/37 tin lead solder is used, with 1% ammonium chloride in glycerin as a flux. Glass enters the tinning operation at approximately the same temperature as the solder pot, which is closely controlled at 500°.

WASHING . . . After tinning, the glass is allowed to cool. Windows are then racked in a modified dishwasher and washed thoroughly in order to neutralize and remove flux and to provide optically clear surfaces.

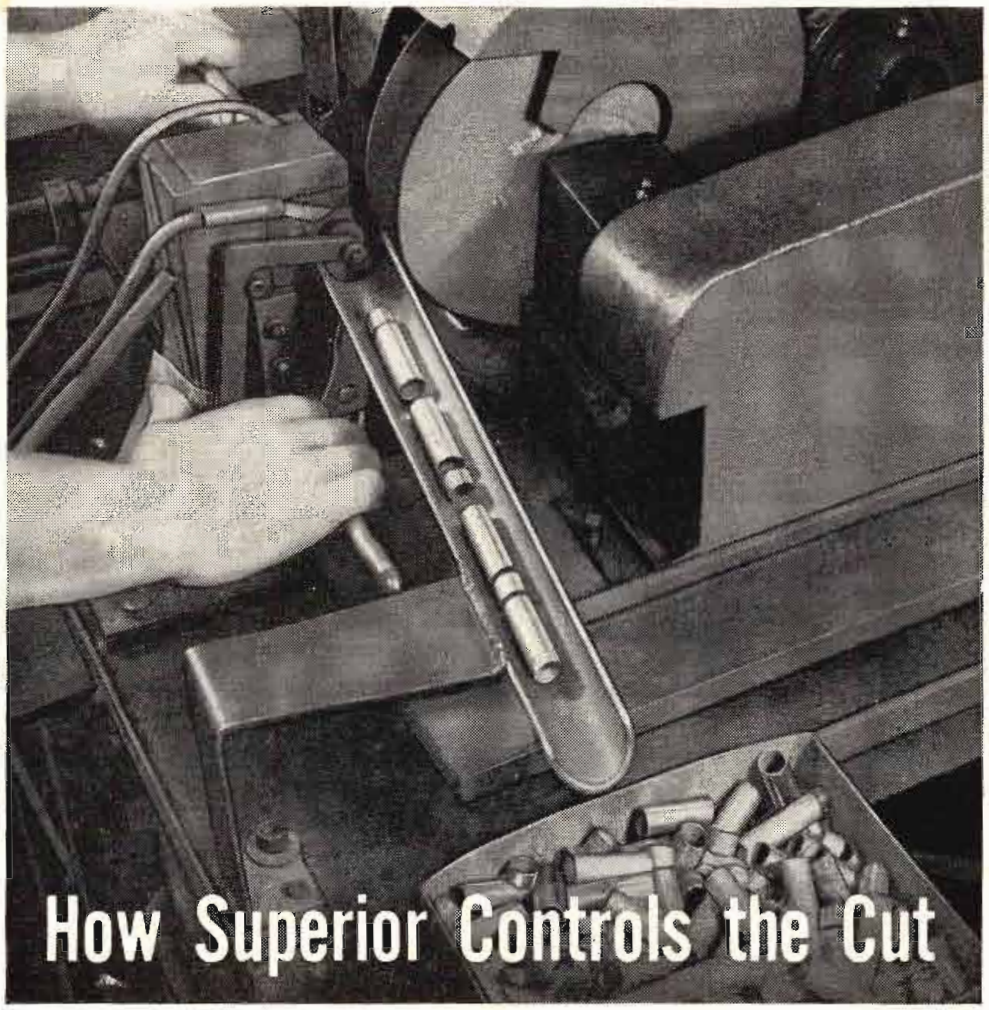
OTHER MARION METHODS. Current demands on industry by the mobilization program accentuate the importance of efficient production methods. Marion's method of metalizing and tinning glass has helped us to get better seals, to lower our costs and to increase production.

This is only one of a number of methods which Marion is presenting in the hope that some of them will help you as they have helped us. We will be pleased to furnish you with more detailed information if desired.

MARION ELECTRICAL INSTRUMENT CO., 401 CANAL ST., MANCHESTER, N. H.

marion meters

MANUFACTURERS OF MARION Ruggedized PANEL METERS



to give you better tubular parts

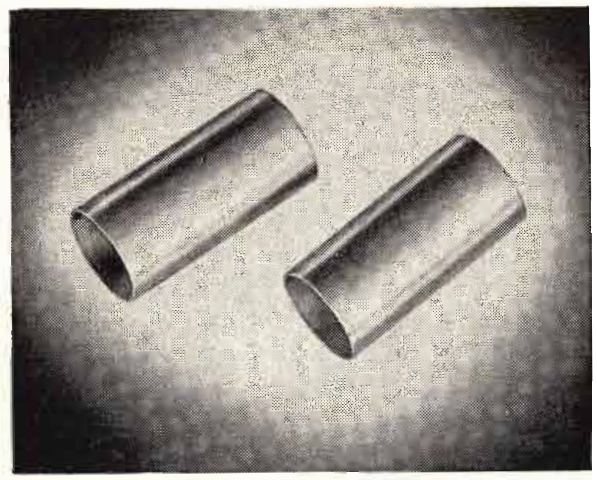
● Cutting tubing into exact lengths as the first step in the fabrication of tubular Electronic parts is a simple operation. Or is it?

Complications set in when the temper of the tubing is changed to meet customer specifications; when the tubing to be cut has a wall .010″ or thinner; when length tolerances as close as .010″ are required; when a 3° to 10° angle cut with a tolerance of ± ½° is called for; and when flattening, denting or other distortion must be prevented.

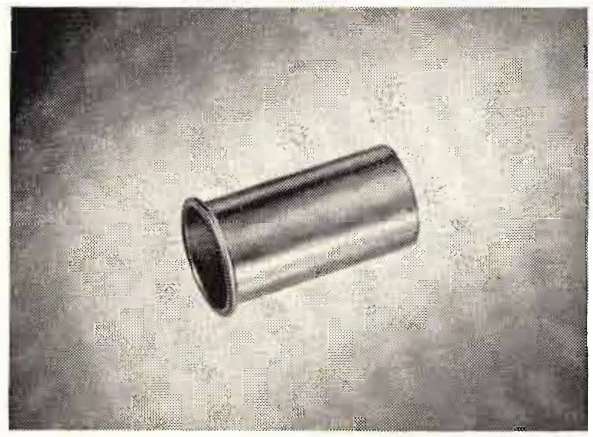
But overcoming complications in simple operations . . . and finding ways around them in other basically more difficult ones, is a specialty of the Electronics Division of Superior.

Our customers for Electronics parts have come to expect us to deliver the goods, exactly to specifications, whether standard production or complex experimental parts. What's more, they frequently ask us for suggestions about improvement on their designs and specifications . . . and they get them.

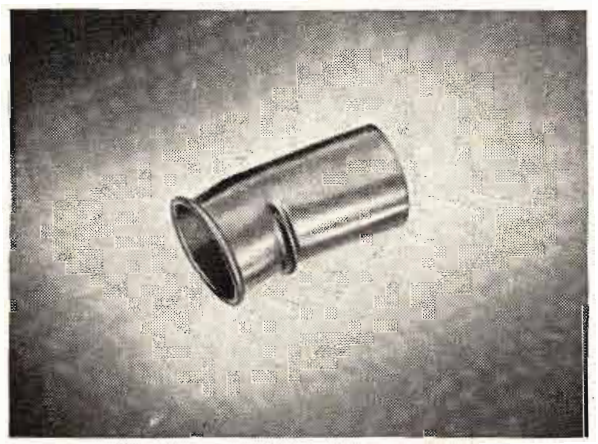
There is nothing unusual about all this—it's our job and we know how to do it. If you are a manufacturer or experimenter in the Electronics Industry and you need a tubular part that presents a problem, tell us about it. We'll probably be able to help and will gladly do so. Write The Superior Tube Company, 2021 Germantown Ave., Norristown, Pennsylvania.



Cutting and Tumbling. Cutting machines and jigs of many types and sizes are combined with extensive tumbling equipment to permit fast accurate production of quantities of parts at Superior.



Fabrication: Parts can be readily rolled at either or both ends, flared, flanged, expanded, or beaded (embossed) as required. The anode above is one of many such parts we produce at high speed and low cost.



The Finished Part. Final stage in the fabrication of the part shown above at three stages of production is a bend nicely controlled for both precise angle and freedom from other, unwanted distortion.

This Belongs in Your Reference File

. . . Send for It Today.

NICKEL ALLOYS FOR OXIDE-COATED CATHODES: This reprint describes the manufacturing of the cathode sleeve from the refining of the base metal. Includes the action of the small percentage impurities upon the vapor pressure, sublimation rate of the nickel base; also future trends of cathode materials are evaluated.

Superior

THE BIG NAME IN SMALL TUBING

All analyses .010″ to ⅝″ O.D.

Certain analyses (.035″ max. wall) Up to 1⅜″ O.D.

***SUPERIOR TUBE COMPANY** • Electronic products for export through Driver-Harris Company, Harrison, New Jersey • Harrison 6-4800*

ARE YOU DESIGNING A TRANSFORMERLESS TV CHASSIS?

Additional 15-volt Bonus in B+ Voltage now possible with new G-E Germanium Power Rectifier

● **A B+ reserve that eliminates marginal operation** under low line conditions is now available to television circuit designers. General Electric's G-10, an entirely new rectifier of the junction type, has a forward resistance of *only 3 ohms*—considerably lower than that normally encountered with other type rectifiers.

● **Life tests** conducted on typical samples indicate that a life of 10,000 hours may be expected. Our application engineers are ready to demonstrate important advantages for your consideration.

● **Military applications**—Where extremely low forward resistance and high efficiency are necessary, these rectifiers are being accepted for use in military equipment. *General Electric Company, Electronics Park, Syracuse, New York.*

Specifications

Description and Maximum Ratings
TYPE G-10

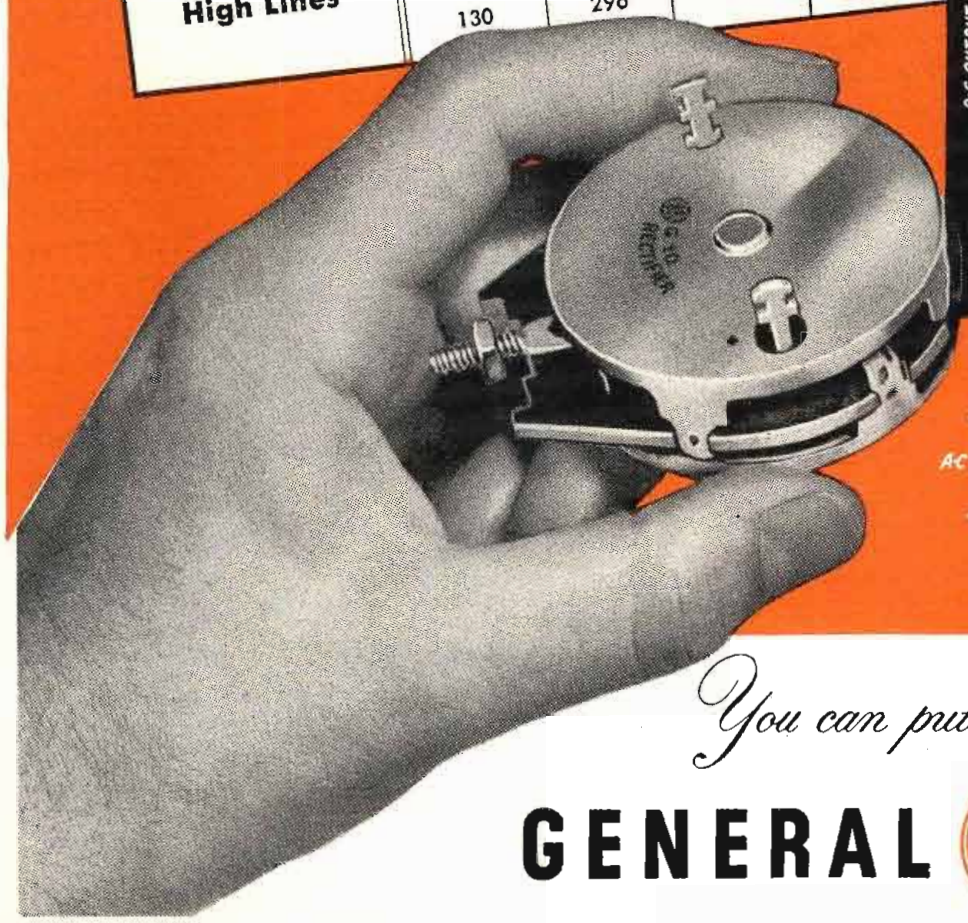
Ambient Temperature	40°C	55°C	65°C
RMS Input Voltage (Max.)	130	130	130 Volts
RMS Current (Max.)	1.2	1.2	.2 Amps
D-C Output Current (Max.)	400	350	50 Ma
D-C Surge Current (Max.)	25	20	2.5 Amps
Peak Forward Current (Max.)	3	3	.5 Amps
Peak Inverse Voltage (Max.)	400	400	400 Volts
Full Load Voltage Drop (Max.)	1.5	1.4	1.3 Volts
Operating Frequency (Max.)	50	50	50 Kc

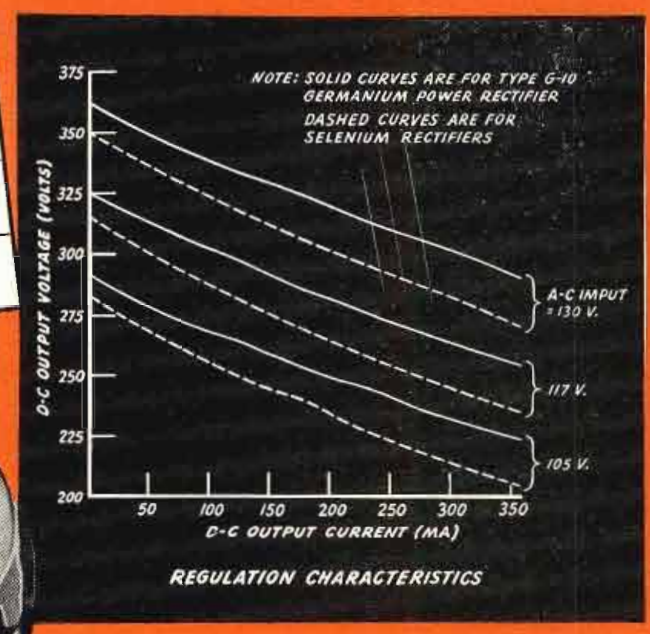
ALSO AVAILABLE

Single Rectifier Types		G-10A	G-10B	G-10C
RMS Input Voltage (Max.)	25°C	32	50	65 Volts
D-C Output Current (Max.)	25°C	200	200	200 Ma
Peak Inverse Voltage (Max.)	25°C	100	150	200 Volts

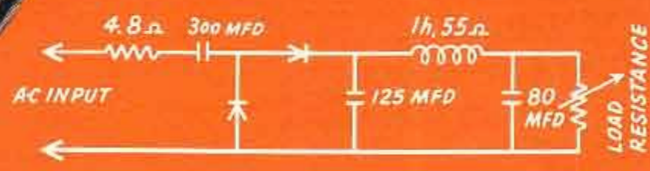
Typical B+ Voltages for Low, Nominal and High Lines

A-C Input Voltage	D-C Output Voltage $R_L = 900$	$R_L = 1000$	$R_L = 1100$
105	240	243	247
117	266	270	273
130	296	302	305





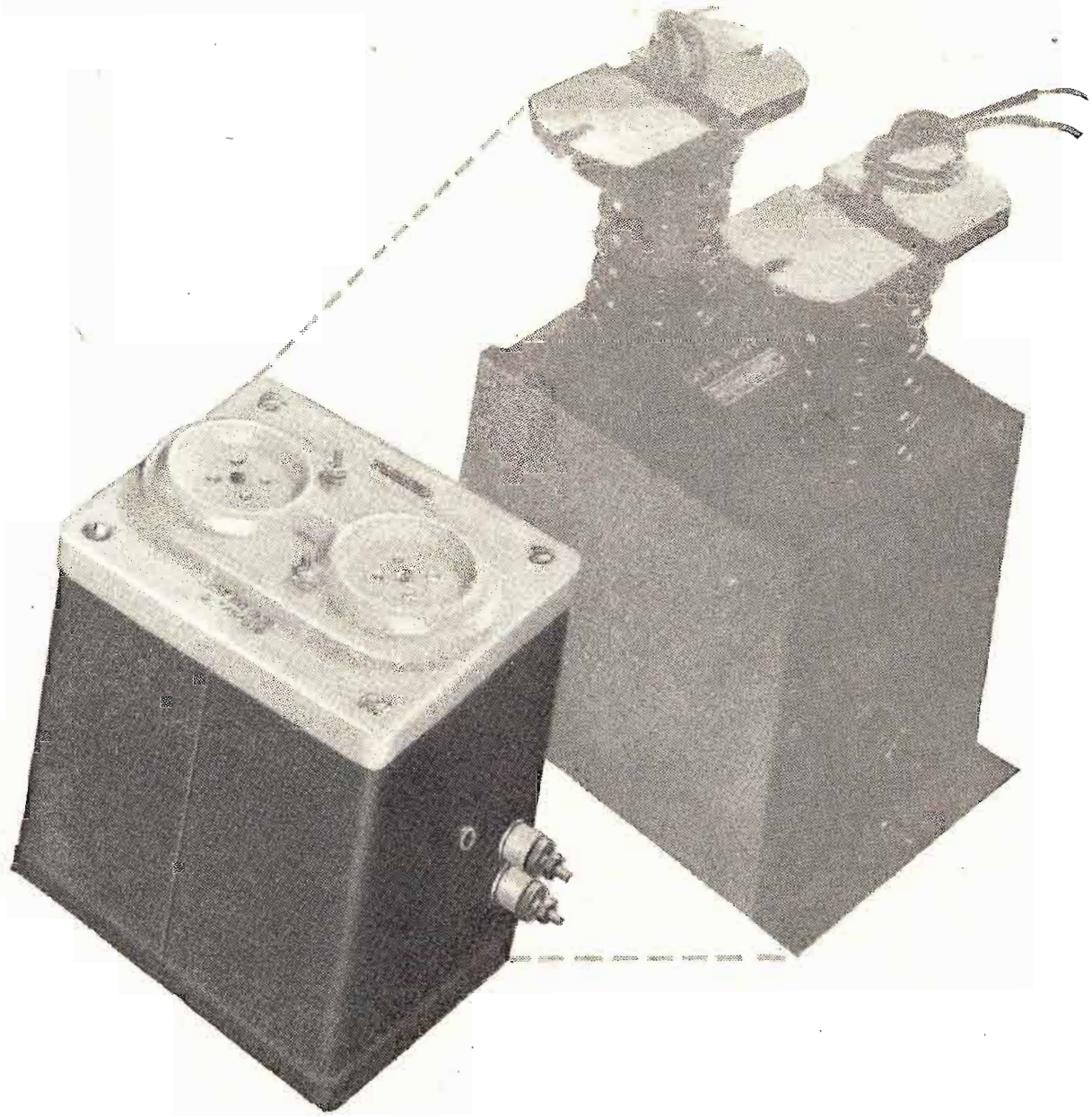
REGULATION CHARACTERISTICS



VOLTAGE DOUBLER POWER SUPPLY

You can put your confidence in—

GENERAL ELECTRIC



Making little ones out of big ones . . .

Many a design problem has been simplified by the Westinghouse ability to reduce transformer size and weight.

Here, for example, is a case where a transformer was required to work in a voltage-doubler circuit at 18,000 volts. The old model created a space problem.

First step in redesigning, Westinghouse engineers applied a smaller, lighter Hipersil® Core. That, plus improved insulation, made it possible to reduce coil size and spacing. Then a wet-process porcelain cap, with integral tube sockets, eliminated the need for stand-off insulators. The net result was an over-all reduction of 30% in both size and weight of the completed power unit . . . with a great big bonus: The saving to the equipment assembler in installation costs alone made the new design highly profitable, because it was no longer necessary to wire tube sockets.

Savings like this are available to you, too. If size, weight, performance, or quantity production have any bearing on your transformer problem, call your Westinghouse representative, or write Westinghouse Electric Corporation, Specialty Transformer Department, Sharon, Pennsylvania. J-70610

WHY SHOULD YOU BUY ALSIMAG® CERAMICS?

When you buy AlSiMag ceramics you get:

1. Engineering know-how accumulated during half a century of specialization.
2. Unexcelled production facilities.
3. The widest choice of ceramic materials available in the industry.
4. Equipment of a size and completeness that can handle YOUR job.
5. Research which has constantly improved known ceramics and has led in the development of new special-purpose ceramics.
6. The highest quality custom made ceramics, delivered when and as promised.

One of the most important questions is: "*Can they deliver on time and according to promise?*"

American Lava Corporation has equipment of a size and completeness which is not matched in the industry. A book showing about 200 pictures of equipment producing AlSiMag technical ceramics has just been published. This book will give you a good idea of the size, versatility and skill of our organization. We'll be glad to send you a copy if you'll request our booklet "50 Years of Progress." As you look through it we believe you'll agree that we have the equipment and know-how to handle YOUR job.

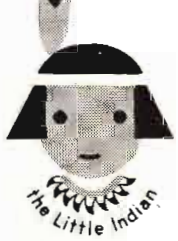
50TH YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENNESSEE

OFFICES: METROPOLITAN AREA: 671 Broad St., Newark, N. J., Mitchell 2-8159 • PHILADELPHIA, 1649 North Broad St., Stevenson 4-2823
SOUTHWEST: John A. Green Co., 6815 Oriole Drive, Dallas 9, Dixon 9918 • NEW ENGLAND, 1374 Massachusetts Ave., Cambridge, Mass., Kirkland 7-4498
LOS ANGELES, 232 South Hill St., Mutual 9076 • CHICAGO, 228 North LaSalle St., Central 6-1721 • ST. LOUIS, 1123 Washington Ave., Garfield 4959

Don't Scout Around for Buttons (Capacitors that is...)!



THE LITTLE INDIAN SAYS-

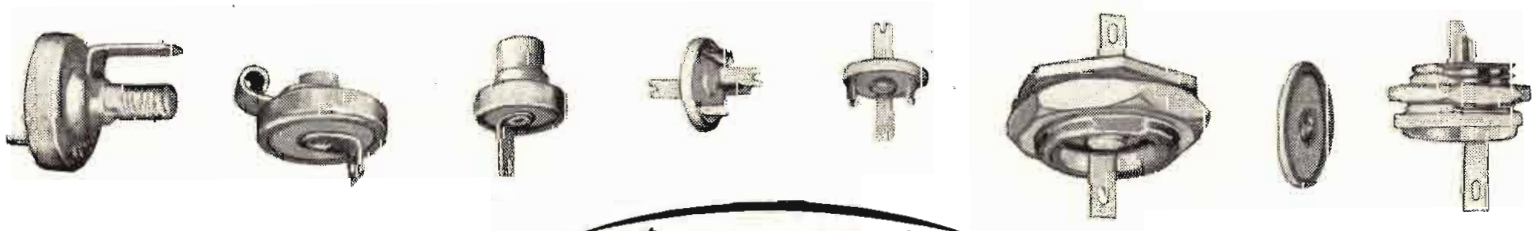
Sangamo can furnish

SILVERED MICA BUTTON CAPACITORS for any requirement

You can count on Sangamo whenever you need small sized, light weight button capacitors that are electrically and mechanically stable.

Sangamo Silvered Mica Button Capacitors meet all requirements of components for V. H. F. and U. H. F. applications. They have extremely low series inductance—ideal for application in high frequency circuits. Button capacitors with temperature coefficients and drift characteristics up to and including "E" of JAN-C-5 specification can be furnished. These capacitors are encased in silver plated, corrosion resistant brass. The case serves both as a shield and as the low potential terminal.

Sangamo Buttons are stable over a normal operating range from minus 50° C to plus 85° C. Higher operating temperature requirements will be considered and may be negotiated with our engineering department.



Those who know ...*choose Sangamo*

The SANGAMO Tribe

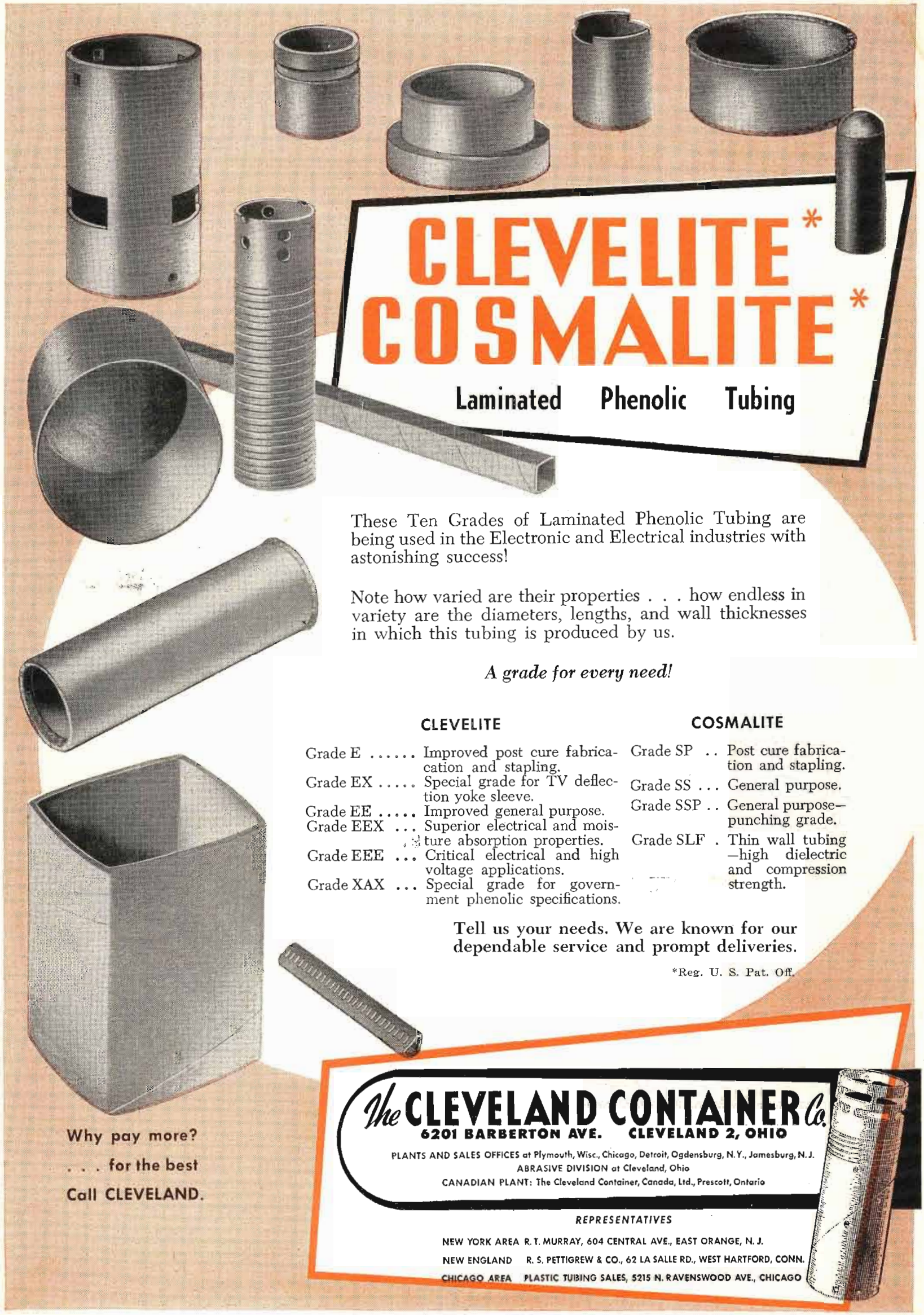
PAPER · MICA · SILVER · ELECTROLYTIC CAPACITORS

SANGAMO ELECTRIC COMPANY

MARION, ILLINOIS

SC52-4

IN CANADA: SANGAMO COMPANY LIMITED, LEASIDE, ONTARIO



CLEVELITE* COSMALITE*

Laminated Phenolic Tubing

These Ten Grades of Laminated Phenolic Tubing are being used in the Electronic and Electrical industries with astonishing success!

Note how varied are their properties . . . how endless in variety are the diameters, lengths, and wall thicknesses in which this tubing is produced by us.

A grade for every need!

CLEVELITE		COSMALITE	
Grade E	Improved post cure fabrication and stapling.	Grade SP ..	Post cure fabrication and stapling.
Grade EX	Special grade for TV deflection yoke sleeve.	Grade SS ...	General purpose.
Grade EE	Improved general purpose.	Grade SSP ..	General purpose—punching grade.
Grade EEX ...	Superior electrical and moisture absorption properties.	Grade SLF .	Thin wall tubing—high dielectric and compression strength.
Grade EEE ...	Critical electrical and high voltage applications.		
Grade XAX ...	Special grade for government phenolic specifications.		

Tell us your needs. We are known for our dependable service and prompt deliveries.

*Reg. U. S. Pat. Off.

Why pay more?
. . . for the best
Call CLEVELAND.

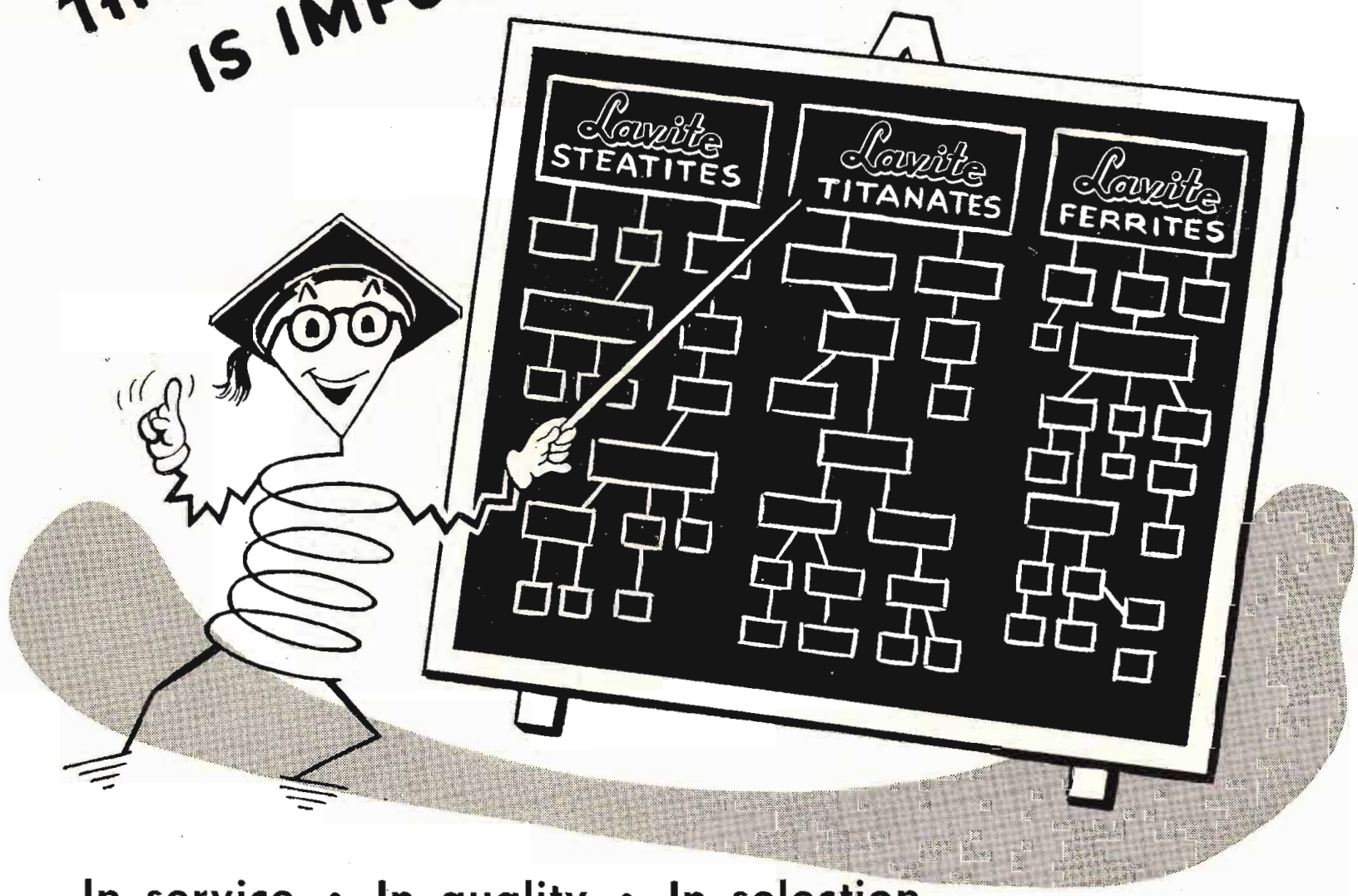
The CLEVELAND CONTAINER Co.
6201 BARBERTON AVE. CLEVELAND 2, OHIO

PLANTS AND SALES OFFICES at Plymouth, Wisc., Chicago, Detroit, Ogdensburg, N.Y., Jamesburg, N.J.
ABRASIVE DIVISION at Cleveland, Ohio
CANADIAN PLANT: The Cleveland Container, Canada, Ltd., Prescott, Ontario

REPRESENTATIVES

NEW YORK AREA R. T. MURRAY, 604 CENTRAL AVE., EAST ORANGE, N. J.
NEW ENGLAND R. S. PETTIGREW & CO., 62 LA SALLE RD., WEST HARTFORD, CONN.
CHICAGO AREA PLASTIC TUBING SALES, 5215 N. RAVENSWOOD AVE., CHICAGO

THIS 75 YEARS OF 'KNOW-HOW' IS IMPORTANT TO YOU!



In service • In quality • In selection

In service — 75 years of "Know-How" can prove unbeatable when it comes to satisfying your requirements promptly and accurately.

In quality — 75 years of "Know-How" packs a lot of accomplishments — in research, development and manufacture — to provide a dependable standard in all Lavite Ceramics equal to your most stringent specifications.

In selection — 75 years of "Know-How" has produced three main groups of technical ceramics (Lavite Steatites, Lavite Ferrites and Lavite Titanates), each of which offers unlimited selection in combination of characteristics.

In short — I invite you to profit by these 75 years of Ceramic "Know-How" on both defense and industrial needs. Steward's engineers will be happy to work with and for you — send them your specifications!

Ask for general characteristic data on all Lavite Technical Ceramics.

Remember —
There are non-critical Ferrites for non-critical uses.

D. M. STEWARD MANUFACTURING CO.
3608 Jerome Ave. Chattanooga, Tennessee

Sales Offices in Principal Cities

RAYTHEON

Ready for YOU now!

. . . this reliable source of Reliable Tubes

CK 5654
the high Gm RF pentode

CK 5686
the all purpose power output tube, good from audio to 150 mc.

CK 5725
the gating or mixer pentode (dual control grids)

CK 5726
the high perveance twin diode

CK 5749
the remote-cutoff RF amplifier pentode

CK 5751
the high Mu dual triode

CK 5814
the medium Mu dual triode

This great, new plant at Quincy, Mass. — bringing the total Receiving Tube Division manufacturing area to 400,000 square feet — is devoted exclusively to the production of Raytheon quality tubes. It is now operating full blast to meet, *and meet promptly,* the tremendous demand for Raytheon Reliable Miniatures.*

***RAYTHEON WAS THE FIRST...**
to develop ARINC Reliable Tubes and produce them in quantity. CK5654, the first ARINC type, was initially shipped in October 1947.

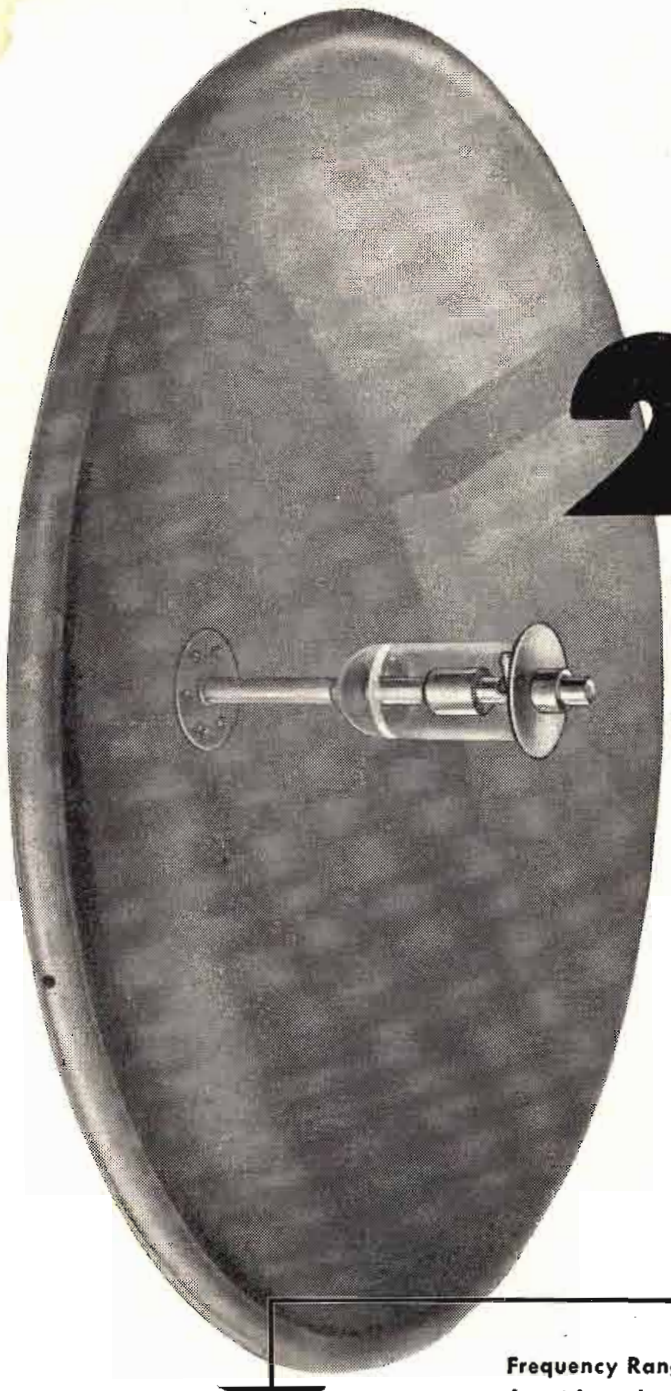
Close to 400 Raytheon distributors are at your service on these tubes. Application information is yours for the asking from Raytheon at Newton, Chicago, Los Angeles.

RAYTHEON ®

RAYTHEON MANUFACTURING COMPANY
Receiving Tube Division
Newton, Mass., Chicago, Ill., Atlanta, Ga., Los Angeles, Calif.

Excellence in Electronics

RELIABLE SUBMINIATURE AND MINIATURE TUBES · GERMANIUM DIODES AND TRANSISTORS · RADIAC TUBES · RECEIVING AND PICTURE TUBES · MICROWAVE TUBES



TOP PERFORMANCE 2000 MCS

and every other microwave frequency

WORKSHOP PARABOLIC ANTENNAS are now recognized as the *top performers* for all microwave frequencies. This is the result of years of specialization on all types of high-frequency antennas in laboratories equipped with the most up-to-date research and test equipment in the industry. Normally, we can meet your requirements with our standard equipment, but for special applications, reflectors can be supplied in a wide range of sizes and focal lengths.

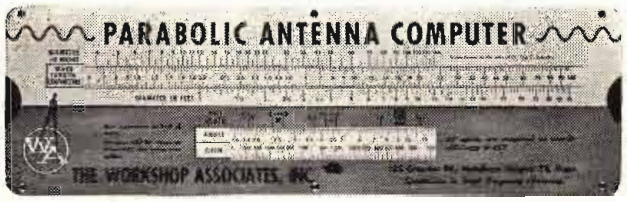
Model 2000

Frequency Range	1990 to 2110 Mcs.			
Input Impedance	52 ohms nominal			
VSWR	1.25 to 1 or better over band			
Power Rating	1 kw. continuous			
Polarization	Either vertical or horizontal available at time of installation.			
Reflector Size	48″	72″	96″	120″
Gain (db, approx., over isotropic radiator)	27	30	32	34.5
Half Power Angles (H plane)	9.2°	5.75°	4.25°	3.25°
(E plane)	10.28°	6.4°	4.55°	3.65°
Side Lobes	20 db down or better			
Input Connection	Weatherproof type "N" fitting. Special fittings are available for RG-8/U, RG-17/U or ⅞″ copper line. Specify when ordering.			
Dish Heaters	Available for all models. Capacities range from 400 to 4000 watts.			

OTHER STANDARD MODELS

MODEL NO.	FREQUENCY (MCS.)	GAIN* (DB.)	HALF POWER ANGLE* E Plane	H Plane
940	920-940	19.0-28.0	19.75°-7.8°	17.75°-6.9°
7000	5925-7425	36.0-43.0	3.24°-1.36°	2.86°-1.21°

*Gain and Half Power Angles are dependent on size and frequency of parabolas, — 4, 6, 8 or 10 foot diamater.



FREE SLIDE RULE—This pocket slide rule quickly computes diameter, wavelength, angle and gain for parabolic antennas. Reverse side carries FCC frequency allocations, conversion tables and other data. Write for your copy.

Write for Parabolic Antenna Catalog

The WORKSHOP ASSOCIATES

DIVISION OF THE GABRIEL COMPANY

Specialists in High-Frequency Antennas

135 Crescent Road, Needham Heights 94, Massachusetts

Men who design, engineer and buy America's products rely on..and use..National Laminated Plastics because..

"In long range planning at National, emphasis is placed on engineering research. Designed to benefit National's customers and the entire industry as well, the operation breaks down into three broad divisions. *First*, testing materials against our standards and customers' specifications. *Second*, developing new products to meet specific customer requirements. *Third*, improving present manufacturing methods. In short we at National feel that engineering research provides our eyes and ears for the future."

John K. Johnston
Vice President
National Vulcanized Fibre Co.

Circuit Breaker Bushing Sleuth

George Holton, electrical scientist in National's lab, is testing a Phenolite circuit breaker bushing for dissipation factor at 60 cycles. Tests of this character are constantly carried on for production control and in the development of new products.

National Laminated Plastics nationally known—nationally accepted

NATIONAL VULCANIZED FIBRE

A tough horn-like material with high dielectric and mechanical strength. Excellent machinability and forming qualities, great resistance to wear and abrasion, long life, lightweight. Sheets, Rods, Tubes, Special Shapes.

PHENOLITE Laminated PLASTIC

Phenolite possesses an unusual combination of properties—a good electrical insulator, great mechanical strength, high resistance to moisture; ready machinability, lightweight. Sheets, Rods, Tubes, Special Shapes.

Just published! National Laminated Plastics Handbook.
Write for copy. Your company letterhead please.

National Vulcanized Fibre Company

Wilmington Delaware

Offices in *Principal Cities*

Since 1873

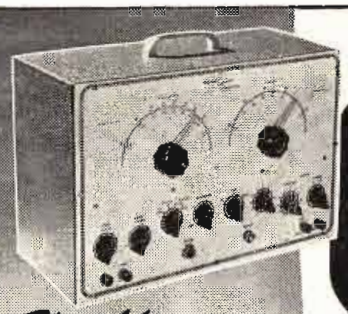
Hardness gets its full measure

Important in the production control and development of Phenolite and National Vulcanized Fibre is the degree of punchability of stock for meeting particular customers' specifications. This laboratory research operation with the Rockwell Hardness Tester is shown above.

Phenolite Varsity 1952

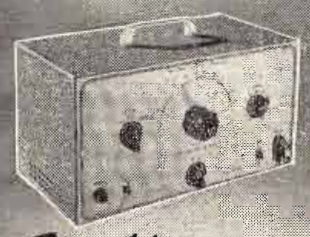
Here's the team of skilled scientists, captained by Gerald H. Mains, who occupy key positions at the Phenolite laboratory. They're evidence of National's continuing research program. Their combined know-how is quickly available to National's customers.

New 1952 HEATHKITS

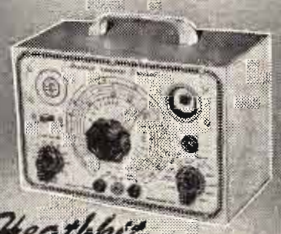


Heathkit TELEVISION GEN. KIT $39.50

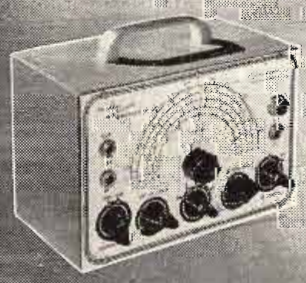
Heathkit ELECTRONIC SWITCH KIT $19.50



Heathkit AUDIO GEN. KIT $34.50



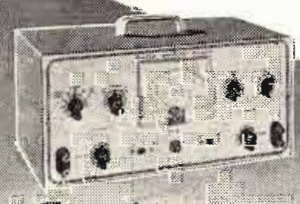
Heathkit CONDENSER CHECKER KIT $19.50



Heathkit R. F. SIGNAL GEN. KIT $19.50

Heathkit A.C. VOLTMETER KIT $29.50

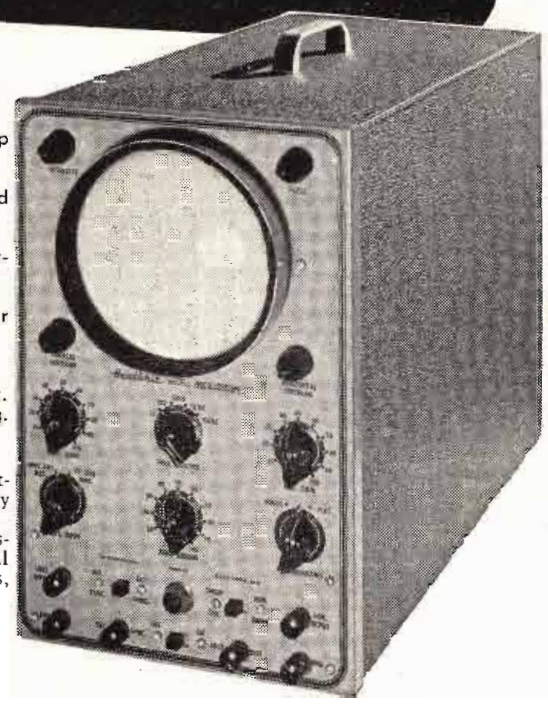
Heathkit SQUARE WAVE GEN. KIT $29.50



Heathkit INTERMODULATION ANALYZER KIT $39.50

Heathkit AUDIO FREQ. METER KIT $34.50

Heathkit 5" OSCILLOSCOPE KIT



- New "spot shape" control for spot adjustment — to give really sharp focusing.
- A total of ten tubes including CR tube and five miniatures.
- Cascaded vertical amplifiers followed by phose splitter and balanced push-pull deflection amplifiers.
- Greatly reduced retrace time.
- Step attenuated — frequency compensated — cathode follower vertical input.
- Low impedance vertical gain control for minimum distortion.
- New mounting of phase splitter and deflection amplifier tubes near
- CR tube base.
- Greatly simplified wiring layout.
- Increased frequency response — useful to 5 MC.
- Tremendous sensitivity .03 RMS per inch Vertical .6V RMS per inch Hor.
- Dual control in vernier sweep frequency circuit — smoother acting.
- Positive or negative peak internal synchronization.
- Multivibrator type Wide Range Sweep Generator.

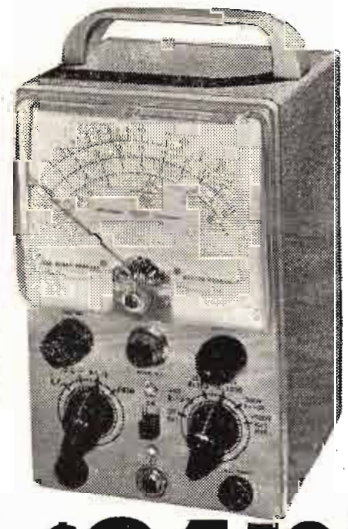
A brand new 1952 Heathkit Oscilloscope Kit with a multitude of outstanding features and really excellent performance. A scope you'll truly like and certainly want to own.

The kit is complete with all parts including all tubes, power transformer, punched and formed chassis, etc. Detailed instruction manual makes assembly simple and clear — contains step-by-step instructions, pictorials, diagrams, schematic, circuit description and uses of scope. A truly outstanding value.

$43.50

MODEL 0-7
SHIPPING WT. 24 LBS.

Heathkit VACUUM TUBE VOLTMETER KIT



- New styling — formd case for beauty.
- New truly compact size — Cabinet 4⅛" deep x 4-1/16" wide x 7⅜" high.
- Quality Simpson 200 microamp meter.
- New ohms battery holding clamp and spring clip — assurance of good electrical contact.
- Highest quality precision resistors in multiplier circuit.
- Calibrates on both AC and DC for maximum accuracy.
- Terrific coverage — Reads from ½V to 1000V AC, ½V to 1000V DC, and .1 to over 1 billion ohms resistance.
- Large, clearly marked meter scales indicate ohms, AC Volts, DC Volts, and DB — has zero set mark for FM alignment.
- New styling presents attractive and professional appearance.

The 1952 Model Heathkit Vacuum Tube Voltmeter! Newly designed cabinet combines style and beauty with compactness. Greatly reduced size to occupy a minimum of space on your work-bench. Covers a tremendous range of measurements and is easy to use. Uses only quality components including 1% precision resistors in multiplier circuit for greatest accuracy, Simpson 200 microamp meter with easy to read scales for fast and sure readings.

All parts come right with kit, and complete instruction manual makes assembly a cinch.

$24.50

MODEL V-5
SHIPPING WT. 5 LBS.

YOU SAVE BY ORDERING DIRECT FROM MANUFACTURER

EXPORT AGENT
ROCKE INTERNATIONAL CORP.
13 E. 40th ST.
NEW YORK CITY (16)
CABLE: ARLAB-N.Y.

The HEATH COMPANY
. . . BENTON HARBOR 24, MICHIGAN

Basic Slotted Line Equipment

for measurements of **POWER ☆ VOLTAGE**

IMPEDANCE ☆ ATTENUATION ☆ STANDING-WAVE RATIO

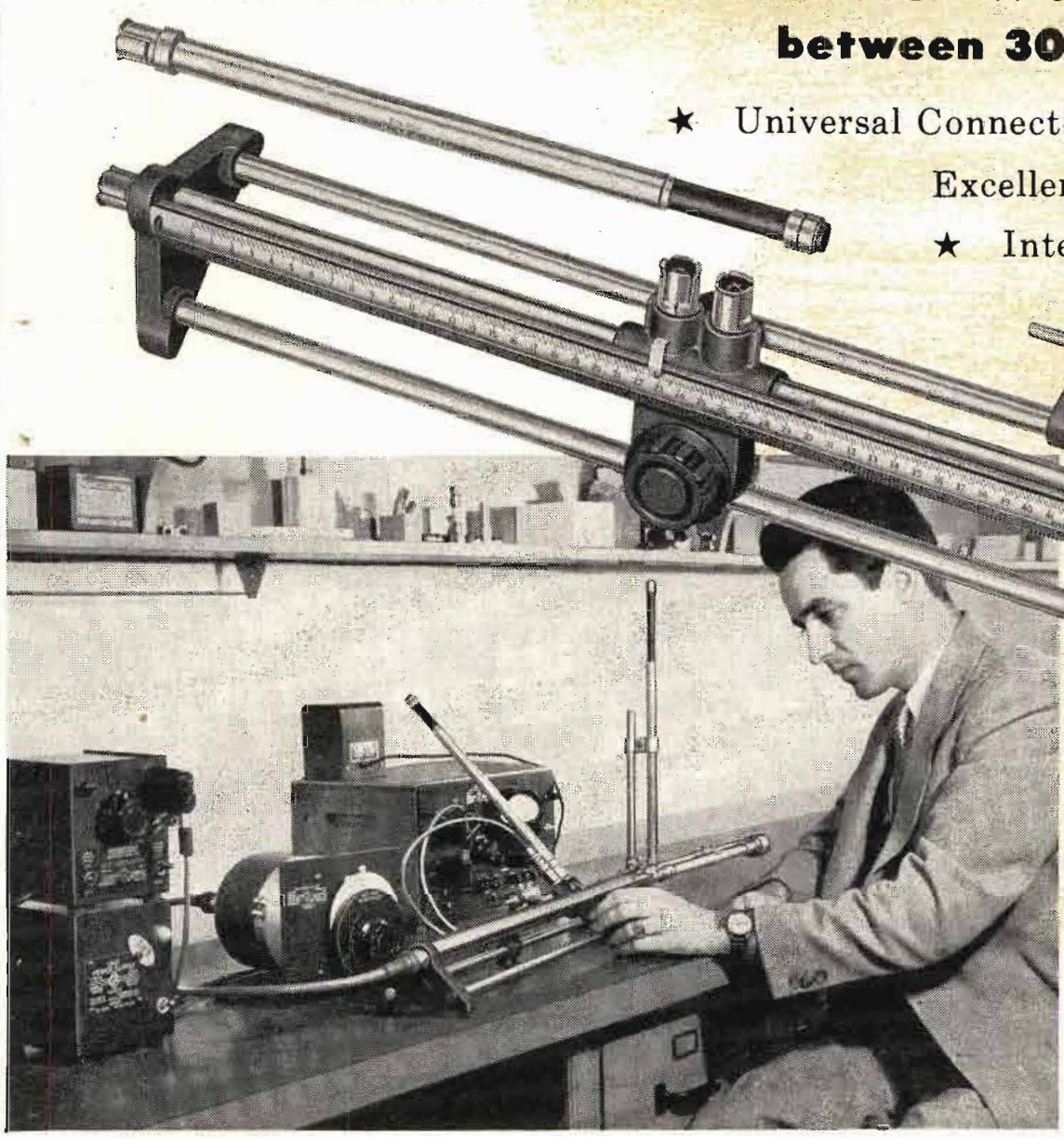
between 300 and 5,000 Mc

★ Universal Connectors Eliminate Male-Female Adaptors

Excellent Electrical Characteristics ★

★ Interchangeable Units ★ Inexpensive

Ideal for the UHF T-V Band



FOR a relatively small investment, any laboratory can be equipped with slotted line measuring equipment with which a considerable number of impedance and standing-wave measurements can be made. The Type 874-EK Basic Coaxial Kit is offered as a complete package for this purpose.

The G-R Type 874-LB Slotted Line is one of the important basic measuring instruments for use at ultra-high frequencies. With it the standing wave pattern of the field in a coaxial transmission line can be determined quickly, simply and accurately.

The G-R Slotted Line is a 50-ohm, air dielectric, coaxial transmission line with a longitudinal slot in the outer conductor. The inner conductor is supported at its ends only, by two Type 874 Connectors minimizing reflections and discontinuities caused by dielectric supports.

A probe, mounted on a carriage with a 50 cm maximum travel, samples the field within the line. A built-in crystal rectifier is used as a detector of the r-f voltage induced in the probe. The rectifier is tuned to the operating frequency by means of adjustable stubs. Terminals are provided so that a receiver can also be used as a detector.

A large number of associated elements and inexpensive auxiliary units are available. These include Unit Oscillators, Unit Power Supplies, Amplifiers and Detectors, Mixer Rectifiers, Voltmeter Rectifiers, Bolometer Bridge, Voltmeter Indicator, Attenuators, Line Elements, Filters, Adaptors, etc.

Type 874 EK BASIC COAXIAL KIT $342.25

Type	*Cost*
One 874-LB *Slotted Line*	$220.00
One 874-D20 *Adjustable Stub (20 cm)*	10.50
One 874-D50 " " *(50 cm)*	12.00
25 ft. 874-A2 *Polyethylene Cable*	6.75
Two 874-B *Basic Connectors*	2.50
Two 874-C *Cable Connectors*	4.00
Two 874-C8 *Cable Connectors*	4.00
One 874-LA *Adjustable Line*	15.00
Two 874-P *Panel Connectors*	5.00
One 874-Q1 *Adaptor to Type N*	4.50
Two 874-R20 *Patch Cords*	12.00
One 274-NF *Patch Cord*	2.50
One 874-Q6 *Adaptor*	2.00
One 274-NE *Shielded Connector*	5.50
One 874-T *Tee*	7.50
One 874-WM *Matched 50-Ohm Termination*	10.50
One 874-WN *Short-Circuit Termination*	3.50
One 874-WO *Open-Circuit Termination*	2.00
One 874-Z *Adjustable Stand*	12.50

Complete Kit $342.25

GENERAL RADIO Company

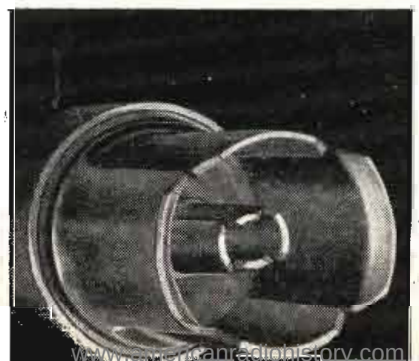
275 Massachusetts Ave. Cambridge 39, Mass.

90 West St. **NEW YORK 6** *920 S. Michigan Ave.* **CHICAGO 5**

1000 N. Seward St. **LOS ANGELES 38**

For a 16-page Booklet describing the Complete Line, Fill-In the Coupon below

The versatility of the entire line of G-R u-h-f measuring equipment is based on the Type 874 Connector with which all coaxial elements are equipped. These universal male-female connectors are designed for simple, quick, plug-in connect and disconnect. Each will plug into any other. Their electrical and shielding characteristics are excellent. Conversion adaptors for use with other types of terminals are available.



GENERAL RADIO COMPANY, 534
275 Massachusetts Ave., Cambridge 39, Mass.

Send me the 16-Page Booklet describing the complete lin of G-R slotted line measuring equipment.

Name .....

Address .....
STREET

.....

TELE-TECH
RADIO-TELEVISION-ELECTRONIC INDUSTRIES
O. H. CALDWELL, Editorial Director ★ M. CLEMENTS, Publisher ★ 480 Lexington Ave., New York (17) N. Y.

NARTB's Engineering Department

Achievements Include: Annual BC Engineers' Conferences; TV Construction-Cost Surveys; Recording and Reproducing Standards; Engineering Handbook; Audio Proof of Performance; Sample Transmitter Logs, and Survey of Aeronautical Hazards and Towers

In 1922 a group of radio-station owners conceived the idea of an association of broadcasters. Thus the old National Association of Broadcasters was born, with Commander Eugene F. McDonald, now president of Zenith Radio, as its first president. Although primarily concerned with the management side of radio, the need for a complete service to the broadcaster was recognized in the 1938 reorganization, and an engineering department was added.

In the fourteen years since the engineering department was formed, the NAB changed its name to National Association of Radio & Television Broadcasters. Creation of the engineering department brought forth fruit in the form of much needed standardization of many operations and performances in the broadcast engineer's field. The current Engineers' Handbook, the fourth edition, is a monument to the work of Director of Engineering, Neal McNaughton, and his department.

Promoting Interests of BC Engineers

The current Broadcast Engineers' Conference at the Annual Convention (Chicago, Hotel Hilton, March 31 to April 2) will be the sixth such annual engineering event. With intense interest generated by the imminence of the TV thaw and heightening activity in UHF-TV, last year's attendance of 500 engineers listening to 21 technical papers, will doubtless be eclipsed. Considering that the broadcast engineer is so often underpaid, and nearly always discounted as an important entity by radio-station owners, the efforts of the National Association of Radio and Television Broadcasters in promoting this service for the industry's engineers are being well rewarded.

In all, 1411 radio stations now have membership in the NARTB. This total is made up as follows: 960 AM stations; 365 FM stations; and 86 TV stations. These figures are interesting in that about half the active FM stations, about a third of the AM stations, and over *two-thirds* of the TV stations support the NARTB. The TV figures are especially significant and reflect the support which TV-station owners give the national organization in its fight to get the freeze lifted and TV allocations increased. It is a sign of the times that the TV owners are now supporting their organization in their fight for "lebensraum," whereas only a decade ago it was the AM operators who were ardent supporters.

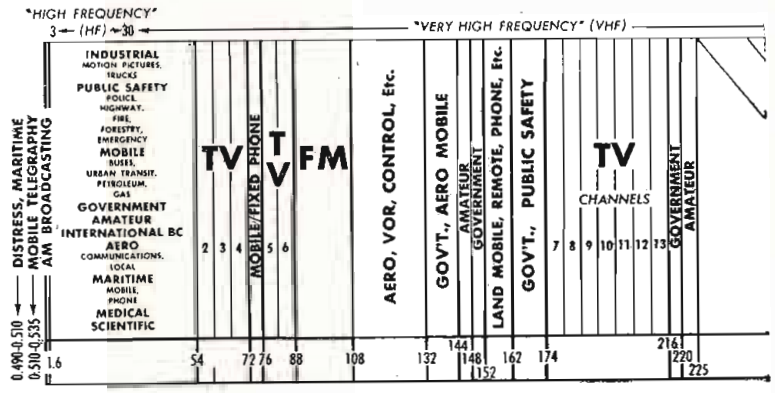
Participation in Industry Problems

Representing the interests of every broadcaster, whether member or not, the Engineering Department participates in FCC, NARBA, CCIR (International Radio Consultative Committee) meetings and all domestic hearings concerning frequency allocations and broadcast rules. While not providing consulting service for individual stations or problems, the department handles those which appear to affect its members as a whole—even including flying the Director of Engineering to Hawaii as a witness in a tax case affecting all broadcasters!

Seven other NARTB departments, besides engineering, exist to serve the broadcaster; these are the Audio—including FM and AM; Video; Employer-Employee Relations; Government Relations; Legal; Public Relations; and Research Departments. The latest, and probably most important, promulgation by the NARTB is its TV Code. Issued in an effort to save television from tripping over "low necklines," both real and figurative, the Code and Seal of the NARTB may be the deciding factor in avoiding future *legal* FCC censorship.

RADARSCOPE

Revealing Important Advances Throughout the Spectrum of Radio, TV and Tele Communications



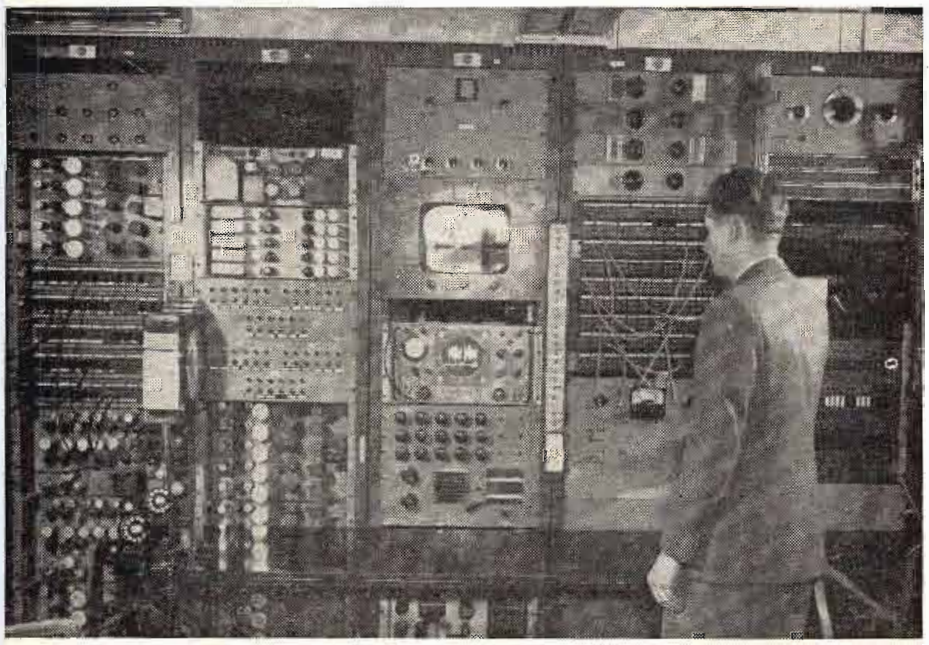
MANUFACTURING

MATERIALS AMPLE for 1952 TV expansion, declares the RTMA Television Committee's task force assigned to study the effect on materials and manpower caused by the lifting of the "freeze." The task force concludes that:

1. The requirements for TV transmitters, amplifiers, cameras, studio equipment and antennas can be met from present inventories of equipment and the current rate of material allocations to manufacturers of this equipment.
2. The requirements for construction materials for existing structures to amounts which can be buildings and towers can be reduced by utilizing provided under self-certification NPA regulations.
3. There will be an increased demand for TV receivers which may not be completely satisfied by the industry's programmed production. However, a continuation of first quarter NPA allotments of critical materials will permit extension of TV service to more people in more areas.

TELEVISION

TV WITHOUT CRT is the long range object of several research projects presently being carried out. The high cost, large bulk, limited practical size, and relative fragility of picture tubes are lending impetus to the search for a system which will overcome these drawbacks. Of particular interest to economy-minded engineers are the savings made possible by substituting a simple viewing system for the elaborate equipment necessary for theater TV and other large audience displays. One method to eliminate the CRT considers the use of a single light source which scans the picture area by means of a synchronized shutter or rotating prism arrangement. The selected beam of light passes through a medium with variable light transmission characteristics, and is projected on a movie screen. A second system under investigation has a two-planar crossed-wire grid arrangement incorporated in the screen itself. Each wire junction represents a picture element, and when a potential is selectively impressed across the junction chosen by the electronic scanning system, a phosphor or gas emits light with an intensity proportional to the magnitude of the potential. With some modifications, either of the two systems can be adapted to color TV, still maintaining the almost unlimited size of its presentation. However, let us not hurry to convert our conventional picture tubes to fish bowls and flower vases—it may be several years before the myriad of obstacles to a workable system can be overcome and a practical CRT-less viewing arrangement realized.



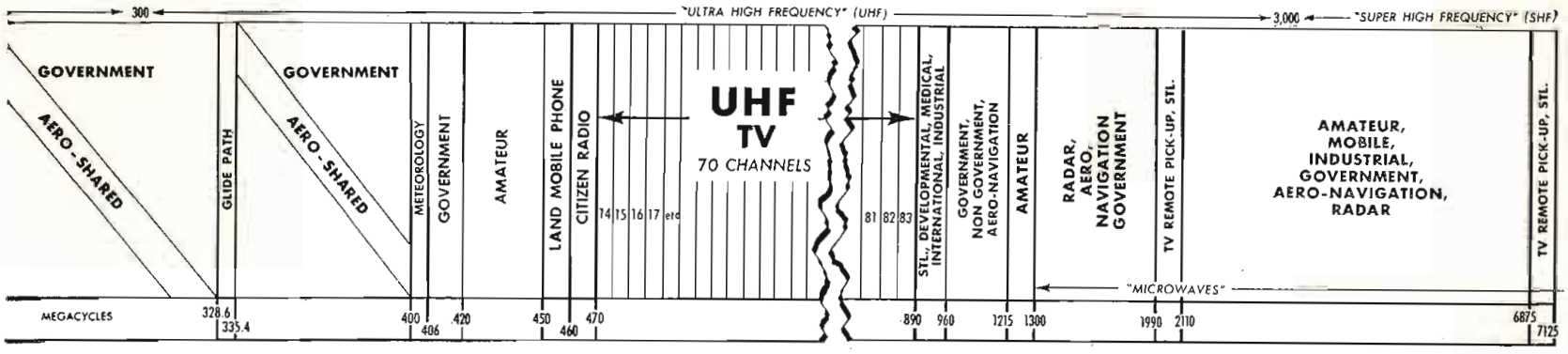
Equipment for checking television transmission, employed by American Broadcasting Company in conjunction with master control installation shown on our front cover. The five racks, left to right, contain: 1) Video patch panels and distribution amplifier, 2) Circuits for feeding film studio camera outputs simultaneously to outlying studio, 3) Grey scale generator, pulse cross monitor for examining sync pulses, and waveform oscilloscope, 4) Audio distribution panel, and 5) Private telephone line connections.

AVIATION

INTERNATIONAL AVIATION will receive increased attention this year,—particularly the South American and South Atlantic routes and areas. ILS and GCA installations will be added in many regions and the US manufacturer will find his sales restricted only by material shortages. In particular, high-altitude navigation equipment such as radiosondes for use in charting winds at 40,000 feet and above, to provide reliable information for the new high-flying aircraft will be demanded of designers. All phases of airborne electronics will shortly see an expansion similar to that experienced around the end of World War II.

RADIO BEACONS

"MOPAT" is short for a new master-oscillator, power-amplifier transmitter which is extending the reach of airway radio beacons. With airplane speeds rising, the 200-mile range of the previous 6-kw transmitter is not enough. A pilot runs out of range of a beacon too quickly. With 16 kw delivered by Mopat the beacon can be picked up by the pilot for bearings 400 miles away. Mopat is a crystal-controlled pulse transmitter operating at 1000 megacycles. It makes use of the recently developed high-power klystron tubes, which are an outgrowth of radar work.



AUDIO

FLAT RESPONSE in audio amplifiers and sound reproduction equipment does not necessarily produce the best subjective hearing reaction. This growing trend of thought in the industry is based upon the observation that at high sound intensity levels which result in discomforting listening fatigue, the ear tends to shift its response from the easily overloaded and sensitive mid-range (about 800-3500 cps) by hearing low frequencies lower and high frequencies higher. Furthermore, much of the speech information is contained in the high and low frequencies. Consequently, greater listening comfort may be induced by attenuating the mid-range about 2 VU instead of providing a flat response throughout the audible range.

INSTRUMENTATION

ELECTROLUMINESCENT PHOSPHORS will find numerous applications in the next few years in self-luminous instrument dials, complex circuit failure warning systems, control board indicators, and glow lamps or tubes formed in the shape of flat plates. Unlike the phosphors used in fluorescent lamps and cathode-ray tubes, these types convert electrical energy directly into light without the intermediate action of electron or ion impingement. The electroluminescent powder is supported in a dielectric medium between two plates of a capacitor, one of which is transparent. When a potential is applied to the capacitor plates, the phosphor is excited and light is emitted. Brightness of the light emission is determined by the intensity and frequency of the electric field. (See also TELE-TECH, July 1951, p. 62)

COMPUTERS

IT USED TO BE that the mathematics defining many "effects" noted in research laboratories were developed long after the practical experiment, and in some cases even after the physical results had been translated into a practical application. Times are changing. Now, in place of the experiment, it is frequent practice to determine mathematically beforehand whether or not the contemplated device or technique will work. Electronic computers, because of their high speed and their ability to solve even the most complex equations are playing a leading role in present day development. As the components used in computers are made smaller and smaller, and perhaps through the use of transistors, the physical size and costs of these machines may ultimately be brought to a point where no research laboratory can afford to be without one.

NEW HORIZON

BODY-HEAT is the new power source proposed by Princeton, N.J., seers for future wrist-watch radios employing transistors. Since the average human body radiates about 60 watts continuously, day and night, it is high time that this wasted heat energy is put to work, even at its low temperature potential of 98.6 degrees Fahrenheit. Probably 10 watts or more could be picked up from a chest-and-belly pad; 5 watts from an inside money-belt! These thermal quantities should be ample to operate practical buckle-on portable radio devices. Human energy has already been harnessed to drive the self-winding watch and the pedometer; now body-heat may have a use in operating wrist radios, hearing aids, or additional supersensory electronic devices, even adding to the five senses with which nature has endowed the marvelous human machine.

NAVIGATION

New "reflection plotter," developed by Raytheon for use in conjunction with shipboard radar, enables mariners to accurately interpret all movements of nearby vessels. By marking successive locations of ships on the plotter, as seen on the PPI below, it becomes possible to determine the course of all ships within range of the radar, and to determine how far away and when these vessels will pass. Any lines that project across center of PPI represent collision courses. By knowing elapsed time between successive position dots, what operating range radar is set for, the amount of time remaining to avert disaster can quickly be determined.

Design of

High speed relay useful tures low power con-

By EUGENE W. PIKE, Head, Applied Physics Section
Raytheon Manufacturing Co., 148 California St., Newton 58, Mass.

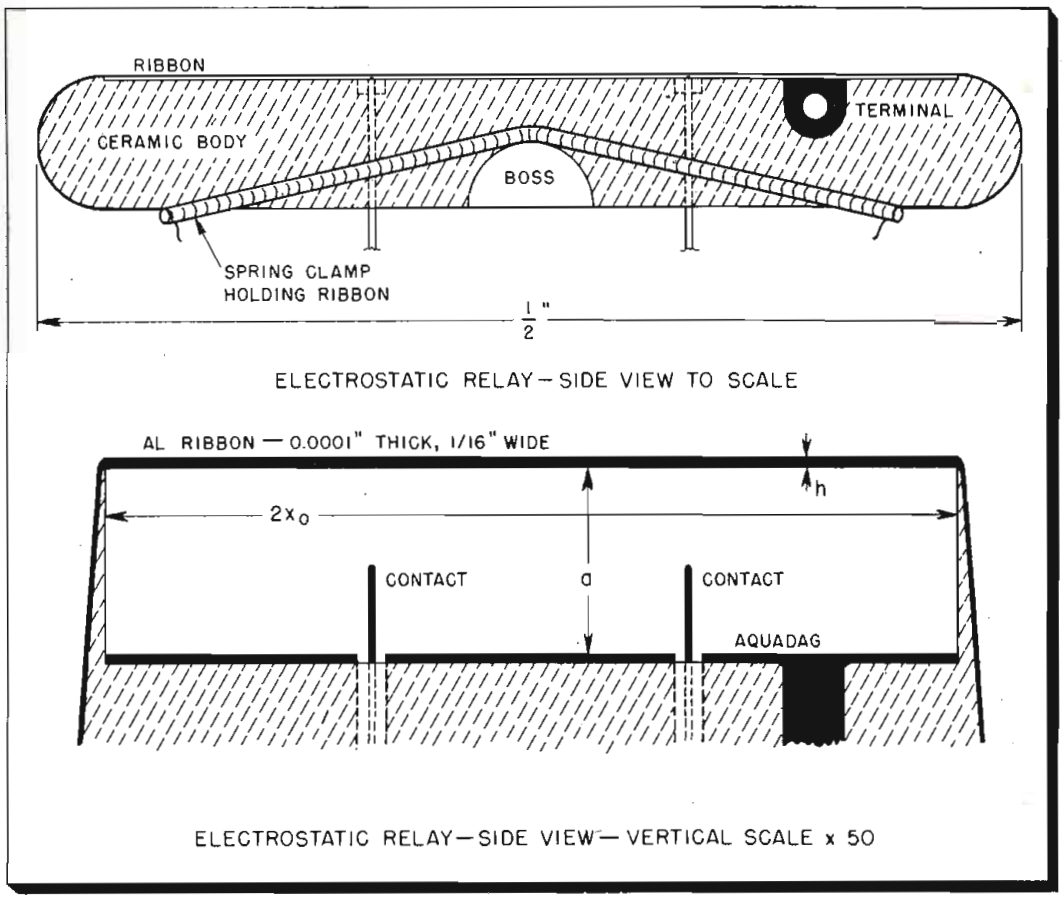


Fig. 1: Drawing of relay shows taut metal ribbon suspended over contacts, parallel to conducting plate. Potential applied between plate and ribbon deflects ribbon down against contacts, closing circuit

IN designs limited to conventional voltages, spacings, frequencies, and materials, electromechanical transducers (motors, generators, relays, etc.) based on electromagnetic forces are far more compact and efficient than transducers based on electrostatic principles. A number of physicists and engineers have pointed out, however, during the past quarter-century, that if very clean, very precise elements are used with close spacings, in a high vacuum, with high voltages, the reverse is true—the electrostatic devices are much more compact and efficient. This paper presents a brief and wholly theoretical study of an electrostatically-driven relay, intended in the first instance to illustrate the resources of this approach.

This study indicates that a relay based on the electrostatic deflection of a taut metal ribbon has a number of properties difficult to attain in conventional electromagnetic designs. These include:

a. Size and weight comparable to subminiature tubes.
b. Holding power consumption ranging from microwatts down to micro-micro-microwatts.
c. Operation directly from r-f power of any frequency.
d. Practical operating times below fifty microseconds.

Its limitations at the present stage of design, are the very low power-handling capacity of the contacts, and false operation under quite small (20 g) transverse accelerations. To some extent, speed can be exchanged for stability, producing a relay having the small size, weight, and power consumption mentioned above, but operating times of a few milliseconds.

The design considered in this paper is shown in Fig. 1; a thin ribbon of metal is stretched taut, parallel to a fixed conducting plate. If a potential difference is applied between the plate and the ribbon, the ribbon will be deflected from its initial position by the electrostatic force, and this motion can bring it against suitably placed contacts, so that it acts as a relay. The specific arrangement shown, in which the ribbon is stretched over a grooved block, with the deflecting plate formed by a layer of conducting material on the bottom of the groove, was suggested by Paul Stutsman.

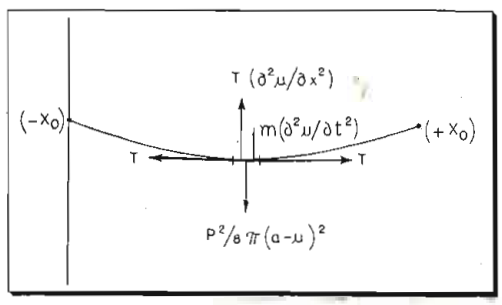
To prepare for the mathematical study using the cgs-esu system of units, let the length of the ribbon between supports be $2\,x_0$, its thickness be h, and its mass per unit area be m. Let the spacing between the ribbon and the deflecting plate be a, the tension per unit width be T, the stress in the ribbon be Y (dynes/cm^2), the density of the ribbon be D, and the potential difference be P. The deflection of the ribbon under the electrostatic force will be $u(x)$, where x is the distance from the center; the analysis is in terms of the proportional deflection $y(x) = [u(x)/a]$.

The equilibrium of the ribbon at any point along its length, and at any instant of time, is given by

$$T\,(\partial^2 \mu/\partial x^2) - m\,(\partial^2 \mu/\partial t^2) - P^2/8\pi\,(a-\mu)^2 = 0 \qquad (1)$$

where the first term is the pressure on the ribbon arising from the tension, the second is the accelerative reaction, and the third is the electrostatic pressure. This equation is easily derived by reference to the sketch of Fig. 2. In this sketch, the ribbon is being accelerated downward by the electrostatic force, and u is chosen to be positive upwards. Then, according to this sign convention, the electrostatic pressure [the third term in Eq. (1)] is negative. The pressure arising from the tension arises because the tensions acting on the opposite ends of an element of length dx are not quite equal and opposite, but deviate from exact opposition by an angle $(\delta^2 u/\delta x^2)\,dx$; the resultant of the two tensions is then (per unit width) T dx $(\delta^2 u/\delta x^2)$. Dropping the dx to get the force per unit area, or the pressure, results in the first term of Eq.

Fig. 2: Sketch of forces acting on ribbon shows the electrostatic force acting downward against the tension and accelerative reaction



Subminiature Electrostatic Relays

in aircraft, computer and telemetering applications, feasumption and direct operation from r-f at any frequency

(1). This force is directed upward, so that the term must be positive; both T and $(\delta^2u/\delta x^2)$ are, in our sign convention, positive, so the term will have a positive sign in Eq. (1).

Similarly, since the ribbon is being accelerated downward, there is an inertial pressure, directed upward, equal to the mass per unit area times the acceleration, or $m(\delta^2u/\delta t^2)$. The pressure is positive, m is positive, but $(\delta^2u/\delta t^2)$ is negative in our sign convention, so the term must have a negative sign in Eq. (1).

Re-arranging, and writing in terms of y,

$$(\partial^2 y/\partial t^2) - \phi_0^2 (\partial^2 y/\partial x^2) - P^2/8\pi a^3 m (1 - y)^2 = 0 \qquad (2)$$

where $\phi_0 = \sqrt{T/m} = \sqrt{Y/D} = 4\beta_0$ x_0; β_0 is the natural frequency of the undefected ribbon.

This nonlinear partial differential equation does not admit a simple solution, especially if impedances in the line to the deflecting plate cause the potential of this plate to change as the ribbon deflects. Under special conditions where one or more of the

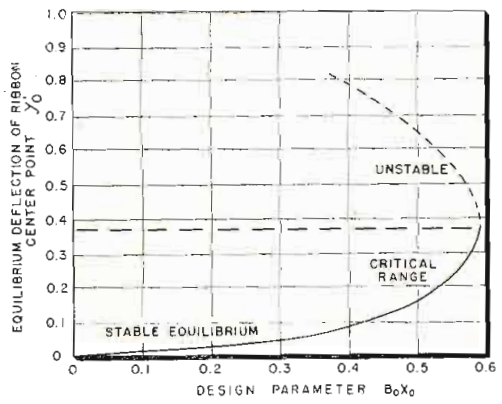


Fig. 3: Graph of design function shows ribbon stability at various proportional deflections

terms are zero or fixed, useful special solutions can be obtained.

The equilibrium positions of the ribbon are obtained by setting the time derivative equal to zero. If P equals V, the applied potential to the plate, the resulting equation is

$$(\partial^2 y'/\partial x^2) + V^2/8\pi a^3 T (1 - y')^2 = 0 \qquad (3)$$

where the prime denotes equilibrium. This equation can be integrated directly to provide a relationship between the length $2x_0$ of the ribbon and the equilibrium deflection y'_0 of the center of the ribbon, whose form is

$$X_0 = (1/B_0)\sqrt{(1 - y_0')/2} \cdot \left[y_0' + (1 - y_0') \tanh^{-1}\sqrt{y_0'}\right] \qquad (4)$$

where $B^2_0 = V^2/8\pi a^3 T$ for brevity.

A graph of this function is shown in Fig. 3. The striking feature of this plot is that there is a definite maximum for the real value of (B_0x_0), at about 0.58, which occurs at a proportional deflection of $y'_0 = 0.39$. A little investigation shows that at this

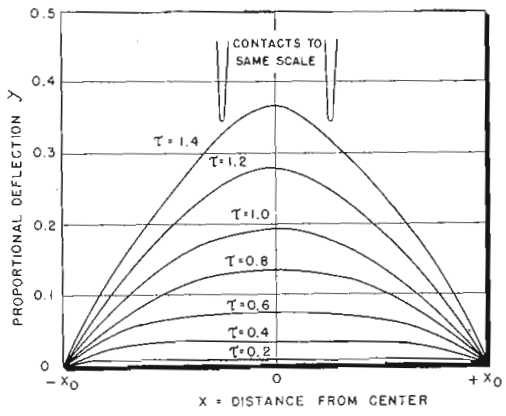


Fig. 4: Proportional ribbon deflections for different values of τ; vertical scale magnified

point the ribbon becomes unstable, with the center portion snapping over against the deflecting plate. This, then, provides the first principle for the design of relays of this type:

In order to obtain a stable design, the proportional deflection in any equilibrium position must be less than about 0.08, and the value of (B_0x_0) must be less than about 0.4.

The pressure between the taut flexible ribbon and a contact must arise in the same way as the first term in Eq. (1); that is, by a change in direction of the ribbon around the contact. In this case, the force will be, as before, the total tension times the angle turned around the contact. This angle turned is called the "wrap."

Since, in order to produce large electrostatic forces with reasonable voltages, it is necessary to make the spacing a very small, this small value of the stable proportional deflection constitutes a severe limitation on the designer. It essentially eliminates the use of normally-closed contacts, since the "wrap" around any practical contact would have to be greater than the limiting stable deflection. For normally open designs, however, this limitation may be evaded by using the contacts themselves to support the ribbon in three sections, in the equilibrium deflected position. For the condition that the contacts are one-third of the way from the undeflected ribbon position to the deflecting plate, and that the center span of the ribbon is three-tenths of the total length, then values of (B_0x_0) for the free ribbon as large as 0.6 can be used in manufacture with reasonable confidence in the stability of the product.

Rewriting Eq. (2) in the form

$$(\partial^2 y/\partial\tau^2) - (\partial^2 y/\partial z^2) = (B_0X_0)^2 (1 - y)^2 = 0.36(1 - y)^2 \qquad (5)$$

where $\tau = t\ \phi_0/x_0$ and $z = (x/x_0)$ are abbreviations, an estimate of $y(\tau, z)$ can be built up, by difference techniques closely allied to the familiar "relaxation" process of the stress analysts, on a grid in the (τ, z) plane which has $y = 0$ when $z = \pm 1$, or $\tau = 0$. Fig. 4 shows this approximate solution, in steps of 0.2 in τ, with the vertical scale magnified for clarity. The contacts considered in the paragraph above are marked in to scale, and it is plain that the ribbon will make contact at about $\tau = 1.5$.

Since $\tau = t\ \phi_0/x_0$, the closing time t_c of the relay, after application of a step function voltage V, will be

$$t_c = 1.5\ X_0/\phi_0 = 1.5\ X_0\sqrt{D/Y}\ ; \quad T = Yh = 2.25\ X_0^2\ Dh/t_c^2 \qquad (6)$$

Substituting this in

$$(B_0\ X_0)^2 = 0.36 = V_0^2\ X_0^2/8\pi\ a^3T \qquad (7)$$

the final result is

$$t_c^2 = 20\ a^3\ Dh/V^2 \qquad (8)$$

This is the second basic equation for the design of electrostatic relays, relating the closing time to the mechanical and electrical parameters. Notably, the closing time is proportional to the three-halves power of the spacing between the ribbon and the plate, but only to the square root of the mass per

(*Continued on page 116*)

A New All-Purpose

Imagine orthicon equipment, designed as successor to

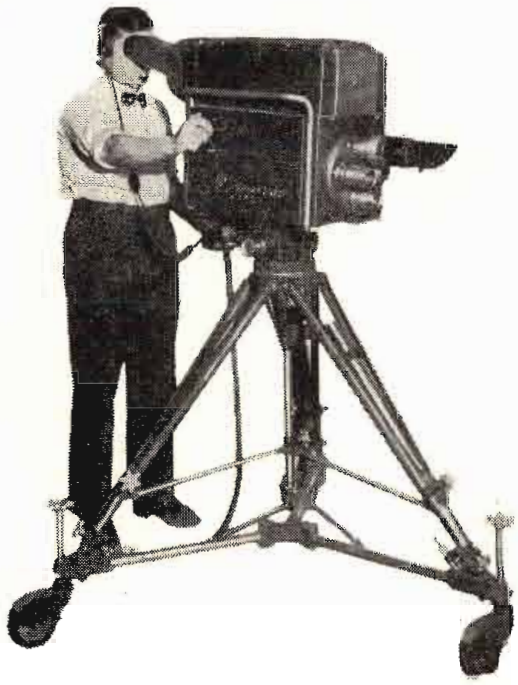


Fig. 1: Overall view of all-purpose TK-11A

By A. REISZ
TV Terminal Equipment Engineering
RCA Victor Div., RCA
Camden, N. J.

THE new image orthicon camera equipment (TK-11A and TK-31A) for monochrome television pickup is a successor to the well known TK-10 and TK-30 equipments. These new units embody many improvements and continue to include all of the desirable basic characteristics of the earlier models.

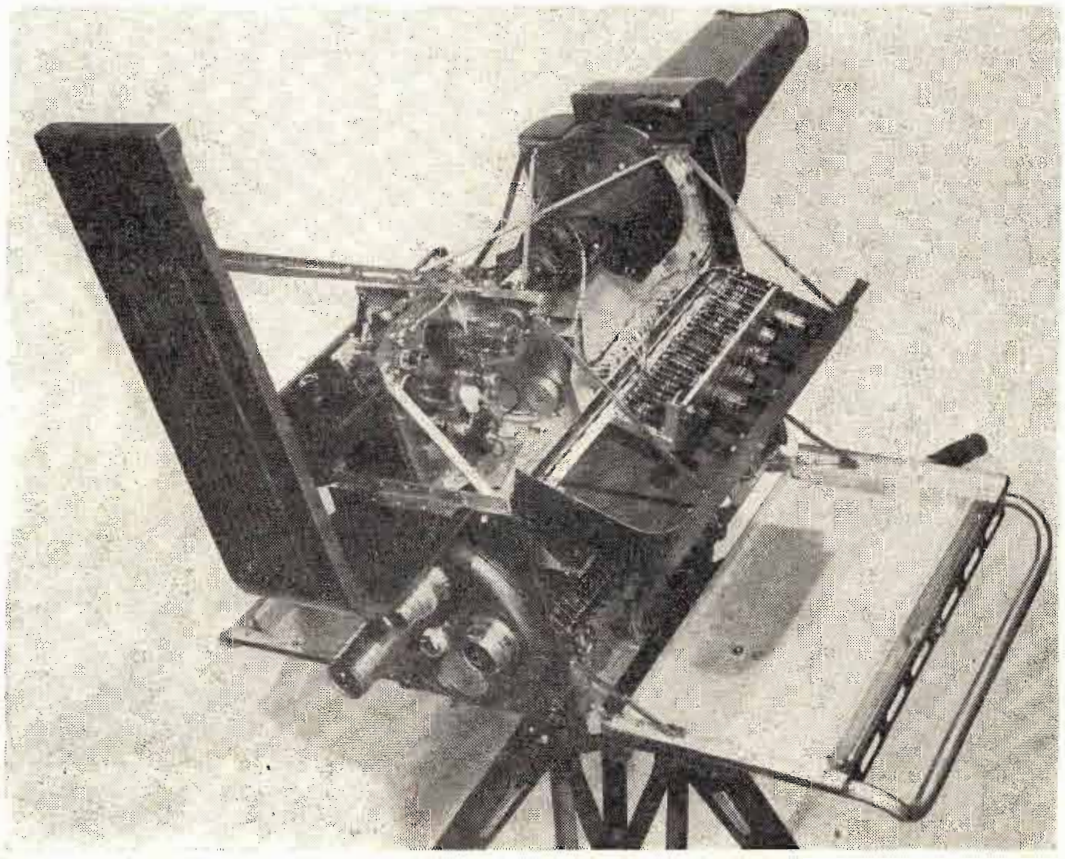
The new design, with the overall objectives of greater stability and flexibility, is centered around a single type of all-purpose camera which may be used for either field or studio applications. Associated with the camera is a new electronic view finder, also available in only a single design which matches the camera. Past practice in the packaging of studio and field camera controls and power supplies has been continued, but with improvements. The general appearance and characteristic styling of the RAC equipment have been preserved, making it possible to mix new and old equipment without sharp contrasts in appearance.

Almost complete interchangeability with the TK-10 and TK-30 equipments has been achieved. This is a valuable feature since it permits substitution of new units for old, or vice versa, in case of emergencies. The interchangeability extends to all of the major units, lenses, and interconnecting cables with the exception of the field power supply. In this case, the older unit may *not* be substituted for the new unit because of the increased power requirements of the new field camera chain. However, the new field power supply may be substituted for the old unit.

For the most part, operating techniques are the same as for the older models. The principal operating controls have been retained in the same forms and in the same locations. However, many of the secondary controls have been relocated or eliminated, and some new controls have been added.

Hand in hand with the evolution of the new Image Orthicon Camera came the design of necessary associated studio equipment. Such equipment includes the new viewfinder, studio camera control, field camera control and a redesigned field power supply. It is obvious that this equipment does not comprise all of the necessary operating units of a camera chain and, therefore, in our reference to the TK-11A and TK-31A chains we intend to also include familiar units of previous designs that are necessary to make the equipment chains complete. Figs. 4 and 5 are block diagrams of items making up the camera chain. The Master Monitor (TM-6A) is a completely new design.

Fig. 2: View of interior shows accessibility. View-finder, circuits, and orthicon can be reached quickly



Camera Design Features

The camera comprises a mounting for the image orthicon pickup tube together with its focus, deflection and alignment coils, complete horizontal and vertical deflection circuits, a video pre-amplifier, and an optical system consisting of a turret with four lens positions and means for adjusting optical focus and iris openings. It is entirely self-contained except for a B power supply and certain electrical controls which are located, for operating convenience, at the camera control. All electrical connections are made through a single cable and plug which carry input power and sync generator signals to the camera, and video output and control circuits from it.

Physically, the camera is divided into three main compartments. In the center compartment is located the pickup tube with its deflection, focus and alignment coils. The two side compartments, accessible by opening the side doors, contain the video and deflection amplifiers respectively. On

Television Camera

well-known earlier units, keynotes performance stability and flexibility

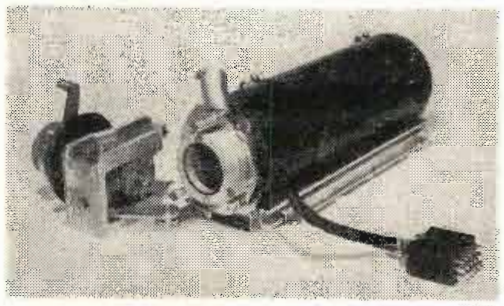


Fig. 3: Yoke assembly and focus drive mechanism removed from camera. Note blower has fitting and plug for electrical connection

the front end of the camera is the lens turret, and on the rear are some of the electrical controls and the control handle for rotating the turret and certain of the electrical controls. On the right-hand side of the camera (from the rear or operating position) is the optical focus control handle. This focus control and the turret handle are normally the only two controls which require the attention of the camera man during a program. An essential adjunct of the camera is the viewfinder which permits the camera operator to evaluate his framing, focus, field of view and scene content.

Ball Bearing Slides

The camera focus coil—yoke—alignment coil assembly moves on ball bearing slides. Although rigidly fastened to the frame when in position, the entire assembly is removable in a few moments for servicing because it is a plug-in unit. This suspension is smoothly driven through its entire travel for optical focusing by 2¼ turns of a focus knob. The knob remains in place when the side door is opened. This remarkably simple yet rugged drive mechanism imparts a non-linear motion so that relatively great image orthicon motion per degree of knob rotation is obtained for long focal length lenses and close ups. In contrast, a vernier motion is provided near infinity focus and when short focal length lenses are in use where rapid motion would make accurate focusing difficult.

The improved yoke provides better shading, less geometric distortion and improved shielding of deflection fields from the image section. A simple wrap-around mu-metal shield extends from the image end past the alignment coils for quite complete shielding against external magnetic fields.

Alignment Coil Assembly

An entirely new alignment coil assembly has been incorporated in the camera. It comprises two pairs of coils in space quadrature so that independent control of currents in the two pairs of coils will produce a correcting cross field in any direction required. In this system, no mechanical adjustment of the coil is required; it is rigidly mounted. The alignment procedure involves the simultaneous adjustment of two potentiometer controls which determine the currents in the two sets of coils.

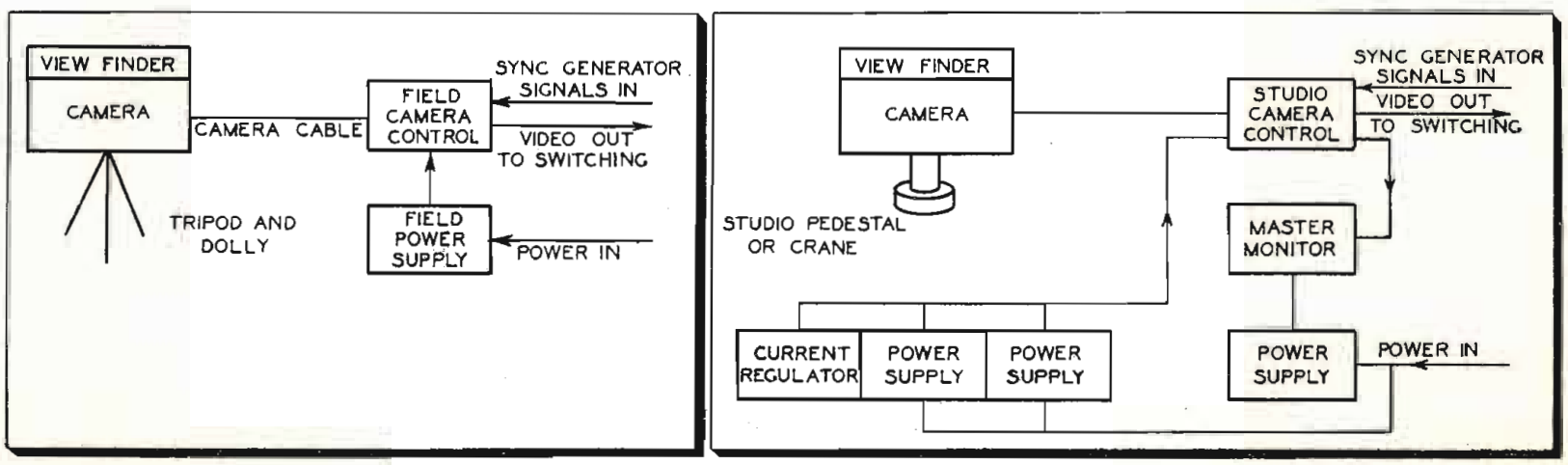
In order to simplify the alignment procedure, an auxiliary orthicon focus control has been included in the camera. Temporary control of orthicon focus at the camera may be selected by operating a switch on the rear of the camera. The camera man himself may then "rock" the focus back and forth to check the setting of the alignment controls without requiring the services of a second operator at the camera control position. At the conclusion of his adjustment procedure, the selector switch may be returned to normal, and the control of orthicon focus is thereby restored to the camera control position.

The cooling blower is readily unplugged and removed from underneath the camera and when slipped in place makes connection with a gas mask type hose which directs clean cooling air to the base end of the image orthicon. This air is restrained at the base end by a gasket and is forced between the tube and deflection coils and between the yoke and focus coil where space has now been provided. A redesigned shoulder socket and retaining mask permit exit of air in the front while a preset thermostat contained in the mask (in intimate contact with the photocathode) samples tube temperature to activate a relay-rectifier circuit for blower cycling free from electrical surge. This arrangement is capable of automatically maintaining proper orthicon operating temperature for stable performance and longer tube life. Provisions are also made for continuous operation of the blower and the target heater to meet extreme conditions.

Remote Iris Control

To facilitate proper adjustment of the light reaching the photocathode of the pickup tube, a system for remote control of the iris in the ob-

Fig. 4-5: Block diagrams of equipment arrangement for (l) field camera chain and (r) for studio camera chain



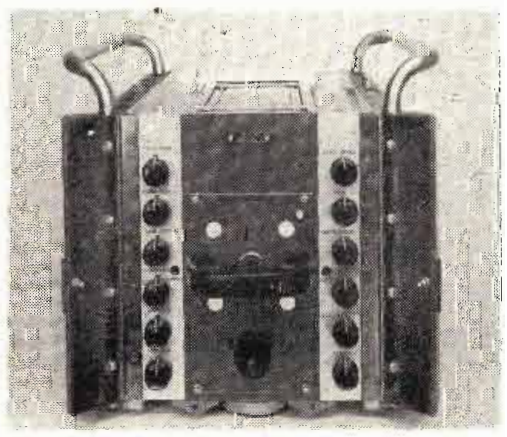
jective lens has been included in the camera. The system includes both control and indication of iris setting. This is provided at the camera control position. The movement of the iris is obtained with a small dc motor and gear train mounted directly on the lens and coupled to the control circuit through brush contacts on the turret. A potentiometer, also part of the motor assembly, geared directly to the iris gives an electrical potential which indicates the iris position. This indication is presented on a meter at the control position. The circuit connections for both motor control and indication are made through the camera cable by superimposing these circuits on the existing program sound circuit. The only operating control is a two-way lever key (telephone type) which provides for reversal of the motor for opening or closing the iris. Motion over the whole range is accomplished in about 6 seconds. A control panel, including motor power supply, control key, and meter, is available as part of either the field or studio type of camera control.

Lens turret control is positively indexed with an improved hand grip and a hollow shaft for the use of special lenses. A one-piece turret shaft, with a large opening from end-to-end, is employed. Space is provided behind the turret for a filter disc to control light without impairing control of focus depth. Write-in tabs indicate the lens in use.

Other Camera Features

Side compartments are enclosed by hinged covers. Sturdy handle bars on the doors provide easy portability. Adequate ventilation is allowed but a splash plate protects the camera interior. A strong catch mechanism holds the door secure but can be easily released with one finger. When open, the doors are held horizontal with knuckle type stays to provide a ready service shelf.

Fig. 6: Rear view showing "setup controls"



Protection of the Image Orthicon is assured through the use of a circuit which cuts off the tube when there is loss of driving signals, deflection circuit failure, or failure of the activating relay.

Vertical deflection incorporates feedback and phase correction for excellent linearity and stability without need for linearity adjustments. Target blanking insertion is at low impedance to eliminate cross-talk problems. Horizontal deflection has excellent linearity, single knob linearity control, and freedom from transients by an improved push-pull type circuit and a novel ferrite output transformer. A seven microsecond return time insures good operation even with the extreme delay conditions associated with 1000 foot camera cable operation. Both

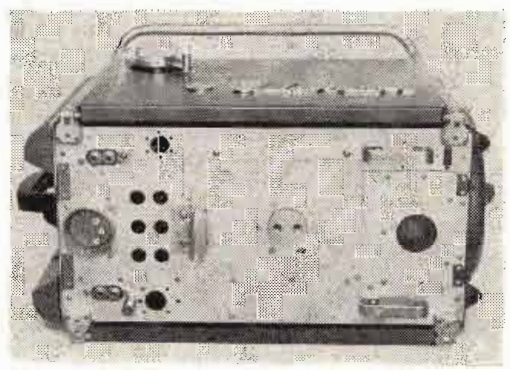


Fig. 7: Underside view of new camera. Blower assembly at right pulls out easily

deflection circuits can be switched from normal scan to 15% over-scan to guarantee against burned target areas during warm-up and rehearsals, while maintaining linearity and aspect ratio. Adequate and symmetrical centering controls are available.

A pulse type high-voltage supply provides stable picture tube operating potentials and, incidental to this, a resistive configurating maintains constant loading on the -500v. supply as image focus is varied to speed the narrowing-down process when operation is being optimized during setup.

Focus modulation circuitry provides low-impedance feed of horizontal and vertical parabolic waveshapes in a 4/3 aspect ratio to the orthicon wall to provide continuous beam focus over the usable target area. Improved corner resolution results as does also the possibility of defocusing all multiplier blemishes simultaneously with a minimum of sacrifice in resolution.

The decelerator control is now

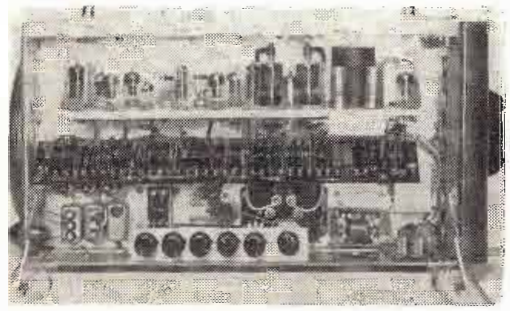


Fig. 8: Deflection side of camera. Note miniaturized components, accessibility, and the convenient grouping of "setup" controls

continuously variable fro 0-120V for accurate port hole control. Image accelerator control provides "S"-distortion correction. Vertical deflection reversal is provided by a switch for quick transformation to operation with the type TP-10A portable film projector for field film insertions. Switch is made at the same time to a preset centering potentiometer to insure operation with the same target area. Horizontal deflection reversal is possible in that two coaxial leads feed the yoke so that a simple change of the yoke connections at the yoke plug will permit, for example, multiplexer operation.

Horizontal shading at the camera position allows shading the viewfinder picture. A multiplier video gain control allows a cure in the rare case of dynode overload. A line voltage tap switch compensates for line voltage drop associated with different cable lengths. An elapsed time indicator conveniently records hours of tube operation.

Three miniature sensitive 24 volt relays are used—one for tally light service. Interchangeability with existing units is maintained but it is a simple wiring change here and in the new field control if 24 volt tally operation is desired.

Video Pre-Amplifier

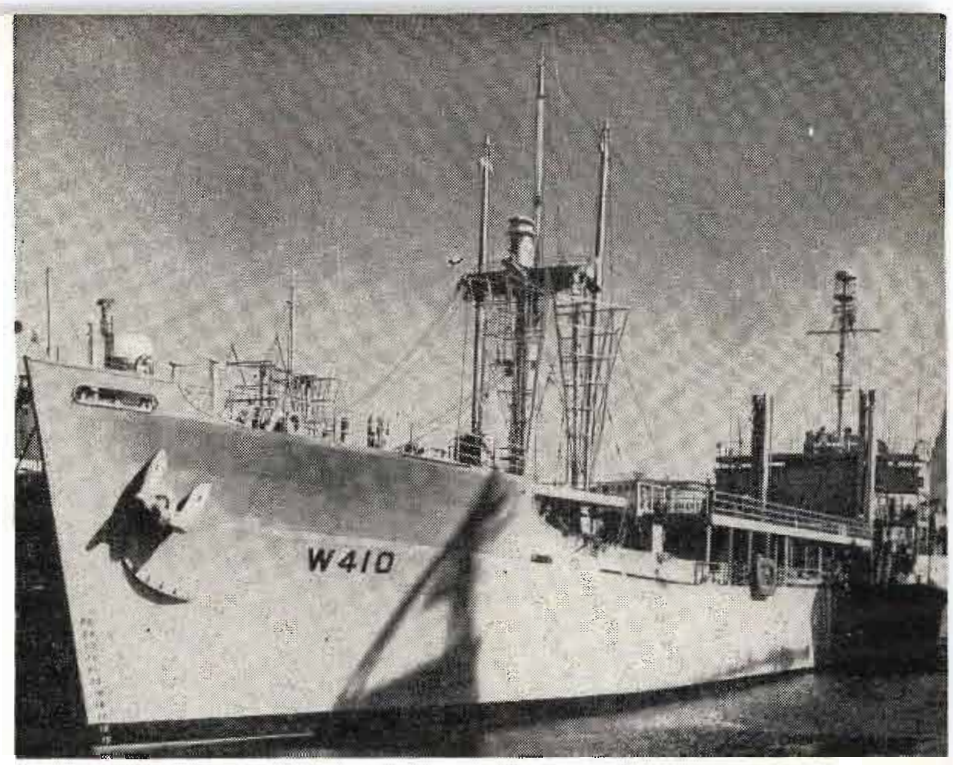
The video pre-amplifier is a plug-in unit with all power connections made through a single plug and receptacle, and with three small coaxial connectors for the input, main output, and view finder output signal connections. The amplifier is mounted on rubber to minimize the effects of vibration and shock.

Ample gain insures a bright viewfinder picture with even a low-limit camera tube. Two stages of cathode high peaking eliminate overshoot and smear by very accurately compensating for the amplifier input loss of high frequencies while reducing microphonics associated with conventional high peaking. Low fre-

(*Continued on page* 74)

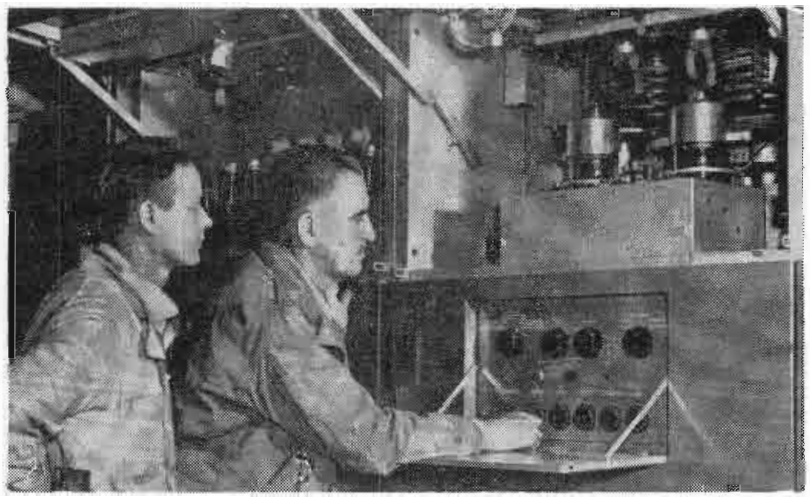
VOICE of AMERICA Goes to Sea

Using balloon-raised antenna, 150 kw shipboard station will retransmit broadcasts from land-based stations



The Coast Guard cutter, COURIER, awaits orders for the tour of duty which will send it around the world, pouring radio information into Soviet controlled lands from off-shore. The raised platform seen amidships is a flight deck from which 69 x 33 ft. barrage balloons are released and sent 1,000 ft. into the air, carrying aloft the half-wave antenna for the 150 kw transmitter. Other features include eight whip antennas for dual diversity reception, and cork and reinforced concrete transmitter mountings.

THE *Courier*, 5,800-ton, 338 ft. Coast Guard cutter, was commissioned on Feb. 15, 1952, as the first of a proposed fleet of sea-going radio broadcast relay stations. This shipboard station will receive broadcasts from land-based Voice of America stations and retransmit them into Communist-dominated areas. Manned by a crew of 80, the vessel contains a 150 kw transmitter, one of the most powerful ever installed on a ship. Other equipment includes several transmitters, antennas, receivers, recorders, a small announcing studio for occasional ship-originated programs, and barrage balloons. The overall conversion cost for the ship ran close to $2,500,000, of which approximately $900,000 went for three months of work and the equipment involved in the radio installation.



Ivan Boor, chief engineer of the sea-going station, adjusts the power amplifier section of one of the two Collins 35 kw transmitters as Jean Seymour, project engineer, looks on. The six Eitel-McCullough 3X2500 tubes in the push-pull parallel, grounded-grid final are forced air cooled. Designed to operate in the 6-22 MC range with high level AM, these transmitters feed two folded broadband dipoles near the bow of the ship. The room containing the transmitters is air conditioned by a central cooling system.

Jean Seymour describes the RCA 150 kw standard broadcast transmitter to Voice of America reporter Bob Jones. The four 9C21 tubes, connected in parallel in the final stage, are cooled with distilled water which passes through a salt water heat exchanger. Power is supplied from three 500 kw, three-phase, 440 CPS generators which are driven by individual deisels. Transmitter output may be fed to a balloon-supported half-wave antenna, or to a balloon-and-buoy rhombic, or to an emergency three-wire flat top.

Commander Oscar Wev (r) shows Foy D. Kohler, Chief of the Voice of America, the gimbal-mounted Fairchild disc recorder turntable which remains level in spite of the ship's rolling. Also included in the receiving room are an Ampex tape recorder, Collins and Northern receivers covering 500 KC to 54 MC which can patch directly into the three transmitters, and much other auxiliary equipment. For supplementary communication with other stations, the COURIER carries a 5 kw, 4-26 MC, teletype-voice-cw transmitter, and a 960 MC, 50 watt, single channel microwave transmitter.

Germanium Diodes for Indicating

DC meters with germanium rectifiers have high "Chatter" and "arcing" can be minimized with

By FRED J. LINGEL
Commercial and Gov't Equip. Dept.
General Electric Co.
Syracuse, N. Y.

BY adding one or two germanium diodes in a suitable rectifier circuit, dc indicating instruments and sensitive dc relays can be used on ac and r-f through 150 MC. Both instruments and sensitive relays utilize similar techniques for the proper use of diodes, and for this reason both applications are covered in this article.

In measurement applications, a dc meter with a rectifier has several advantages over an ac meter. The biggest one is the increased sensitivity. For example, a 0-150 v. moving iron ac voltmeter will take approximately 10 ma. for full scale deflection. A diode type rectifier meter on the other hand can be made with a full scale current of less than 0.1 ma. Other advantages of rectifier type dc meters are wide frequency range, good pointer response, small size and availability for multi-function testers such as ac-dc voltohm milliammeters.

In control applications, ac relays will often chatter and cause arcing. With a dc relay and a properly designed diode rectifier circuit, these troubles are eliminated. In addition, the relay can be made to operate on at least ⅓ the current and has the advantage of size and weight over an ac relay.

Advantages of Germanium Rectifiers Over Copper Oxide

Until the last few years, the best rectifiers for instrument and relay applications were the small copper oxide types. With the advent of inexpensive, stable, small size germanium diodes, such as the GE Types IN48 and IN51, still more advantages have been added to rectifier type ac meters and relays.

Germanium diode rectifiers have the following advantages over copper oxide rectifiers:

1. Completely insulated so they

Temp. vs Z — Low

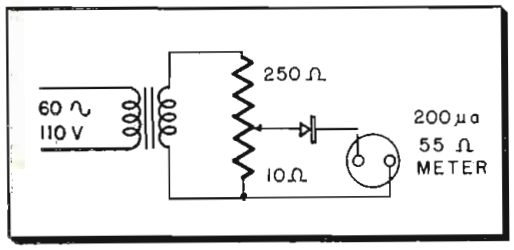


Fig. 1: When a diode operates from a low resistance source into a low resistance meter load, the meter deflection increases with increased temperature, because the diode forward resistance decreases with increased temperature. The decrease in back resistance which occurs at the same time does not influence the indication to any great extent because the diode back resistance at elevated temperature is still very large in comparison with that of the rest of the circuit.

Temp. vs Z — High

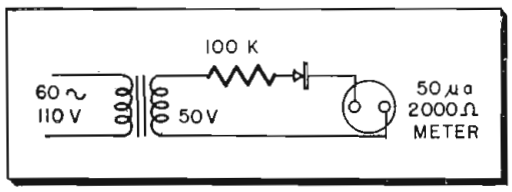


Fig. 2: When a diode operates from a high resistance source into a high resistance load, the meter deflection decreases with increased temperature, because the diode back resistance decreases with increased temperature. The reduced forward resistance has little effect on the meter deflection in this circuit because it is swamped out by the high resistance of the meter load.

Temp. vs Z — Constant

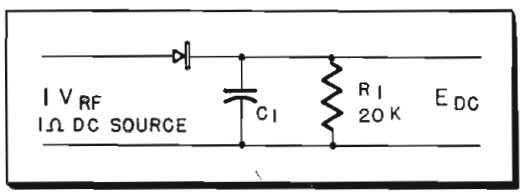


Fig. 3: A condition in which the meter deflection remains practically constant with temperature results from the combined action of two effects. First, the meter deflection tends to increase with increased temperature since the diode is working from a low impedance source into the relatively low impedance load of the condenser C_1. Second, the decrease in back resistance acts as a load in parallel with R_1 to effectively decrease the pointer deflection because of the increased temperature. The two factors work together to produce a more or less constant meter deflection with change in temperature. The load resistance in Figs. 1 and 2 can also be chosen to obtain similar temperature compensation.

Freq. vs Uniform Output

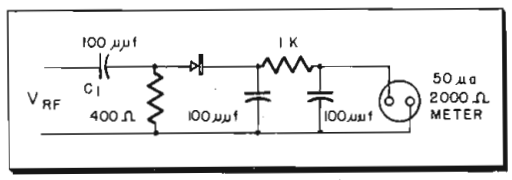


Fig. 4: The series condenser offers a gradual decreasing input impedance with increased frequency and tends to provide more uniform output with change in frequency.

Multirange Rectifier

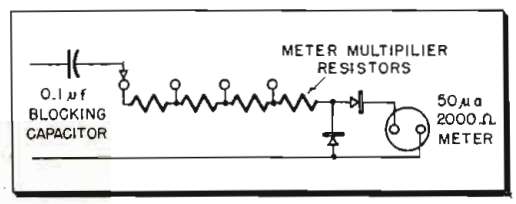
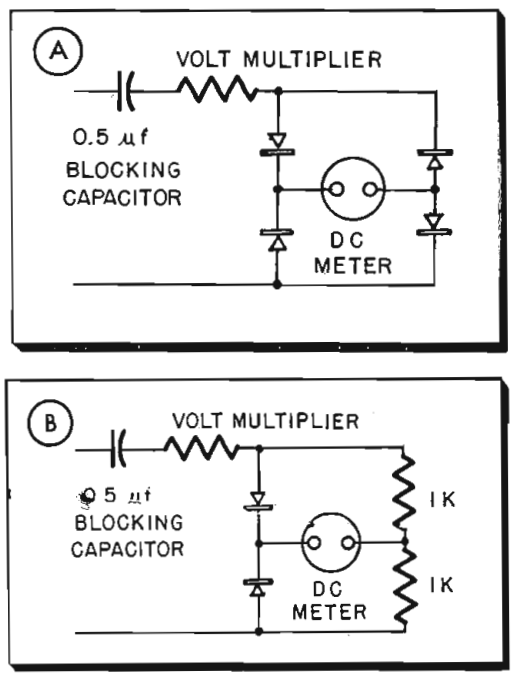


Fig. 5: With well spaced components and with resistors of low distributed capacitance and inductance, a multirange rectifier type instrument with sensitivity of approximately 10,000 ohms/v may give an accuracy within ± 10% over the frequency range of 60 cycles to 6 MC.

Maximum Output



Figs. 6a, b: Where maximum output with minimum input is of primary importance, these circuits are suggested for frequencies between 25 cycles and 25 K.C. The circuit of Fig. 6a gives about 10% greater deflection than Fig. 6b, but Fig. 6b is less expensive, takes less room and has somewhat better temperature and frequency characteristics.

Instruments and Relays

sensitivity, wide frequency range and small size.

dc relays; circuits require small actuating currents

The following list indicates the principal scope of the circuits in the figure indicated:
Figs. 1-3: Temperature effects on diode impedance.
Figs. 4-8: Frequency range limited to 25 cycles to 250 MC by pointer oscillation and relay chatter.
Fig. 9: Meter protection from high reverse voltages. ..
Fig. 10: Sensitivity change with different rectifier types.
Fig. 11: Relay operation with increased sensitivity and no chatter.
Figs. 12-13: Elimination of contact sparking.
Fig. 14: Rectifier arrangements for microameters.
Fig. 15: Dimensions of plug-in sealed assembly.
Figs. 16-19: Typical characteristic curves for different diodes.
Table 1: Condensed specifications for some germanium diodes.

can be mounted in a small space.
2. Enclosed in a sealed protective housing so they are not as susceptible to fumes and humidity as copper oxide.
3. High peak back voltage rating for probe type testing.
4. High back voltage and low forward resistance, which makes it possible to use temperature compensating resistance swamping circuits. This avoids one of the big disadvantages of copper oxide, namely poor temperature coefficient.
5. Wide frequency range running from 25 cycles through 150 MC in the one size unit.

Low Forward-To-Back Resistance Ratio

Germanium diodes can be used for instrument and sensitive relay rectifiers in a number of circuits. The best diode types are generally those with low forward to back resistance ratio and low forward resistance, such as the IN51 and IN48. This is because the instrument or relay is generally a relatively low resistance load, and diodes with a low forward resistance and a fair back resistance work best. The higher back resistance types, such as IN52 and IN63, also work well for this service but are more costly.

The data shown may be applied directly to applications of sensitive relays, in which case the meter is replaced by the relay coil.

Increased Sensitivity

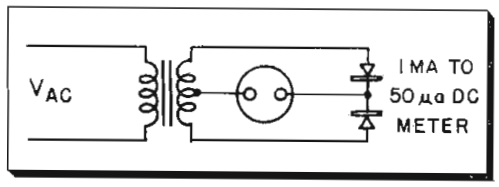


Fig. 7: For increased sensitivity over somewhat limited frequency range, a center tapped potential transformer arrangement may be used.

Temp. — Freq. Response

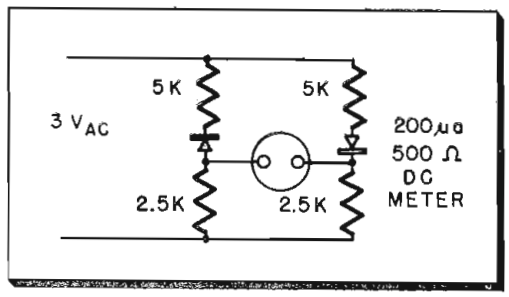


Fig. 8: Good temperature and frequency characteristics have been obtained with this circuit. Here advantage is taken of the high peak back voltage of the diode as compared to copper oxide. This permits adding temperature compensating resistors in series with each diode to effectively swamp out the change in diode forward resistance with temperature.

Meter Protection

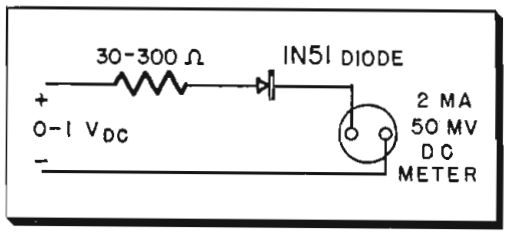
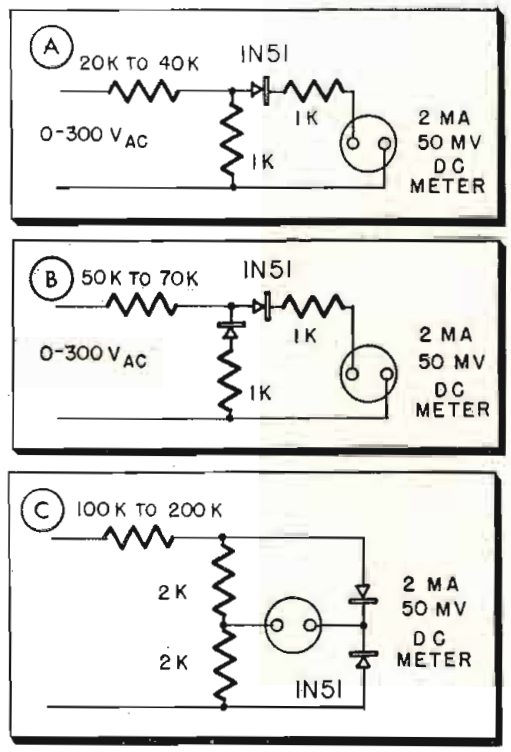


Fig. 9: Where meter protection from high reverse voltages is desired, a diode may be connected so the reverse current is limited to 3 ma with negative 30 v applied in place of the normal positive 0-1 v. The 30-300 ohm resistor is adjusted to calibrate the meter to 1 v full scale. The normal uniformly divided scale of the meter will be changed by the addition of the diode to one with the divisions contracted near the zero and approximately shown below:

Volt	MA	Volt	MA
1	2	.4	0.41
.8	1.4	.2	0.1
.6	0.9		

Where the peak back voltage exceeds 50 v, the higher peak back voltage diodes such as the IN52 or IN63 are preferred.

Sensitivity changes



Figs. 10 a, b, c: Actual 30 v. meter rectifier circuits using 2 ma and 50 mv dc meters are good for frequencies from 60 to 5000 cycles with less than ±3% change for the temperature range —25 to +125°F (—32 to +87°C). The main difference in each of the three circuits is the increase in sensitivity in going from the single diode half wave rectifier to the double center tap type. The resistors should be good quality non-inductive type. The scale characteristics will approximate those shown below:

Volt.	MA	Volt.	MA
300	2	120	0.75
240	1.6	60	.4
180	1.1		

The exact amount of series resistance will depend upon the individual diode.

Chatter Prevention

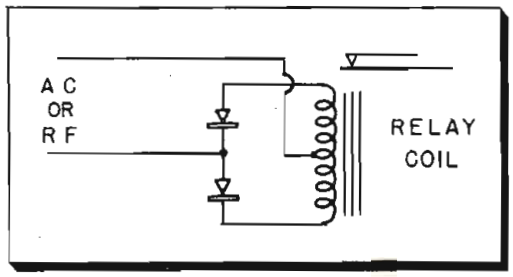


Fig. 11: Good 400-800 cycle relay operation has been obtained using a center tap brought from the relay coil with three wires connected to the diodes as shown. In this circuit the flux is held constant over both halves of the ac cycle. Greater freedom from chattering and increased sensitivity result from this arrangement.

(*Continued on page* 100)

For MANUFACTURERS

New Methods, New Materials and New Machines

Edited By Bernard F. Osbahr

Dynamic Measurements on Filter Chokes

By G. TINT, Fada Radio & Electric Co., 525 Main St., Belleville, N. J.

IF the no-load inductance of a choke is desired, an impedance bridge will give good results. A inductance is to be measured with a bridge, however, is impractical if the given dc load flowing through the coil. The circuit shown provides a simple method of determining this operating inductance without the use of special equipment. The ac voltmeter should be a Ballantine type.

The parameters, C, L, and R depend on the dc rating and inductance of the unknown. The values shown are for a 2 or 3 henry choke rated at about 200 ma (dc). These are approximate values and may be varied 25% either way depending on availability of parts. The R, however, must be measured on a bridge immediately after the test since cooling will affect the results appreciably.

Adjust both supplies simultaneously until rated dc load is flowing through the coil with 10 v. rms (standard for filter choke measurements) across it. Now switch the voltmeter and read the ac voltage across R. Then $I_{AC} = V_R/R$; $Z_x = 10/I_{AC}$; $X_x = \sqrt{Z^2_x - R^2_x}$ (If the dc resistance of the unknown is equal to or less than 10% of the impedance, it may be neglected in the above calculation and the reactance X may be considered equal to the impedance Z.) And $L_x = X_x/2\pi F$ where f is the frequency of the ac supply source.

$$$ 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 preferred. Our usual rates will be paid for material used.

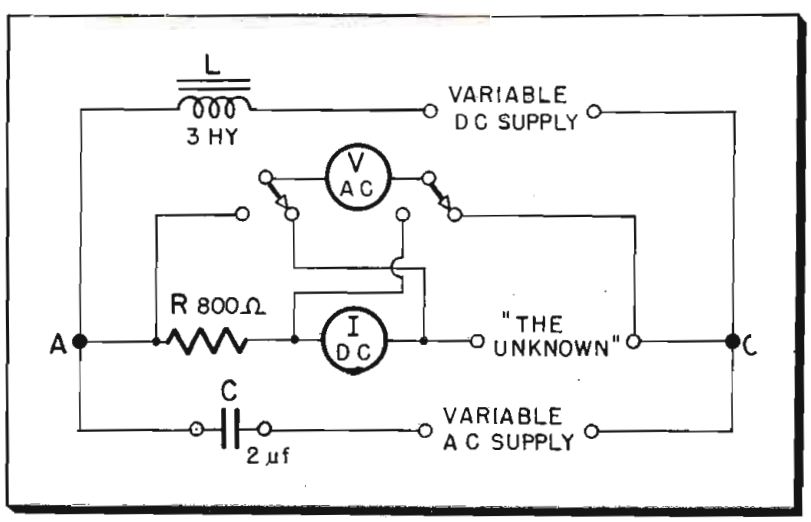
Single Crystal Diodes

Uniformity has proven a most elusive goal in the fabrication of germanium diodes. One cause of non-uniformity is the fact that the surface of the crystal slab often comprises the cross sectional area of several individual crystals. A technique which is presently being attempted forms ingots which are single crystals. Essentially the process consists of suspending a germanium eed at the top of the melt and withdrawing it at the rate of a few inches per hour. When the complete ingot has been formed, it may weigh several hundred grams. After slicing, each slab surface is the cross section of a single crystal, and a whisker contacting any point on the surface should provide the same operating performance when the unit is finally processed.

Salvaging with Ultrasonics

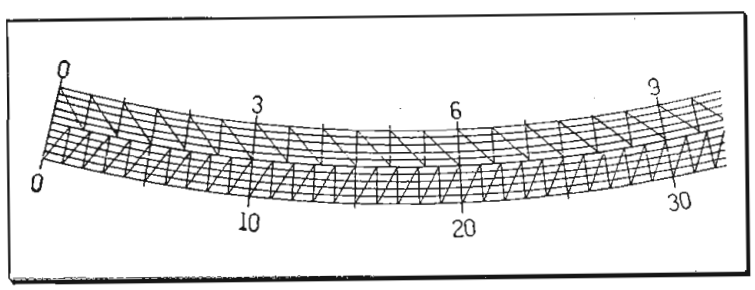
Ultrasonic frequencies are now being used at Raytheon Manufacturing Company, Waltham, Mass., to conserve materials vital to the nation's defense program. Tungsten, high on the list of critical materials, is among those alloys being salvaged by means of a new device. This device provides 27 KC energy to literally shake the glass beads off the tungsten rods salvaged from vacuum tubes which have proved faulty during manufacture, and which require re-processing. Raytheon's device permits the removal of glass sealed to the tungsten rods ten times faster than was possible by previously-used methods. Other

Photo of equipment arrangement using ultrasonics to salvage critical metals used in the manufacture of vacuum tubes.



(Left) Dynamic filter choke measurement schematic

(Below) For easier and more accurate meter readings, each of the dial scales on Sensitive Research Instrument Corp. (Mt. Vernon, N. Y.) meters are made up of five equally spaced lines instead of one. By running diagonals across the five lines for each unit value, as shown in the diagram, values of 1.2, 1.4, 1.6, etc., are readily obtainable. There are many possible extensions of this principle.



View of the Brush tape recorder that uses a "rigidized" metal speaker grille.

glass-sealing alloys such as molybdenum, platinum, kovar and rodar can also be salvaged by this method.

Soldering Carbon To Metal

A new process announced by the Stackpole Carbon Company, St. Marys, Pa. makes it as practical to solder carbon to metal as it is to solder metal to metal in most cases. Thus, by having this heretofore unwettable refractory material soldered directly to metal supports, the user gains all of the advantages of carbon for contacts, small brushes, friction devices and many other purposes. Costly fixtures formerly necessary for bolting or clamping the carbon units in place are eliminated. For example, the new method permits welding carbon contacts directly to metal arms. Carbon brushes can be soldered to phosphor bronze or beryllium copper leaf springs, thus eliminating brush holders and shunts and simplifying equipment design. Carbon friction discs also can be soldered to metal backing plates.

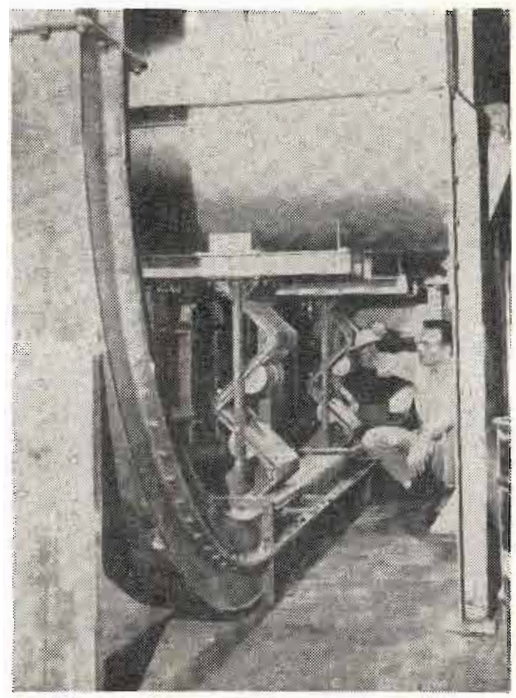
"Rigidized" Grilles

"Bodyguard" for tape recorder speakers is the new grille on the Brush "Soundmirror" tape recorder. Fabricated from 5-WL perforated pattern rigidized metal, this new speaker grille contributes greatly to the looks and life of the entire unit. Excellent sound transmission is provided and top protection for the speaker itself is assured. No pencils or other damaging objects can accidentally break through the surface. All dents, scratches, scuffs and fingerprints tend to be concealed by the design. Rigidized Metals Corporation, 657-P Ohio Street, Buffalo 3, New York is the manufacturer.

Impurity Separation

In 1945 RCA Victor began the commercial manufacture of vinyl records. Because vinyl compounds are much tougher than those regularly used for 78-rpm records damage to stampers, caused by the presence of minute particles of iron and steel in the vinyl compound, was encountered. Because of the toughness of this compound the contamination did not imbed itself; it just scratched the surface of the stampers. Naturally, this marred the sound patterns cut into the grooves of the stampers; and records pressed from scratched stampers had to be rejected. It is interesting to note that the degree of contamination causing this production difficulty was very small. One special permanent (non-electric) magnetic separators manufactured by the Eriez Manufacturing Company, Erie, Pa. were installed on the handing line before the stampers. One is a series of plate-type magnets installed in a zig-zag chute after a Ball and Jewell cutter; the other is a magnetic hump unit used in a gravity flow conveyor system. The latter separator is called a hump because of its shape. Installed vertically, or at least at an angle greater than 65°, it directs material flow 30° from the normal by strategically placed baffle

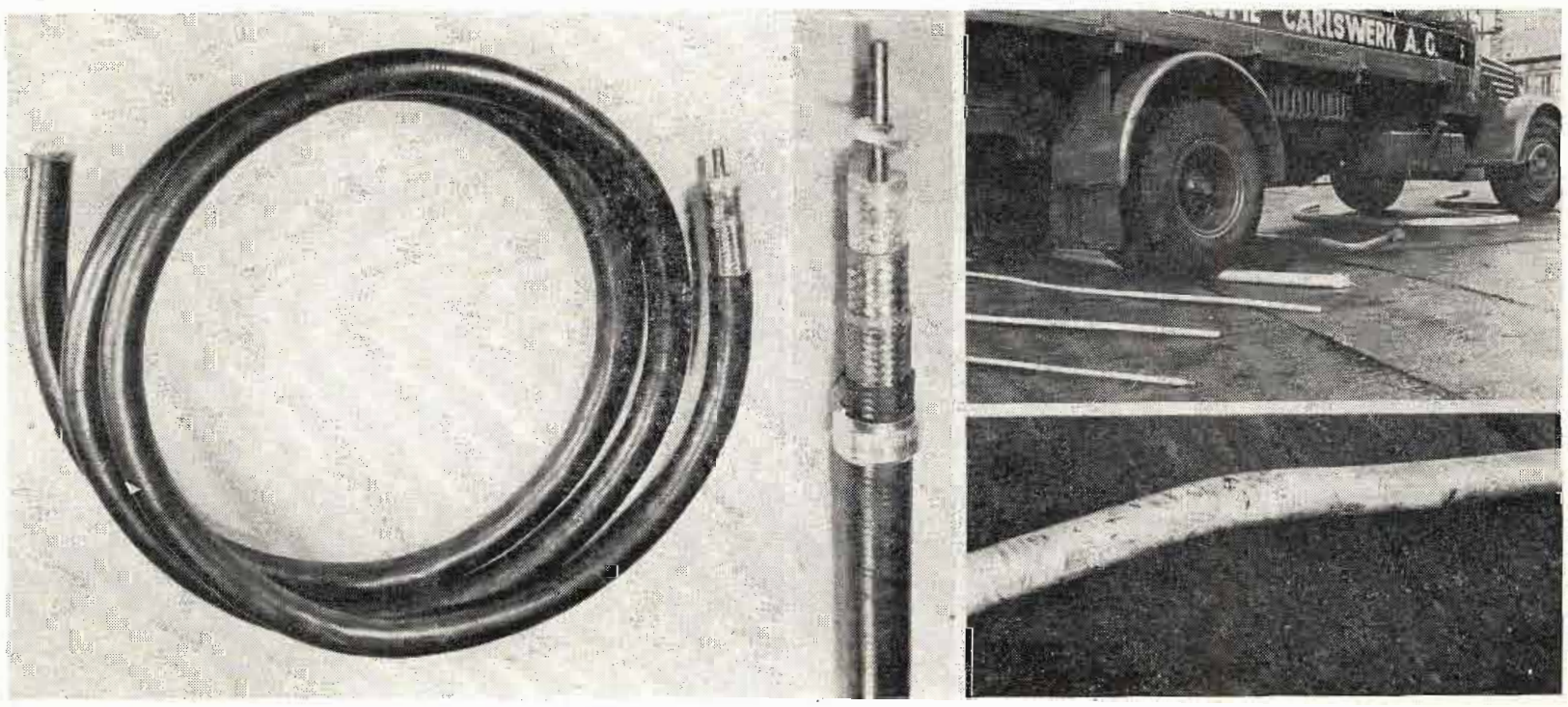
(*Continued on page* 108)



Magnetic impurity separators installed on vinyl compound line in phono record plant.

FLEXIBLE-TYPE STYROFLEX CABLE DEVELOPED

(Left) New type of flexible coaxial cable using polystyrene tape as insulation is less than 1 in. in diameter and can be coiled into an 8-10 in. radius. (Center) Close-up showing construction details of the Phelps Dodge cable. (Right) Sturdiness of construction of aluminum sheathed cables is shown by the fact that this six ton truck did not deform any of the different sized cables in running over them. Lower photo shows about 3mm flattening on 68mm cable when rear wheels of truck were first parked on it, cma, and then having the truck start forward suddenly. Additional information on page 108.



Nonlinear Elements and

Saturable reactors, ferroelectric capacitors Details of new nonlinear resistor, termed resistive detectors, overload protectors,

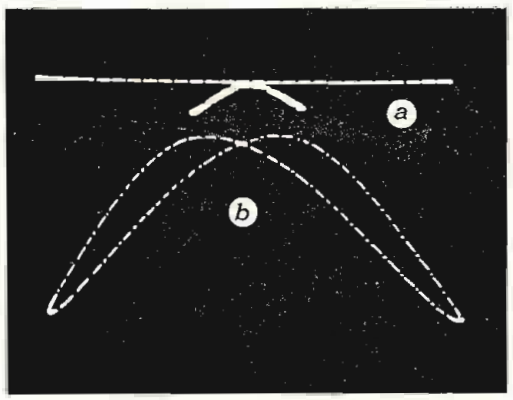


Fig. 1: Dynamic FM oscillograms of a saturable reactor. Horizontal lines indicate the carrier frequency which in this case is 5 megacycles.

By Dr. HANS E. HOLLMAN
U. S. Naval Air Missile Test Center
Point Mugu, Calif.

IN the early days every radio and audio-frequency engineer tended to linearize all of his devices in order to minimize nonlinear as well as intermodulation distortions. This tendency went so far that he linearized every individual component instead of considering the over-all device, such as a complex sound transmission or reproducing system or a telemetry system.

In the last decade this situation has changed. Step by step, physicists and electronic engineers are facing nonlinearity problems not only with a view toward higher fidelity, but also in regard to artificial nonlinearities, as exemplified in magnetic amplifiers and electronic computers.

Nonlinearity problems have been well known since the earliest days of radio. The oldest nonlinear element or nonlinear resistor, in modern terminology a varistor, is the crystal detector of which the modern versions are silicon and germanium diodes. In addition to resistive elements, we also know nonlinear reactances and impedances, such as saturable reactors in the inductive field and ferroelectric capacitors in the capacitive field.

Let us consider, under a common aspect, some peculiar problems of all of these three types and some significant applications in various fields of electronic engineering.

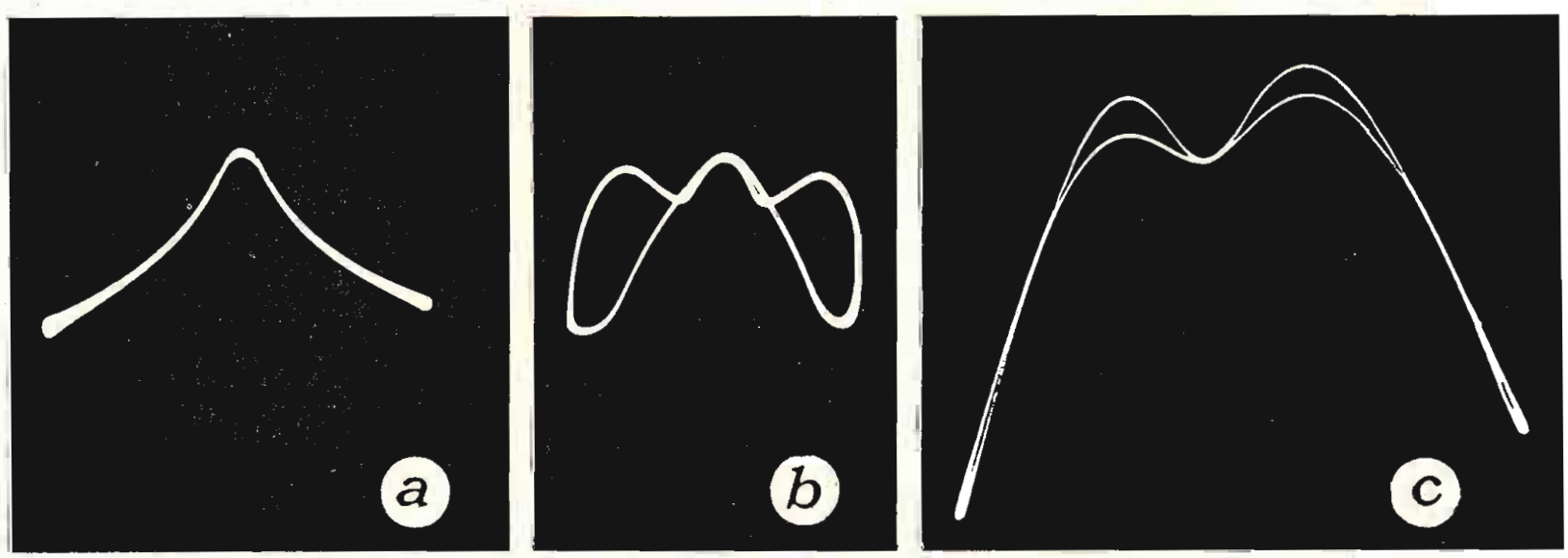
Saturable Reactors

The saturable reactor is a choke containing an iron core with nonlinear permeability, which means the nonlinearity is caused by the hysteresis loop. Approximately ten years ago, the saturable reactor appeared as the heart of the magnetic amplifier in which a large amount of i-f energy is controlled or modulated by a minute input energy. According to this definition, the magnetic amplifier is nothing but the new version of the magnetic modulator which, long before the invention of vacuum tubes, was utilized for the keying of powerful radio transmitters, in particular r-f machines.

The magnetic amplifier improves the old magnetic modulator by two additional steps: first, by a transformation of the i-f energy into dc energy or into the a-f range; second, by a positive feedback. Nevertheless, the magnetic amplifier achieved its present perfection by the development of highly sensitive alloys characterized by very small hysteresis loops, thus exhibiting low losses and sharp knees. In addition, ferrites known under such trade names as Ferramics[1] and Ferroxcube[2] shift the frequency range into the r-f field.

Commonly, ferromagnetic properties are expressed in terms of, or are demonstrated and investigated by means of, the hysteresis loop disclosing flux density versus magnetization. Another method may be derived from modulation. For this purpose, we operate the reactor under test as a frequency modulator of a test transmitter. The fluctuating frequency deviations caused by ac magnetization are detected by means of an FM monitor, the output of which, in combination with the magnetizing currents, deflects the beam of a cathode ray oscilloscope in both axes. In this way, we obtain dynamic FM oscillograms as shown in Fig. 1. The horizontal line indicates the carrier frequency according to zero permeability or inductance. Curve (a) then is the FM characteristics under a low magnetization, its center portion coinciding with

Fig. 2: Nonlinear capacity of Rochelle salt condenser. (a) capacity, under influence of impressed voltage, decreases symmetrically from its zero value; (b) at lower voltages, hysteresis phenomena and double humps produce a butterfly oscillogram; (c) FM curve with double humps



Applications in AF and RF Circuits

and varistors comprise the three component groups. "polaristor" explained. Applications of these devices, as modulators, harmonic generators, mixers, etc. is discussed

PART ONE OF TWO PARTS

the carrier frequency because only the virgin portion of the hysteresis loop is effective. Under high ac magnetization, hysteresis manifests itself not only in the phase shift according to curve (b), but also in an increased carrier frequency due to the greater slope of the hysteresis loop. This frequency shift disappears as soon as we deal with the reversible permeability, that means as soon as the modulator is subjected to a bias.

Ferroelectric Capacitors

The second type of nonlinear elements are ferroelectric capacitors; these are condensers, the capacity of which vary with the strength of the applied electric field or the impressed voltage. Among other peculiarities, in particular, in addition to piezoelectricity and an abnormally high dielectric constant, such a nonlinearity was first observed in a crystal of Rochelle salt.[3] Therefore, we may say that the dielectric nonlinearity is one form of Seignette-electricity. On the other hand, the similarity between ferromagnetic and Seignette-electric phenomena suggests the general term ferroelectricity. Since ferroelectricity is a manifestation of the polarized dipole molecules in the crystal lattice, we may point out that all piezoelectric dielectrics, in addition to their high permittivity, are also nonlinear, which means, their dielectric constant varies not only with temperature but also with the electric field.

From Rochelle salt, a straight line leads to the Hi-K titanates such as barium titanate[4] and mixtures of barium and strontium titanate having dielectric constants as high as 18,000.[5]

Similar to ferromagnetics, the performance of ferroelectrics also may be expressed in terms of their hysteresis loop revealing the relationship between polarization and polarizing force. Hence, we may apply the aforementioned FM method to ferroelectric condensers. In this manner, one can see directly the capacity or permittivity as it decreases under the influence of an impressed polarizing voltage.[5] Basically, this phenomenon is closely related or may well be proportional to the well known temperature effect.

The ferroelectric FM characteristics are very complex because of their form and shape being dependent on various factors, namely, polarization and frequency as well as temperature. Such characteristic curves are depicted in Fig. 2. Characteristic (a) reveals the relationship between the capacity of a Rochelle salt piezoid and the control voltage when operating below Curie temperature. Important to note the

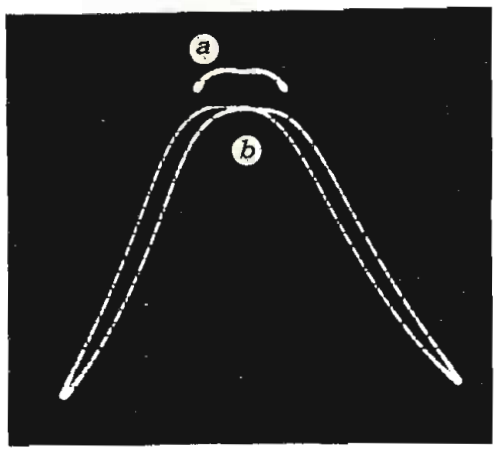


Fig. 3: Ferroelectric FM oscillograms under two different modulation amplitudes

irregularities around the center portion, which, in the ferroelectric hysteresis loop, appear only in the form of minute ripples. Oscillogram (b) is an electrically enlarged picture of the center portion in which the irregularities, in combination with the phase shift, produce the shape of a butterfly. Such a butterfly oscillogram is very characteristic of all types of ferroelectric substances.

A peculiar phenomenon can be observed in that the permittivity, in the vicinity of its zero value, increases a little bit before it decreases in the normal way under the influence of a stronger polarization. The results are double humps as disclosed by oscillogram (c).

Fig. 3 illustrates the same experiment as we remember from the ferromagnetic modulator (Fig. 1). The double hump phenomenon, however, causes the zero capacity to increase, thereby shifting the entire FM characteristic (a) to lower frequencies,

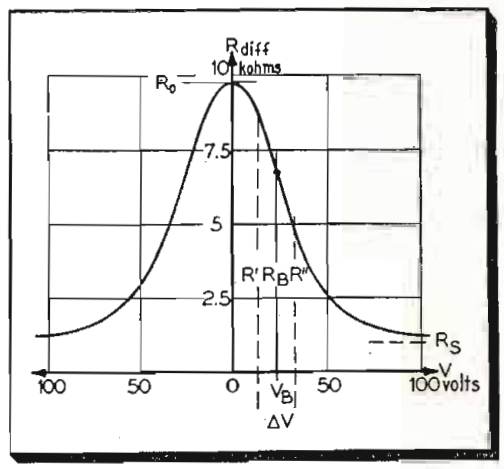


Fig. 4: Curve showing Polaristor differential resistance versus impressed voltage

i.e., to increasing zero capacities until, under a stronger ac polarization, the curve assumes its normal shape (b).

All FM oscillograms reveal a certain asymmetry which may be expressed in terms of a residual prepolarization equivalent to an external bias. This dielectric prepolarization can be artifically enforced to such a degree that the crystal operates under its reversible hysteresis. In other words, its FM characteristic assumes the form of a straight line as accurately as under the influence of an external bias. For this purpose, the crystal is heated above its Curie temperature and then cooled down under the steady influence of a strong polarizing field. Such a prepolarized piezoid makes an external bias unnecessary. The effect is equivalent to the behavior of piezoelectric and electrostrictive transducers which, when subjected to a similar prepolarization, also show a linear electromechanical response.[6] Whether the addition of small impurities, such as lead titanate, may be advantageous in the purely dielectric field, is open to conjecture.

Nonlinear Resistors (Varistors)

The third group of nonlinear elements covers the resistive field in the form of the so-called varistors. It is not my intent to deal with such types as thermistors which, in a certain sense, are also nonlinear, nor with vacuum diodes. Let us consider,

(*Continued on page* 127)

VHF-Microwaves

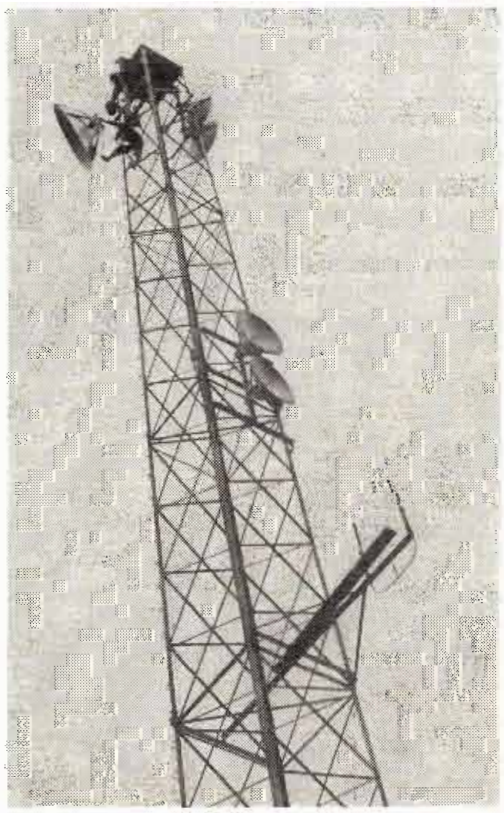
Five base radio stations wave relays over 118-mile

New Jersey State Trooper uses 15-watt mobile transmitter to make traffic control report to headquarters station

By ALBERT J. FORMAN
Assistant Editor, Tele-Tech

THE flexible radio communications network covering the 118-mile New Jersey Turnpike provides a self-sustaining system for expeditious handling of information on traffic movement, emergency repairs, accidents and law enforcement. Extending the length of the recently opened Turnpike from the New Delaware Memorial Bridge at Pennsville to the George Washington Bridge, the $225,000 network integrates communication between base stations mobile police and service units, road maintenance stations, radio interchange points and toll booths; more than 150 locations in all.

Fig. 1: Six-foot parabolic antenna nears top of 150-foot tower at Bordentown. Two microwave dishes halfway down the tower link network to police center at W. Trenton. VHF antennas at lower right contact outlying mobile stations



Basically the system consists of five base radio stations which contact all other units and one another through seven microwave relay stations. The microwave system provides for the simultaneous and independent transmission of seven channels of information, including a spare channel which will eventually act as an essential link in the highway chain from the Pennsylvania Turnpike to the New York Thruway.

One problem which confronted the Paul Godley Co. of Great Notch, N. J., formulator of the engineering requirements, and RCA, designer and installer of the equipment, was to obtain maximum utilization of allocated frequencies with a minimum of co-channel and adjacent channel interference. The magnitude of this consideration is emphasized by the over-crowded radio spectrum being used by many services in the populous New York-Philadelphia area. Directional antennas which confine radiations to the right-of-way were an essential element in resolving the interference problem.

The five base stations transmit on 155.19 MC and receive from the mobile and way stations on 154.83 MC. Their two-element broadside antennas, mounted on the same self-supporting towers (see Fig. 1) which accommodate the parabolic antenna assemblies of the microwave system, have a 3.6 power gain. These directional antennas confine emissions essentially to the Turnpike area, as shown by the radiation patterns of Fig. 3.

The 60-watt base station transmitter that feeds the VHF antenna is the RCA Type CT-12A, which is shown on the left of Fig. 2, installed in a temporary housing along with channeling and microwave equipment. A basic crystal controlled frequency is multiplied through two tripler and two doubler stages to obtain the 36th harmonic. A phase modulator provides a maximum phase swing of nearly 90°, giving ± 15 KC deviation for 100% modulation. Undesired in-the-band emission is suppressed to —90 db, while out-of-the-band frequencies are attenuated 70 db. The matching system to the 50 ohm antenna load impedance uses a double section pie-type filter. Receiver sensitivity is 0.5 μv for 20 db quieting, selectivity is 110 db adjacent channel attenuation at ±30 KC, and signal-to-noise ratio is 50 db. Total power consumption is about 400 watts during operation, and 100 watts during standby.

Outlying Transmitter Signals

When the base station receives a signal from one of the outlying transmitters, it sends this information to the 960 MC microwave relay, which in turn transmits it to some or all of the other relays. These relays then pass the message on to associated VHF base stations which retransmit the information to the mobile and way stations in their respective areas, thereby covering any desired section of the Turnpike which may be dictated by central control.

The 58 mobile units incorporated in the network are equipped with 15-watt transmitters, shown in Fig. 6, which transmit on 154.83 MC and receive on 155.19 MC, the reverse of base station operating frequencies No special wiring provisions have been made in the automobiles carry-

Cover New Jersey Turnpike

interconnect 150 fixed and mobile units through seven micro-highway. Novel dual antenna aids mobile communication

ing transmitter-receivers. Because highway patrols travel considerably more than metropolitan police, the standard auto generator keeps the 6-volt battery sufficiently charged in spite of an additional current drain of 11.8 amps standby and 54 amps operating.

The mobile Carfone transmitter utilizes ±0.005% crystal tuning, multiplying the crystal frequency 18 times. Spurious emission is attenuated 100 db in the band, and 85 db at other frequencies. The phase modulation limiter is of the positive and negative type, maintaining 70% average modulation on normal speech. Deviation is ±15 kc for 100% modulation. Salient receiver characteristics are as follows: sensitivity, 0.8 μv for 20 db noise quieting; spurious response attenuation, 100 db; selectivity, more than 100 db at 35 kc; bandwidth, ±15 kc; frequency stability, up to ±0.0005%; and oscillator radiation less than 0.1 mv.

One notable feature of the mobile equipment is the antenna switching

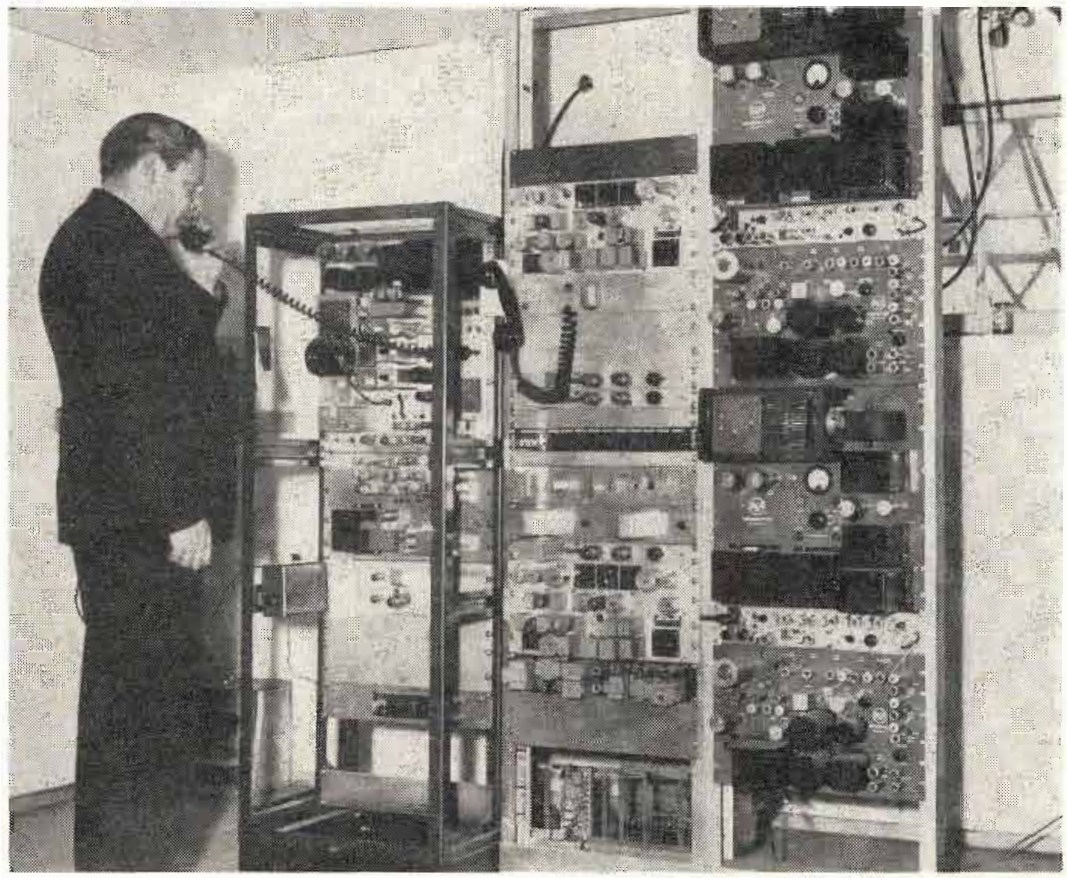
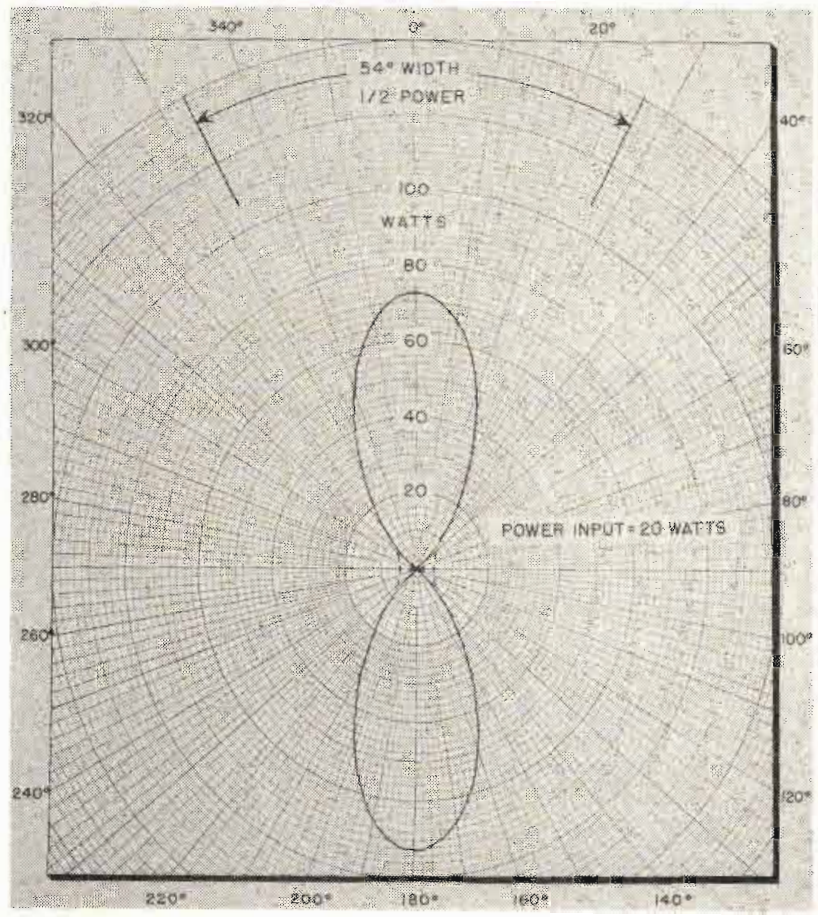
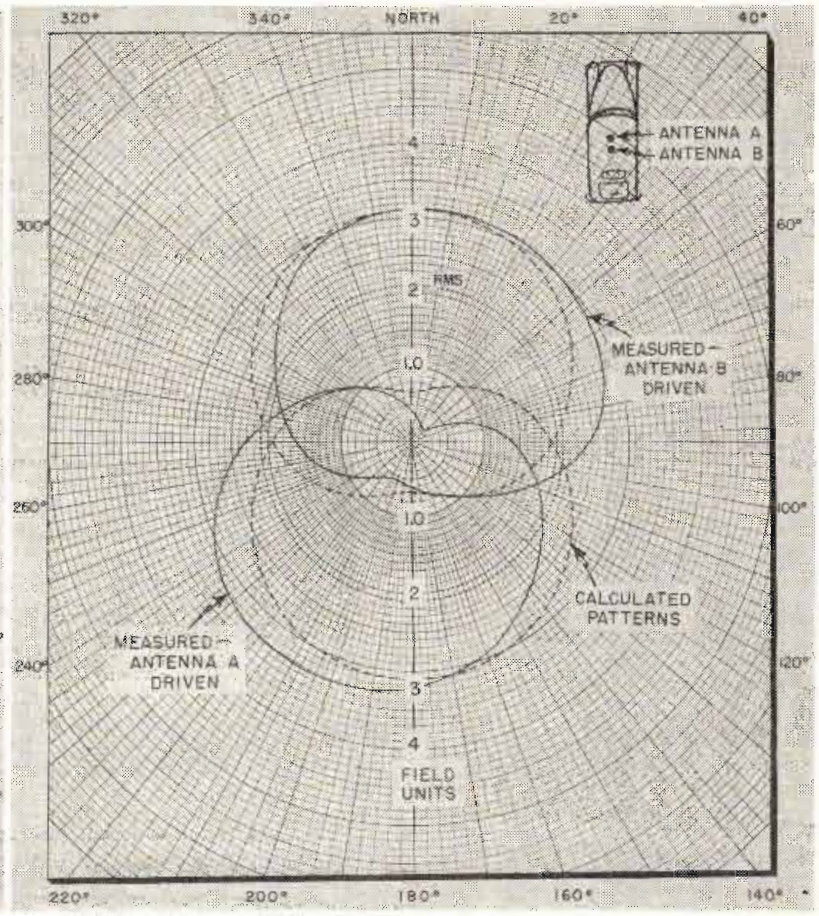


Fig. 2: Terminal station where VHF ties into the microwave system. Shown in temporary housing are (l to r) VHF transmitter and receiver, multiple channeling equipment, and microwave relay rack

Fig. 3: (l) Directivity of VHF base station antenna is indicated by horizontal plane radiation patterns. Fig. 4: (r) Radiation patterns for dual car-top antenna shows how directivity may be reversed by changing driven element with switch inside car. Dashed lines are calculated patterns





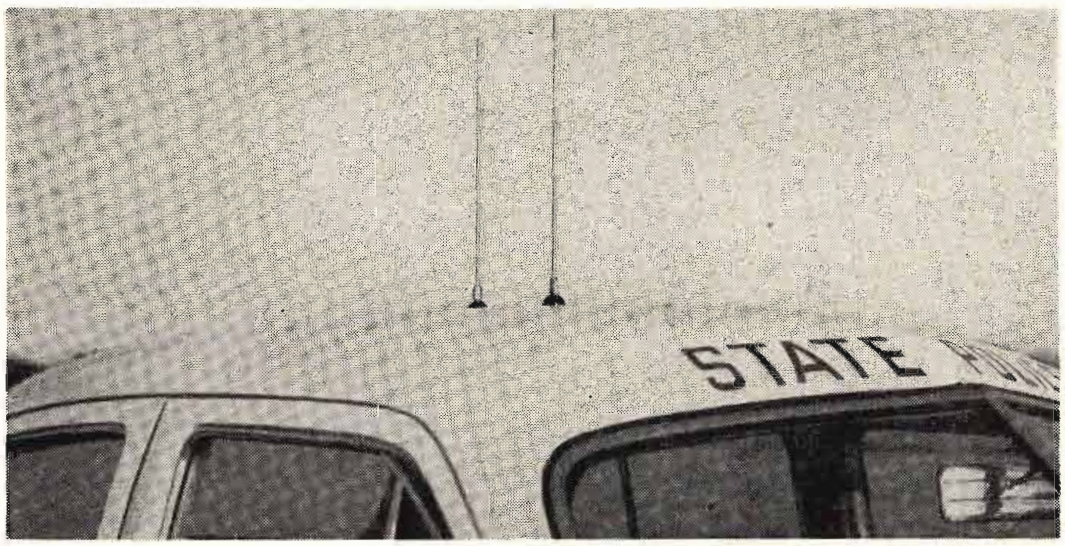


Fig. 5: Dual antenna atop car has forward or backward directivity at a flick of a switch on dashboard control box. Either element can be radiator or reflector to pick up stronger of two signals

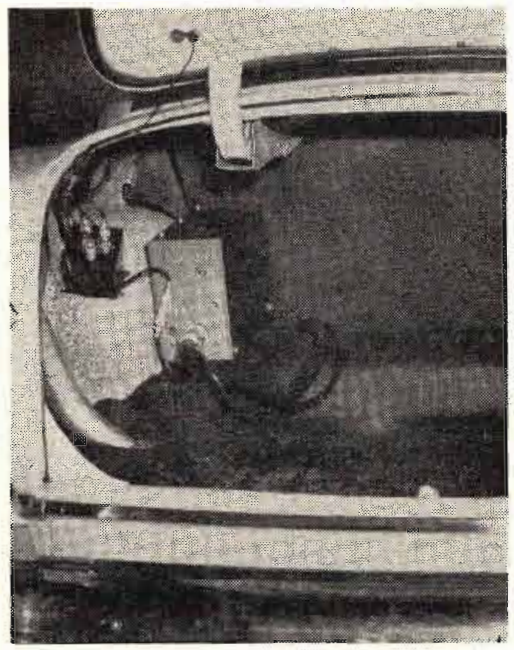
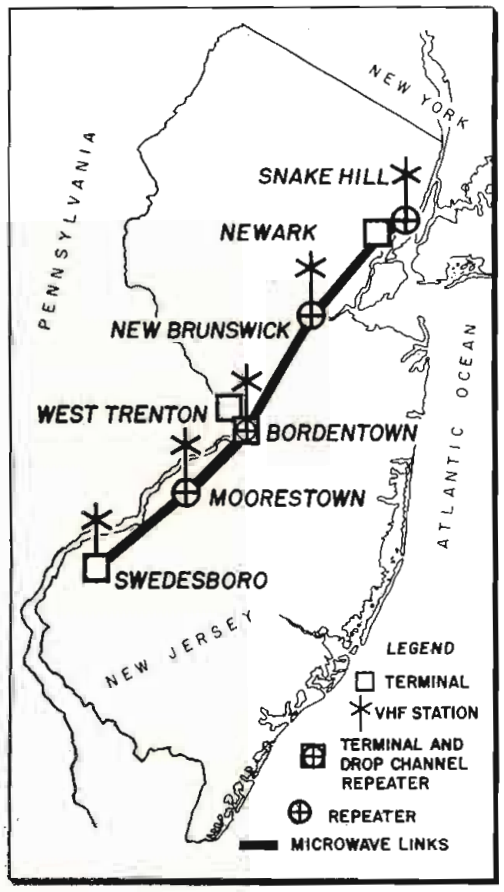


Fig. 6: Transmitter and receiver in car trunk. Coax box at left is antenna switching unit

arrangement which is employed when the mobile unit is in between two base stations and is receiving signals of comparable strength from both. A manually operated sensing and lock-out device prevents voice garbling by electrically reorienting the dual antenna arrangement shown in Fig. 5. The effect of this novel design is to select one of the two stations by changing the antenna directivity, effectively eliminating reception from the other base station, which, of course, is operating on the same frequency. Since the front-to-back power ratio of the dual antenna lies between 20:1 and 25:1, transmitting and receiving benefits gained by the switching arrangement are apparent. Fig. 4 is a plot of the calculated and measured field patterns of the dual antenna.

System flexibility is highlighted in the case of two or more patrol cars working from both sides of a traffic jam in one particular locale. Should they attempt to communicate with each other by transmitting on 154.83 MC, their usual transmitting frequency, their conversations would be picked up by the nearest base station and retransmitted down the line. If a number of similar situations were to arise along the Turnpike simultaneously, the entire network would be tied up. In order to prevent this, and to facilitate handling local problems, the patrol officer need only throw a switch which changes the transmitting frequency to 155.19 MC, the mobile receiving frequency, and at the same time decreases the power to about one watt. Consequently, the reduced power, change in frequency, and directional antenna restrict transmissions to between cars, leaving the main system free to expedite other traffic when so desired.

Fig. 7: Map shows location of five VHF and seven microwave stations along N. J. Turnpike



Way Stations

Operating on the same frequencies as mobile units, way stations employ fixed 15-watt transmitters to communicate with each other and to interconnect with the rest of the network through the base stations. Their function is to serve interchange points, maintenance locations, administration control points, police, concessionaires supplying emergency services, and toll booth supervisors. Way stations equipped with bi-directional antennas have an effective radiated power of 25 watts. Most of the toll booths use half-wave whip skirt dipoles.

Mounted on towers up to 175 ft. high, seven microwave relays beam network communications along the Turnpike at 25 to 40 mile jumps. The locations (see Fig. 7), call letters and operating frequencies of the relay stations are as follows: New Brunswick, KED-44, 957 MC; Newark, KED-42, 953 MC; Moorestown, KED-47, 957 MC; W. Trenton (State Police), KED-46, 953 MC; Swedesboro, KED-48, 959 MC; Snake Hill, KED-43, 955 and 959 MC; and Bordentown, KED-45, 955 and 959 MC. The first four are control stations, while the last three are unattended. Primary control is centered at New Brunswick. The Snake Hill installation is temporarily located at Elizabeth.

The RCA Type CW-5B relay equipment provides for seven simultaneous channels operating on a single carrier. Going south from New Brunswick, for example, they are: 1) Bordentown station control phone, 2) Moorestown-Swedesboro stations control phone, 3) Direct phone to Moorestown Police, 4) Direct phone to W. Trenton State Police, 5) Maintenance phone, 6) Teletype, and 7) Spare channel.

Fig. 8 shows the construction men grappling with the 6-ft., 195-lb. microwave dish at the start of the strenuous 150 ft. haul up the Bordentown tower shown in Fig. 1. The microwave transmitter which feeds this parabolic antenna has a power output of 2 watts, a crystal frequency multiplication factor of 324, frequency stability of $\pm 0.005\%$, and spurious emission attenuation of over 40 db. The phase modulation is 5 radians per channel with approximately 0.5% system distortion; an audio response characteristic of 2 db

(*Continued on page* 94)

The NARTB Engineering Conference

Sixth Annual Meeting in Chicago March 31 to April 2 will feature more than 22 papers; over 38 exhibitors will display the newest broadcast equipment

CHICAGO'S Conrad Hilton Hotel will echo with technical expressions and opinions of exhibits as the Sixth Annual Broadcast Engineering Conference swings into action during March 31 to April 2, 1952. The Conference is one of the prominent features of the Thirtieth Annual Convention of the National Association of Radio and Television Broadcasters, and will bring top engineering talent together to discuss the technical aspects of television, audio, antennas, UHF and other topics associated with broadcasting. A sumptuous banquet in the Grand Ballroom on the last day of the program will round out the pleasant experiences of several luncheons and best-foot-forward presentations of over 35 exhibitors.

Agenda for the Broadcast Engineering Conference is given below, and a list of NARTB exhibitors and their respective space numbers is presented on page 88.

IN THIS ISSUE:

Features of interest to Broadcast Engineers:

Monday, March 31

Morning Session. Presiding: J. R. Poppele, Vice President in Charge of Engineering WOR-TV, N. Y.

Television Control Room Layouts—Rodney Chipp, Director of Engineering, DuMont Television Network

UHF Transmitters and Antennas—John E. Young, Manager, Broadcast Transmitter Engineering Section, Radio Corp. of America

Television Signal Switchboard For Studio and Master Control—H. Thomas, Federal Telecommunication Laboratories, Inc.

Television Camera Switching—Allen A. Walsh, National Broadcasting Co.

J. Poppele

O. Towner

Afternoon Session. Presiding: Orrin Towner, Technical Director WHAS—WHAS-TV, Louisville, Ky.

Advances in Television Equipment Design—L. L. Pourciau, General Precision Laboratory

Improvements in Television Film Reproduction—V. J. Duke and K. W. Mullenger, National Broadcasting Co.

A New Television Camera—John Roe, Radio Corp. of America

A Synchro-Lite Powered 16mm Film Projector for Television—R. E. Putnam, General Electric Co.

Methods of Controlling and Improving Video Signals—R. Betts, Allen B. DuMont Laboratories, Inc.

Tuesday, April 1

Morning Session. Presiding: Frank Marx, Vice President in Charge of Engineering, American Broadcasting Co.

Dynamic Measurement of Base and Circuit Operating Impedances in a Directional Array—Walter F. Kean, Consulting Engineer

Mechanical and Electrical Design Consideration in Speech Input Systems of Highest Fidelity—Norbert L. Jochem, Chief Audio Frequency Engineer, Gates Radio Co.

New 5 KW and 10 KW Transmitters—L. K. Findley, Broadcast Development Engineer, Collins Radio Co.

New Audio Consoles For AM-FM-TV—John Hilliard, Chief Engineer, Altec Lansing Corp.

F. Marx

W. B. Lodge

Joint Luncheon in Grand Ballroom—12:30 P.M.—Speaker: Harold E. Fellows, President, NARTB. Special Feature: "The First Thirty Years Are The Easiest"

Afternoon Session. Presiding: William B. Lodge, Vice President in Charge of Engineering, Columbia Broadcasting System

"Lighting for Television"—A Film Produced by The Columbia Broadcasting System—To be introduced by William B. Lodge, Columbia Broadcasting System

Research in Broad Band Transmission—Dr. W. H. Doherty, Director of Research in Electrical Communications Bell Telephone Laboratories.

Construction and operational Economics of Television Broadcasting—Robin Compton, Associate, George C. Davis, Radio and Television Consulting Engineers

A 35 KW Television Amplifier for Channels 2-6 F. J. Bias, General Electric Co.

Planning and Installation of the First Television Station in Argentina—M. Silver, Federal Telecommunication Laboratories, Inc.

Wednesday, April 2

Morning Session. Presiding: Raymond F. Guy, Manager, Radio and Allocation Engineering, National Broadcasting Co.

High Gain Loop Antenna for Television Broadcasting—A. Kandoian, Federal Telecommunication Laboratories, Inc.

UHF Propagation—Dr. George Brown, Research Engineer, Radio Corp. of America

Television Studio Equipment Planning—C. A. Rackey, National Broadcasting Co.

A Gray Scale Generator—G. Edward Hamilton, Eastern Division Television Engineering, American Broadcasting Co.

R. Guy

S. Bailey

Joint Luncheon in Grand Ballroom—12:30 P.M.

Afternoon Session. Symposium: Ultra-High-Frequency Television, Presiding: Stuart Bailey, Jansky and Bailey, Consulting Radio and Television Engineers, Washington, D. C.

Panel: Ralph N. Harmon, Engineering Manager, Westinghouse Radio Stations, Washington, D. C.; James McNary, Consulting Radio and Television Engineer, Washington, D. C.; John Battison, Director of Education, National Radio Institute, Washington, D. C.; John Young, Manager, Broadcast Transmitter Engineering Section, Radio Corp. of America, Camden, N. J.; Robert P. Wakeman, Research Engineer, Allen B. DuMont Laboratories, Passaic, N. J.

J. DeWitt

Symposium: Small Television Operations.

Presiding: Col. John H. DeWitt, President WSM—WSM-TV, Nashville, Tenn.

Panel: Frank P. Bremmer, Vice President and Chief Engineer, WATV, Newark, N. J.; Nevin Straub, Technical Director, WJAC, Johnstown, Pa.; R. A. Isberg, Chief Engineer, KRON-TV, San Francisco, Cal.; J. E. Mathiot, Technical Director, WGAL-TV, Lancaster, Pa.

See page 88 for list of exhibitors

TELE-TECH
RADIO-TELEVISION-ELECTRONIC INDUSTRIES

TV STATION DATA

Personnel, Addresses, and Equipment for 109 VHF Stations Now Operating

TELE-TECH
RADIO-TELEVISION-ELECTRONIC INDUSTRIES

State	City	Call Letters	Network-Facility	Channel	Video ERP (KW)	Audio ERP (KW)	Ant. Ht. Above Av. Terrain (Ft.)	Trans. Address	Principal Studio Address	Company Address	No. Studio Cameras	No. Field Cameras	No. Microwave Equipt's	35 MM Projectors	16 MM Projectors	2 by 2 Slide Projectors	3¼ by 4 Slide Projectors	Sets in Area (Thousands)	Population Served 0.5 MV Contour (Thousands)	Chief Engineer	Manager
ALA.,	Birmingham	WAFM–TV	ACD	13	26	13	531	Radio Park	Radio Park	Protective Life Building	3	3	1	–	2	2	–	90	—	J. L. Evans	Thad Holt
		WBRC–TV	N	4	12.2	6.2	—	Red Mountain	1727½ 2nd-Avenue N.	P. O. Box 2311	3	–	–	–	2	2	1	92	995	G. P. Hamann	G. P. Hamann
ARIZ.,	Phoenix	KPHO–TV	ACDN	5	17.5	8.75	400	Westward Ho Hotel	631 N. 1st Avenue	631 N. 1st Avenue	3	2	1	–	2	2	–	55	329	G. L. McClanathan	J. C. Mullins
CALIF.,	Los Angeles	KECA–TV	A	7	29.4	14.7	3040	Mt. Wilson	1708 Talmadge Street	ABC TV Center	15	6	3	2	5	4	1	1,450	1,350	J. A. Stagnaro	P. G. Hoffman
		KHJ–TV		9	30.2	15.7	3100	Mt. Wilson	141 N. Vermont Avenue	141 N. Vermont Avenue										Robert Arne	Ward Ingrim
		KLAC–TV		13	31.4	15.75	2955	Mt. Wilson	1000 Cahuenga Boulevard	1000 Cahuenga Boulevard	3	7	4	1	2	2	1	1,250	3,254	R. W. Conner	Don Fedderson
		KNBH	N	4	25.25	13.25	3013	Mt. Wilson	Sunset & Vine Street	Sunset & Vine Street	14	6	2	4	4	4	–	1,161	3.000	R. W. Clark	T. B. McFadden
		KNXT–TV	C	2	25	12.5	2838	Mt. Wilson	1313 N. Vine Street	1313 N. Vine Street										L. H. Bowman	Wilbur Edwards
		KTLA		5	30	15	2921	Mt. Wilson	5451 Marathon Street	5451 Marathon Street										Raymond Moore	Klaus Landsberg
		KTTV	D	11	30.9	15.6	2340	Mt. Wilson	5746 Sunset Boulevard	5746 Sunset Boulevard	4	12	4	1	2	5	1	1,100	1,900	E. E. Benham	R. A. Moore
	San Diego	KFMB–TV	ACDN	8	27	13.7	730	Mt. Soledad	1405—5th Avenue	1405—5th Avenue	–	4	2	–	2	2	1	124	500	Thorton Chew	H. L. Chernoff
	San Francisco	KGO–TV	A	7	25.4	12.6	1260	ABC TV Center	ABC TV Center	ABC TV Center	3	6	1	2	2	2	1	315	1,600	A. E. Evans	G. V. Grubb
		KPIX	C	5	30.5	15.5	538	Mark Hopkins Hotel	2655 Van Ness Avenue	2655 Van Ness Avenue	3	3	1	–	2	3	1	325	2,225	A. E. Towne	P. G. Lasky
		KRON–TV	N	4	14.5	7.5	1325	San Bruno Mountain	901 Mission Street	901 Mission Street	5	5	2	–	2	3	1	315	2,220	R. A. Isberg	C. Thieriot
CONN.,	New Haven	WNHC–TV	ACDN	6	15.1	7.55	500	Hamden	1110 Chapel Street	1110 Chapel Street	3	–	–	–	3	2	1	233	404	V. DeLaurentis	A. De Dominicis
DEL.,	Wilmington	WDEL–TV	DN	7	—	—	480	Shipley Road	Shipley Road	10th & King Streets										J. E. Mathiot	J. G. Walsh
D. C.,	Washington	WMAL–TV	A	7	22	12	525	American University Campus	4461 Conn. Avenue N.W.	724—14th Street, N.W.	4	4	2	–	2	3	–	—	—	F. W. Harvey	K. H. Berkeley
		WNBW	N	4	20.5	10.5	330	Wardman Park Hotel	Wardman Park Hotel	724—14th Street, N.W.	7	7	2	2	3	2	1	350	1,500	C. H. Colledge	E. Juster
		WTOP–TV	C	9	27.3	14.2	460	40th & Brandywine St., N.W.	40th & Brandywine St., N.W.	Warner Building	–	8	2	–	2	3	1	336	2,810	G. Klink, Jr.	J. S. Hayes
		WTTG	D	5	17.5	10.5	587	5217—19th Road N. Arlington, Va.	12th & "E" Streets, N.W.	12th & "E" Streets, N.W.	5	3	2	–	2	2	–	336	1,500	M. Burleson	W. Compton
FLA.,	Jacksonville	WMBR–TV	ACDN	4	14.8	7.4	438	Ft. of Vine Street	605 S. Main Street	605 S. Main Street	2	2	1	–	2	2	–	55	432	E. B. Vordermark	G. Marshall, Jr.
	Miami	WTVJ	ACDN	4	16.5	8.25	306	Everglades Hotel	17 N.W. 3rd Street	17 N.W. 3rd Street	5	3	1	–	2	–	2	108	560	E. W. Lewis	Lee Ruwitch
GA.,	Atlanta,	WAGA–TV	CD	5	26.2	14.4	530	1018 W. Peachtree	1018 W. Peachtree	1018 W. Peachtree	4	–	1	–	2	4	–	165	700	G. B. Smith	S. P. Kettler
		WLTV	A	8	23.8	12.5	558	1601 W. Peachtree, N.E.	15 Forsyth Street, S.W.	15 Forsyth Street, S.W.	2	–	–	–	2	4	2	175	750	H. J. Aderhold	W. T. Lane
		WSB–TV	N	2	50	25	930	780 Willoughby Way, N.E.	1601 W. Peachtree, N.W.	10 Forsyth Street, N.W.	4	2	2	–	2	2	1	156	1,800	C. F. Daugherty	J. M. Outler, Jr.
ILL.,	Chicago	WBKB	C	4	25.2	12.6	650	33 N. LaSalle Street	190 N. State Street	190 N. State Street	6	10	2	2	3	1	–	1,078	5,801	W. P. Kusack	J. H. Mitchell
		WENR–TV	A	7	28.3	14	660	20 N. Wacker Drive	20 N. Wacker Drive	20 N. Wacker Drive	16	3	2	2	4	5	1	1,090	4,062	E. C. Horstman	J. H. Norton, Jr.
		WGN–TV	CD	9	29.0	14.5	586	435 N. Michigan Avenue	441 N. Michigan Avenue	435 N. Michigan Avenue	15	7	2	2	2	2	2	1,100	5,500	C. J. Meyers	F. P. Schreiber
		WNBQ	N	5	23.25	12.29	627	20 N. Wacker Drive	Merchandise Mart	Merchandise Mart	13	3	1	3	3	3	1	1,078	5,915	H. C. Luttgens	H. C. Kopf
	Rock Island	WHBF–TV	ACD	4	23.3	11.7	370	Telco Building	Telco Building	Telco Building	3	3	–	–	2	1‡	–	100	—	R. J. Sinnett	L. C. Johnson
IND.,	Bloomington	WTTV	ACDN	10	34	15	707	E. Hillside Drive	535 S. Walnut Street	535 S. Walnut Street	2	2	4	–	2	3	2	134	1,469	M. L. Weigel	Robert Lemon
	Indianapolis	WFBM–TV	ACDN	6	30.8	18.1	408	Meridian & Washington Sts.	1330 N. Meridian Street	1330 N. Meridian Street	4	4	–	–	2	1	1	212	645	H. S. Holland	H. M. Bitner, Jr.
IOWA	Ames	WOI–TV	ACDN	4	15.7	8	560	Ames	Iowa State College	Iowa State College	–	4	2	–	2	1	2	90	350	L. L. Lewis	R. B. Hull
	Davenport	WOC–TV	N	5	22.9	12.5	350	Pleasant Valley Twp.	805 Brady Street	1000 Brady Street	5	2	3	–	2	1	–	89	284	P. G. Arvidson	E. C. Sanders
KY.,	Louisville	WAVE–TV	ADN	5	24.1	12.05	510	334 E. Broadway	334 E. Broadway	334 E. Broadway	4	2	1	–	2	1	2	140	700	W. E. Hudson	N. Lord
		WHAS–TV	C	9	50	25	529	6th & Broadway	6th & Broadway	6th & Broadway	6	–	1	–	2	–	1	130	856	O. W. Towner	V. A. Sholis
LA.,	New Orleans	WDSU–TV	ACDN	6	31	15.5	395	Hibernia Bank Building	520 Royal Street	520 Royal Street	–	5	1	–	2	2	2	75	800	L. G. Riddle	R. D. Swezey
MD.,	Baltimore	WAAM	AD	13	26.1	14	530	3725 Malden Avenue	3725 Malden Avenue	3725 Malden Avenue	3	2	1	–	2	2	1	358	2,700	G. H. Lahman	K. L. Carter
		WBAL–TV	N	11	27	13	540	2401 Violet Street	2601 N. Charles Street	2601 N. Charles Street										W. C. Bareham	L. H. Peard, Jr.
		WMAR–TV	C	2	16	8	405	Mathieson Building	Charles & Redwood Streets	Sun Square	3	4	3	–	3	3	1	358	—	C. G. Nopper	E. K. Jett
MASS.,	Boston	WBZ–TV	N	4	26.5	13.3	529	1170 Soldiers Field	1170 Soldiers Field	1170 Soldiers Field	3	3	2	2	2	2	1	862	4,500	W. H. Hansen	W. C. Swartley
		WNAC–TV	ACD	7	26.6	13.3	500	Medford, Mass.	21 Brookline Avenue	21 Brookline Avenue	5	3	1	2	2	1	1	862	3,600	G. W. Steffy	L. Travers
MICH.,	Detroit	WJBK–TV	CD	2	16.5	8.3	485	9009 Lyndon	500 Temple	Birmingham	2	2	3	–	2	4	1	—	—	P. Frincke	L. B. Wailes
		WWJ–TV	N	4	20.5	10.25	660	Penobscot Building	615 W. Lafayette Boulevard	622 W. Lafayette Boulevard										E. J. Love	W. E. Walbridge
		WXYZ–TV	A	7	27.9	13.9	480	5057 Woodward Avenue	5057 Woodward Avenue	28 W. Adams St.	8	3	2	2	2	2	–	705	3,300	Charles Kocher	J. G. Riddell
	Grand Rapids	WOOD–TV	ACDN	7	28.5	14.5	501	E. 92nd Street	National Bank Building	National Bank Building	2	–	3	–	2	1	1	193	980	Robert Wilson	Willard Schroeder
	Kalamazoo	WKZO–TV	ACDN	3	16	8	525	AB Avenue & 24th Street	124 W. Michigan Avenue	124 W. Michigan Avenue	–	–	2	–	2	1	1	178	290	C. E. Lee	J. E. Fetzer
	Lansing	WJIM–TV	ACDN	6	20.6	10.3	420	Saginaw & Howard Streets	Bank of Lansing Building	Bank of Lansing Building	–	–	–	–	2	2	–	82	1,000	Chorles Wallace	H. F. Gross

MINN.,	Minneapolis	KSTP–TV	N	5	24.7	17.3	560	3415 University Avenue	3415 University Avenue	3415 University Avenue												S. E. Hubbard	
		WTCN–TV	ACD	4	17.9	9	490	Foshay Tower Bldg.	50 S. 9 Street	50 S. 9 Street	6	3	2	–	2	2	2	301.5	1,250	J. M. Sherman	F. VanKonynenburg
MO.,	Kansas City	WDAF–TV	ACDN	4	22	11	745	3030 Summit Street	3030 Summit Street	1729 Grand Avenue	2	2	1	–	2	1	1	190	1,200	J. A. Flaherty	H. D. Fitzer
	St. Louis	KSD–TV	ACDN	5	16	8	530	1111 Olive Street	1111 Olive Street	1111 Olive Street	4	–	1	–	2	2	–	372	1,839	J. E. Risk	G. M. Burbach
NEBR.,	Omaha	KMTV	ACD	3	16.7	8	591	2615 Farnam Street	2615 Farnam Street	Shenandoah, Iowa	2	2	–	–	2	4	1	125	450	R. J. Schroeder	W. Saddler
		WOW–TV	DN	6	17.2	9	590	3509 Farnam Street	3509 Farbam Street	Insurance Building	2	2	2	–	2	4	1	120	728	W. J. Kotera	F. P. Fogarty
N. J.,	Newark	WATV		13	30.5	15.3	595	W. Orange	1020 Broad Street	1020 Broad Street	6	2	3	–	4	4	1	—	12,191	F. V. Bremer	I. R. Rosenhaus
N. MEX.,	Albuquerque	KOB–TV	ACDN	4	5	2.5	—	905 S. Buena Vista	234 S. Fifth Street	234 S. Fifth Street	2	2	1	–	2	2	–	13	150	G. S. Johnson	G. S. Johnson
N. Y.,	Binghamton	WNBF–TV	ACDN	12	23.5	12	850	Ingraham Hill	Chenango & Lewis Streets	Capitol Theatre Building	2	–	–	–	2	1	–	80	—	L. H. Stantz	C. D. Mastin
	Buffalo	WBEN–TV	ACDN	4	16.2	10.2	335	Hotel Statler	Hotel Statler	Hotel Statler	4	2	1	–	2	2	–	254	1,408	R. J. Kingsley	C. R. Thompson
	New York	WABD	D	5	16.7	8.35	1340	Empire State Building	515 Madison Avenue	515 Madison Avenue	21	4	2	2	4	5	–	3,000	14,000	R. D. Chipp	C. J. Witting
		WCBS–TV	C	2	19.5	9.75	1465	Empire State Building	15 Vanderbilt Avenue	485 Madison Avenue	65	6	3	8	10	4	6	3,000	14,000	Orville Sather	Craig Lawrence
		WJZ–TV	A	7	16.3	8.15	1378	Empire State Building	7 W. 66th Street	30 Rockefeller Plaza	38	8	2	3	3	6	1	3,000	14,000	Frank Marx	J. Trevor Adams
		WNBT	N	4	14.5	7.25	1445	Empire State Building	30 Rockefeller Plaza	30 Rockefeller Plaza	75	15	4	8	8	2	10	3,000	14,000	O. B. Hansen	Ted Cott
		WOR–TV		9	22	11	975	North Bergen, N. J.	Broadway & 67th Street	1440 Broadway	8	11	2	3	4	5	2	3,500	13,740	J. R. Poppele	T. C. Streibert
		WPIX		11	21.7	10.4	1408	Empire State Building	220 E. 42nd Street	220 E. 42nd Street	7	8	3	2	2	5	–	3,500	14,000	T. E. Howard	G. B. Larson
	Rochester	WHAM–TV	ACN	6	23.4	11.7	497	Pinnacle Hill	201 Humboldt Street	201 Humboldt Street	6	–	2	–	2	1	1	128	625	K. J. Gardner	William Fay
	Schenectady	WRGB	N	4	16.32	8.16	832	New Scotland, N. Y.	60 Washington Avenue	1 River Road	3	2	2	–	2	1	1	195	758	W. J. Purcell	R. B. Hanna, Jr.
	Syracuse	WHEN	ACD	8	27	13.5	380	101 Court Street	101 Court Street	101 Court Street	4	3	2	–	2	2	–	160	485	H. E. Crow	Paul Adanti
		WSYR–TV	N	5	26	12.8	640	Sentinel Heights	Syracuse University	224 Harrison Street	–	5	–	–	2	2	2	166	513	Armand G. Belle Isle	E. R. Vadeboncoeur
	Utica	WKTV	ACDN	13	25	12.5	830	Smith Hill, P. O. Box 386	Smith Hill, P. O. Box 386	Copper City Broadcasting	1	–	–	–	2	2	1	70	288	DeF. T. Layton	M. C. Fusco
N. CARO.,	Charlotte	WBTV	ACN	3	16.3	8.2	1111	Route No. 2 Gastonia	Wilder Building	Wilder Building	3	3	1	–	2	2	–	122	717	M. J. Minor	C. H. Crutchfield
	Greensboro	WFMY–TV	ACDN	2	16.72	8.36	470	212 N. Davie Street	212 N. Davie Street	200 N. Davie Street	2	–	–	–	1	1	1	101	1,050	W. E. Neill	Gaines Kelley
OHIO	Cincinnati	WCPO–TV	AD	7	21	12	695	2345 Symmes Street	2345 Symmes Street	1121 Union Central Bldg.	2	2	2	–	2	2	1	331	1,143	J. B. Epperson	M. C. Watters
		WKRC–TV	C	11	24.5	12.3	660	1932 Highland Avenue	800 Broadway	800 Broadway	4	2	–	–	2	1	2	329	1,333	G. A. Wilson	U. A. Lathom
		WLW–T	N	4	19.5	23.5	670	2222 Chickasaw Street	140 W. 9th Street	140 W. 9th Street	2	7	2	–	2	2	–	329	1,638	Howard Lepple	J. T. Murphy
	Cleveland	WEWS	AC	5	16	8	640	Parma	1816 E. 13th Street	1816 E. 13th Street	6	3	3	–	2	2	1	700	1,600	J. B. Epperson	J. C. Hanrahan
		WNBK	N	4	39.22	20.26	620	Brecksville	815 Superior Avenue	815 Superior Avenue	4	4	2	2	2	2	–	570	2,930	S. E. Leonard	John McCormick
		WXEL	ACD	9	25.6	13	725	4501 Pleasant Valley Rd.	1630 Euclid Avenue	1630 Euclid Avenue	8	3	1	–	3	2	1	600	—	Thomas Friedman	Franklin Snyder
	Columbus	WBNS–TV	C	10	24.30	12.15	485	495 Olentangy Boulevard	495 Olentangy Boulevard	33 N. High Street	3	2	1	–	4	2	1	175	1,000	L. H. Nafzger	R. A. Borel
		WLW–C	N	3	15.25	7.8	455	3165 Olentangy River Road	3165 Olentangy River Road	140 W. 9th St., Cincinnati 2	2	2	1	–	2	1	–	210	1,030	C. B. Sloan	James Leonard
		WTVN	AD	6	19.8	10	545	50 W. Broad	50 W. Broad	50 W. Broad	2	2	–	–	2	2	–	300	1,300	J .P. Gill	John Rossiter
	Dayton	WHIO–TV	ACD	13	24	12	570	1414 Wilmington Avenue	1414 Wilmington Avenue	41 S. Ludlow	2	2	1	–	2	2	–	227	460	E. L. Adams	Robert Moody
		WLW–D	N	5	16	8	490	Frytown & W. Carrollton Rd.	4595 S. Dixie Highway	4595 S. Dixie Highway	2	3	2	–	2	2	–	219	1,122	L. G. Sturgill	H. P. Lasker
	Toledo	WSPD–TV	ACDN	13	25	12.3	—	117 S. Superior Street	136 Huron Street	136 Huron Street	3	2	1	–	2	2	1	158	750	W. M. Stringfellow	A. L. Haid
OKLA.,	Oklahoma City	WKY–TV	ACDN	4	16.9	8.5	935	500 E. Britton Road	500 E. Britton Road	500 E. Britton Road	7	7	3	–	4	6	–	113	530	H. J. Lovell	P. A. Sugg
	Tulsa	KOTV	ACDN	6	16.6	8.5	490	National Bank Building	302 S. Frankfort	302 S. Frankfort	4	2	1	–	2	2	1	81	575	G. G. Jacobs	H. M. Alvarez
PA.,	Erie	WICU	ACDN	12	3	1.5	115	35th & State Streets	35th & State Streets	3515 State Street	2	–	1	–	3	3	1	83	210	Michael Csop	Herbert Stewart
	Johnstown	WJAC–TV	ACDN	13	9.24	4.62	—	Laurel Ridge		329 Main Street	–	–	–	–	2	1	–	133	750	T. E. Campbell	Alvin Schrott
	Lancaster	WGAL–TV	ACDN	4	1	0.5	260	8 W. King Street	24 S. Queen	8 W. King Street	2	–	–	–	2	2	2	136	—	J. E. Mathiott	H. E. Miller
	Philadelphia	WCAU–TV	C	10	27	14	667	12 S. 12th Street	1622 Chestnut Street	1622 Chestnut Street	–	14	3	–	3	3	–	1,000	3,300	J. G. Leitch	D. W. Thornburgh
		WFIL–TV	A	6	27	13.5	650	Roxborough	46th & Market Streets	401 N. Broad Street	2	8	3	–	2	–	2	1,010	4,607	L. E. Littlejohn	R. W. Clipp
		WPTZ	N	3	16	8	720	Wyndmoor	1619 Walnut Street	Architects Building	9	5	2	2	4	2	1	1,005	3,300	R. J. Bowley	E. B. Loveman
	Pittsburgh	WDTV	ACDN	3	16.6	8.3	818	4101 Grizella Street	Chamber of Commerce Bldg.	Chamber of Commerce Bldg.	3	2	1	–	2	3‡	–	380	2,500	R. W. Rodgers	H. C. Lund
R. I.	Providence	WJAR–TV	ACDN	11	30	15	615	Rehoboth, Mass.	176 Weybosset Street	176 Weybosset Street										T. C. J. Prior	J. J. Boyle
TENN.,	Memphis	WMCT	ACDN	4	13	7	640	Highway No. 70 & Macon Rd.	3rd & Madison Avenue	495 Union Avenue	4	2	1	–	2	2	–	118	750	E. C. Frase, Jr.	H. W. Slavick
	Nashville	WSM–TV	ACDN	4	23.8	11.9	682	15th & Compton Avenue	15th & Compton Avenue	7th & Union Street	2	2	2	–	3	1	1	60	650	Aaron Shelton	Irving Waugh
TEXAS	Dallas	KRLD–TV		4	27.3	13.6	465	Camp & Griffin Streets	Herald Square	Herald Square										R. N. Flynn	J. W. Runyon,
		WFAA–TV	ACDP	8	27	13.5	400	3000 Henry Hines Building	3000 Henry Hines Building	1122 Jackson Street	5	3	1	–	2	–	1	165	1,000	C. L. Dodd	R. W. Nimmons
	Fort Worth	WBAP–TV	AN	5	16.4	8.2	490	3900 Barnett Street	3900 Barnett Street	400 W. 7th Street	3	3	2	–	2	1	1	154	1,600	R. C. Stinson	George Cranston
	Houston	KPRC–TV	ACN	2	15.1	7.54	502	Post Oak Road	Post Oak Road	Lamar Hotel	2	2	1	–	2	–	1	125	1,075	P. Huhndorff	J. Harris
	San Antonio	KEYL	ACD	5	17.7	8.8	417	Transit Tower	Transit Tower	Transit Tower	3	2	1	–	2	2	1	67	561	W. J. Jackson	G. B. Storer, Jr.
		WOAI–TV	N	4	22	11	480	1030 Navarro Street	1030 Navarro Street	1030 Navarro Street	5	3	1	–	2	2	1	70	720	C. L. Jeffers	A. X. Pangborn
UTAH,	Salt Lake City	KDYL–TV	N	4	3	1.9	500	179 S. Main Street	69 Regent Street	143 S. Main Street	5	2	1	–	2	2	–	70	340	J. M. Baldwin	S. S. Fox
		KSL–TV	ACD	5	18.4	9.2	440	10 S. Main Street	145 Motor Avenue	10 S. Main Street	–	4	1	–	3	3	2	75	300	V. E. Clayton	L. D. Murdoch
VA.,	Norfolk	WTAR–TV	ACDN	4	24	12	365	720 Boush Street	720 Boush Street	Brambelton Avenue	2	2	1	–	2	3	1	102	675	R. L. Lindell	Campbell Arnoux
	Richmond	WTVR	N	6	20	12	431	Staples Mills Road	3301 W. Broad Street	3301 W. Broad Street	2	3	1	2	2	3	1	109	781	J. W. Kyle	W. M. Havens
WASH.,	Seattle	KING–TV	ACDNP	5	19	10	410	301 Galer Street	302 2nd Avenue ,W.	Smith Tower Building	4	–	2	–	4	2	1	125	594	G. A. Freeman	Otto Branht
W. VA.,	Huntington	WSAZ–TV	ACDN	5	16.53	8	588	8th Street Road	W. Va. Building	W. Va. Building	2	–	1	–	2	2	–	75	1,300	L. E. Kilpatrick	L. H. Rogers
WISC.,	Milwaukee	WTMJ–TV	ACDN	3	16	10	325	720 Capitol Drive	720 Capitol Drive	33 W. State Street	4	6	3	–	2	2	1	313	941	E. L. Cordes	W. J. Damm
MEXICO,	Matamoras	XELD–TV	ACN	7	2.5	1.25	—	Nr. Esido De Buenos Aires, Mexico	Nr. Esido De Buenos Aires, Mexico	1111 S. E. Levee, Brownsville, Texas	–	2	–	–	2	2	–	—	351	W. R. Sloat	B. L. Harris

Notes: A—ABC Network, C—CBS Network, D—Dumont Network, N—NBC Network, P—Paramount Network,
Population and receiver density figures provided by stations. Station data is latest available at time of going to press.

Multichannel FM-FM

Frequency multiplexing system, widely used carrier channels. Equipment operates in 200

By M. V. KIEBERT
Bendix Aviation Corp.
Detroit, Mich.

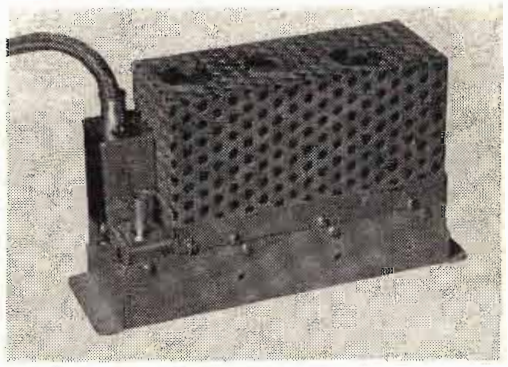


Fig. 9: Representative transmitter, Type 840A

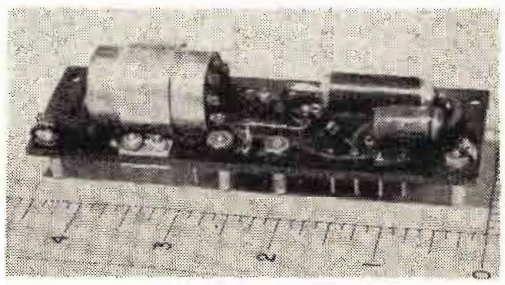


Fig. 10: Typical plug-in subcarrier oscillator

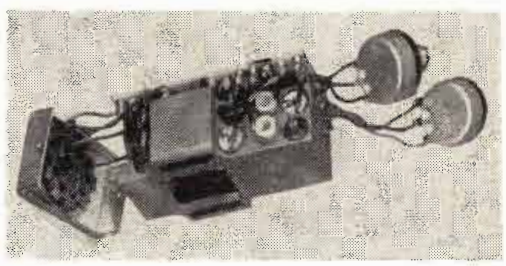


Fig. 11: Type 873 voltage-controlled oscillator mounted in precision cast aluminum block

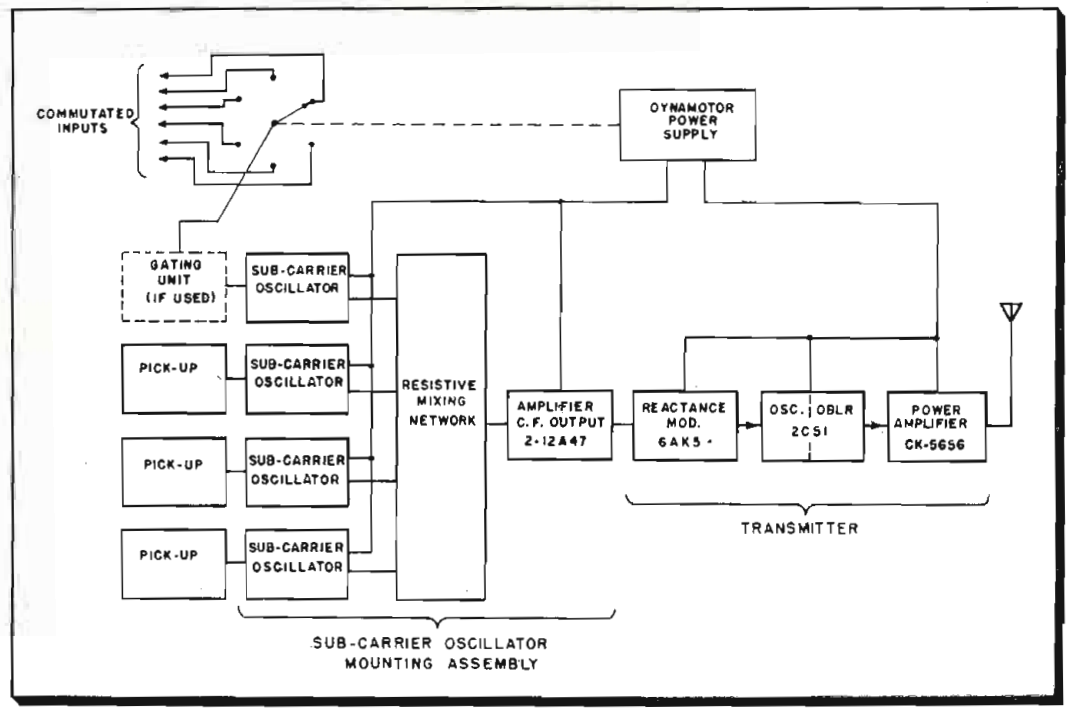


Fig. 8: Typical transmitter system showing self-excited oscillator, modulator and amplifier stages

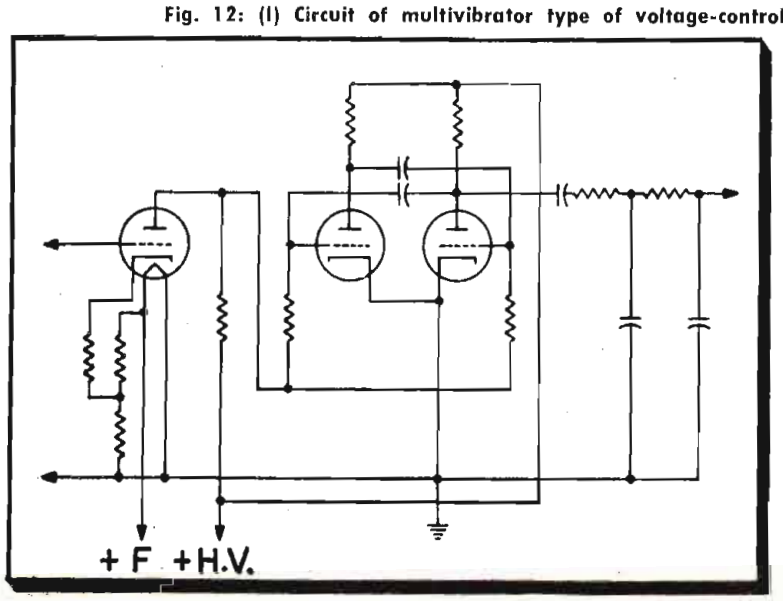
THE basic transmitting equipment is of essentially straightforward design employing a self-excited oscillator modulated by a conventional reactance modulator. The oscillator is followed by one or more multiplying stages and one or more power output stages which may employ grounded grid triodes or special multi-grid tubes. The block diagram of such a system is shown in Fig. 8, and a photograph of a typical transmitter is presented in Fig. 9.

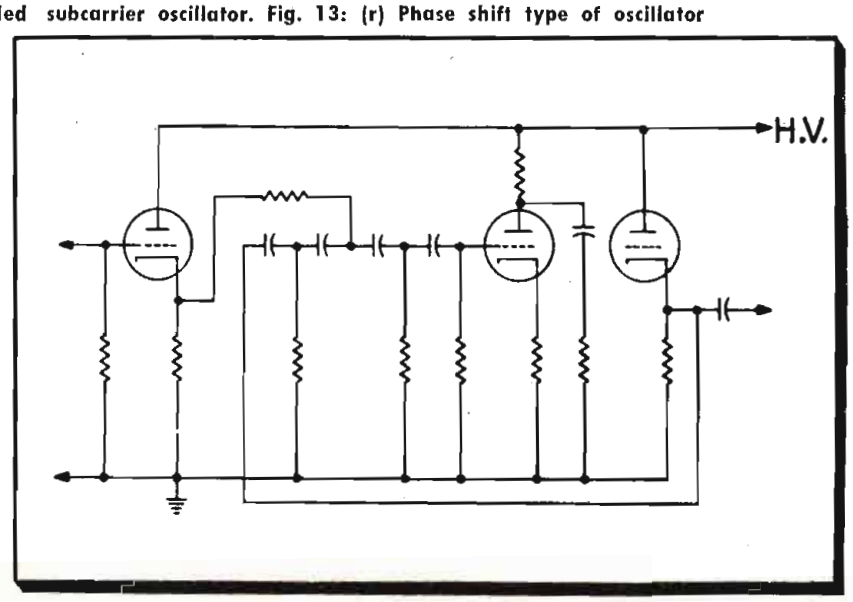
One type of plug-in subcarrier oscillator is illustrated in Fig. 10. Another voltage-controlled oscillator (Fig. 11) is mounted in a precision cast aluminum block which is then potted in a heavy silicone grease. This type of assembly provides an essentially isothermal mounting thus aiding the temperature compensating problem. The silicone grease not only helps the heat transfer problem, but also aids in mechanical damping when the equipment is operated in high vibrational fields. Representative circuits for voltage-controlled subcarrier oscillators are shown in Figs. 12 and 13.

Fig. 14 is a typical strain gage subcarrier oscillator, while Fig. 15 represents a circuit suitable for use with a thermocouple or other similar low voltage, low impedance device.

Fig. 17 is representative of the variable reactance type of subcarrier

Fig. 12: (l) Circuit of multivibrator type of voltage-controlled subcarrier oscillator. Fig. 13: (r) Phase shift type of oscillator





Telemetering System

PART TWO
OF TWO PARTS

in mobile applications, has commutation arrangement to increase number of sub-MC band, has 16 channels operating with less than 0.25% cross-modulation errors

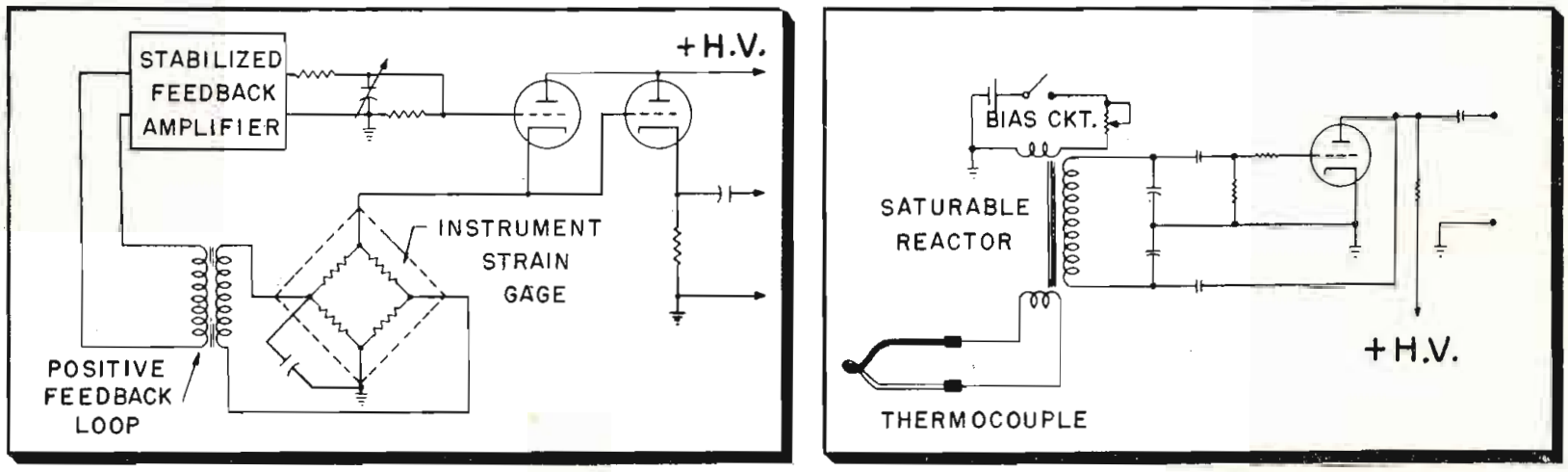


Fig. 14: (l) Circuit of typical strain gage subcarrier oscillator. Fig. 15 (r) Circuit for use with thermocouple or similar low voltage device

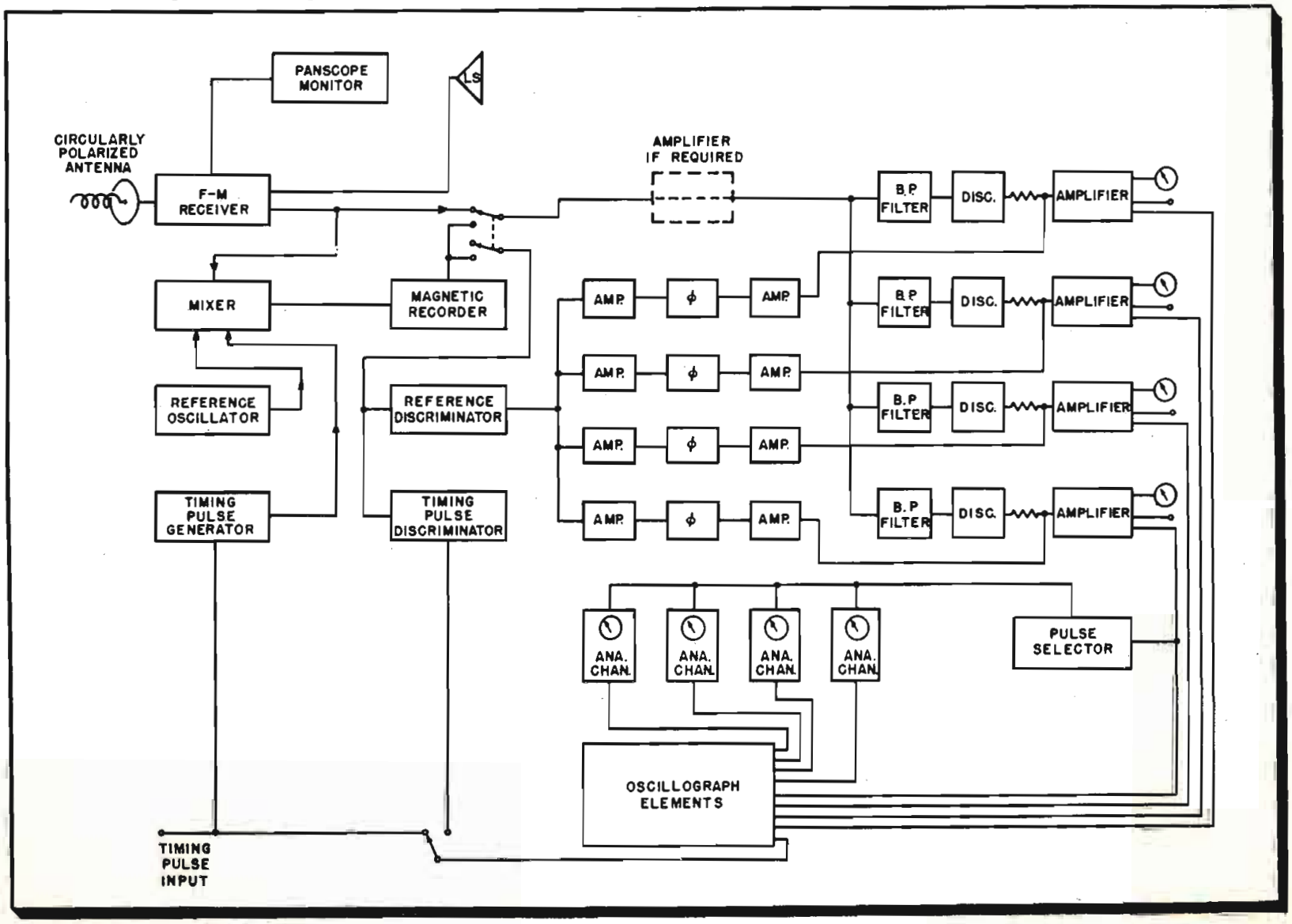
oscillator circuit. It is to be noted that the pick-up itself is a part of the subcarrier oscillator circuit. This unit requires a minimum of power and consists of but few components and hence has found wide application in missile test work. One drawback to the wider use of the unit is the difficulty of commutation due to the basic nature of the circuit.

The plate power supply for the transmitting equipment is generally provided by a dynamotor which may also serve to drive a mechanical commutator. Such a unit is shown in **Fig. 18.**

The observing station may be lo-

(*Continued on page* 90)

Fig. 16: Block diagram of basic observing station showing all system elements normally included in such equipment



CUES for BROADCASTERS

Practical ways of improving station operation and efficiency

An Automatic Fader for Phono Turntables

GLEN SOUTHWORTH, Chief Engineer, KBKH, Pullman, Wash.

IN some station operations the gain of phono channels may be preset and the phono motor started at the same time that the channel is made live by throwing a single switch on the console. This is a convenient arrangement for stations playing much recorded music, but has the disadvantage of not protecting the listeners' ears should the disc be miscued or the turntable bumped thus skipping the needle a few grooves into the record. A technique which retains the simplicity and convenience of the single switch operation is the use of a circuit which automatically fades in the recording, thus minimizing the disagreeable effects produced when the record is brought up to speed in the middle of a recorded passage.

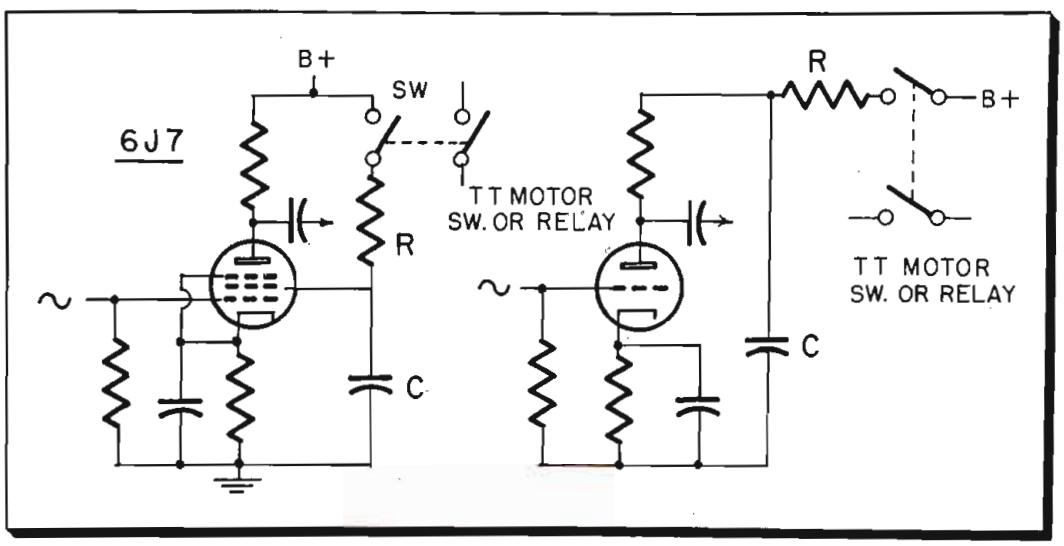
The simplest way to produce automatic fading is to supply the plate or screen voltage to one of the turntable preamp tubes through an RC time delay network. In the case of a pentode tube this may usually be very easily accomplished by putting a switch leg in the screen supply and changing the capacity of the screen bypass capacitor for the desired charging time.

A typical circuit is shown in the accompanying diagram, although numerous variations may be used with equal effectiveness. In the case of a triode stage the best method of obtaining automatic fading seems to be to interrupt the plate supply voltage. In either case, it is recommended that tubes with self bias be used, and that too large signal voltage is not applied to the tube grid. Usually some increase in distortion occurs during the fading process, but due to its transitory nature is not likely to be noticeable.

The time constants of the RC network should be determined experimentally, as some circuits will reach nearly their full gain at voltages much below normal. Similarly, the length of fade may be subject to individual preferences or the length of time required for the turntable to get up to operating speed.

The automatic fader may be used for a number of other applications if desired, as it is capable of producing a more even slow fade than manual control. Suggested uses are for special dramatic effects, or if desired, sounds such as chimes may be simulated when the fader is used in conjunction with an audio oscillator. In this last case a constant tone is applied to the grid of the fader tube at the same instant that the supply voltage to the tube is cut off. The sound resulting from the gradual fadeout may be used to simulate beeps, pops, explosions, triangles, or chimes, depending upon the duration of the tone produced and the frequency of the applied audio voltage.

Circuit for automatic fading-in control for turntable or other audio circuits



$$$ 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 preferred. Our usual rates will be paid for material used.

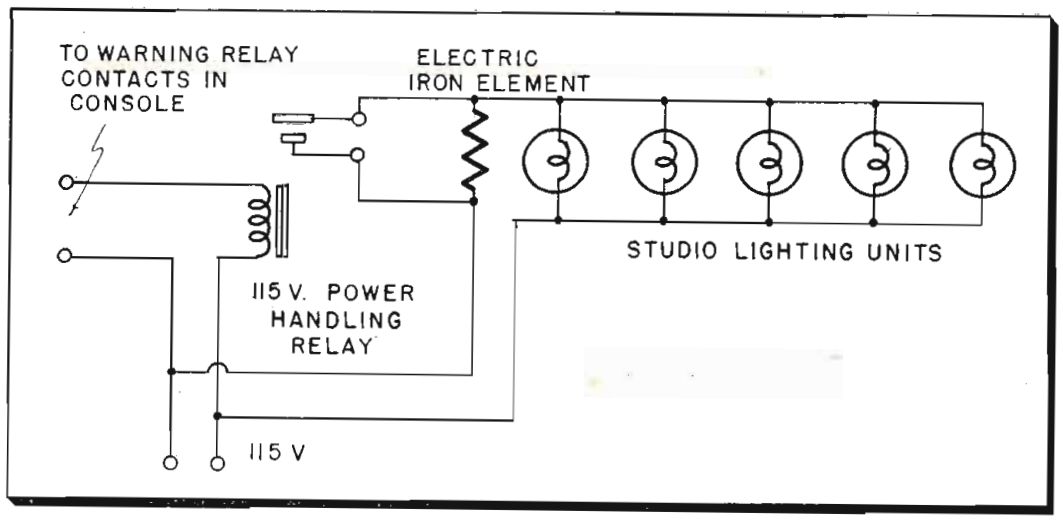
Multi-Conductor Mike Cable Aids Remote Setups

R. S. HOUSTON, 425 Chestnut Lane, Wayne, Pa.

WHEN it is desirable or necessary to set the remote amplifier some distance from the pickup point, and there are several mikes, the problem of having sufficient mike extensions becomes acute, especially if the distance is greater than 50 ft. In a permanent setup, it is often undesirable to tie up mike cable that could be used on non-permanent remotes. Also, several mike lines are somewhat unsightly where appearance counts. To eliminate most of these problems, and to facilitate fast setups, a six conductor shielded cable of 25 ft. length was attached to a 3-position Cannon wall outlet unit. This unit was mounted in an aluminum box made from an old ET. At the end of the cable was attached an 8-circuit Jones plug. The extra two positions connected the shield to the next cable, or to the amplifier. The shield in turn connects to shield connections at the outlet box.

On all the remote amplifiers, a female connector was installed to take the cable plug. This was connected directly in parallel with the mike input sockets in the amplifier. This allowed mikes to be at both the remote position and plugged into the amplifier without the need for special connections or switches. If need be, this system could be used for paralleling of mikes by plugging mikes into corresponding outlets in the remote outlets and at the amplifier.

In the original setup, 200 ft. of multicable were purchased, and divided into two 25-ft., one 50-ft., and one 100-ft. lengths. This has facilitated the removal of the amplifier in the case of a permanent setup where the amplifier is used elsewhere. Through the use of extra wires in a larger cable, a cueing system could be arranged by using the "B" supply in the amplifier and neon lamps near the main microphone or the director.



Fool-proof studio "live" warning light using resistance controlled indicator

Talk-Back Console With Mike Preamp Across Monitor

ORVILLE D. JACKSON, Assistant Engineer, WGGH, Marion, Ill.

AT WGGH there is a complete Gates setup, which includes the SA50 console. This console includes two "talk-back" keys, which are set for use with an external amplifier. However, in view of the plentiful power available, the terminals which are supposed to feed the auxiliary amplifier were tied across the input of the monitor. This put the output of the microphone pre-amplifiers across the input of the monitor amplifier, skipping all gain controls, and providing plenty of volume for talk-back, and guaranteeing that the mike used for this purpose will never get on the air. Associated relay circuits, of course, had to be altered. There are sufficient terminals on the talk-back keys to take care of these changes.

Incandescent or Fluorescent Studio Light Cue

PHILIP WHITNEY, Chief Engineer, WINC, Winchester, Va.

QUITE often a station's otherwise tranquil day is spoiled because an announcer or studio program did not see the warning or "On the Air" signal light. Here is a signal which the the announcer can't miss unless he is in the wrong studio.

Instead of applying the warning light relay to illuminate a small bulb in the conventional "On the Air" sign or red bezel, the contacts are used directly, or operate through a power handling relay, to short out a small resistance which has been placed in series with the studio lights. This resistor may be an electric iron replacement element. The lights, therefore are normally lighted at only about ⅔ brilliance when the studio is not on the air, but when a microphone is opened, the relay shorts out the dropping resistance and the room is immediately flooded by a perceptibly higher light level.

It has been found that it is very difficult NOT to notice this type of warning signal and the embarrassing situation mentioned earlier has practically ceased to exist. The cut and try method will probably be found to be the best solution as to just what resistance and wattage will be needed in a particular application. The system may be used with either incandescent or fluorescent type lamps, and will generally result in added lamp life because of lower operating temperature.

Presetting a Tape

KENNETH J. DOLAN, Chief Engineer, WARA, Attleboro, Mass.

IN many small radio stations where announcers are required to operate the console; turntables, do some program patching and operate tape recorders for both recording and playing back program material, production and program quality are quite apt to suffer.

At WARA, we were faced with the same situation. A great many of our "Man-on-the-Street interviews" and other special events are done via tape recordings. Due to the amount of equipment in our studio-control room the location of our tape machine was not within an arm's reach of the announcer-operator. If for example, a tape was to be played back on the air directly following some program or announcement, the announcer-operator would have to get up from the control desk to reach the switch starting the tape machine. At times the microphone switch would be left on, by mistake, and there would be the noise of a man getting up, chair sqeaking and then the final clunk of the tape starting switch, as it was thrown. Many times there would be long periods of silence between programs.

In order to eliminate this situation a remote tape starting switch, of the mercury type, was installed on the control desk well within an easy reach of the announcer-operator, thus eliminating all of the above inefficiencies and faults. The Magnecord PT6-AH is used at WARA. Inside of the motor section of this tape machine there is a terminal board to which the different switches, etc. connect. Disconnect the lead going to terminal #5 on this terminal board at point x and connect the remote switch in series with it, returning the other side of the remote syitch back to terminal #5. As this #5 terminal is the common lead between the forward and rewind switches, both rewind and forward control of the tape machine are accomplished with one remote switch.

Therefore the announcer-operator can put a tape on the machine at his own convenience and set the regular tape control switch to the proper position and then without having to leave the control desk, operate the tape machine with the remote switch, with no effort, at the proper time. This could be called *presetting.*

Rewinding after the tape has been played is accomplished in the same way, except that the tape control switch on the machine has to be switched to its rewind position. The tape machine can now be operated from either the control desk or the machine itself, provided the remote switch is in the ON position.

Lightning Protector for Broadcast Antennas

D. ELMO DARRAH, 1802 South Walter, Albuquerque, New Mexico

MANY broadcasters find lightning strikes on their towers quite troublesome. A heavy stroke of lightning may practically destroy a beacon. Some stations use copper balls or rings to shield beacons from lightning bolts. These divert the lightning from the beacon but do not prevent severe wear and tear on other antenna circuit lighting and r-f equipment, transmission lines and transmitter final components.

A simple preventative for most lightning damage is the installation of a small, pointed "lightning rod" beside the beacon and extending a few inches above it. During a storm the pointed rod ionizes the air surrounding the tower whenever the atmospheric voltage rises toward the

(*Continued on page* 84)

"Split Channels" for More

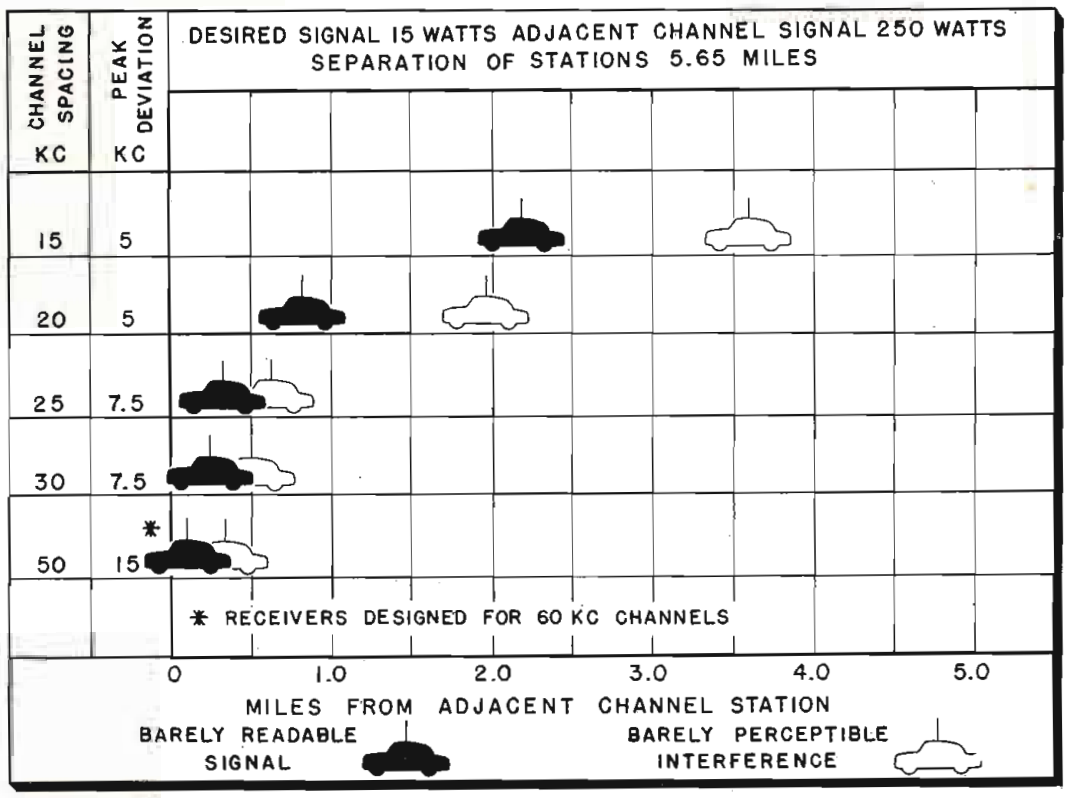


Fig. 7: Effects of interfering station in split channel field tests

Results obtained from field can be made to operate on

By HUGH H. DAVIDS

General Electric Co., Syracuse, New York

THE data for a desired signal power output increased to 15 watts (Fig. 7), which gave a signal of about 10 uv in the vicinity of the interfering Station #1, show similar results. The distances for the two interference criteria are reduced as would be expected, but the relative severity of interference is about the same.

Fig. 8 gives the results of the same tests for split channels 15, 20, and 25 KC spacing, except that the power of the interfering station was reduced to 50 watts. It will be seen again that there is a great impairment in adjacent channel performance in going from 30 KC to 20 KC channels (using 25 KC and 15 KC as minimum spacings).

There is a significant change in the character of the adjacent channel interference as the channels are split. For channel spacings down to 30 KC, the interference was due to increased noise from desensitization and the interfering transmitter noise.

For the closer channel spacing the modulation of the interfering signal began to be evident. With 15 KC spacing and 50 watts interfering signal output, the interference was predominantly due to breakthrough of the unwanted modulation.

Graphical Analysis

As a verification of the results of the field test, graphical analysis of adjacent channel performance was made of these receivers. Receiver interference characteristics were prepared (Fig. 9) and transmitter sideband distribution curves made for voice modulation with 5, 7½, and 15 KC peaks (Fig. 10).[2]

If templates are made of the transmitter sideband distribution curves, occurrence and cause of adjacent channel interference can be determined. The template is placed on the graph of receiver interference characteristics with the ordinate corresponding to the carrier frequency superimposed on the ordinate corresponding to the channel spacing in question and raised vertically until the sideband characteristic intersects the receiver interference characteristic at some point.

If the section of the sideband marked O-P intersects first, the interference is an increase in noise due to the noise output of the transmitter.

If N-O intersects first, it is noise but it is pulsed with the cadence of the interfering modulation.

If in the region of N, then it is break through of the interfering modulation. Finally, if M touches first then desensitization is the first to occur.

The exact level of interfering signal to produce a given amount of interference cannot be determined by this graphical method until a means of correlating the amount of area intersected with the amount of interference is determined. However, the relative performance of different receivers can be established and the nature of the interference that a given receiver will first experience can also be determined.

Using receivers A and C, the better, respectively, of the split channel and 60 KC adjacent channel receivers under test, we find the following results:

1. With receiver C for both 50 KC and 60 KC spacing, adjacent channel interference first occurs due to transmitter noise.

2. Using peak swings of 7½ KC and channel spacings of 30 KC, receiver A suffers interference first from the same cause and at approximately the same level of interfering signal. However, for 25 KC spacing the area of interference changes to area N-O and is evidenced as pulsed noise and occurs at a level of interfering signal about 20 db lower for equivalent interference.

3. Using peak swings of 5 KC and channel spacings of 20 KC, receiver A experiences interference first from the intersection of region N-O well up towards N, characterized by pulsed noise with perhaps some modulation break-through. This occurs at a level of interfering signal about 30 db lower than the equivalent interference level for receiver C on 50 KC channels. With the channel spac-

Mobile Radio Stations

PART TWO OF TWO PARTS

tests conducted in Syracuse, N. Y. show how an increased number of stations adjacent channels when index of modulation and channel width are reduced

ing of 15 KC the intercept is in the region of N, and character of interference is modulation breakthrough. The level of the interfering signal is about 55 db lower for equivalent interference than for the receiver C on 50 KC channels.

The field test data taken agree substantially with these predicted results.

Now, if 5 KC peak swing is used with receiver A on 30 KC channels, the source of noise is still transmitter noise and the interfering signal level approximately the same as receiver C on 50 KC spacing. If the channel spacing is reduced to 25 KC, the same pulsed noise begins to appear but the interfering signal level is reduced only about 3 db. This indicates that split channel operation with 30 KC channel spacing and 5 KC peak swing is practical with little degradation of performance over that now obtained on 60 KC channels with the best equipment.

Receiver Interference Curve

To investigate what would be required to produce a receiver to give equivalent performance on 20 KC channels, a receiver interference curve can be drawn on Fig. 9 which will be the profile of the 5 KC peak sideband template with the carrier set on 20 KC. This curve is marked "hypothetical 20 KC channel receiver E." It is shifted over 3 KC to 5 KC from the curve for receiver A. Since the i-f selectivity of A as measured by 20 db quieting has a bandwidth of 10 KC at 6 db, it can be seen that this hypothetical receiver would have an i-f bandwidth of 2 KC to 4 KC at 6 db. Of course, this would be much too narrow to pass intelligence up to 3000 cps with peak swing of 5 KC. Furthermore, in this determination no allowance has been made for drift or for accuracy of setting of stations, so even if the peak swing were reduced to 3 KC, the minimum practical for a top audio frequency of 3000 cps, the nose width would still have to be too narrow to give normal reception.

Split channel operation makes the rejection of intermodulation interference more difficult as signals producing the interference are closer to the desired signal and can penetrate deeper into the receiver before the high i-f selectivity can attenuate them sufficiently. This can be overcome by improvements in front end design, but with split channels the number of stations which can combine to give intermodulation will be increased. Even with the improvement mentioned above, much more frequent occurrence of intermodulation interference can be expected.

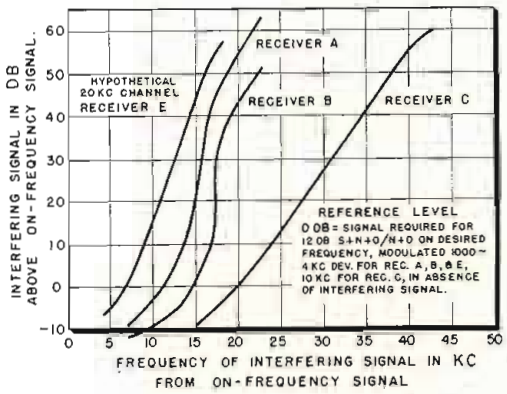


Fig. 9: Interference characteristics of narrow band receivers at 152-174 MC

Conclusions

1. Adjacent channel operation in fully overlapping service areas on 30 KC channels in the 152-174 MC band using 5 KC peak deviation appears practical. The shift to 30 KC channels could be made readily and quite rapidly. However, once made it would be very difficult to make a further increase in the number of channels in the band, for instance, by going to 20 KC channels.

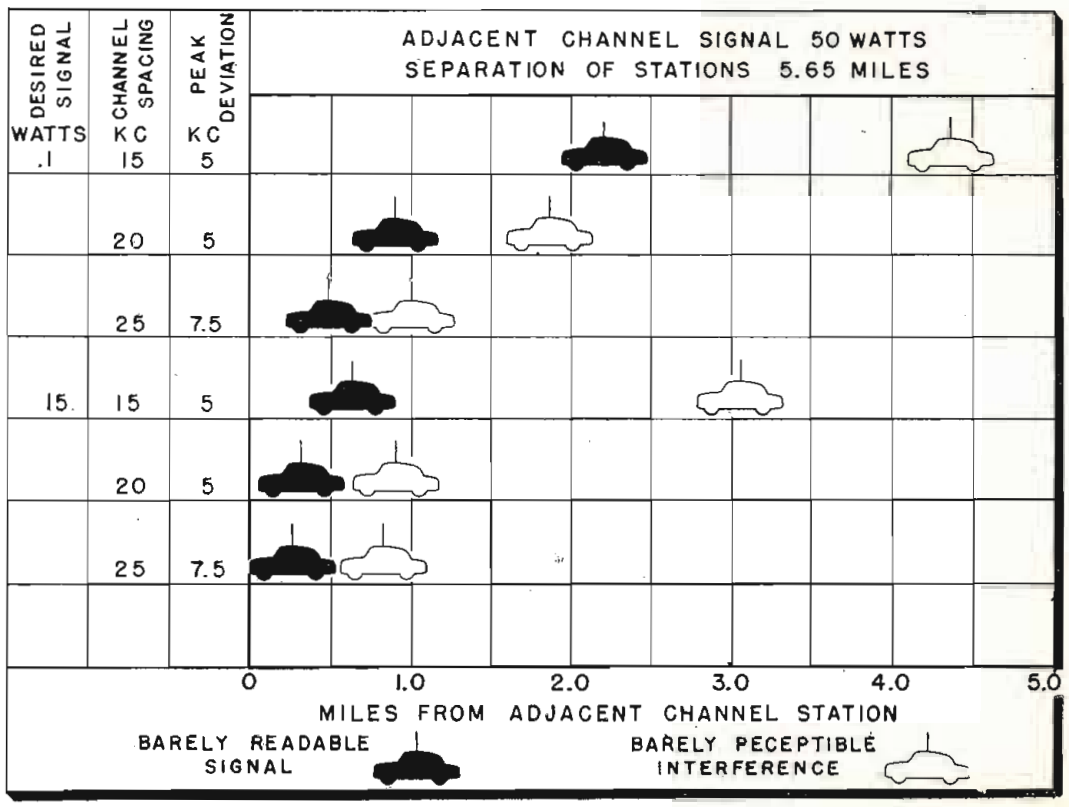
2. Adjacent channel operation in fully overlapping service areas on 20 KC or narrower channels does not seem to be practical at the present state of the art with angular modulated signals (FM or PM).

3. A limited system of adjacent channel operation on 20 KC channels is practical. In this system, stations in service areas that do not overlap or where the overlap is only for regions of low signal level would operate on 20 KC spacing.

In fully overlapping service areas, stations would operate on alternate channels of 40 KC. Such a system would leave the door open for an ultimate change to unlimited use of 20 KC channels, without disruption of frequency assignments, if

(*Continued on page* 115)

Fig. 8: Effects of interfering station in split channel field tests



Tetrodes Improve

Use of 4X150A and 4X150G high power gain per stage

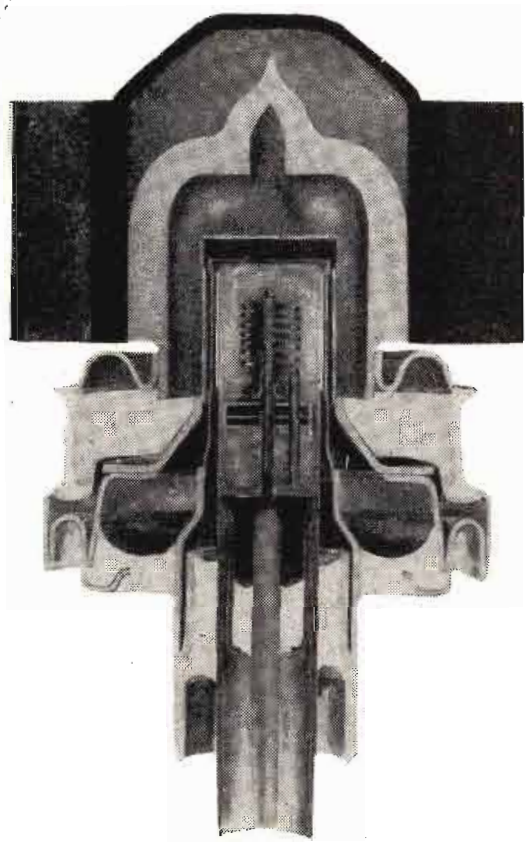


Fig. 1: Photo showing cross-sectional view of Eimac type 4X150G UHF coaxial tetrode

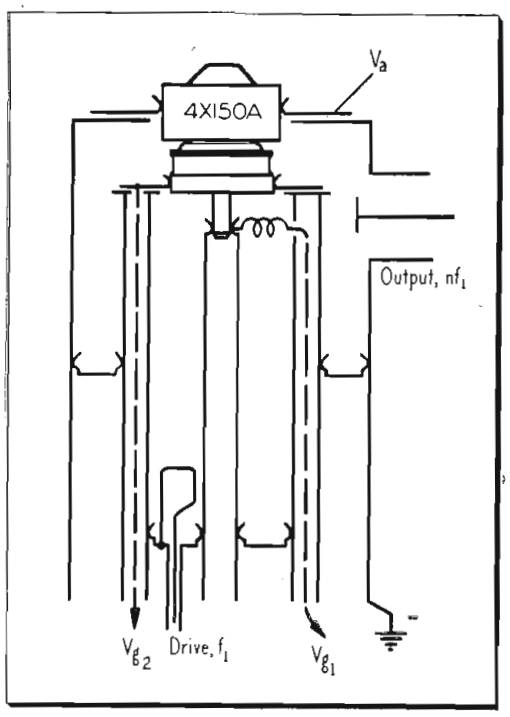
By DONALD H. PREIST
Research Engineer,
Eitel-McCullough, Inc.,
San Bruno, Calif.

There is very little in the literature on the subject of frequency multiplication at VHF and UHF, especially at power levels of interest in practical transmitter designs. The advantages of using tetrodes or pentodes and the benefits of positive feedback seem to have escaped serious recognition. Before discussing these aspects of harmonic generation in detail, it may be of value to summarize the known methods of design of frequency multipliers and to indicate the special advantages of the positive feedback multiplier.

The basic theory of harmonic generation has been stated by Terman[1] and others, and has been expanded by Scott and Black[2]. Special circuits involving feedback as a means of improving the efficiency of harmonic generators have been described by Sterky[3], principally to enable the generation of several harmonic frequencies simultaneously. Brown[4] has shown how, in the case of a triode multiplier, the degenerative feedback caused by the plate-to-grid capacitance and the cathode lead inductance may be neutralized by special circuits. The advantages of using tetrodes or pentodes and the benefits of positive feedback seem to have escaped serious recognition.

It appears that the major problem in using tubes as frequency multipliers at UHF is the elimination of unwanted feedback effects, most of which are functions of the circuitry and especially of the tube itself considered as a major portion of the total circuitry involved. This has a dominating effect on the performance and is of even more importance than the establishment of correct operating bias, etc., which is the dominating factor at low frequencies.

Fig. 2: Section through a re-entrant coaxial frequency multiplier with the 4X150A



Feedback

Let us consider the effects of feedback in general in a frequency multiplier. It is clear that feedback may be either positive or negative and may occur both at the driving frequency and at the harmonic frequency. It will be evident that feedback at the driving frequency will, if negative, increase the driving power required, and if positive, will decrease it. Feedback at the harmonic frequency if negative will likewise have a bad effect and if positive will be beneficial because the tube may then be considered as a direct amplifier at the harmonic frequency. This has been described by Reinartz[6].

On the other hand, in limiting cases such as at UHF where the tube may work only as an inefficient amplifier at the output frequency, very little may be gained by abstracting some of the output power and using it to drive the tube, bearing in mind that the power gain at the output frequency may approach unity and that the circuit problems involved in maintaining a high grid-cathode impedance at both the fundamental and harmonic frequencies may be complex. The discussion may therefore be limited mainly to the application of feedback at the fundamental or driving frequency. The circuit problem here is to arrange that the tube amplifies the driving voltage and at the same time generates the maximum amount of power at the desired harmonic frequency. The

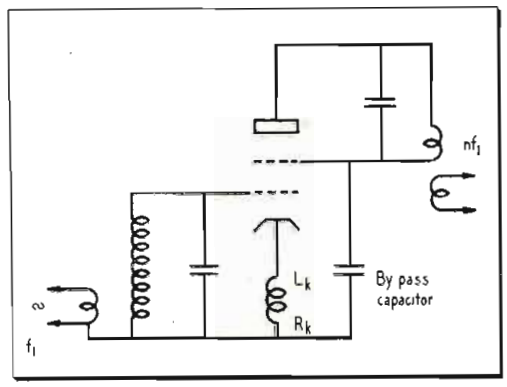


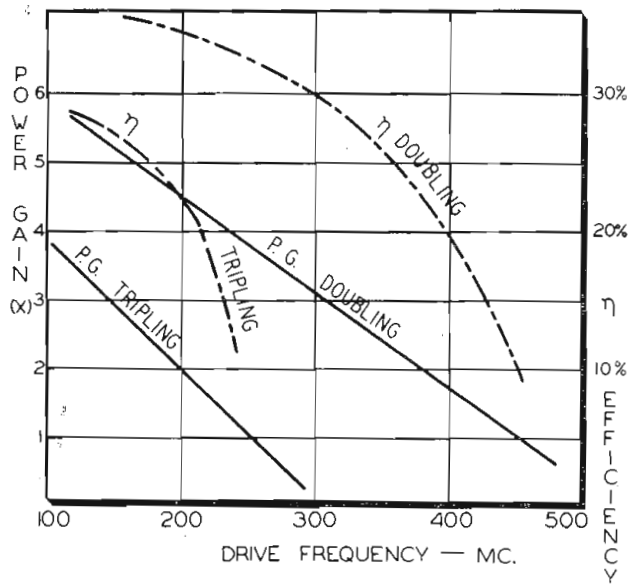
Fig. 3: Equivalent circuit of Fig. 2

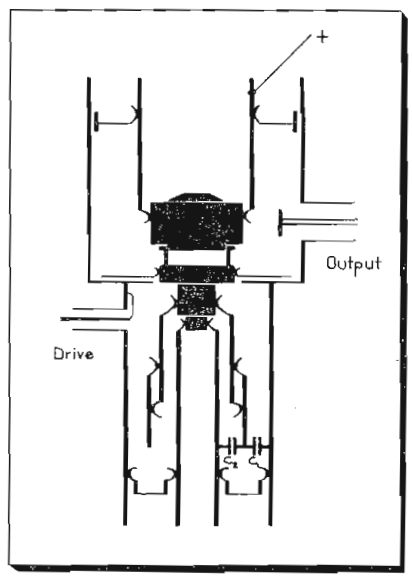
amplified drive voltage must then be fed back to the input circuit in-phase, and with controllable amplitude.

It is difficult to arrange this conveniently with a triode, but it is relatively easy with a tetrode or pentode. The extra electrode or electrodes may then be used together with the control grid and cathode to provide the feedback, while the anode current may be used exclusively for the purpose of harmonic generation. If the feedback is carried far enough to produce self-oscillation at the drive frequency, the result is an "electron-coupled" oscillator-doubler, similar to the original electron-coupled oscillator described by Dow[5], except that the output circuit in that case was tuned to the fundamental frequency. On the other hand, if the feedback is not sufficient to cause

Harmonic Generation at VHF and UHF

with positive feedback frequency multipliers permits in transmitters operating in the 1,000 MC band





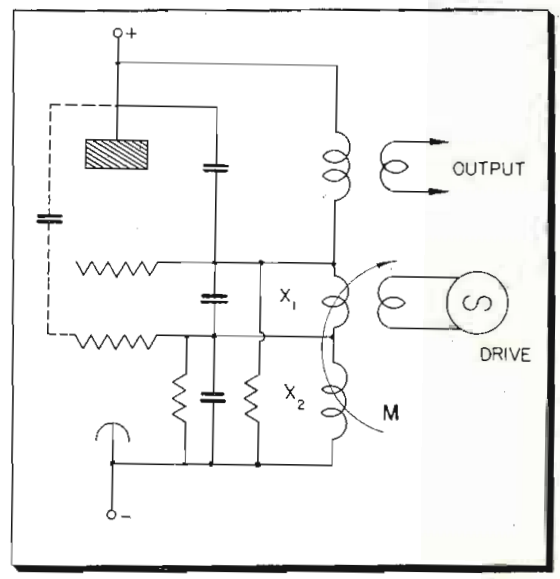


Fig. 4: (L) Performance of 4X150A multiplier of Fig. 2. Fig. 5: (C) Coax multiplier with 4X150G. Fig. 6: (R) Equivalent circuit of Fig. 5.

self-oscillation, the circuit may be driven from an external source. The function of the feedback is then simply to provide a decrease in the driving power required.

One concludes then that tetrodes or pentodes are preferable to triodes as frequency multipliers because positive feedback at the drive frequency may be applied easily. An example of this at UHF will be given later. It is also true, however, that the degenerative effect of C_{gp}, the grid-plate capacitance of the tube, which has been shown to affect the performance adversely[4], is less in a tetrode or pentode simply because C_{gp} is less. Finally the multi-grid tube has the advantage of great inherent power amplification.

Bandwidth Decrease

It will be inferred that the decrease in driving power obtained by positive feedback is not obtained without some corresponding disadvantage. This shows up as a decrease of the bandwidth of the circuit. However, in many practical applications a narrow bandwidth can be used and it is then of interest to consider the limits to the use of positive feedback and the power gains that can be obtained by actual working multipliers at various frequencies. Conversely, it is evident that negative feedback in such a multiplier can be of little value and is almost always a disadvantage.

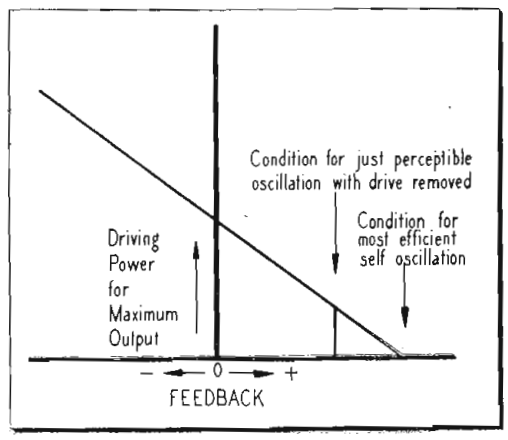
The problem in circuit design is therefore: a) how to eliminate the inherent degenerative effects, and b) how to continue this process further to produce the maximum allowable amount of positive feedback as a means of decreasing the required driving power, preferably using tetrodes or pentodes. Since there are available tetrodes which work efficiently into the UHF region, it is of interest to consider the special circuit problems involved in their use. Two examples, the Eimac 4X150A and 4X150G (Fig. 1), will be taken.

Firstly, the 4X150A will be used to illustrate what can be done simply by using a tetrode in a straightforward multiplier circuit, without positive feedback added. Fig. 2 shows a section through a re-entrant coaxial cavity muliplier for this tube. Both the input and output circuits are tuned to $(2n\lambda/4 + 1)\lambda/4$ electrical length, and the screen-grid and cathode are bypassed together at the tube socket. The equivalent circuit is shown in Fig. 3. At frequencies below about 400 MC, the cathode lead inductance L_k is negligible and the residual C_{gp} may likewise be neglected because of the excellent shielding of the tube. At frequencies above about 400 MC, however, the effect of L_k becomes noticeable in the form of degenerative feedback caused by the introduction of an r-f voltage at the output frequency between cathode and screen-grid and also between cathode and control grid. Also, as the frequency rises, the losses in R_k, the r-f resistance of the cathode leads, and the dielectric losses in the tube base, increase. There is also a smaller degenerative effect due to the passage of anode current at the drive frequency through L_k. The result is the performance shown in Fig. 4, in which power gain and efficiency for various frequency multiplication ratios are plotted against frequency. A marked decline in performance is noticeable above 500 MC.

Considering next the 4X150G, a UHF version of the 4X150A, which is a special case because of the coaxial arrangement of the connections, effective bypassing of the screen grid to the cathode becomes impossible at frequencies above a few hundred

(*Continued on page* 118)

Fig. 7: Relationship of feedback and driving power for obtaining maximum output



Series-Resonant Discriminators

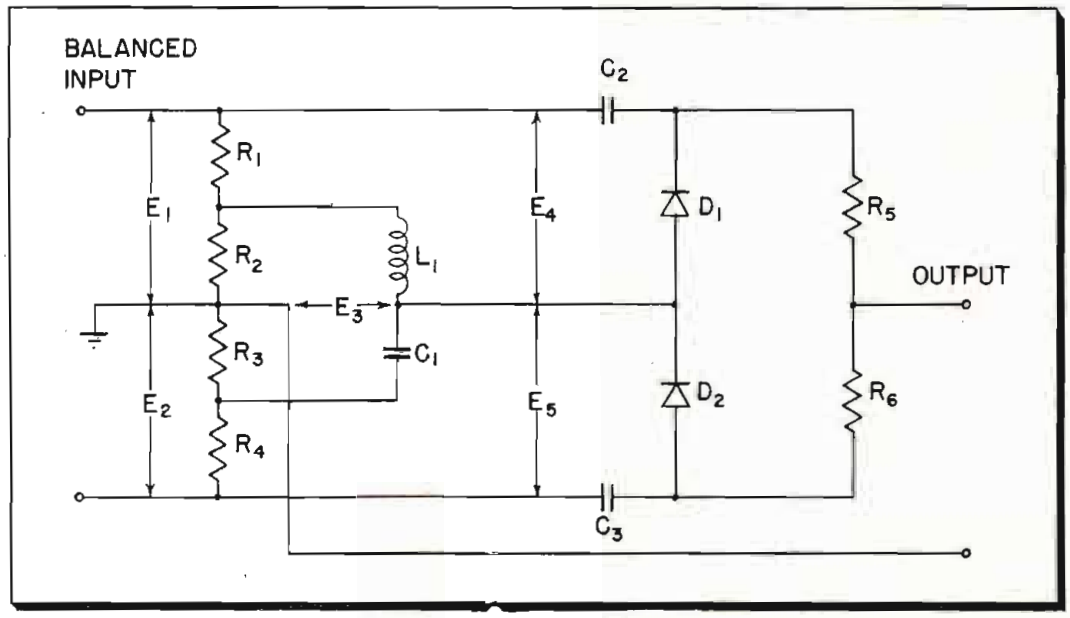


Fig. 1: Schematic diagram of simple series resonant discriminator with typical phase detector

By GLADDEN B. HOUCK, JR.

General Precision Lab., Inc., Pleasantville, N. Y.

A discussion of the ... makes possible re-

ALTHOUGH the series resonant type of frequency discriminator has not been widely recognized, it is worthy of attention because, unlike the more familiar types, it is useful where continuously variable frequency or bandwidth is desired. It is easily constructed from commonly available components and can be used over a wide range of center frequencies. Bandwidth and center frequency are independently variable, so that design is much simpler than with more conventional circuits.

A simple form of the series resonant type discriminator with a typical phase detector is shown in Fig. 1. The circuit is arranged for balanced operation, input voltages E_1 and E_2 being equal in magnitude and opposite in phase. The input resistances R_1 plus R_2, and R_3 plus R_4 are also equal. Resistors R_2 and R_3 are small in relation to R_1 and R_4. They may be initially assumed to be equal to each other, but as will be described later, equality is not an essential condition. Center frequency is determined by inductor L_1 and capacitor C_1, which are series resonant across resistors R_2 and R_3.

The voltages in this discriminator may be represented by the vectors shown in Fig. 2. As in almost all discriminators, two concurrent processes take place. The first is generation of a component vlotage, E_3 in this case, having a definite phase-frequency characteristic from which a complementary pair of component voltages is derived. These component voltages E_4 and E_5, have particular phase-amplitude characteristics. The second, rectification of the components to provide a dc voltage output, is the familiar phase detection process which can be performed by any of several different devices. Although crystal diodes are shown as the phase detectors in Fig. 1, vacuum tube diodes or triodes could serve the same purpose. The vector diagram shows only the first of these processes.

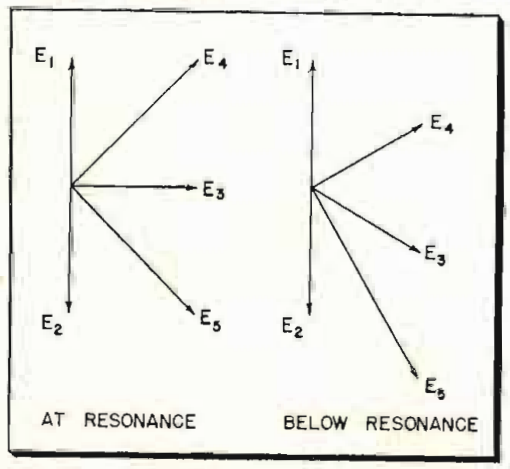
After phase detection, the component voltage vectors E_4 and E_5 become positive or negative dc values proportional to the vector amplitudes. In the particular circuit configuration chosen, the resultant output voltage is proportional to the difference in length between vectors E_4 and E_5. At the series resonant frequency, the phase of E_3 is exactly in quadrature with the two reference phases established by E_1 and E_2. The difference between the rectified values of vectors E_4 and E_5 is zero, hence the rectified output voltage is also zero. At a frequency slightly below resonance, E_3 is larger than E_4, and when rectified produces a negative ouptut voltage. At a frequency slightly above resonance the reverse follows, and a positive output appears. The characteristic polarity reversal of the output voltage as the input frequency sweeps through resonance can easily be recognized as that of a frequency discriminator.

Design Conditions

Initial design values of the discriminator components (L_1, C_1, and R_1 through R_4) can be selected when the desired center frequency and peak bandwidth are known. For best linearity, the peak bandwidth should be at least double the operating bandwidth. There are, however, many servo applications in which a steep frequency response characteristic is more desirable than linearity, and in this case the peak and operating bandwidths may be equal.

Output loading conditions imposed by the preceding driver stage will usually dictate the choice of R_1 and R_4. With these values known, L_1 and C_1 may be chosen. These should resonate at the center frequency, and should also provide at least as large a reactance value at this frequency as the resistance of R_1 and R_4. This latter design condition is an important one because, for optimum output voltage, the quadrature voltage should be at least as large as the reference voltage. The voltage output from the discriminator drops rather rapidly with a decrease in reactance when the reactance is less than the value of either R_1 or R_4. On

Fig. 2: Voltage vectors about resonance



Offer FM Design Advantages

factors governing the operation of this often overlooked circuit. Its use ceivers having bandwidth and center frequency independently variable

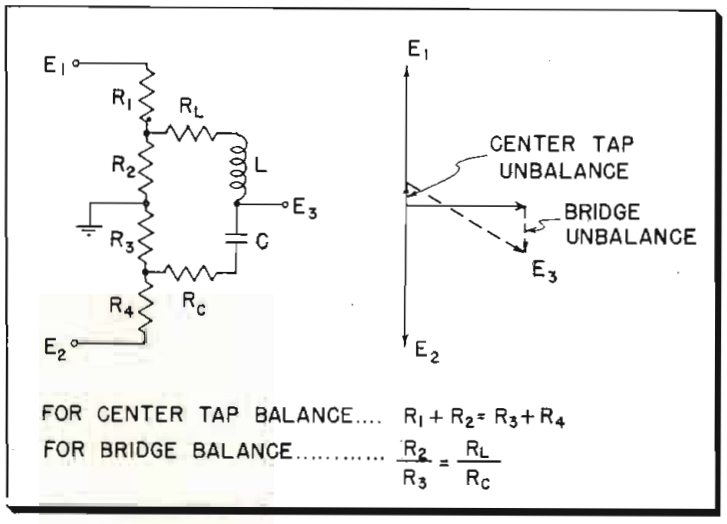


Fig. 3: (L) Balance conditions for series discriminator. Dotted lines show unbalanced effect

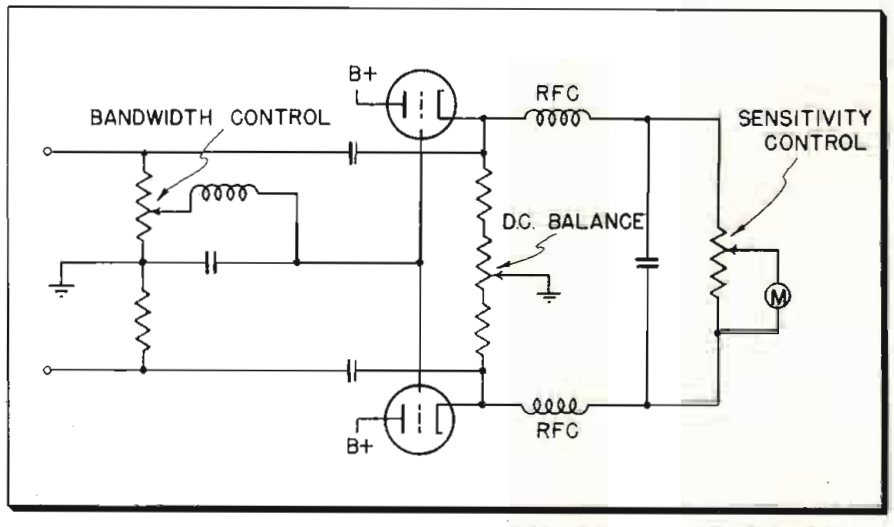


Fig. 4: (R) Variable bandwidth discriminator

the other hand, there is little purpose in increasing the reactance value above that of the resistance because voltage output rises less rapidly with increasing reactance until, at a reactance of approximately double the resistance value, any further gain in output voltage is insignificant.

Trial Results

These conditions are not difficult to satisfy. A few trials will show that there are several readily available capacitor and inductor combinations which satisfy them at center frequencies of 10 MC or lower. So far as circuit operation is concerned, there is no objection to the use of a larger inductor or smaller capacitor than indicated. However, the bulk of an overly large inductor will probably limit its use to breadboard layouts; while the possibility of having to work with troublesome stray capacity effects may bar the use of a small capacitor.

Bandwidth is determined by resistors R_2 and R_3, which establish the Q of the series resonant circuit. These resistors are very small in relation to R_1 and R_4 in any practical circuit design, and hence can be adjusted quite independently. They should be non-inductive composition type because inductance in this part of the circuit, if appreciable, will affect phasing and result in non-linearity of the output response. Such non-linearity will be apparent as a difference in peak amplitudes on either side of resonance.

A similar non-linearity effect may be caused by improper location of the grounding point in the R_2-R_3 pair. Accurate location of this point becomes more important as the ratio of the bandwidth to center frequency increases. Strictly speaking, the resistors should be proportional to the series internal resistances of the inductor and capacitor, as shown in Fig. 3. This arrangement provides a Wheatstone bridge balance for cancellation of in-phase voltage. However, the point is best found by trial, as any stray capacity in a particular layout will affect location.

Ground Connection

When stray capacity is not a factor, as at low frequencies, it will frequently be found that a ground connection at the R_3-R_4 junction is satisfactory. This can be expected from the Wheatstone bridge relation, the series internal resistance of the capacitor usually being very close to zero. A single resistor may then be used in place of the R_2-R_3 pair. This leads to the possibility of continuous bandwidth control with a single variable resistor or potentiometer, one end of which is grounded. Such a circuit is shown in Fig. 4.

Initial design value of the R_2-R_3 pair is computed from the relation, $(f_0/\Delta f = Q = \omega L/R)$; where f_0 = center frequency, Δf = peak bandwidth (center to either peak), L = inductance of L_1, R = total resistance of L_1-C_1-R_2-R_3 loop.

Note that resistance of L_1 must be subtracted from the resistance indicated by the equation in order to arrive at the resistance of the R_2-R_3 pair. If the coil chosen in initial design has too much resistance to begin with, it will be necessary to choose another coil.

The circuit has been found to be a convenient one for use at odd frequencies. One such circuit, built for operation at a center frequency of

(*Continued on page* 114)

Fig. 5: Transformer coupled discriminator

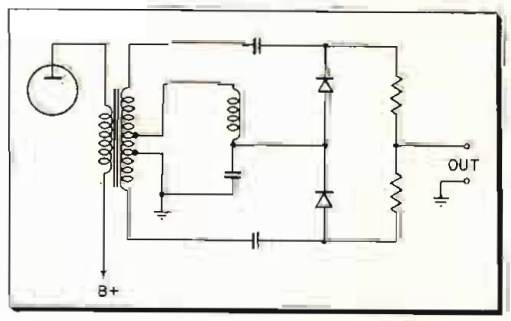
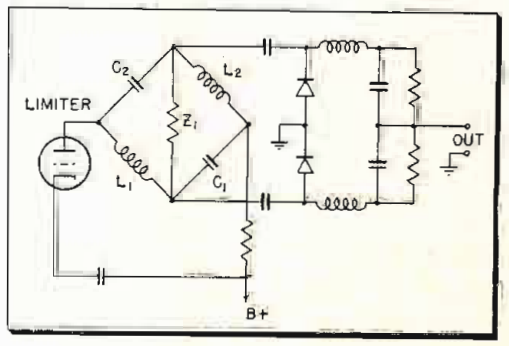


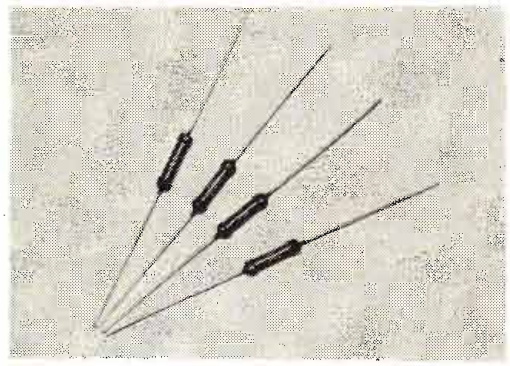
Fig. 6: Twin series version of series resonant discriminator, adapted from monocyclic square



New Equipment and Components

Resistors

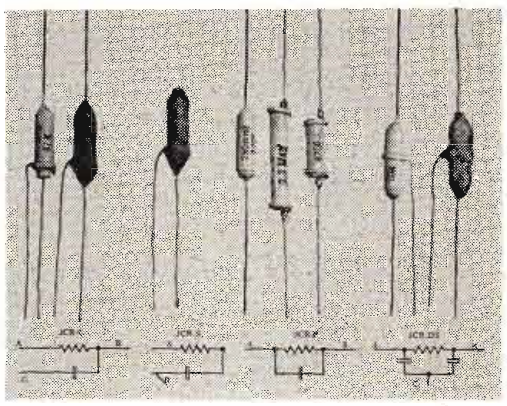
Two new types of deposited carbon and boron carbon resistors (DCC and BOC) are said to provide higher resistance values in



less space and at a lower cost than wire wound precisions. Both units are conservatively rated at ½ watt. Body length is 9/16 in. Diameter of outside caps is 5/32 in.—**International Resistance Co., 401 North Broad Street, Philadelphia 8, Pa.**—TELE-TECH.

"Capristors"

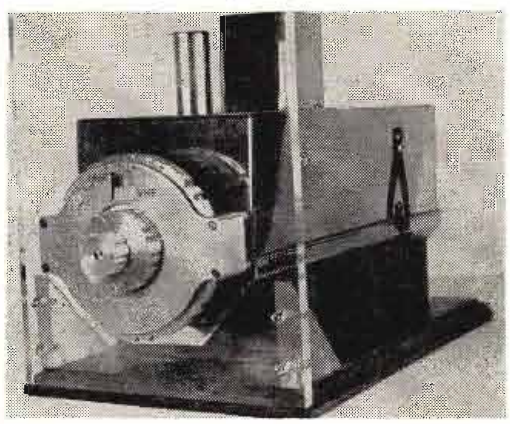
Four new "capristors" are said to reduce assembly time, save space, reduce costs and provide full ratings of equivalent standard



resistors and capacitors in the manufacture of radio, television and radar equipment. Capristors are a combination of capacitors and resistors which are equivalent to simple forms of printed circuits. They are larger than printed circuits, but provide higher ratings. They can be used for diode filters, band pass filters, interstage coupling elements and other resistor-capacitor circuits. Capristors are available either non-insulated, with white enamel, or insulated with a thermosetting dip type coating, vacuum wax impregnated.—**Speer Carbon Co., St. Marys, Pa.**—TELE-TECH.

82-Channel TV Tuner

Employing the "spot" or "detent" principle of the Standard VHF Tuner, this new unit covers all 82 prospective television channels. Selection is made simply by turning the dial until the desired channel number appears in the dial window. The new tuner, which is capable of receiving both

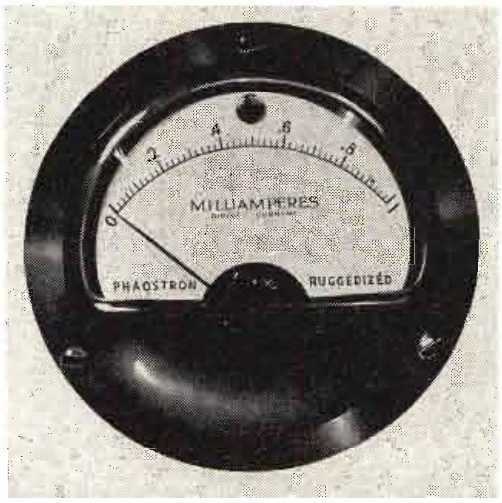


VHF and UHF signals without adjustment by repairmen, also utilizes the fine-tuning principle used in the Standard VHF tuner.

The new tuner will be supplied with all channels "pre-tuned" at the factory, so it will not be necessary for the dealer or serviceman to make any station adjustment. The selecting dial consists of three superimposed knobs. To get the station desired, the viewer turns one knob for the tens digit, another for the units digit, and a third knob for fine tuning, the number of the selected station appearing in the dial window.—**Standard Coil Products Co., Inc., 2329 N. Pulaski Road, Chicago 39, Ill.**—TELE-TECH.

Ruggedized Meter

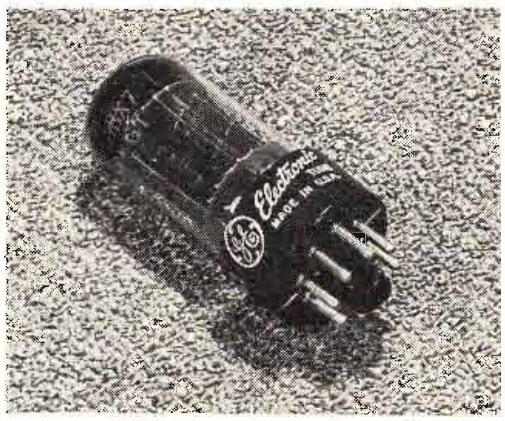
Manufactured under license arrangements with Marion Electrical Instrument Co., a new line of ruggedized hermetically-sealed



electrical indicating instruments provide accurate and sensitive electrical measurement under conditions of shock, vibration, tumbling and widely diverse weather conditions. They are completely interchangeable with all existing ruggedized types in ac and dc ranges and the 2½ in. and 3½ in. sizes meet the dimensional requirements of JAN-1-6. These meters are manufactured in standard 1½ in., 2½ in., 3½ in., and 4½ in. sizes. They are fabricated, assembled, adjusted, tested and hermetically sealed under controlled and exacting conditions, free from contamination in an air-conditioned, temperature-controlled plant.—**Phaostron Co., 151 Pasadena Ave., South Pasadena, Calif.**—TELE-TECH.

Twin Triode

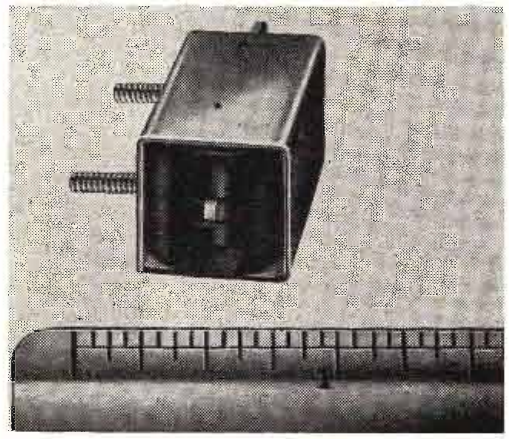
Type 6BX7-GT, is a twin triode designed for the vertical output stage of television receivers as a combined vertical deflection



amplifier and vertical oscillator. It will provide better linearity and more sweep at a lower driving voltage. Because it will operate at a lower voltage, use of the tube will also result in a saving of transformer copper. Among typical operating characteristics for each section are a cutoff voltage of 40 v. with 250 v. on the plate and 80 ma plate current at zero bias with 100 v. on the plate.—**General Electric Co., Syracuse, N. Y.**—TELE-TECH.

Tape Recording Head

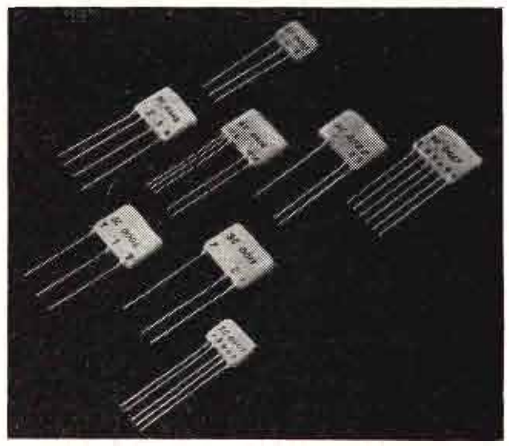
The TR-16, a low-cost magnetic tape recording head, features excellent frequency response; compactness (.765 in. wide by



845 in. long by .609 in. thick); precision-controlled track width—may be furnished with a track of from .025 to .100 in.; flexibility of mounting, using standard 2-56 mounting screws, and may be adapted to specific mounting bracket or used with Shure mounting bracket which provides vertical and angularity adjustments. The TR-16 may be used for multiple-track applications. It has effective mu-metal shielding for optimum hum reduction and simplification of placement of hum-producing components.—**Shure Bros., Inc., 225 W. Huron St., Chicago 10, Ill.**—TELE-TECH.

Printed Circuits

In the production of printed circuit patterns, resistors, capacitors and conductors are "printed" on vitreous, high-dielectric



ceramic plates by a silk screen process. The dielectric properties of the ceramic are used for the capacitors, while silver is used for conductors and carbon graphite or other resistance materials for resistors. After the patterns are printed they are bonded permanently to the ceramic surface by controlled curing; then are protected from abrasion and humicity by the application of an impervious plastic covering. One printed circuit replaces from two to six individual components, with a resulting reduction of soldered connections of from 25% to 80%, depending on the circuit. Since only external leads need be soldered, assembly errors and faulty connections are minimized.—**Stupakoff Ceramic and Manufacturing Co., Latrobe, Pa.**—TELE-TECH.

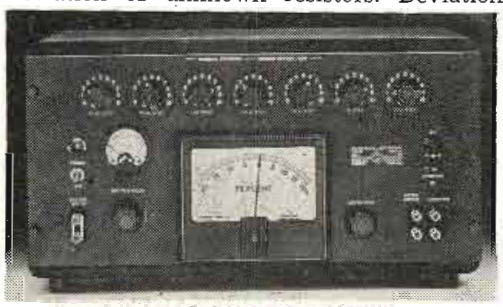
Parabolic Antenna Feed

Faced with the requirement for an antenna to use with a completely pressurized system, standard 2000 MC, parabolic antennas were redesigned to maintain a pressure of 8 to 10 lbs. per square inch. Solving the problem of increased radome density, VSWR has been held under 1.25 to 1 for the dipole style feed. The new feed will mate with ⅞ in. Telflon flexible copper air line, having .045 in. wall and 11/32 in. conductor. However, it can be simply adapted to brass line where desirable.—**Workshop Associates, Div. of The Gabriel Co., 135 Crescent Road, Needham Heights 94, Mass.**—TELE-TECH.

for Designers and Manufacturers

Resistance Limit Bridge

The Type 1652-A Resistance Limit Bridge indicates on a large panel meter percentage deviation of unknown resistors. Deviation



can be measured from an external standard or from an internal standard adjustable from 1 ohm to 1,111,111 ohms in steps of 0.1 ohm. Maximum deviation is ±20% and accuracy is between 0.2% and 0.5%, depending on application. The limit bridge can also be used to match one resistor to another, or as a conventional decade Wheatstone bridge for resistance measurements by the null method. Production applications were of primary importance in the design of this bridge, although it is as useful in the laboratory and model shop as in manufacturing departments. To facilitate the speed and convenience of production measurements, test jigs can be connected directly to panel terminals.—**General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.**—TELE-TECH.

TV Lenses

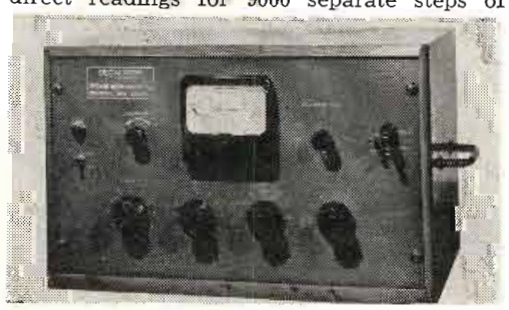
A new line of lenses for television cameras, made by Carl Zeiss, Jena, is now available for the American market. The Carl Zeiss lenses are presently made in mounts to fit RCA cameras only. However, mounts to fit Du Mont, General Precision and General Electric cameras will shortly be available. Among the many features on the new Zeiss lenses is a system for faster matching of objectives, assuring finer definition and easier control during telecasting. All lenses are "T" coated for maximum light transmission and are easily identified by a red "T" engraved on the lens mount. At present the line includes focal lengths ranging from 1 to 14 inches.—**Ercona Camera Corp., 527 Fifth Ave., New York 17, N. Y.**—TELE-TECH.

Electrometer

Model 145 electrometer is ac operated and features direct measurement on a panel meter of dc potentials from 0 to 150 mv. Special modification to give full scale deflection of 30 mv is available. Input terminals are available inside a shielded compartment on the front panel or on a probe which may be used remotely. Input impedances of 10^9, 10^{10}, 10^{11}, or 10^{12} ohms may be selected. All useful circuit points are available through panel connectors, and provision is made for connection to a strip chart recorder. The instrument is housed in a sloping panel 14 x 15 x 9 in. cabinet.—**Special Instruments Laboratory, Inc., 1003 Highland Ave., Knoxville, Tenn.**—TELE-TECH.

Signal Generators

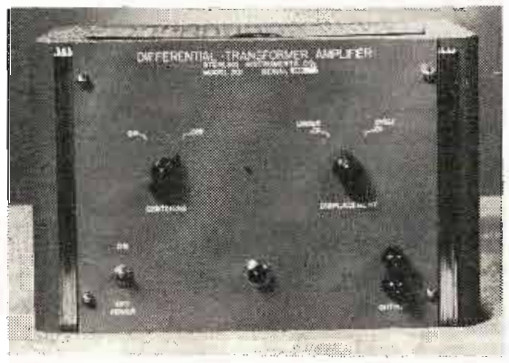
New signal generators known as "Deralators" and consisting of a series of decade-switched oscillators, will cover the 10 KC to 10 MC range. Model 10-100 features: direct readings for 9000 separate steps of



frequency; high frequency accuracy without the use of charts or dials; short term stability, ± 2 cps at all frequencies; high accuracy, ± 0.05% at maximum frequency. Two other models will soon be available. One will be known as Model #100-1, covering 100 KC to 1 MC. The other is Model #1-10 and covers 1 MC to 10 MC.—**Decade Instrument Co., Caldwell, N. J.**—TELE-TECH.

Differential Transformer Amplifier

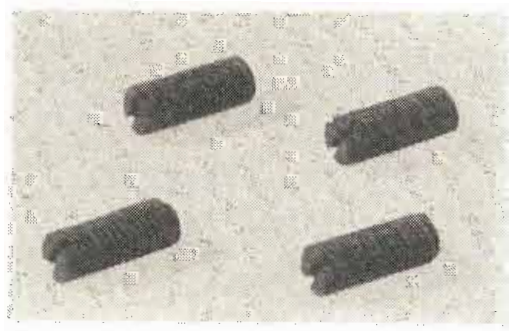
Model 301 differential transformer amplifier is capable of statically and dynamically measuring displacement, force, vibration,



torque, acceleration, pressure, thickness, etc. The instantaneous data may be presented on the screen of a cathode-ray oscillograph, while permanent records may be obtained with direct writing recorders, or recording galvanometers. The frequency response of the Model 301 is from dc to 1000 cps, with a range of motion from ± 0.001 in. to ± 0.1 in. of the transformer core. The output is phase sensitive and indication is given for positive or negative motion. It is powered from 110 v. 60 cps, and has a self-contained carrier oscillator to excite the primary of the linear variable differential transformer. No external power source is needed for the transducer. Model 302 will soon be available for use in the range from ± 0.0001 in. to ± 1.000 in. for measurement of longer displacements at lower frequencies.—**Sterling Instruments Co. 13331 Linwood Ave., Detroit 6, Mich.**—TELE-TECH.

Ferrite Cores

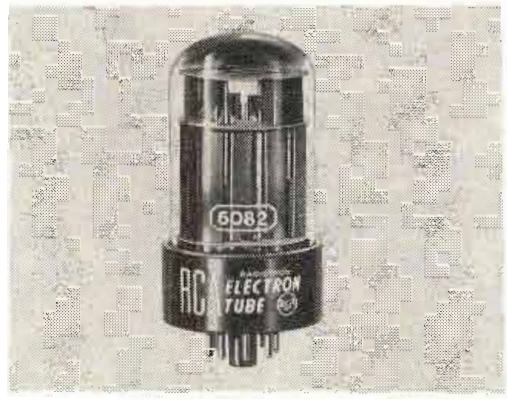
High permeability, low loss ceramic ferrite cores have been developed incorporating sharp, accurately molded threads. Suitable for use at frequencies through the broadcast



band, these easily adjustable tuning slugs are available in .181 in., 0.239 in. and 0.248 in. diameters, and lengths from ¼ in. to ¾ in. Other dimensions will be supplied to customer specifications. Tuning is accomplished by a transverse screwdriver slot, or a rectangular or hexagonal hole through the length of the core. Elimination of the brass adjusting screw effects a considerable saving of a scarce defense item, and measurably improves the Q value of inductive circuitry. The threaded ferrite cores are fabricated from non-critical materials, and are valuable components in sub-miniaturization work, allowing high efficiency coupled with excellent stability.—**Ferricore, Inc., 16 School St., Yonkers 2, N. Y.**—TELE-TECH.

Twin Power Triode

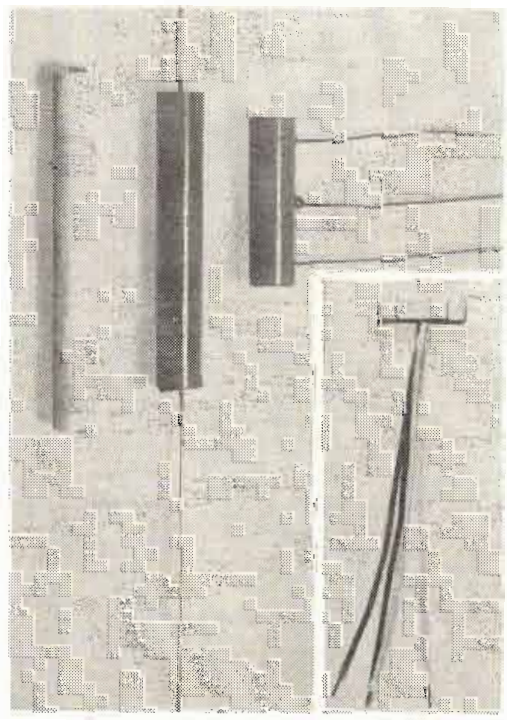
Type 6082 is a new, low-mu, high perveance, twin power triode designed for use as the regulator tube in stabilized dc power-



supply units of aircraft receivers. Featuring conservative ratings, the 6082 consists of two triode units in one envelope and utilizes a 26.5-v. heater. Each unit has a mu of 2, a transconductance of 7000 micromhos, and a plate-dissipation rating of 13 watts. Use is made of a button stem to strengthen the mount structure and to provide relatively wide inter-lead spacing for reduction in susceptibility to electrolysis. These features all contribute to the dependability of the 6082 and to its suitability for use in military aircraft.—**Tube Department, Radio Corporation of America, Harrison, N. J.**—TELE-TECH.

Tubular Selenium Rectifiers

Series 280 tubular selenium rectifiers are available with axial and radial leads. Sealed in phenolic tubes, the 0.28 in. round cells are



rated at 25 v. and 10 ma. Similar Series 500 has 0.5 in. cells rated at 25 v. and 30 ma. Total voltage rating is about 400 v/in. of length. Series 160-ERM translator (see inset) consists of two full-wave bridge rectifiers connected in opposed parallel, and is used in instrument circuits with dc meters to translate applied ac into a current capable of actuating the dc meter. No rectification is involved in the functioning of the circuit. Also introduced are miniaturized rectifiers and units with external resilient members.—**Conant Laboratories, 6500 "O" St., Lincoln 5, Neb.**—TELE-TECH

WASHINGTON
News Letter

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

FREEZE END—Despite the rising crescendo of the public demand for the end of the three-and-a-half-year-old television "freeze," the FCC has had to lengthen its timetable of the ban's lifting from mid-March to early April, to iron out the differences of viewpoint on policies among the Commissioners and to enable the FCC staff to complete the huge report. The latter is to run from 700 to 800 mimeographed pages, with the new rules, standards, and city-by-city allocations consuming about 75 pages. The remainder of the document is to be devoted to the FCC's opinion in support of its decision and the legal answers to those of the 1,500-odd comments filed last Fall whose recommendations are not being followed.

EDUCATIONAL TV—With the determined and vocal pressure of the educational institutions and organizations, aided by potent political backing, the FCC was deemed certain to allocate for educational television a share of the ultra-high-frequency TV spectrum space—probably around 10 per cent. But, in the opinion of most unbiased experts, the educator television proponents do not realize that they must be prepared for large investments, running into possibly hundreds of thousands of dollars for the construction and equipment of stations; and operating costs for regular telecasting services are likewise substantial.

PUBLIC CLAMOR—The increasing clamor by the public for the lifting of the FCC television "freeze" which has been in effect since September, 1948, was brought into the Senate during the hearings on the new Commissioner, Robert T. Bartley, when Senators from Colorado, Missouri, New Hampshire, Texas, and Wyoming emphasized how their constituents were bombarding them with demands to have the Commission authorize the construction of television stations in their areas. With the long delay in the thawing of the "freeze," together with the anticipated lengthy processing of the new television station grants, the FCC might become the target of considerable criticism in the next few months from the populations of the regions of the country now without video service.

NEW FCC CHAIRMAN, COMMISSIONER—Continuity of work on the pressing problems, particularly television in the allocation plan, theatre television and "phonevision" was assured with the appointment of 71-year-old veteran Commissioner Paul A. Walker to succeed Wayne Coy as Chairman; and the selection of Robert T. Bartley, for three years FCC Telegraph Division Director—for five years in broadcasting as Vice President of the Yankee Network—and a top official of the National Association of Broadcasters,—as Commissioner. Chairman Walker, the only remaining "charter" member of the FCC who has served since its creation in the summer of 1934, has the loyal support of the Commissioners and its staff, and is expected to guide the FCC helm in a successful and efficient manner. New Commissioner Bartley, who has been administrative assistant to Speaker of the House Sam Rayburn, his uncle, for the past 3½ years, is ranked as able and energetic, and will particularly benefit the FCC in its relationships with Congress. He has the advantage, too, of practical knowledge of the broadcasting field as an important qualification for the FCC Commissionership.

MILITARY PROCUREMENT — Electronic-radio procurement and research contracts from the Armed Services continue to flow out steadily. This month (April) should delineate specifically the military procurement funds for the electronics-radio-radar manufacturing field in the 1953 fiscal year appropriations of the Department of Defense. The Munitions Board, in order to aid the manufacturers in securing important components for the equipment requirements of the Armed Services, recently revamped its eleven advisory committees with more than 50 officials of manufacturing companies serving as members without compensation. These advisory groups make recommendations to the Munitions Board on military aspects of industrial mobilization planning, procurement, and stockpiling of critical materials.

MOBILE RADIO OPPOSITION—The proposals of the motion picture industry for exclusive television microwave relay channels to transmit theatre television programs are meeting stiff opposition from the major industries engaged in mobile radio communciations. The theatre TV hearings, which had been set to start March 10, have been postponed by the FCC until May 3.

National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington Editor

Cinch
ELECTRONIC COMPONENTS

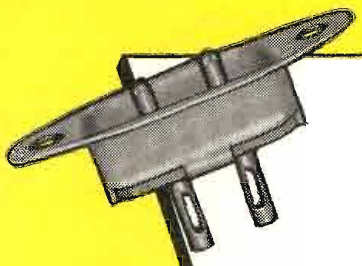
TV 110 VOLT DISCONNECT PLUG
No. 15 M-14684

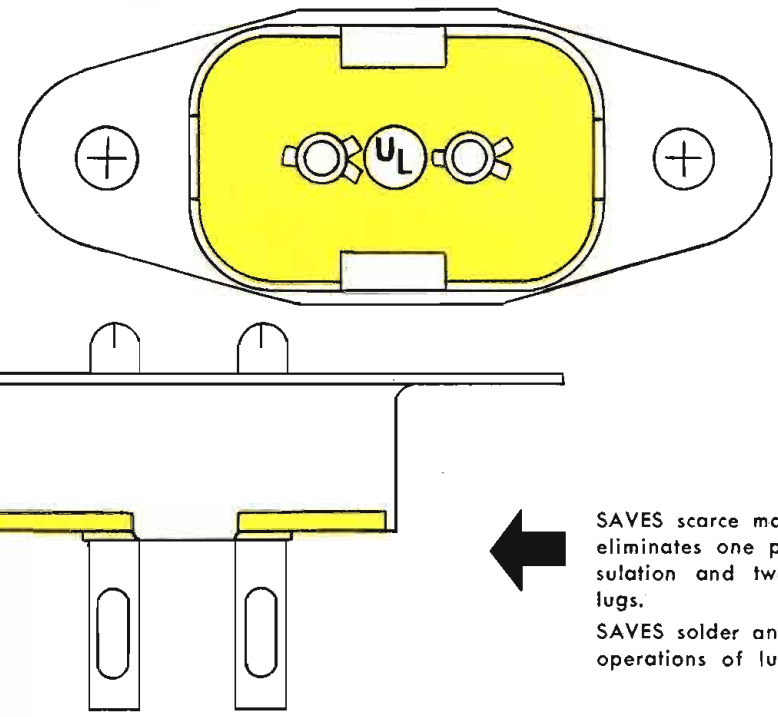
PATENT PENDING

TV 110 VOLT DISCONNECT PLUG

The new CINCH one piece pin with solder tail is featured in the re-designed CINCH 110 Volt TV lead in. Underwriters approved, this improved disconnect is a contribution of CINCH engineering to the industry's programs of material conservation and design simplification.

CONSULT CINCH.





ELIMINATES INTERMITTENTS. The new one piece pin with solder tail insures positive electrical flow through plug to set by eliminating old style pin-lug riveted joint.

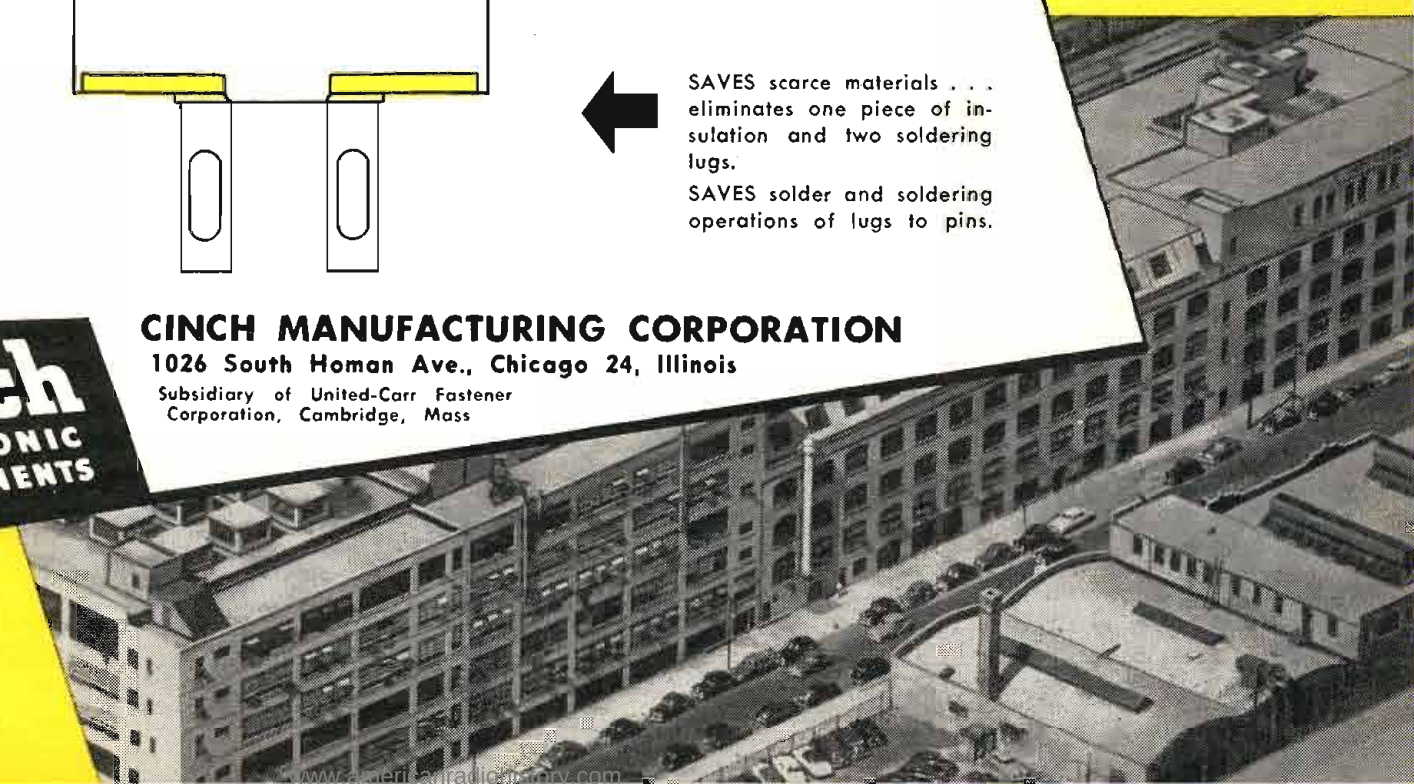
SAVES scarce materials . . . eliminates one piece of insulation and two soldering lugs.

SAVES solder and soldering operations of lugs to pins.

Cinch
ELECTRONIC COMPONENTS

New one piece pin with solder tail can be used in other conventional pin plug applications and assemblies.

CINCH MANUFACTURING CORPORATION
1026 South Homan Ave., Chicago 24, Illinois
Subsidiary of United-Carr Fastener Corporation, Cambridge, Mass



TELE-TECH's NEWSCAST

De Forest Dinner at Waldorf, April 8

A testimonial dinner to Dr. Lee de Forest, inventor of the three-element tube which underlies all present-day radio, television and electronic equipment, is scheduled for the Waldorf-Astoria Hotel, Park Avenue, New York, on Tuesday evening, April 8. Former President Herbert Hoover will make the principal address, and leading industry figures, including members of the De Forest Pioneers, will take part.

A recent informal estimate places at $60 billions the total value of the equipment based on Dr. de Forest's primary invention, in the fields of radio, TV, sound pictures, long-distance telephony, communications, medicine, instrumentation, and miscellaneous electronic applications.

Admiral Stone to Preside

Admiral Ellery W. Stone, president of American Cable & Radio Corporation, (who was an associate of Dr. de Forest in 1920) will preside at this 50th anniversary of "Doc's" entry into "wireless" in 1902. Others who will join in the de Forest tribute are Brig. Gen'l. David Sarnoff, Dr. Allen B. Du Mont, Col. Sosthenes Behn, William J. Barkley, John V. L. Hogan, Frank Andrea, Haraden Pratt, Charles A. Rice, Louis Pacent, Walter Marshall, Admiral S. C. Hooper, ex-Gov. Charles A. Edison, Dr. Marvin J. Kelly, and Dr. Orestes H. Caldwell, Editor of TELE-TECH.

The dinner is being sponsored by the De Forest Pioneers, in cooperation with AIEE, IRE, NARTB, RTMA, ARRL, SMPTE, VWOA, and the Radio Pioneers.

Bronze Bust of Inventor

Elmo N. Pickerill, President of the De Forest Pioneers, will present to Yale University, on behalf of the Pioneers, a bronze bust of Dr. de Forest, sculptured by Frederick Allen Williams of New York. The bust will be received on behalf of the University by Irving S. Olds, (Yale, 1907), a Fellow of the Yale Corporation and Chairman of the United Steel Corporation. Lee de Forest grad-

(*Continued on page* 70)

DR. DE FOREST INVENTED TUBE 45 YEARS AGO

At the Waldorf in New York, April 8, industry leaders will pay tribute to Dr. Lee de Forest on the 50th anniversary of his entry into "wireless," and the 45th anniversary of his invention of the three-element tube. Picture shows a recent radio interview with Dr. de Forest by O. H. Caldwell, editor of TELE-TECH, over station WGCH, as arranged by Walter Lemmon, owner of the station in Greenwich, Conn., where the inventor's daughter and grandchildren now reside.

Coming Events

April 16-18—Network Symposium, Polytechnic Institute of Brooklyn and Office of Naval Research, 33 West 39th St., New York, N. Y.

April 19—IRE Spring Technical Conference, Cincinnati Section, Cincinnati, Ohio.

April 21-24—National Committee of the International Scientific Radio Union and IRE Professional Group on Antennas and Propagation, Spring Technical Meeting, National Bureau of Standards, Washington, D. C.

April 21-25—SMPTE, 71st Convention, Drake Hotel, Chicago, Ill.

April 24-26—AFCA, National Convention, Philadelphia, Pa.

May 4-8—Electrochemical Society, 50th Anniversary Meeting, Benjamin Franklin Hotel, Philadelphia, Pa.

May 5-16—British Industries Fair, Earls Court and Olympia, London, England.

May 5-7—IRE-AIEE-RTMA Symposium on Progress in Quality Electronic Components, Dept. of Interior Auditorium, Washington, D. C.

May 8-10—ASA, Semi-Annual Meeting, Hotel Statler, New York City.

May 12-14—IRE National Conference on Airborne Electronics, Dayton-Biltmore Hotel, Dayton, Ohio.

May 16-17 Southwestern IRE Conference and Radio Engineering Show, Rice Hotel, Houston, Tex.

May 19-22—1952 Radio Parts and Electronic Equipment Show, Hotel Stevens, Chicago, Ill.

May 23-24—Audio Fair in Chicago, Conrad Hilton Hotel, Chicago, Ill.

June 23-27—AIEE Summer Meeting, Hotel Nicolet, Minneapolis, Minn.

August 19-22—1952 APCO Conference, Hotel Whitcomb, San Francisco, Calif.

August 27-29—Western Electronic Show & Convention, WCEMA and IRE, Long Beach, Calif.

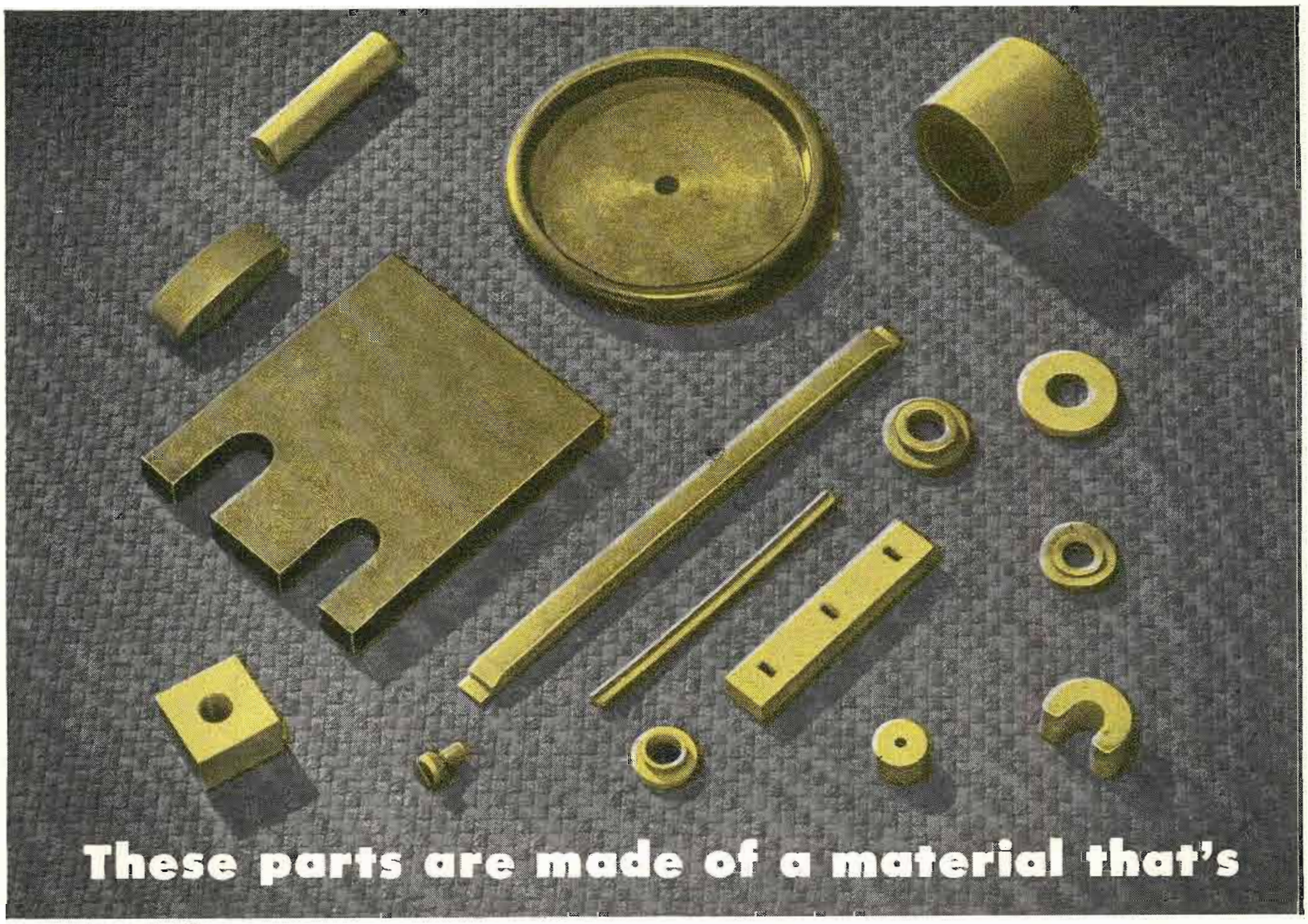
September 8-12—ISA, 7th National Instrument Conference and Exhibition, Sherman Hotel, Chicago, Ill.

September 22-25—NEDA, 3rd National Convention, Ambassador Hotel, Atlantic City, N. J.

September 29-October 1—Eighth National Electronics Conference and Exhibition, Sherman Hotel, Chicago, Ill.

October 21-23—1952 RTMA-IRE Fall Meeting, Syracuse, N. Y.

AFCA: Armed Forces Communications Assn.
AIEE: Amer. Institute of Elec. Engineers.
APCO: Associated Police Communication Officers
ASA: Acoustical Society of America
IRE: Institute of Radio Engineers
ISA: Instrument Society of America
NARTB: Nat'l. Assoc. of Radio & Television Broadcasters.
NEDA: Nat'l. Electronic Distr. Assoc.
NEMA: Nat'l. Electrical Mfrs. Assoc.
RTMA: Radio-Television Mfrs. Assn.
SMPTE: Society of Motion Picture & TV Engineers
WCEMA: West Coast Electronic Mfrs. Assn.



Half the weight of aluminum!

If your product consists of parts that call for unusual physical, electrical and mechanical properties or a *combination* thereof, then you'll find no material more versatile than Taylor Vulcanized Fibre.

Here is basic cellulose material that, in addition to being extremely light in weight, is exceptionally tough and resilient. It possesses great mechanical and high dielectric strength . . . along with excellent forming qualities. It is unaffected by most solvents and is attractive in appearance.

What's more, Taylor Vulcanized Fibre can be sheared, sawed, cut, formed, punched, shaved, broached, drilled, turned, swaged, milled, tapped and machined, engraved, stamped, sanded, ground, burred, cleaned, painted and tumbled!

And, it's available in sheets, rods, rolls and coils in 7 job-proved grades, each of which has been engineered to make *your* product or part better.

Why not explore the possibilities of using Taylor Vulcanized Fibre in your product *today?* Let us tell you, too, about Taylor Phenol, Melamine and Silicone Laminates . . . and our modern fabricating facilities. Write for complete engineering data and a generous assortment of samples. There's no obligation, of course.

TAYLOR FIBRE CO.

NORRISTOWN, PENNA. • LA VERNE, CALIF.

VULCANIZED FIBRE • PHENOL • MELAMINE • SILICONE LAMINATES

uated from Yale in the Class of 1896.

Information on plans for the de Forest testimonial can be obtained from A. M. McLennan, assistant vice-president, IT&T, 67 Broad St., New York 4, N. Y. Telephone Bowling Green 9-3800.

Ralph R. Batcher, chief engineer, engineering division RTMA, 489 Fifth Avenue, New York, N. Y., is among those co-operating in arrangements for the April 8 dinner.

AIEE, IRE and RTMA to Sponser Quality Conference

A "Symposium on Progress in Quality Electronic Components" will be held in the auditorium of the Dept. of Interior, Washington, D. C. on May 5–7, 1952. It will be under the joint sponsership of the American Institute of Electrical Engineers, the Institute of Radio Engineers, and the Radio-Television Manufacturers Assoc. with the active participation of the agencies of the U. S. Dept. of Defense and the National Bureau of Standards. Following is a representative list of the papers to be presented:

"Electronic Production Requirements from Industries Viewpoint," Glen McDaniel, President—Radio-Television Manufacturers Association

"Electronics in the Defense Production Program." John A. Milling, Chairman, Electronics Production Board, Defense Production Authority, Washington, D. C.

"Some Factors in Today's Electronics Production," Capt. Rawson Bennett, USN, Bureau of Ships, Washington, D. C.

"Reliability of Military Electronics," Edwin A. Speakman, Vice Chairman, Research and Development Board Department of Defense, Washington, D. C.

"Electronic Components in Continental Europe," Lt. Col. C. B. Lindstrand, USAF, Electronics Production Resources Agency Department of Defense, Washington, D. C.

"Electronic Components in Great Britain," W.A.G. Dummer, Telecommunications Research Establishment, London, England

"Electronic Components in Soviet Russia," Maj. G. W. King, USAF, Air Technical Information Center Wright-Patterson Air Force Base, Dayton, Ohio

"Recent developments in Ceramic Bi-electrics," Edward J. Smoke, Rutgers University, New Brunswick, N. J.

"Metallic Refractories, New Materials for the Electrical Industry," Robert Steinitz, American Electro Metal Corp., Yonkers, N. Y.

"Some Fluorochemicals for Electrical Applications," N. M. Bashara, Minnesota Mining & Mfg. Co., St. Paul, Minnesota

"Manufacture of Mica Paper for Insulation," R. L. Griffeth and M. E. R. Younglove, Mica Insulator Company, Schenectady, N. Y.

"Progress in the Use of Teflon, Including Soldering and Cementing," M. A. Rudner, U. S. Gasket Co., Camden, N. J.

Advances in Miniaturization

"Compact Assembly Methods," S. T. Danko—Signal Corps Engineering Laboratories, Ft. Monmouth, N. J.

"Reproducibility of Printed Components," W. H. Hannahs and J. Eng—Sylvania Electric Products, Inc., Bayside, Long Island, N. Y.

"Miniaturized Components for Transistor Application," P. S. Darnell—Bell Telephone Laboratories, Inc., Murray Hill, N. J.

Progress in Basic Components

"Adhesive Tape Resistors," B. L. Davis—National Bureau of Standards, Washington, D. C.

"Metallic Film Resistors," C. T. Graham—Polytechnic Research and Development Co. Brooklyn, N. Y.

"E—C Glass Resistors," J. K. Davis—Corning, Glass Work, Corning, N. Y.

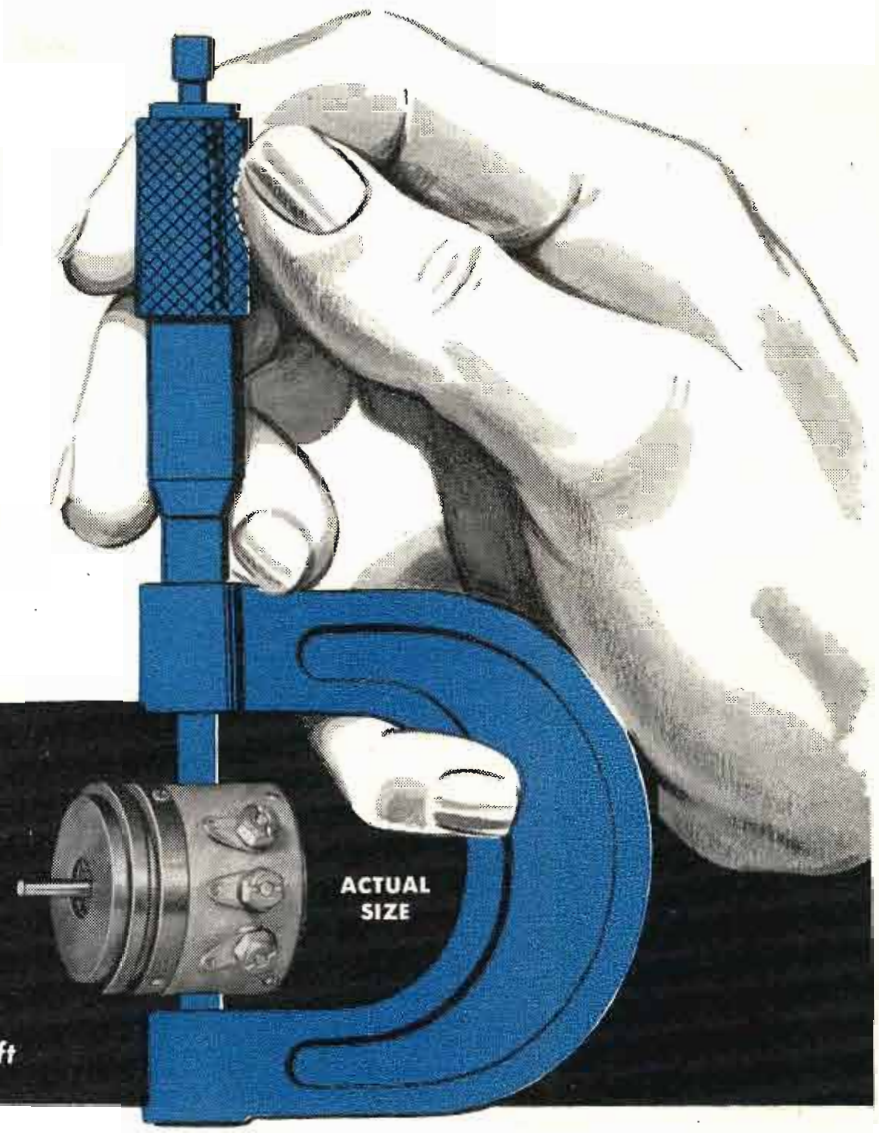
"Stability of Standard Component Resistors," C. K. Hooper—Westinghouse Electric Corp., Baltimore, Md.

(*Continued on page* 72)

Another achievement in potentiometer design by **Helipot** *the world's largest manufacturer of precision potentiometers . . . the*

TINYTORQUE

MODEL T



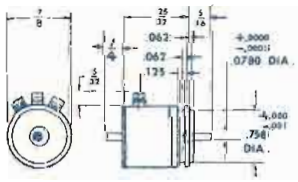
ULTRA-LOW TORQUE
.005 inch-ounce nominal starting torque

MINIATURE SIZE
7/8" diameter x 25/32" overall length

FEATHERWEIGHT
Weighs only half an ounce (0.56 oz.)

BALL BEARING CONSTRUCTION
Two miniature ball bearings support shaft

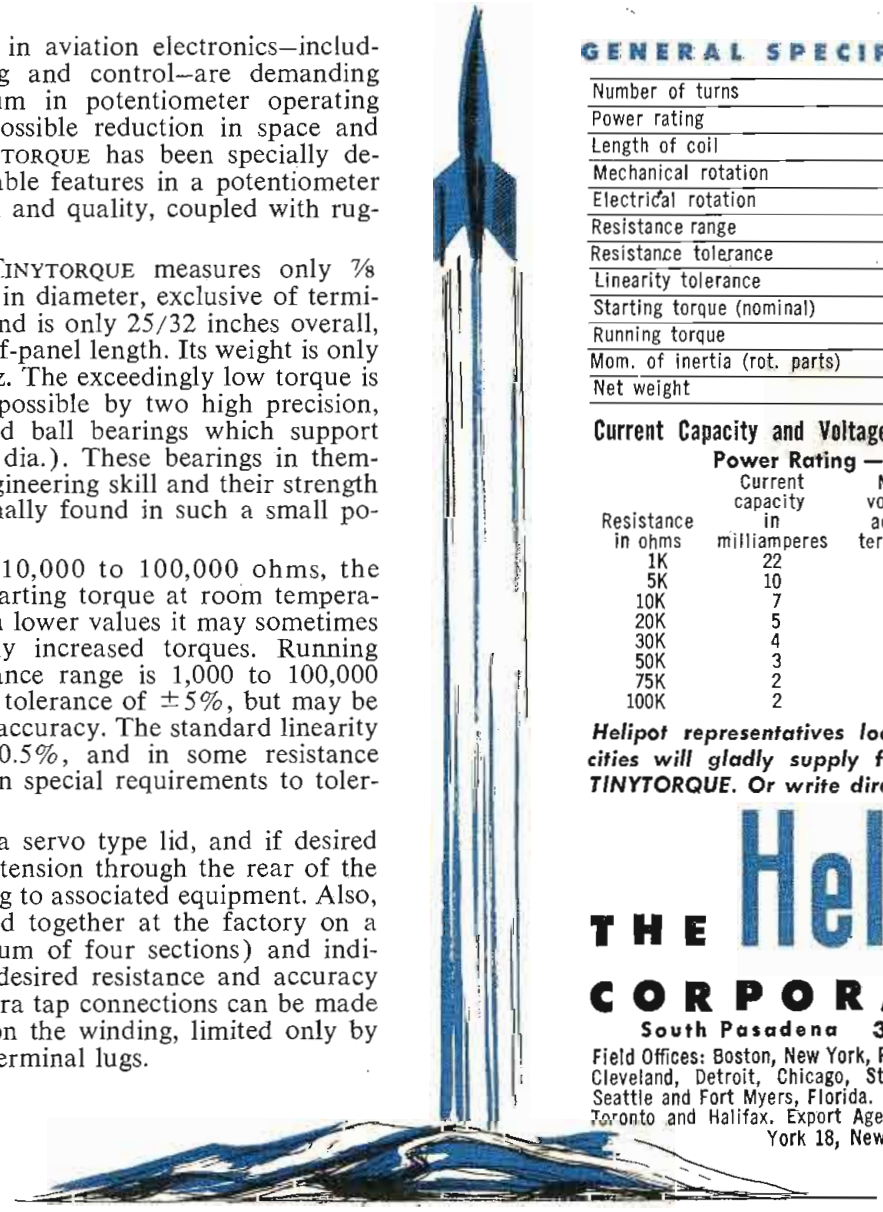
Current developments in aviation electronics—including guided missile telemetering and control—are demanding not only the absolute minimum in potentiometer operating torque, but also the greatest possible reduction in space and weight requirements. The TINYTORQUE has been specially developed to combine these desirable features in a potentiometer of the highest possible precision and quality, coupled with rugged dependability and long life.



The TINYTORQUE measures only 7/8 inches in diameter, exclusive of terminals, and is only 25/32 inches overall, back-of-panel length. Its weight is only 0.56 oz. The exceedingly low torque is made possible by two high precision, shielded ball bearings which support the stainless steel shaft (5/64" dia.). These bearings in themselves are an achievement in engineering skill and their strength provides a ruggedness not normally found in such a small potentiometer of ultra-low torque.

In resistances from 10,000 to 100,000 ohms, the TINYTORQUE has a maximum starting torque at room temperature of only .005 inch-ounces. In lower values it may sometimes be necessary to permit slightly increased torques. Running torque is negligible. The resistance range is 1,000 to 100,000 ohms with a standard resistance tolerance of ±5%, but may be maintained or selected to closer accuracy. The standard linearity accuracy of TINYTORQUE is ±0.5%, and in some resistance values accuracies can be held on special requirements to tolerances as low as ±0.25%.

The TINYTORQUE has a servo type lid, and if desired can be provided with a shaft extension through the rear of the unit to allow mechanical coupling to associated equipment. Also, separate sections may be ganged together at the factory on a common shaft (up to a maximum of four sections) and individual sections may be of any desired resistance and accuracy within the respective ranges. Extra tap connections can be made at almost any specified points on the winding, limited only by the physical space occupied by terminal lugs.



GENERAL SPECIFICATIONS:

Number of turns	1
Power rating	½ watt
Length of coil	2"
Mechanical rotation	360° continuous
Electrical rotation	355° +0° −5°
Resistance range	1000 to 100,000 ohms
Resistance tolerance	(std.)±5.0%
Linearity tolerance	(std.)±0.5%
Starting torque (nominal)	.005 oz. in.
Running torque	Negligible
Mom. of inertia (rot. parts)	.000377 gm. cm.²
Net weight	0.56 oz.

Current Capacity and Voltage Limits of Model T

Power Rating — ½ watt

Resistance in ohms	Current capacity in milliamperes	Max. voltage across terminals	Temperature Coefficient
1K	22	23	various
5K	10	50	various
10K	7	72	.00002
20K	5	100	.00002
30K	4	125	.00002
50K	3	160	.00002
75K	2	200	.00002
100K	2	200	.00002

Helipot representatives located in all major cities will gladly supply full details on the TINYTORQUE. Or write direct!

THE Helipot CORPORATION
South Pasadena 3, California

Field Offices: Boston, New York, Philadelphia, Rochester, Cleveland, Detroit, Chicago, St. Louis, Los Angeles, Seattle and Fort Myers, Florida. In Canada: Cossor Ltd., Toronto and Halifax. Export Agents: Fratham Co., New York 18, New York.

"Progress in the Field of Resistors," Jesse Marsten—International Resistance Co., Philadelphia, Pa.

Capacitors & Inductors

"Capacitors for High Temperature Operation," John W. Schell—Erie Resistor Corp., Erie, Pa.

"Expected Performance of Glass Capacitors," Gail Smith—Corning Glass Works, Corning, N. Y.

"Tantalytic Capacitors," L. W. Foster—General Electric Co., Hudson Falls, N. Y.

Coils, Inductors & Transformers

"Progress in Size and Performance of Transformers," G. E. Wilson—General Electric Co., Fort Wayne, Ind.

"Ferrite Inductor Cores," W. W. Stifler, Jr.—Ferrexcube Corp. of America, Saugerties, N. Y.

Miscellaneous Components

"Selection of Fuse Protection for Electronic Circuits," E. V. Sundt—Littelfuse Inc., Chicago, Ill.

"Design Factors Influencing the Reliability of Relays," J. R. Fry—Bell Telephone Laboratories, Inc., New York, N. Y.

"Vibrators for the Armed Services," K. M. Schafer—P. R. Mallory & Co., Inc., Indianapolis, Ind.

"Indicating Instruments for Use Under Severe Conditions," F. X. Lamb—Weston Electrical Instrument Corp., Newark, N. J.

"Influence of Wire and Cable on Improved Components," F. M. Oberlander—RCA, Camden, N. J.

"Teflon Wire," C. E. Dodge, Jr.—Warren Wire Co., Pownal, Vt.

Design & Production Methods

"Unitized Packaging by the Laminar Method," D. C. Heitert—Emerson Electric Manufacturing Co., St. Louis, Mo.

"Heat Transfer from Electronic Components," Walter Robinson—Ohio State University Research Foundation, Columbus, Ohio

"Packaging Principles Employing Plasties and Printed Wiring to Improve Reliability," W. J. Clarke and N. J. Eich—Bell Telephone Laboratories, Inc., Murray Hill, N. J.

Transistors

"The Transistor Development Status at Bell Telephone Laboratories, with Demonstration," W. R. Sittner—Bell Telephone Laboratories Inc., Allentown, Pennsylvania

"Transistor Power Amplifiers, with Demonstration," R. F. Shea—General Electric Co., Syracuse, N. Y.

"Availability of Transistors," Lt. Col. W. F. Starr, USA Electronics Production Resources Agency Department of Defense, Washington, D. C.

Aspects of Reliability

"Electronic Failure Prediction," James H. Muncy, National Bureau of Standards, Washington, D. C.

"Part Failure Problem in Navy Electronics Equipment," M. M. Tall, Vitro Corp. of America, Silver Springs, Maryland

"How Can the Reliability of Electronic Systems be Improved Now?" W. Wagenseil, Hughes Aireraft Co., Culver City, Calif.

"Component Part Specifieations," D. E. Brown Vitro Corp. of America, Silver Springs, Md.

"A Component Manufacturer Looks At Reliability," Leon Podolsky, Sprague Electric Co., North Adams, Mass.

Electron Tubes

"Sealed-in-Glass Germanium Diodes," J. W. Dawson, Sylvania Electric Products, Inc., Boston, Mass.

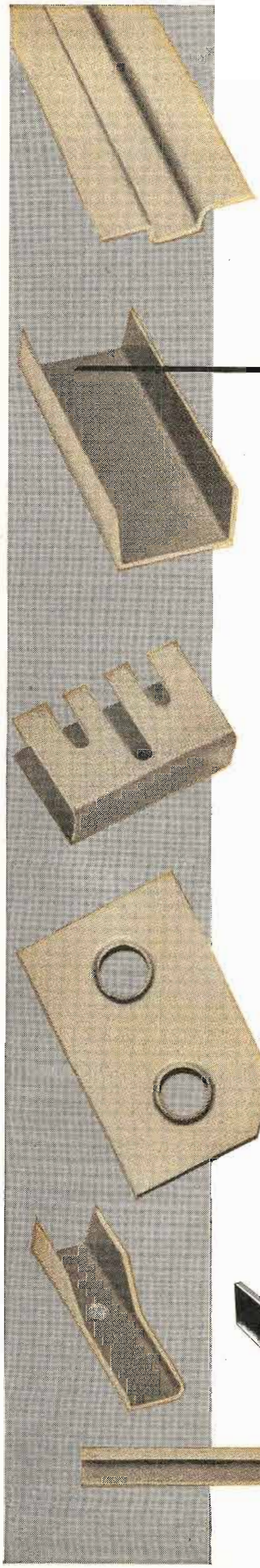
"Reliability of Premium Subminiature Tubes," P. T. Weeks, Raytheon Manufacturing Co., Newton, Mass.

"Methods for Achieving Maximum Reliability in Vacuum Tube Applications," R. L. Kelly, RCA Tube Dept., Harrison, New Jersey

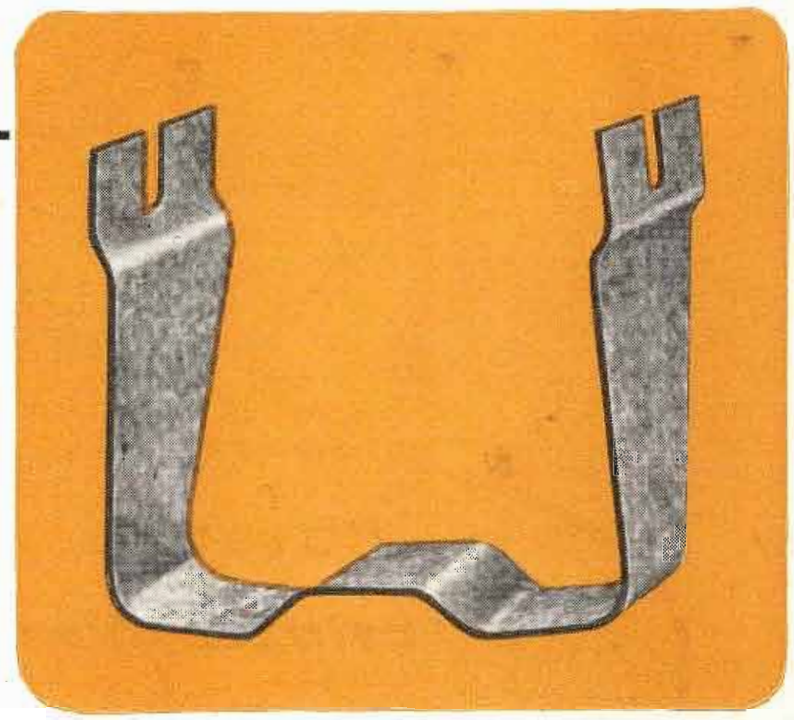
"Failure of Vacuum Tubes from Interface Formation," W. H. Kliever, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

Chase Resistor Head

Edward L. Beaudry, Jr., formerly president of Kay Electric Company, is now president of Chase Resistors Company, with a new factory at 9 River Street, Morristown, N. J.; manufacturers of carbon film resistors as licensees under Western Electric patents.



For Formed Shapes...



from dependable laminated plastics...

IT'S C-D-F POST-FORMING DILECTO

You can combine the good electrical and mechanical properties of C-D-F Dilecto laminated plastic with the low cost operation of post-forming. The result: Better products for many uses at lower cost. Usually no complicated dies are needed to post-form C-D-F Dilecto and the required heating may be done with the simplest equipment.

Your C-D-F sales engineer can help you select the proper Dilecto grade for your post-forming requirements. If you would rather have C-D-F post-form your parts, he'll be happy to quote you on any quantity. Call him today (Sales offices in principal cities)—*he's a good man to know!*

Moisture resistant, light weight, mechanically strong Dilecto is formed from sheets of impregnated cloth or paper. Think... Dilecto may be the tough, versatile plastic for the product now on your drawing board!

CDF

Continental-Diamond Fibre Company

GENERAL OFFICES:
NEWARK 101, DELAWARE

TV Camera

(*Continued from page* 40)

quency response is excellent here and on into the new controls to insure against "clamped-in streaking," which otherwise would appear as long "contrasty" streaks. A response uniform to 8.5 Mc transmits faithfully the entire orthicon capability. A feed-back pair output stage adds viewfinder isolation, sending-end cable termination, linearity, and stability.

In the new viewfinder, when its top is lifted and sides opened, components and circuitry become an open book. A new 7-inch kinescope (used also in the field control) provides the cameraman an excellent monitor to evaluate his operation better. Aluminized backing, a flat face, and a good gun with electrostatic focus yield high brightness, excellent contrast, improved spectral characteristics, good overall focus, and resolving power such that the kinescope is not the limiting factor in detail reproduction. The front is easily detached for kinescope removal.

Variable-width blanking permits the cameraman to see the "on-the-air" picture for accurate framing. Horizontal deflection is highly efficient; vertical deflection is a duplicate of the camera circuit; the video amplifier is wide band; and a driven clamp provides accurate dc restoration. An improved release mechanism is a two-finger, one-hand type.

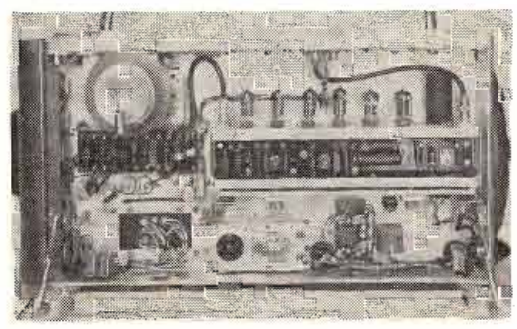
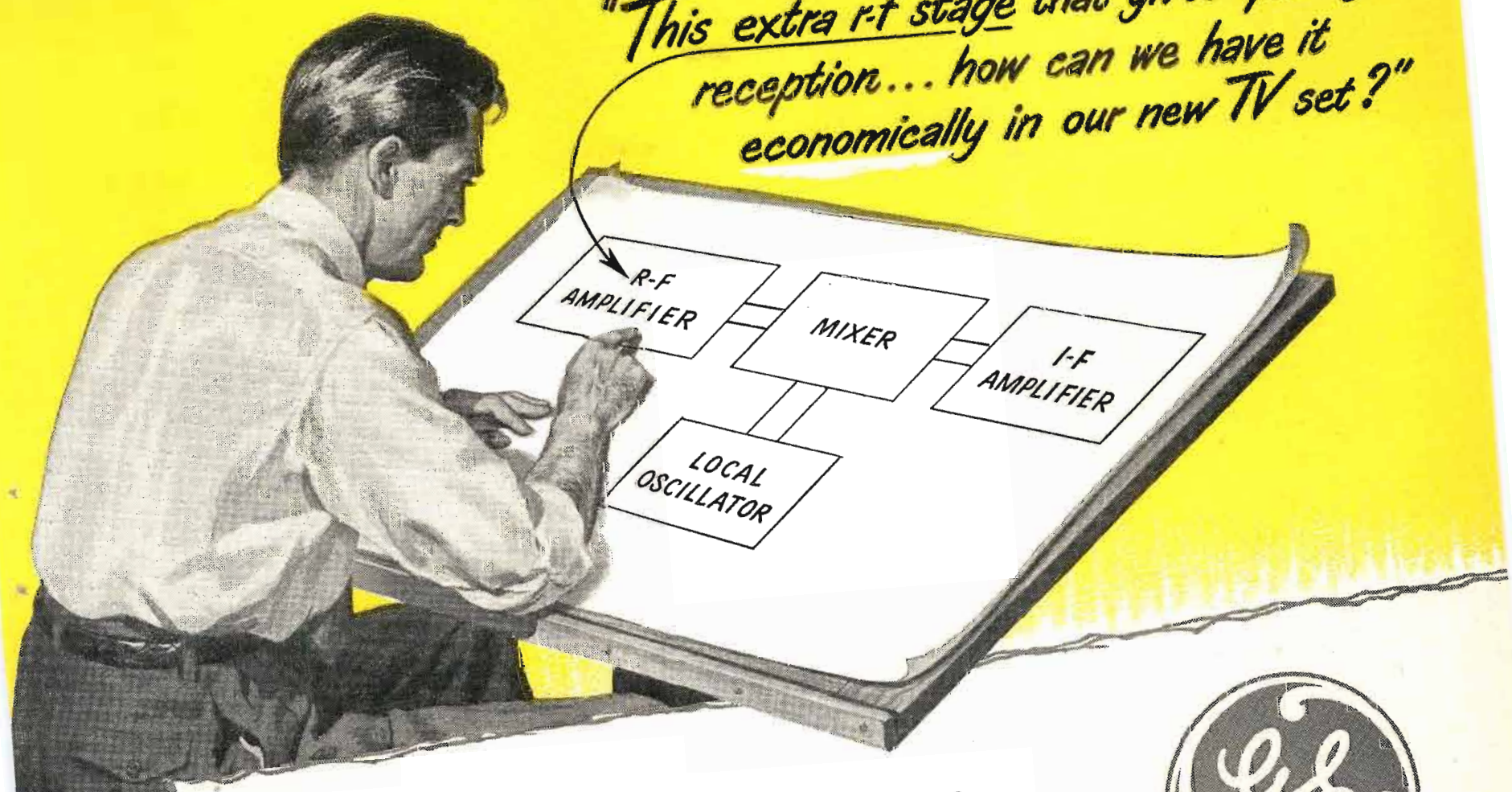


Fig. 9: Video side. Cover is removed to show "plug-in" amplifier mounted in place

A detachable viewing hood may be rigidly mounted to the mask assembly to prevent stray light from striking the face of the kinescope. The number of exposed operating controls has been reduced to three (contrast, brightness, and focus) with rim-type control knobs protruding through the rounded corners of the kinescope mask assembly. Other controls are normally pre-set and are located on the amplifier chassis. No interaction exists between the viewfinder and the camera.

(*Continued on page* 76)



Good news

FOR COST-HARRIED U-H-F DESIGNERS

NOW . . . a brand-new r-f amplifier for ultra-high reception at *one-sixth* the cost of other suitable tubes for the purpose! And G.E.'s 6AJ4 saves you still more! Single-ended construction slashes circuit expense, compared with the coaxial circuits for other u-h-f types.

FOR THE FIRST TIME at a mass-production figure, you can build into your new u-h-f receiver the deluxe features of (1) low noise level, with freedom from snow, (2) minimum radiation interference with other television sets, (3) high selectivity. You can pioneer a u-h-f receiver that will sell and SELL in fringe areas!

PROOF lies in the 6AJ4's high signal gain (see ratings), its improved noise factor over crystal mixer alone, and the 30-db-and-up attenuation which the tube adds between oscillator and antenna.

JUST OFF THE PRESS: descriptive bulletin ETD-520. Wire or write for it today! *Tube Department, Section 13, General Electric Company, Schenectady 5, New York.*

6AJ4
9-pin miniature
u-h-f r-f amplifier

Amplification factor	45
Transconductance	10,000 micromhos
Plate current	15 ma
Power gain at 900 mc, for 10-mc band width	7 db
Noise factor at 900 mc	15 db

GENERAL ELECTRIC

162-1A2

The basic functions performed by either camera control are the following:

1. Provide control of electrical performance of the pickup tube in the camera (electrical focus, beam current, etc.).
2. Synthesize the picture signal to be delivered to the video switching equipment (adjust signal level, add picture blanking signal, insert dc component and shading, and provide monitoring signal).
3. Provide terminal facilities for the camera cable and other cable connections to the camera and the rest of the system.

The new field camera control for use in remote pickups employing RCA image orthicon cameras is a suitcase type of unit similar in appearance to existing field equipment units. It may be used interchangeably with either the new or old designs of image orthicon cameras. However, the increased power drain of this unit requires the use of a new field power supply. In comparison with older designs, it provides new features and improved performance which will facilitate field operations. The field camera control is housed in a suitcase which is slightly higher than the earlier model, but otherwise is the same in size, making it possible to utilize the same shock mounts, consoles, and arrangements

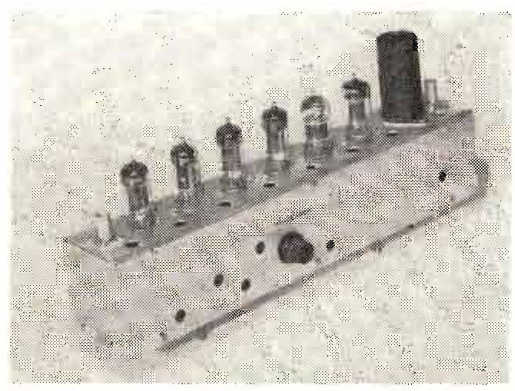


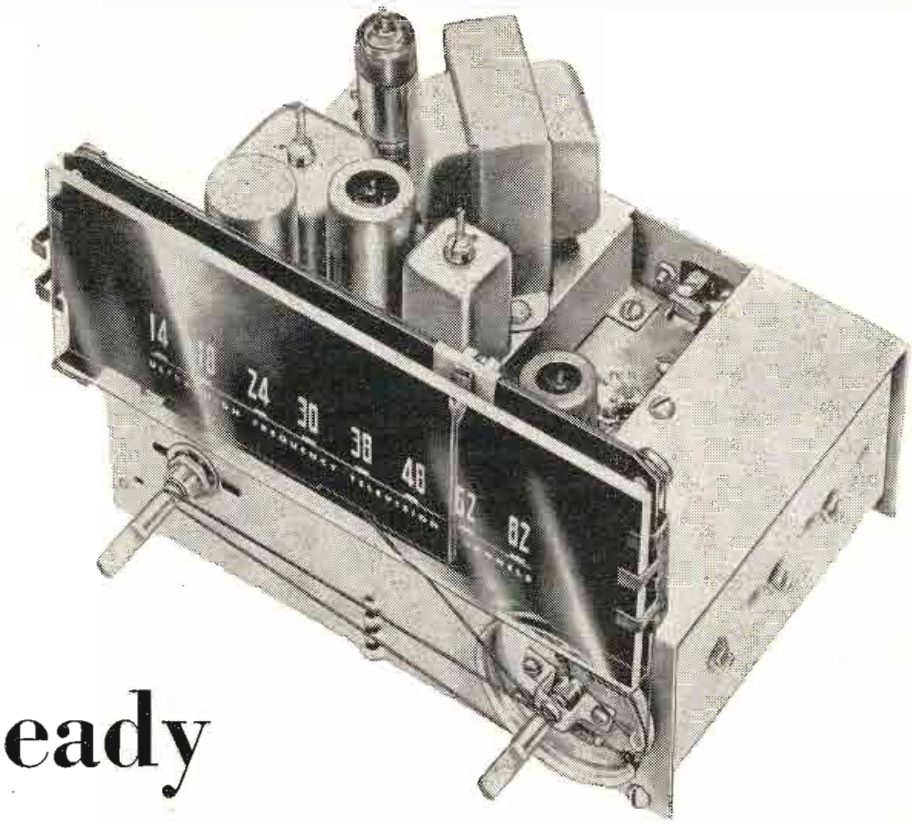
Fig. 10: Close-up of "plug-in" video amplifier

of equipment. Familiar placement of major controls and cable connectors has likewise been retained.

The mechanical construction of the suitcase has been modified to realize the benefits of sub-assembly construction as far as possible. The addition of several new features has been made possible in only slightly increased space by the use of miniature tubes in the majority of sockets and the use of other miniaturized components. Such additions, however have resulted in increased power drain and, therefore, increased heat dissipation. This has made the

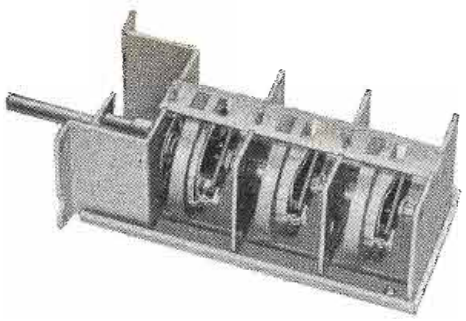
(*Continued on page 78*)

UHF



Mallory Is Ready

to equip any receiver for UHF channels



Mallory UHF Tuner

A new version of the continuously variable Mallory Inductuner®, consisting of three sections of variable inductance. Covers the range between 470 and 890 megacycles with approximately 2 micromicrofarads of shunt capacity and in 270° of shaft rotation. Selectivity is excellent over the entire band.

Available now for assembly in your converter or as an auxiliary UHF tuner in your receiver.

Now In Development

A combination VHF-UHF tuner.

The Mallory UHF converter has been designed to permit the tuning of *all* UHF channels by *any* TV receiver, with no sacrifice of VHF reception. Connection to the receiver involves only the power line and antenna leads—no internal adjustments are required. Check the characteristics listed below and in the panel at the left describing the basic tuner.

Physical dimensions $8\frac{1}{8}'' \times 6\frac{1}{4}'' \times 5\frac{3}{16}''$

Built-in IF amplifier operating at the conversion frequency (channels 5 and 6) makes up for conversion and tuning losses

Temperature compensation and stabilization prevents frequency drift after initial warm-up

Low noise figure

High image and IF rejection ratios

The converter chassis is now available to set manufacturers for assembly with cabinets, dial plates and knobs of their design. Complete technical literature will be sent promptly on request.

Television Tuners, Special Switches, Controls and Resistors

P.R. MALLORY & CO. Inc.
MALLORY

SERVING INDUSTRY WITH
Electromechanical Products—Resistors • Switches • TV Tuners • Vibrators
Electrochemical Products—Capacitors • Rectifiers • Mercury Dry Batteries
Metallurgical Products—Contacts • Special Metals • Welding Materials

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

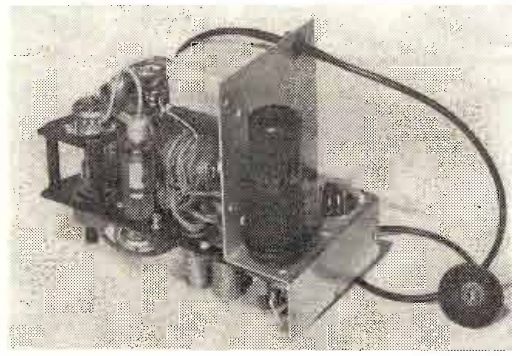


Fig. 11: Plug-in r-f power supply for field camera control is also used in master monitor

inclusion of a small cooling blower necessary.

The new studio camera control is packaged in the same general manner as its earlier counterpart, and may be used as a direct replacement for it with either old or new types of image orthicon cameras. The chassis and attached control panel are intended for mounting in the standard console housing.

In the new unit, the connectors for camera cable, power cable, pulse input, and intercommunication cables are located on the rear apron of the chassis in order to provide additional space for tubes and components on the main panel, and to simplify the process of withdrawing the unit from the console housing. Only the coaxial cable connectors for signal outputs are located on the front (tube) side of the main panel.

The related field camera control embodies much new thinking. Its improved kinescope has been described. Video-frequency response in no way limits the system. New sine-

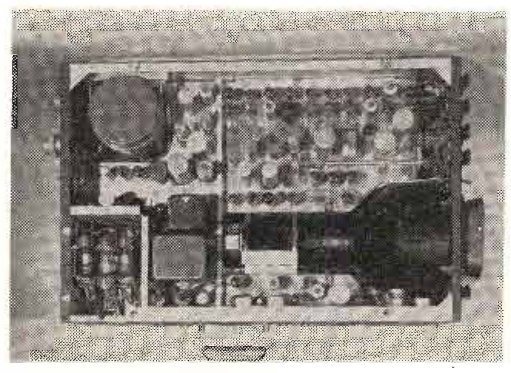


Fig. 12: Tube side of field camera control

wave clamping employed at three places effectively establishes black level and guarantees gray scale rendition while providing no high-frequency unbalance to damage the blanking waveform. A regenerative type blanking circuit stablizes blanking insertion. Fixed blanking set-up adds a controlled amount of "blacker-than-black" blanking.

Two "black-white" stretch circuit

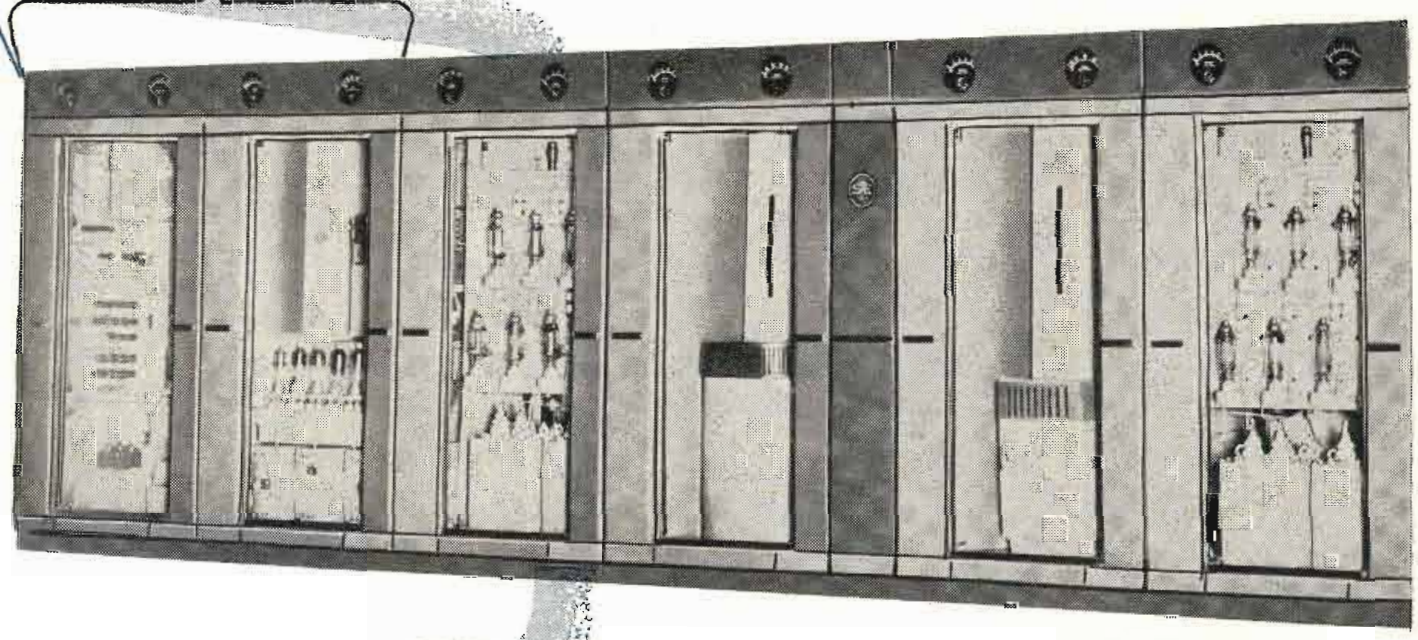
(*Continued on page* 80)

Standard Electronics

TV TRANSMITTERS

500 WATTS TO 20 KILOWATTS

HIGH and LOW BAND



Completely air-cooled

Entirely self-contained

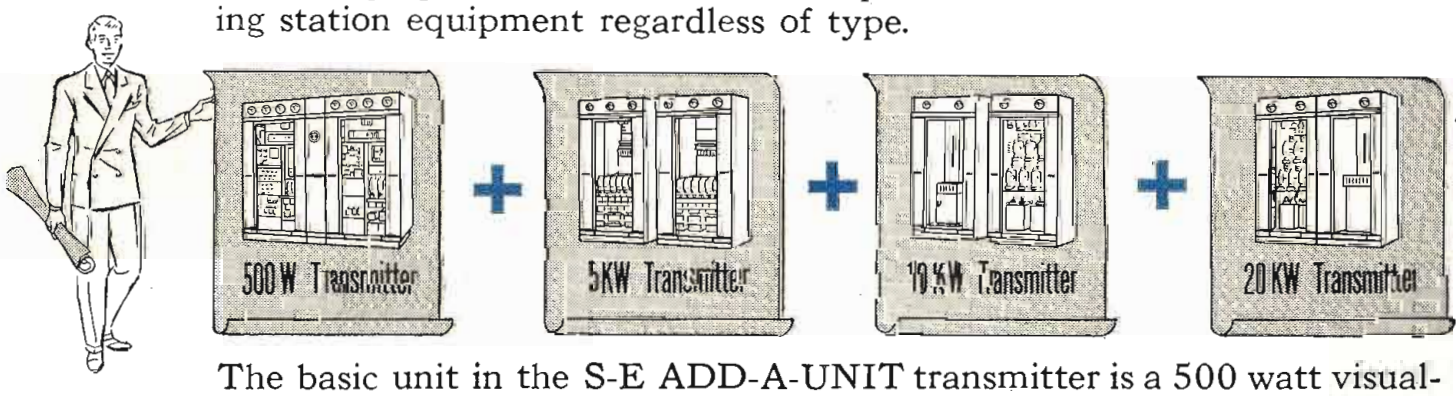
Full length tempered—glass front doors

All vacuum tubes visible during operation

Covering the entire VHF-TV band

—FEATURING FOR THE FIRST TIME, EXPANDABLE ADD-A-UNIT DESIGN!

STANDARD'S exclusive ADD-A-UNIT feature enables you to start operation at minimum cost and later ADD-A-UNIT to increase your power. These high power ADD-A-UNIT Amplifiers can also be added to existing station equipment regardless of type.



The basic unit in the S-E ADD-A-UNIT transmitter is a 500 watt visual-aural unit. This is a complete, self-contained transmitter. Additional amplifiers are available as shown in the diagram to provide complete transmitters of 5, 10 or 20 KW output. These amplifiers may be installed initially or at such time as increased power is granted by the FCC.

WRITE FOR BULLETIN TTS-61 and complete details regarding the S-E Minimum-Station Package; no obligation.

"A CLAUDE NEON, INC. PRODUCT"

STANDARD ELECTRONICS CORP.

285-295 EMMETT STREET, NEWARK 5, NEW JERSEY

switches permit selection of four different conditions of gray scale alteration while keeping overall video amplitude constant. The amount of stretch desired has previously been established by screwdriver adjustment. Synchronizing signals can be added with bridging of this signal to other units for eventual termination.

Two identical isolated video outputs are available from a feedback output stage for direct outgoing-line monitoring. This circuit also yields sending-end termination, improved linearity, and stability by virtue of its feedback nature.

Horizontal kinescope deflection is almost identical to its camera counterpart, as is vertical deflection. An extremely compact, efficient, and well shielded plug-in rf high voltage unit supplies regulated 10-KV second anode, kinescope focus, waveform monitor second anode, and bias voltages for the control unit divorcing it in large measure from the power frequency for "off-frequency" operation.

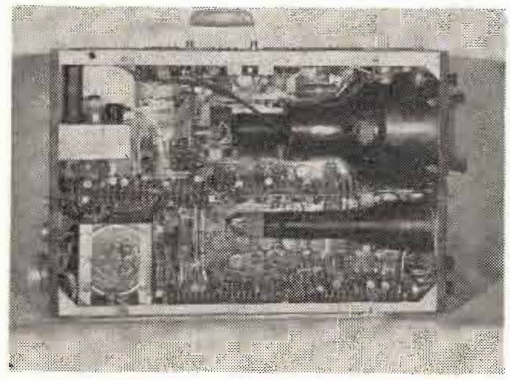


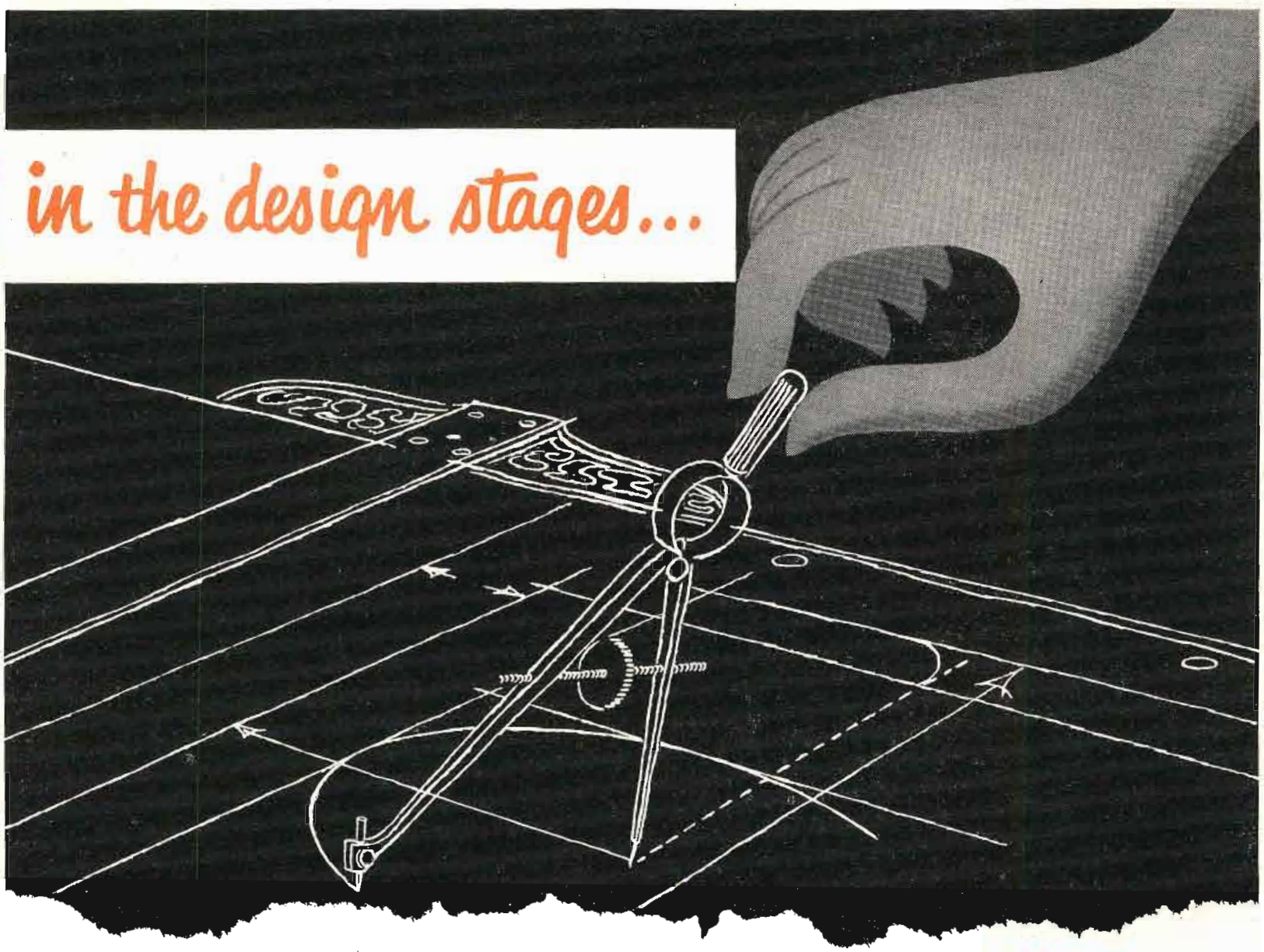
Fig. 13: Circuit side of field camera control

The waveform CRO is fed from a wide band video amplifier with stable half-line or frame horizontal sweep speeds selected by a switch. Astigmatism control yields a well defined spot. An illuminated standard scale with simplified calibration permits accurate level setting.

Camera operating controls are, of course, provided with "target-set" made automatic. Both vertical and horizontal sawtooth shading signals of either polarity are available. Video response is compensated by a "3-position" switch for various cable lengths in common use.

The companion studio control closely duplicates the field control unit in so far as video circuitry is concerned. Regenerative blanking, gray scale alteration, sine-wave clamping, fixed blanking set-up, shading addition, synchronization insertion, and feedback output are again provided. Synchronizing sig-

(*Continued on page* 82)



...the ideal time to ENGINEER SPEED NUT® Savings into your product

Take full advantage of SPEED NUT economy and performance, design SPEED NUTS into your product. Here's why...

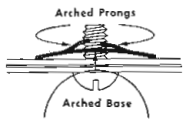
1. SPEED NUTS simplify design problems through low-profile, one-piece construction and multiple-function characteristics.
2. There are thousands of low-cost Standard SPEED NUTS — saving cost of special-design fasteners.
3. The double-locking SPEED NUT principle of Spring Tension Fastening can best be adapted to your design requirements.

Your Tinnerman "Fastener Expert" stands ready to help you profit these 3 ways — call him in soon. And write for "SPEED NUT Savings Stories," Vol. II. Tinnerman Products, Inc., Dept. 12, Box 6688, Cleveland, Ohio.

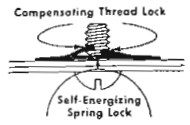
In Canada: Dominion Fasteners, Ltd., Hamilton. *In Great Britain:* Simmonds Aerocessories, Ltd., Treforest, Wales. *In France:* Aerocessoires Simmonds, S. A. — 7 rue Henri Barbusse, Levallois (Seine) France.

Let the SPEED NUT Principle save you TIME, WORK, DOLLARS

PRE-LOCKED POSITION



DOUBLE-LOCKED POSITION



LOOK AT ALL THE LOCATIONS WHERE SPEED NUTS SAVE ON COMMUNICATIONS EQUIPMENT

controls • coil forms • antennae • wiring • cabinets
yoke deflectors • connectors — plus many more

fastest thing in fastenings®

TINNERMAN Speed Nuts®

*Trade Mark Reg. U.S. Pat. Off.

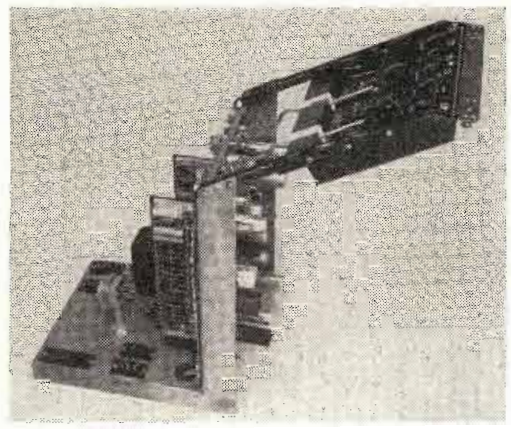


Fig. 14: Studio camera control chassis mounts in standard console housing. All controls are accessible on removal of console front panels

nals for preview monitoring are added to only one of the three identical outputs provided here. Convenient "tipjack" test points permit quick check of the unit by removing only the front console cover.

A special lucite panel with matte black surface and edge lighting permits soft illumination of panel lettering without stray-light, facilitating darkened control room operation.

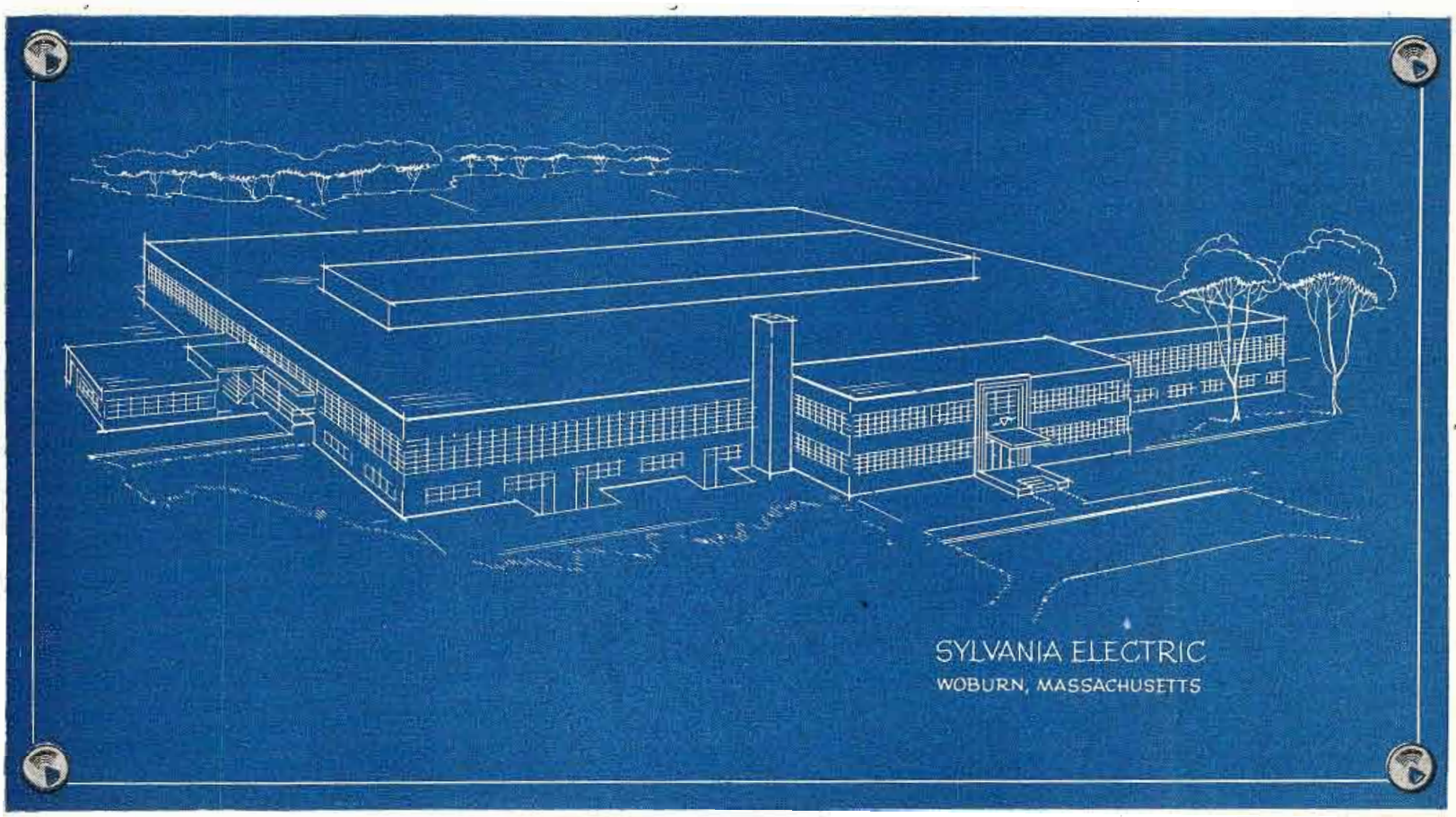
A new field power supply has been provided to operate the field chain because of an increased power drain required by the added features. A different power transformer, new reactors, the addition of a relay to withdraw a series regulator under light load thus providing a regulating range from 1.25 Amp. at 285 volts down to about 400 ma, and an improved cooling system separate it from its predecessor. This supply is readily usable with previous field equipment but here we must modify the interchangeability feature in that the former field supply can't be used with the new field chain.

It is naturally difficult to ascribe proper credit to all concerned with such an extensive development project as this has been. However, J. H. Roe who supervised the project during development, F. E. Cone who is at present supervising the group working on the project, and A. H. Lind, the engineer responsible for the basic development, must be mentioned. Engineers intimately concerned were: S. L. Bendell, W. F. Fisher, R. S. Griswold, R. J. Smith, H. C. Weber, and the author, with invaluable help during certain phases from R. C. Dennison, N. L. Hobson, B. F. Melchionni, and N. J. Oman.

High Quality Audio

In Fig. 10 of "A High Quality Audio Amplifier" on page 35 of the February 1952 issue of TELE-TECH, the variable bass control, P-3, has a resistance of one megohm. The 50 K treble control should be marked P-2. These markings were inadvertently omitted.

Sylvania Electric Erecting New Headquarters For Its Electronics Division



Plant under construction at Woburn, Mass., 17 miles north of Boston. To make microwave components and semi-conductor devices.

To satisfy the growing need for electronic products, Sylvania will soon open a modern new plant at Woburn, Mass.

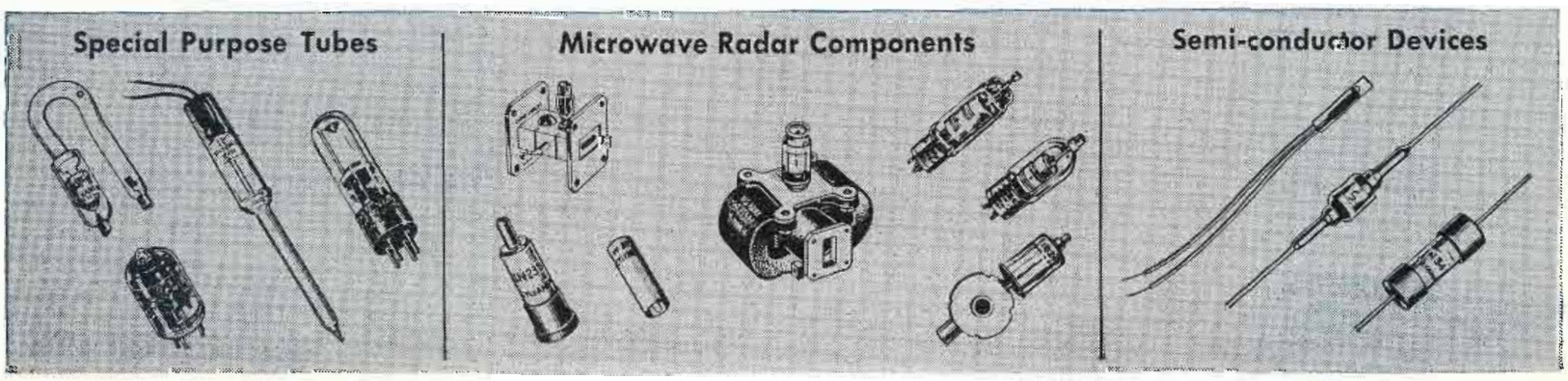
This building of advanced design will provide an additional 100,000 square feet of air conditioned laboratory and production facilities for the manufacture of electronic equipment and components. When completely equipped, it will represent an investment of four million dollars. The new plant will serve as headquarters for all present Sylvania electronic production facilities in the Boston area.

With these greatly expanded plant facilities, Sylvania is assuring you of the newest and best electronic components for radar, television, communications and industry.

SYLVANIA

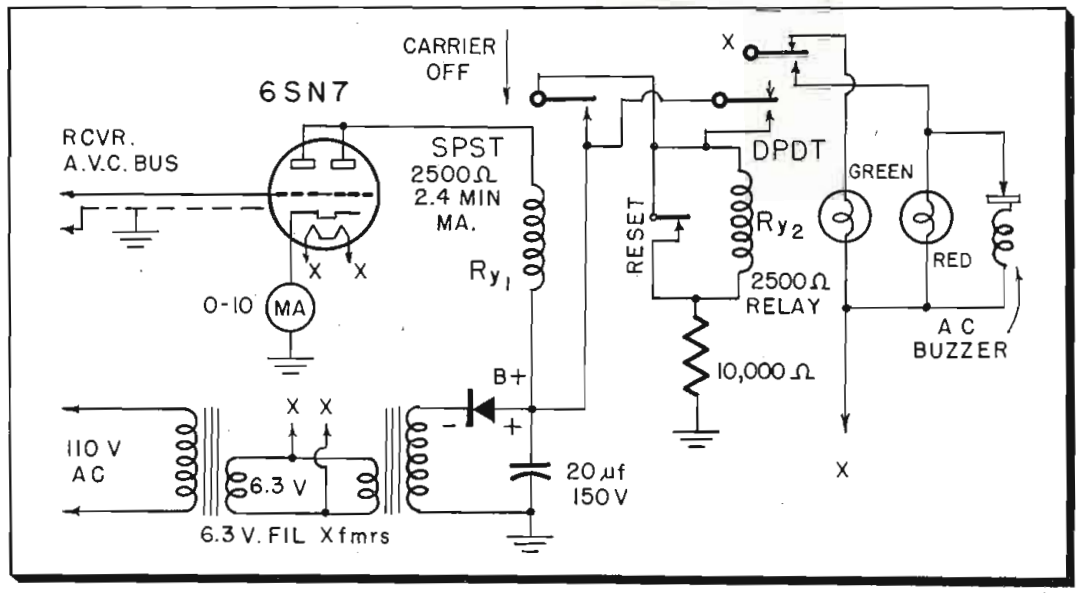
Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.

ELECTRONIC DEVICES; RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS



CUES for BROADCASTERS

(*Continued from page 57*)



Civil defense alerting circuit for use in Conelrad or carrier controlled alarms

danger point. It provides a safe, steady discharge of this electrical energy. The rod causes no detectable change in tower radiation characteristics. If corona discharge of transmitter r-f from the pointed rod is present, the rod can be shortened slightly or the point rounded off.

Conelrad Alerting Monitor

MUNSON ROBINSON, Chief Engineer, WHFB, Benton Harbor, Mich.

TO comply with the new Conelrad requirements an extremely simple alerting attachment has been designed to operate on any broadcast receiver including even small ac-dc types, and is now in use at WHFB. It has the following features.

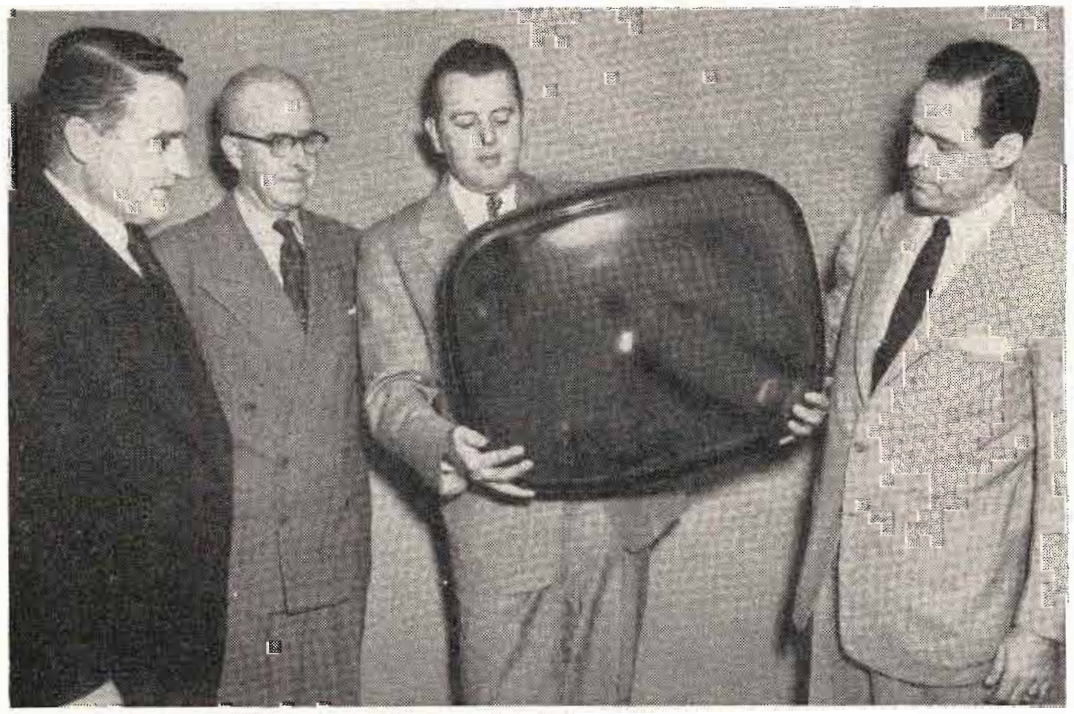
(1) Minimum of parts and simplicity of construction.

(2) The unit is complete with it's own power supply and requires only one connection and ground to the receiver.

(3) When the carrier of the station being monitored is cut, the alerting monitor puts a buzzer and signal light into action. This con-

(*Continued on page* 112)

27-in. ALL GLASS TELEVISION TUBES



Corning Glass Works executives examine new 27-in. rectangular all-glass bulb for TV picture tube manufacturers. Shown are (l to r) J. J. Hanigan, General Manager; E. F. Ling, Manager, Product Engineering; N. J. Vang, Manufacturing Manager; and J. S. Muller, Manager, Electronic Sales Dept.; Electrical Products Division. Volume production of new bulb is scheduled for May. The 27-in. bulb offers a 375 sq. in. picture and features cylindrical face plate design to eliminate reflections.

They bring true listening enjoyment to millions — through the finest in modern sound recording methods and equipment

RCA Victor's modern Vinylite phonograph records are infinitely superior to the old shellac pressings of a few years ago. Better in tone quality, distortion, surface noise and frequency range. This improvement in quality requires more precision than ever before in every step of record manufacture and processing. That's particularly true of the original sound recording and the master discs from which the stampers are made. And RCA Victor has found that Audiotape and Audiodiscs are an ideal combination to meet the exacting demands for today's high fidelity phonograph records — Audiotape for clearest recording of the original sound and Audiodiscs for fast, easy processing without loss of sound quality. In fact this record-making combination is now being used with outstanding success by America's *leading producers* of fine phonograph records and broadcast transcriptions.

Whatever *your* recording work may be, Audiotape and Audiodiscs offer you this same sound perfection — the result of more than 12 years of specialized experience by the only company in America devoted solely to the manufacture of fine sound recording media, both discs and tape.

AUDIO DEVICES, Inc.

444 MADISON AVE., NEW YORK 22, N. Y.
Export Dept.: 13 East 40th St., New York 16, N. Y., Cables "ARLAB"

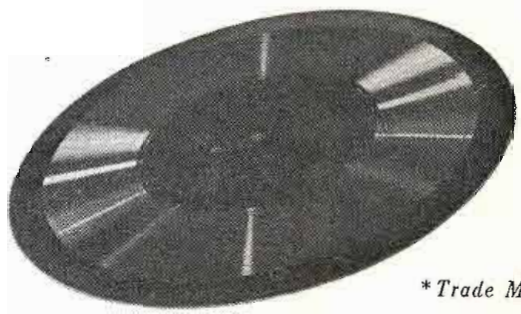
...including

audiotape*

for the original sound

...and **audiodiscs***

for the master recording



**Trade Mark*

LETTERS...

CBS Color-Wheel Traced Beyond Isaac Newton, to Ptolemy!

Editors, TELE-TECH:

Thank you for your reply to my inquiry, quoting the Encyclopedia Brittanica as authority for Sir Isaac Newton's development of the color-wheel, as cited on page 6 of your November, 1951, TELE-TECH.

There is, however, further evidence that the color-disc was used by Newton. This quotation is from *Light & Colour* by R. A. Houston (Longmans' Green and Co., London, 1923) (p. 73):

> "*Maxwell's Colour Disc*—Fig. 40 represents an arrangement for mixing colours, known as Newton's or Maxwell's disc, though a special form of it was mentioned in the second century of our era in the *Optics* of Ptolemy."

In the above quotation from Houstoun, you will note the name of the Alexandrian astronomer Ptolemy. In footnote reference 10 of my paper in the October *Proceedings IRE,* I referred also to Ptolemy, but used an Encyclopedia Americana reference. In the 1918 edition of that under the heading "Color—Additive Combinations" (vol. 7, p. 309) this statement is found: "It owes its present form and use to J. C. Maxwell although it was known to the astronomer Ptolemy in the 2nd century and was rediscovered by the Dutch physicist Musshenbroek in the 18th."

As you may know, Ptolemy's work has survived only in the form of the translations which Alhazen, in the 11th century, passed off as his own original work. The experts express some doubt that the "Optics" is truly Ptolemy's work, since it is not up to the same standard as the rest.

However, and this is one point I would like to make, the CBS color wheel is only a special form of Maxwell's color disc. But the origin of the Maxwell disc goes way back into antiquity, certainly being very much older than Newton.

W. T. WINTRINGHAM
Bell Telephone Laboratories
Murray Hill, N.J.

Cross Talk and Water Supplies

Editors, TELE-TECH:

Your report in the December issue of TELE-TECH (page 25) discussing Liberty Broadcasting System cross talk on 182 stations, has been brought to my attention. In an effort to correct an obvious misunderstanding of the situation, let me endeavor to state exactly what *did* happen.

The Mayor of El Paso, on the date in question, was scheduled to make a city-wide broadcast over the five El Paso radio stations. Remote lines were ordered and installed properly from the local test board to the KELP control room. At broadcast time, the KELP control operator (not an engineer) accidentally threw a wrong control key bridging the local remote line and the network line which runs from LBS master control in the same building. Master control at that time was in control of the western network division, and cross talk appeared on the network in the nature of minus 20 db.

LBS El Paso was the first to report the trouble, *not* a California station. It is quite within reason, I think, that no other stations reported it since the level was so low. As a matter of fact, the error placed the scheduled LBS program on the local lines of the other El Paso stations, since it was a joint origination, yet no El Paso station reported hearing the LBS program. Rather than lam-bast the rest of the engineers around the country for not hearing the cross talk, wouldn't it have been more just to compliment the California engineer for having such acute hearing?

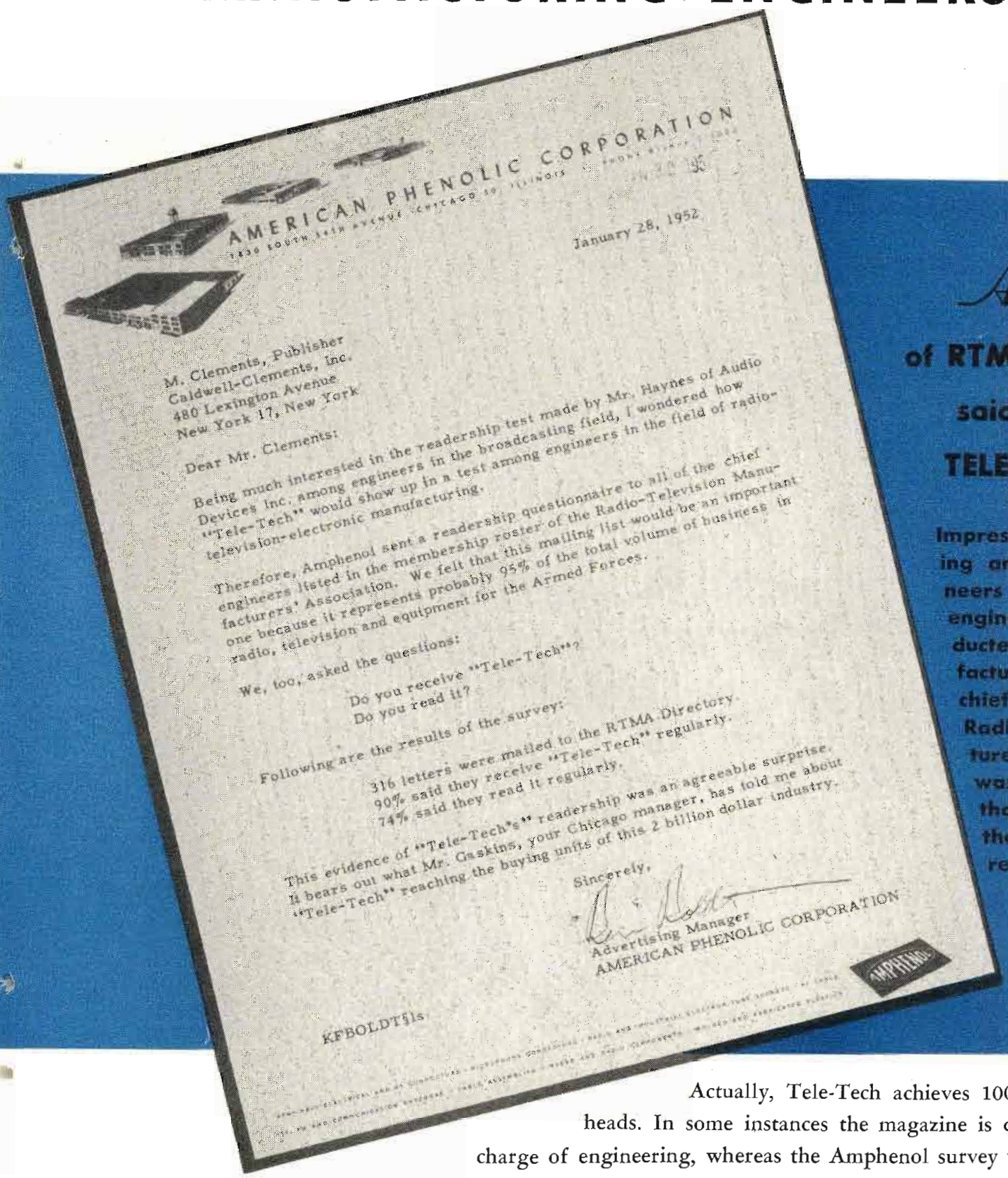
Liberty Broadcasting — DICK WEAVER,
El Paso, Texas — General Manager

Translucent Backdrops

Audio & Video Products Corp., 730 Fifth Ave., New York, N. Y., has been appointed exclusive eastern agent for the M. B. Paul Co., creators of one-piece translucent backdrops for motion pictures and TV. The backdrops are photo enlargements on seamless material suspended in wheel-mounted aluminum frames. They are pigmented to appear black-and-white with front lighting and colored with rear lighting.

AMPHENOL *inquired about . . .*

TELE-TECH'S READERSHIP AMONG MANUFACTURING ENGINEERS



AMERICAN PHENOLIC CORPORATION

1830 SOUTH 54TH AVENUE CHICAGO 50, ILLINOIS

January 28, 1952

M. Clements, Publisher
Caldwell-Clements, Inc.
480 Lexington Avenue
New York 17, New York

Dear Mr. Clements:

Being much interested in the readership test made by Mr. Haynes of Audio Devices Inc. among engineers in the broadcasting field, I wondered how "Tele-Tech" would show up in a test among engineers in the field of radio-television-electronic manufacturing.

Therefore, Amphenol sent a readership questionnaire to all of the chief engineers listed in the membership roster of the Radio-Television Manufacturers' Association. We felt that this mailing list would be an important one because it represents probably 95% of the total volume of business in radio, television and equipment for the Armed Forces.

We, too, asked the questions:

Do you receive "Tele-Tech"?
Do you read it?

Following are the results of the survey:

316 letters were mailed to the RTMA Directory.
90% said they receive "Tele-Tech" regularly.
74% said they read it regularly.

This evidence of "Tele-Tech's" readership was an agreeable surprise. It bears out what Mr. Gaskins, your Chicago manager, has told me about "Tele-Tech" reaching the buying units of this 2 billion dollar industry.

Sincerely,

Advertising Manager
AMERICAN PHENOLIC CORPORATION

KFBOLDT:ls

AMPHENOL

And 90%

of RTMA Chief Engineers said they received TELE-TECH regularly

Impressed by Tele-Tech's standing among broadcasting engineers and radio-TV consulting engineers, Amphenol conducted a test among manufacturing engineers. Every chief engineer listed in the Radio-Television Manufacturers' Association directory was polled, and 90% of those responding reported that Tele-Tech reached them regularly.

Actually, Tele-Tech achieves 100% coverage of engineering heads. In some instances the magazine is directed to vice presidents in charge of engineering, whereas the Amphenol survey went only to chief engineers. Compare this survey with the records of other technical journals in this field reaching only 20 to 50% of policy-level engineers, as shown by their audited renewal percentages.

So join the swing to TELE-TECH the technical magazine with the industry's largest top-level engineering audience. Selective, waste-free circulation now over 18,000!

CALDWELL-CLEMENTS, INC. **Publishers of . . . .**

480 Lexington Avenue, New York 17, N. Y., Plaza 9-7880

Chicago 6: 201 N. Wells St.
RAndolph 6-9225

Los Angeles 5: Chris Dunkle and Associates
2506 W. 8th St.; DUnkirk 7-6149

TELE-TECH

Spring Diffraction School Scheduled

North American Philips Co., Inc. will hold its twelfth X-ray Diffraction School at the company's plant, 750 South Fulton Ave., Mount Vernon, N. Y. during the week beginning Monday, April 21 through Friday, April 25, 1952. Exact program details will be announced later but basic subjects to be covered by prominent educators and scientists will include X-ray diffraction, new high and low temperature camera techniques, fluorescence analysis, Geiger-counter X-ray spectrometer, and electron microscopy and electron diffraction.

Philips initiated these semi-annual diffraction schools in the fall of 1946 in order to acquaint scientists and manufacturers with the latest techniques for use of this new and powerful X-ray analysis tool. For several years, the available accommodations for the Philips Diffraction Schools have been outnumbered by last minute applications.

NARTB Exhibitors

(*See program on page* 51)

5TH FLOOR (EXHIBIT FLOOR) CONRAD HILTON HOTEL

*SPACE NO.**	*EXHIBITOR*
532A (3)	Assoc. Program Service
550A (2)	Bdcast. Adv. Bureau
535A (3)	Capitol Records, Inc., Bdcast Div.
539A	Dresser-Stacey Co.
534	Fed. Tel. and Radio Corp.
553A	Gen. Precision Labs., Inc.
556 (2)	Goodman Radio & TV Prod.
542A (2)	Graybar Electric Co.
515A (2)	Keystone Bdstg. System, Inc.
512A (2)	Lang-Worth Feature Programs, Inc.
560	Musicolor, Inc.
509	Presto Recording Corp.
504 (3)	RCA—Engrg. Prod. Div.
512 (2)	RCA—Recorded Program Services
560A (2)	Radio Daily
533	Screen Gems, Inc., TV Dept.
556A (2)	Sesac, Inc.
504A (3)	Snader Telescriptions Sales, Inc.
502	Standard Radio Transcription Services, Inc.
528A (2)	Standard Rate and Data Service, Inc.
509A	Wincharger Corp.
500 (3)	World Bdstg. System, Inc.
500 (2)	Frederic W. Ziv Co.

*Numbers in parenthesis indicate number of rooms assigned to exhibitor.

EXPOSITION HALL CONRAD HILTON HOTEL

SPACE NO.	*EXHIBITOR*
2	Broadcast Music, Inc.
8	Century Lighting, Inc.
9	Collins Radio Co.
7	Continental Electronics Mfg. Co.
5	Allen B. Du Mont Labs., Inc.
10	Federal Telecommunication Labs. and Graybar Electric Co.
14	Gates Radio Co.
4	General Electric Co.
12	General Precision Labs.
1A	Kliegl Brothers
1, 3	Radio Corp. of America

new uses for Ceramag® NON-FERROUS CORES!

. . . higher temperature operation in nitrogen atmospheres

New equipment designed and sealed in nitrogen, due to high ambient temperatures imposed by miniaturization, poses a real temperature problem for permeability tuning cores as well as for I-F transformer and R-F cores. This is solved handily by Stackpole Ceramag cores thanks to the fact that they stand higher temperatures and show less drift than high-permeability powdered iron cores.

. . . low-frequency loop cores

The extremely high permeability inherent in Stackpole Ceramag ferrite cores makes them unsurpassed for exacting low-frequency loop uses.

. . . supersonic-frequency applications

Ceramag cores assure high permeability with low losses in the supersonic-frequency range.

. . . center cores for powdered iron pot cores

Used as center cores in powdered iron pot cores operating at less than 1 megacycle, Ceramag increases the L by approximately 100% and increases the Q on the order of 50%.

. . . incremental permeability applications

Because Ceramag is more easily saturated than conventional core materials, it is ideally suited for pulse generation, magnetic amplifying and incremental permeability tuning.

STACKPOLE

Electronic Components Division

STACKPOLE CARBON COMPANY • St. Marys, Pa.

FM-FM TELEMETRY

(*Continued from page* 55)

cated at either a fixed location or in mobile equipment. In any event, the equipment must be designed for maximum dependability and stability under extremes of temperature and humidity. The observing station will normally employ a circularly polarized antenna having a gain of 9 to 10 db and a beam width of 60° to 70° between half power points.

Modern high performance receivers are of the double detection superheterodyne type. Typical of such receivers is a unit with the following performance characteristics:

A. Freq. Range: 215-235 MC.
B. Deviation: ± 125 KC nominal: ± 175 KC max.
C. Distortion: Less than 0.5% at 6 v. p. to p. (± 125 KC Deviation) of limited signal.
D. Sensitivity: 20 db quieting 3 μv at center freq. not greater than 5 μv at ± 125 KC.
E. Signal-to-Noise Ratio: 60 db for 10 μv input.
F. Noise Factor: 5 db or better.
G. Image Rejection: 80 db or more.

Fig. 16 is a block diagram of a representative basic observing station, containing all system elements normally included in such equipment.

Telemetering Application

Telemetering is, of course, an established art in fixed systems. However mobile telemetering has given a new lease on life to an old art and extended its horizons. Mobile telemetering has been characterized by high performance under difficult environmental conditions, by simultaneous transmission of a multiplicity of channels of relatively high frequency response. As a result of these extensions of the art, telemetering becomes an ever more important tool in modern technology and will find ever increasing application as our economy expands to provide a better way of living through the intelligent and judicious use of the arts and sciences.

The FM-FM telemetering system has recently been adapted into a flood forecasting and control system for Pa. Simply by dialing, the weather office in Harrisburg can automatically secure a printed tape record of water level height from any one of a number of unattended gaging stations. Needless to say only a little imagination, a few megabucks, and some time will enable a complete automatic weather report to be made from each of these stations when it is dialed. Then, keeping the magnetic tape in mind, it is only another step until we collect and store all this information and by the press of a button have a complete, up-to-the-minute weather map made available.

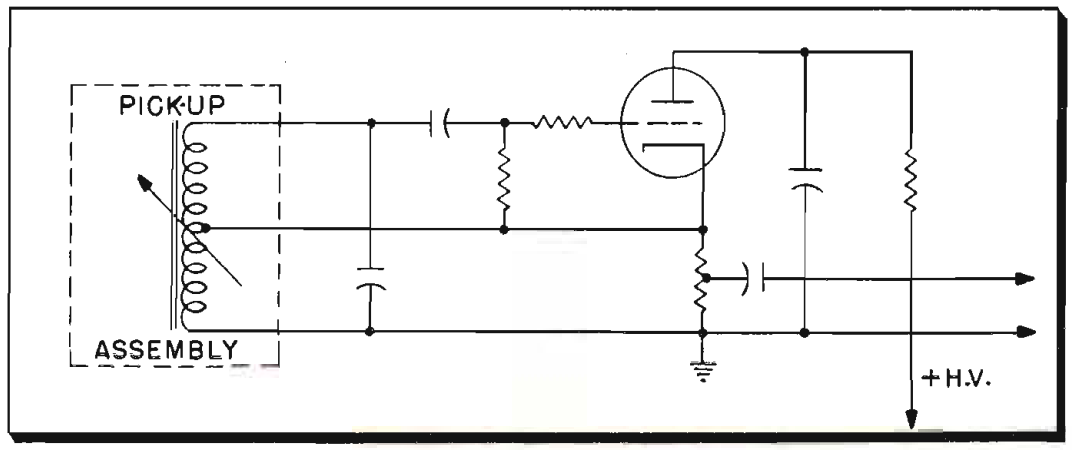
Air Traffic Control

Another potential use of telemetering is for air traffic control. Such a system would avoid the need of reporting in over the range station when on Instrument Flight Rules; would aid air traffic control in coordinating the general flow of traffic; would materially increase safety in air travel by virtue of the fact that the ground station would be able to advise the pilot in event of malfunctioning or misadjustment of equipment which might otherwise be undetected (such as an incorrect barometric pressure setting); and would further aid in improving air safety by indicating the cause of an accident when such occur.

Telemetering control and indication are applicable in many fields. FM-FM systems provide a convenient compromise between simplicity, multiple channels and a fairly high frequency response.

(*Continued on page* 92)

Fig. 17: Variable reactance subcarrier oscillator. Note that pick-up is an integral part of circuit



America's

TOP SHOWS

depend on Houston-Fearless Equipment

The Alan Young Show
CBS Television Network

Starring Alan Young with guests William Perlberg and George Seaton of Paramount Pictures, producers of "Aaron Slick from Pumpkin Creek." Color by Technicolor.

"In 98% of all U.S. Television Stations"

There are many good reasons why Houston-Fearless television camera pedestals and dollies are standard equipment in a vast majority of television stations. They are skillfully designed to give complete mobility to the camera, engineered to withstand constant usage, and built to give dependable performance at all times.

They embody 26 years of leadership in manufacturing camera and film processing equipment for the motion picture studios of Hollywood and throughout the World. You can rely on Houston-Fearless for quality and dependability.

Write for catalog on television equipment.

The **HOUSTON FEARLESS** *Corporation*

• DEVELOPING MACHINES • COLOR PRINTERS • FRICTION HEADS
• COLOR DEVELOPERS • DOLLIES • TRIPODS • PRINTERS • CRANES

11801 W. OLYMPIC BLVD • LOS ANGELES 64, CALIF.

"WORLD'S LARGEST MANUFACTURER OF MOTION PICTURE PROCESSING EQUIPMENT"

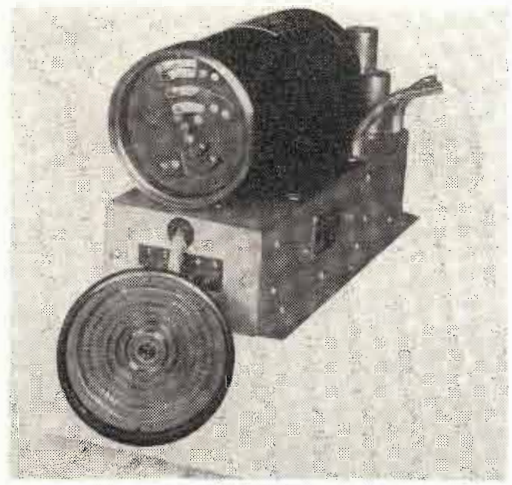


Fig. 18: Type 871 dynamotor-commutator-gate designed for five rps rotation and 27 channels

There are many potential applications in the fields of power control, petroleum and gas pumping and gaging, and long range process control.

FM-FM systems are simple and reliable, and are capable of readily maintaining satisfactory accuracy. FM-FM telemetering provides an electronic gadget dressed up in working clothes and doing a commendable job in both fixed and mobile installations.

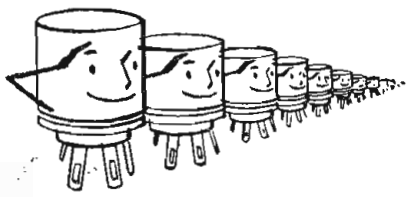
Quality-Controlled Electrical Components

The Sixth Annual Convention of the American Society for Quality Control, which will be held in Syracuse, N.Y. on May 22-24, 1952, will feature discussion of the results of a study by the Electronics Technical Committee. The aim of this study is to establish quality criteria for mass produced electrical components which would be acceptable to both vendor and purchaser. Based on the statistical concepts of a recognized sampling plan similar to that incorporated in Military Standard 105A or the one proposed by the RTMA R12 Committee, this standard would reduce inspection costs and increase confidence between buyer and seller. In operation, the seller would issue an outgoing inspection certificate covering all characteristics which will be accepted by the purchaser without incoming inspection. Response to a questionaire distributed by the Committee to determine the feasibility of the plan indicates strong industry interest.

Trade Mark "Handie-Talkie" Registered by Motorola

Trade-mark registration No. 542,561 has been issued to Motorola, Inc., by the United States Patent Office for the term "Handie-Talkie." This trade-mark cannot be used with any equipment other than that manufactured by Motorola, Inc., and it cannot be used generically in any connection.

SYLVANIA SOCKETS...

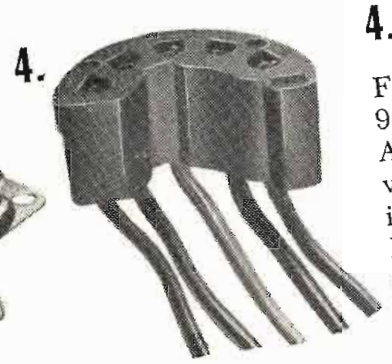


report for Active Duty!

Sylvania's full line of high quality sockets meets rigid military and civilian requirements

JAN 7-Pin Miniature Socket
(Shield Base Type)

For active military duty, Sylvania produces the JAN 7- and 9-Pin miniature sockets. These are available in Low Loss Phenolic and Steatite with Beryllium Copper Silver Plated contacts. The contacts and center shield tab are hot tin dipped after complete assembly.



1. 7-Pin Miniature Socket (Bottom Mounting)
2. RMA 9-Pin Miniature Socket (Shield Base Type)
3. Octal Socket (Top Mounting)
4. Duo-Decal Cathode Ray Tube Socket

For regular commercial use, Sylvania makes RMA 7- and 9-Pin Miniature, Turret, Octal, Duo-Decal, etc., sockets. Available in General Purpose and Low Loss Phenolics with any combination of contact materials. Write for new illustrated catalog giving complete descriptions: Sylvania Electric Products Inc., Dept. A-1104, Parts Sales Division, Warren, Pa.

SYLVANIA

RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS: PHOTOLAMPS: TELEVISION SETS

New Jersey Turnpike

(*Continued from page* 50)

from 300 to 30,000 CPS assures good quality. Power requirement is 45 watts at 115 v., 60 CPS, and the temperature range is —30° C to 70° C.

The CW-5B receiver covers 940-960 MC with about 0.5 MC bandwidth, has two i-f frequencies of 121.3-123.5 MC and 19 MC, and crystal frequencies of 34.120 MC and 34.843 MC. The equivalent noise input is 3.2 μv, noise figure not greater than 20 db. Frequency stability within the temperature range —30° C to 70° C is better than ±0.01%, and power consumption is 100 watts.

Dispatcher's Console

A dual position dispatcher's console at New Brunswick is connected by underground cable circuits with the radio equipment in a small building at the base of the tower. Channeling of the base-mobile system may be handled by one dispatcher when the system is operating end-to-end, or may be divided in various ways (see Fig. 9) by the supervisory control at New Brunswick to implement localized message handling within different sections of the Turnpike. Switching the control circuits of channels carrying way station information does not affect

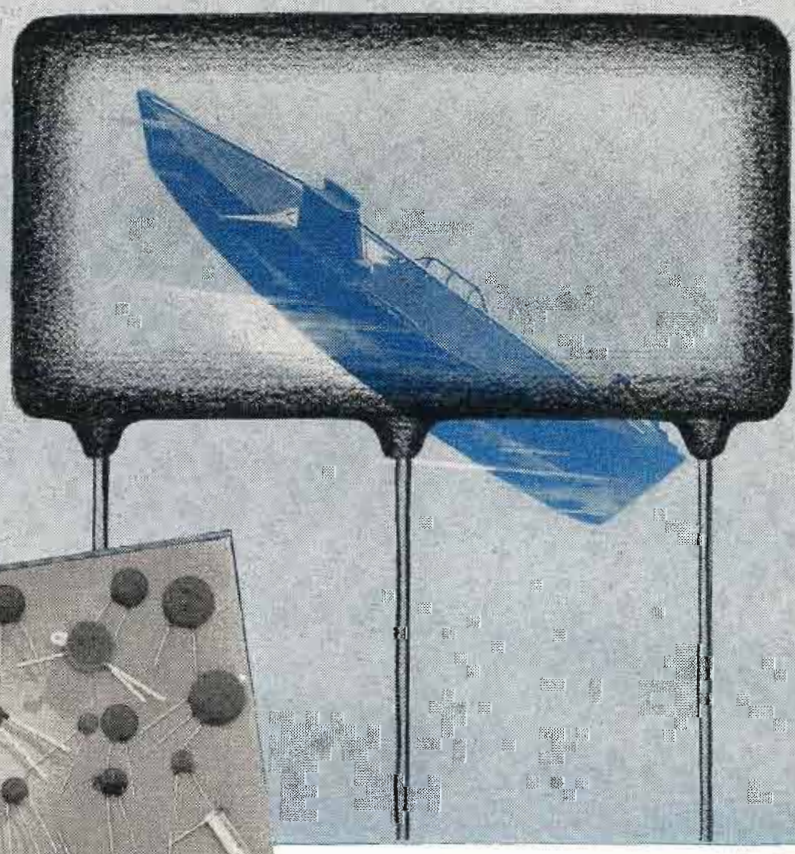
(*Continued on page* 96)

Fig. 8: Six-foot microwave dish at the start of the haul up the 150-foot Bordentown tower

HI-Q SERVES NATIONAL DEFENSE

Whenever Electronics Lend Ears to the Fleet

● Among the countless contributions which electronic engineers are making to our armed services, high importance must be placed on long-range eyes and ears for the fleet... ...not only in increasing the deadliness of its own undersea craft, but equally in protecting its surface vessels from enemy submarines. And throughout the field of electronics, high importance is likewise placed on the dependable long life and rigid adherance to specifications found in **HI-Q** components. Among the countless ceramic units carrying the **HI-Q** trademark, you'll find disc capacitors of by-pass and temperature compensating types ...tubulars, plates and plate assemblies ...new high voltage capacitors in many styles...trimmers, wire-wound resistors and chokes. You'll find, too, that **HI-Q** engineers are your best source for specially designed components to meet your specialized, individual needs.



HI-Q PLATES AND PLATE ASSEMBLIES

HI-Q Plate Capacitors can be produced in single and multiple units in an unlimited range of capacities up to guaranteed minimum values of 33,000 mmf per square inch. The number of capacities on a multiple unit is limited only by the K of the material and the physical size. In **HI-Q** Plate Assemblies (printed circuits) the number of combinations of condensors and resistors which can be incorporated on a single unit is virtually endless...again, limited only by the K of the material and physical size.

HI-Q* DIVISION

AEROVOX CORPORATION

OLEAN, NEW YORK, U. S. A.

*HI-Q is a registered trademark

Export: 41 E. 42nd St., New York 17, N. Y. • Cable: AEROCAP, N. Y. : In Canada: AEROVOX CANADA LTD., Hamilton, Ont.
JOBBER ADDRESS: 740 Belleville Ave., New Bedford, Mass.
SALES OFFICES IN ALL PRINCIPAL CITIES

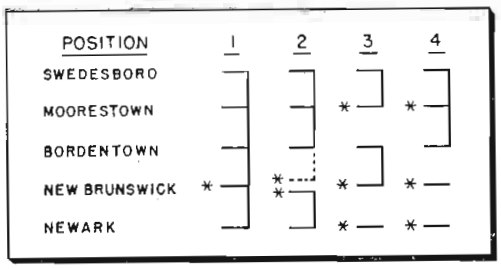


Fig. 9: To localize message handling, network may be divided in various combinations to be directed by several sub-control stations (*)

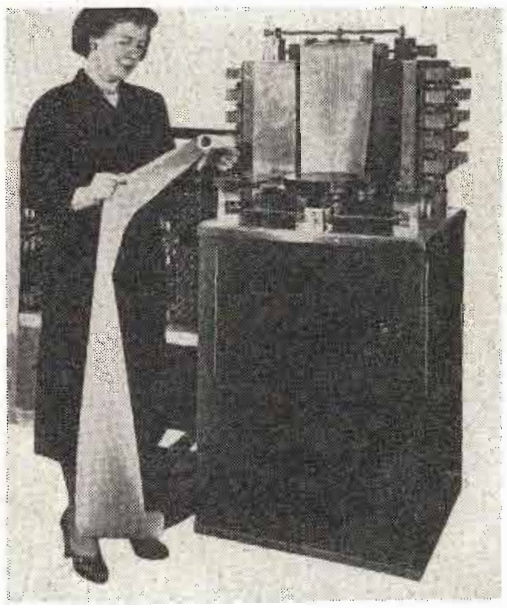
the teletype or direct phone channels.

Under normal conditions power is obtained from commercial lines, but in case of failure at any station, an engine-driven generator starts automatically, picks up the load within a few seconds, and carries the load until power is restored.

At this writing, a permanent organization to service the radio network has not been set up. It is anticipated that about three technicians will be required to keep all equipment maintained, and the New Jersey Turnpike Authority is expected to contract with a qualified company on a bid basis for these services.

In times of national emergency, this flexible communications system will prove a valuable adjunct to a transcontinental web of highways and radio relays for military transport and disaster relief.

STORAGE-FED TYPEWRITER



The high-speed typewriter recently developed by Potter Instrument Co., Great Neck, N. Y., accepts coded pulse signals from an external source such as communication lines, computer or punched cards, and alternately stores and extracts the information once for each line printed. Information is taken from the 80-channel storage unit by a photoelectric pulse generator. The self-synchronous system may be operated continuously or intermittently, and the storage may be used as part of a computer. Forty-seven type characters are mounted on a rotating typewheel, and are struck by hammer solenoids at the rate of 24,000 characters per minute.

Use these cards to get data on ADVERTISED PRODUCTS

Here is a list of the major offerings by advertisers in this issue of TELE-TECH. If you want literature or further information on any of these products, simply enter the code numbers on the postage-free cards on the opposite page.

CODE NO.	ADVERTISER	INFORMATION ON
401	Ace Engineering & Machine	Screen rooms
402	Adams & Westlake Co.	Mercury relays
403	Aireraft Radio Corp.	Signal generators
404	Alden Products Co.	Components & chassis
405	Altec Lansing Corp.	Mixing console
406	American Lava Corp.	Ceramic parts
407	American Phenolic Corp.	Connectors and cables
408	Amperite Co., Inc.	Relays and regulators
409	Ampex Electrie Corp.	Tape recorders
410	Atlas Sound Corp.	Mike stands
411	Audio Devices, Inc.	Audio tape and discs
412	Avery Adhesive Label Corp.	Adhesive labels
413	Bardwell & McAlister	TV lights
414	Bell Telephone Labs.	Communications services
415	Berkeley Scientific Corp.	Frequency meter
416	Berlant Associates	Tape recorder
417	Birtcher Corp.	Tube clamps
418	Boonton Radio Corp.	FM-AM signal generator
419	Bussmann Mfg. Co.	Fuses
420	Camera Equipment Co.	TV tripods
421	Camera Mart, Inc.	Camera dollies
422	Century Lighting, Inc.	Lighting equipment
423	Cinch Mfg. Corp.	Electronic components
424	Cinema Engineering Co.	Degausser
425	Cleveland Container Co.	Phenolic tubing
426	Clippard Instrument Lab.	Resistanee comparator
427	Cont'l Diamond Fibre Co.	Plastic forms
428	Cornell-Dubilier Elec. Corp.	Interference filters
429	Cornish Wire	Cord sets
430	Dage Electric	Connectors
431	Dale Products, Inc.	Resistors
432	Dial Light Co.	Panel lights
433	Distillation Prods. Inds.	Diffusion pumps
434	Dumont Labs., Inc., A. B.	TV console—mixers
435	DX Radio Products Co.	Crystals
436	Eclipse-Pioneer (Bendix)	Beam power amplifiers
437	Eisler Engineering Co.	Glass & welding units
438	Eitel-McCullough, Inc.	Transmitting tubes
439	Elco Tool & Screw Corp.	Screws
440	Eleetrical Industries, Inc.	Terminals
441	Elec Reactance Corp (Hi-Q)	Capacitors
442	Eleetrieal Tower Service	Tower installation
443	Electro Prods. Labs.	DC power supply
444	Electronies Meehanies, Inc.	Insulating material
445	Federated Purchaser, Inc.	Components distributor
446	Freed Transformer Co.	Transformers
447A	General Eleetrie Co.	Germanium power reetifiers
447B	General Electrie Co.	UHF amplifier tubes
448	General Industries Co.	Phono motors
449	General Preeision Lab.	TV studio equipment
450	General Radio Co.	
451	Grayburne Corp.	RF ehokes
452	Grayhill	Test elips
453	Gries Reproducer Corp.	Coil bobbins
454	Guardian Eleetrie	Relays
455	Guthman & Co., E. I.	Coils
456	Heath Co.	Test equip. kits
457	Helipot Corp.	Potentiometers
458	Heppner Mfg. Co.	Ion traps
459	Hermaseal Co., Inc.	Sealed components
460	Hermetic Seal Products	Plug-in headers
461	Houston-Fearless Corp.	TV studio equipment
462	Int'l Resistance Co.	Resistors
463	Jones, Howard B. Div.	Fanning strips
464	Kahle Engineering Co.	Tube mfg. equip.
465	Kenyon Transformer Co.	Transformers
466	Kester Solder Co.	Solder
467	Kinetix Instrument	Servos & transformers
468	Kinney Mfg. Co.	Vacuum pumps
469	Knights Co., James	Crystals
470	Kollsman Instrument Corp.	Instruments & controls
471	Lenkurt Electrie Sales Co.	Iron toroids
472	Magnecord, Inc.	Tape recorders
473	Mallory & Co., Inc., P. R.	UHF converters
474	Marion Elec. Instr. Co.	Meters
475	Measurements Corp.	TV signal generators
476	Melpar, Inc.	Personnel
477	Mieo Instrument Co.	Coil winders
478	National Co., Inc.	Miniature tube mountings
479	Nat'l Vulcanized Fibre Co.	Laminated plastics
480	Niagara Radio Supply Corp.	Sound equip. dist.
481	Northrop Aircraft	Personnel
482	N.R.K. Mfg. & Eng. Co.	Instruments & assemblies
483	Onan & Sons, D. W.	Electric power plants
484	Paramount Paper Tube Corp.	Paper tubing
485	Perfection Electric Co.	TV beam adjuster
486	Phalo Plastics	Communieation cable
487	Philco Corp.	Microwave relays
488	Preeision Paper Tube Co.	Paper tubing
489	Pyramid Electrie Co.	Paper capacitors
490A	Radio Corp. of America	Transmitting tubes
490B	Radio Corp. of America	TV power tetrodes
491	Radio Materials Corp.	Ceramie capacitors
492	Raypar, Inc.	Components
493	Raytheon Mfg. Co.	Reeeiving tubes
494	Sangamo Electrie Co.	Button eapacitors
495	Shallcross Mfg. Co.	Resistors
496	Sorvall, Ivan	Portable ealculators
497	Sperry Gyroscope Co.	Personnel
498	Sprague Electric Co.	Button eapaeitors
499	Stackpole Carbon Co.	
500	Standard Eleetronies	TV transmitters
501	Standard Transformer Corp.	Transformers
502	Steward Mfg. Co., D. M.	Ceramics
503	Superior Tube	Tubular parts
504A	Sylvania Elec. Prods. Inc.	Tubes & components
504B	Sylvania Elec. Prods. Inc.	Tube eonsultants
504C	Sylvania Elec. Prods. Inc.	Tube sockets
505	Synthane Corp.	Laminated plastics
506	Taylor Fibre Co.	Vulcanized fibre
507	Tinnerman Produets	Tension fasteners
508	Tru-Ohm Prods. (Mod. Eng.)	Resistors—rheostats
509	Truseon Steel Co.	Steel towers
510	U. S. Engineering	Eleetronic hardware
511	Weller Electric	Soldering guns
512	Wells Sales, Inc.	Miniature switehes
513	Westinghouse Elee. Corp.	Transformers
514	White Dental Mfg., S. S.	Flexible shafts
515	Workshop Associates	Parabolie antennas

Refer to page 129 for page number of advertiser.

Another TELE-TECH Service . . .

to the industry's largest top-level engineering audience . . . also the best informed . . . now having a

5½ BILLION $ MARKET

Radio · Television · Electronic Industries

In view of the industry's tremendous backlog of planning and the scaling down of military spending, a warning is in order. Don't get caught in the rush. When the freeze is lifted, everyone will want information on such things as New Equipment, Improvements, Substitute materials, Costs, Performance studies, Specifications, Application data and Delivery dates.

To facilitate your own planning, mail these INQUIRY CARDS today!

Perhaps you need more information on

Studio gear	Mobile radio	Printed circuits
Relay stations	Military electronics	Miniaturized parts
UHF TV equipment	Color TV	Aircraft controls
Microwave systems	Video recording	HF test equipment
Radar	Sound recording	Substitute materials

Or, maybe you want data on new capacitors, resistors, rectifiers, power supplies, etc.

TELE-TECH IS "INFORMATION HEADQUARTERS"

FIRST in "Video Techniques" and "Television Systems" in Annual Report on Radio Progress by Proceedings of I.R.E.

FIRST and only magazine to publish a map of TV stations and networks, both cable and relay; specifications of microwave relay equipment; Station & Studio Equipment Directory; Analysis of Armed Forces Procurement.

FIRST in abstracts by Armed Forces Technical Data Digest for recommended reading of military engineering personnel.

FIRST radio-TV technical magazine whose statistical data are reprinted by Encyclopedia Britannica, World Almanac, Information Please Almanac and other organizations.

To get information on any product advertised in this issue, refer to list on opposite page. Select code number of item or items, enter in boxes on card, fill out card and mail.

Not good after June 1, 1952

INQUIRY CARD

Write in boxes the code numbers of products for which you want more information.

Information also wanted on .....

Your company .....

Address .....

.....

Your name .....

Your title .....

TELE-TECH—April 1952

CALDWELL-CLEMENTS, INC., 480 Lexington Avenue, New York 17

Not good after June 1, 1952

INQUIRY CARD

Write in boxes the code numbers of products for which you want more information.

Information also wanted on .....

Your company .....

Address .....

.....

Your name .....

Your title .....

TELE-TECH—April 1952

CALDWELL-CLEMENTS, INC., 480 Lexington Avenue, New York 17

If you want more information on products advertised in this issue, fill out these postage-free inquiry cards and mail to

TELE-TECH

Radio · Television · Electronic Industries

TELE-TECH is the predominant technical journal of a 5½ billion dollar market in the telecommunications and electronic defense industries. In the advertising pages as well as in editorial features, you will often get the FIRST NEWS of important advances in products coming soon or already on the market.

Special Features Coming Up:

RADIO-ELECTRONIC EQUIPMENT FOR AIRCRAFT—Improvements in miniaturized components and printed circuits. New systems of communication. Altitude derating of equipment.

ELECTRONIC INDUSTRIES FOR DEFENSE—Results of new, completely revised surveys of the Armed Forces procurement agencies. Contract procedure changes. Negotiated preparedness contracts. Army, Navy, Air Force data integrated into one issue for the first time.

HOW CALIFORNIA'S ELECTRONIC INDUSTRIES HAVE GROWN—Engineering Directory of West Coast manufacturing, broadcasting, etc. Descriptions of outstanding technical devices. Reviewing aircraft-electronic industry; military guided missile operations. Who's who in management and engineering. Mobile radio in California. Products of California's component manufacturers.

STATION AND STUDIO DIRECTORY—Who's who in manufacturing TV, FM, AM and Microwave equipment for civilian and military applications.

UHF-MICROWAVES' EXPANDING MULTI-MILLION $ MARKET—New systems proving boon to utilities, railroads, oil and gas pipelines. Manufacturers gird for big market.

18,000 CIRCULATION

ALL key men in engineering, manufacturing, operation and Armed Forces procurement; ALL verified as to title and classification under rules of Controlled Circulation Audit, Inc.

CONSTITUTING the industry's largest group of top-level engineers and executives.

GREATEST % OF GAIN IN ADVERTISING

—in radio-TV-electronic publications. 15 months ending March 1952 compared with the previous 15-month period ..... **83.6% GAIN**

Use these postage-free cards to get further information on any products advertised in TELE-TECH

Caldwell-Clements, Inc.

480 LEXINGTON AVENUE NEW YORK 17, N. Y.

CHICAGO—201 N. Wells Street, Chicago 6, Illinois

CALIFORNIA—Chris Dunkle & Associates, 2506 W. 8th St., Los Angeles 5

Publishers also of RADIO & TELEVISION RETAILING

Not good after June 1, 1952

FIRST CLASS
PERMIT No. 22273
(Sec. 34.9, P.L.&R.)
NEW YORK, N.Y.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

3¢—POSTAGE WILL BE PAID BY

TELE-TECH
480 LEXINGTON AVENUE
NEW YORK 17, N. Y.

Caldwell-Clements, Inc.

Not good after June 1, 1952

FIRST CLASS
PERMIT No. 22273
(Sec. 34.9, P.L.&R.)
NEW YORK, N.Y.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

3¢—POSTAGE WILL BE PAID BY

TELE-TECH
480 LEXINGTON AVENUE
NEW YORK 17, N. Y.

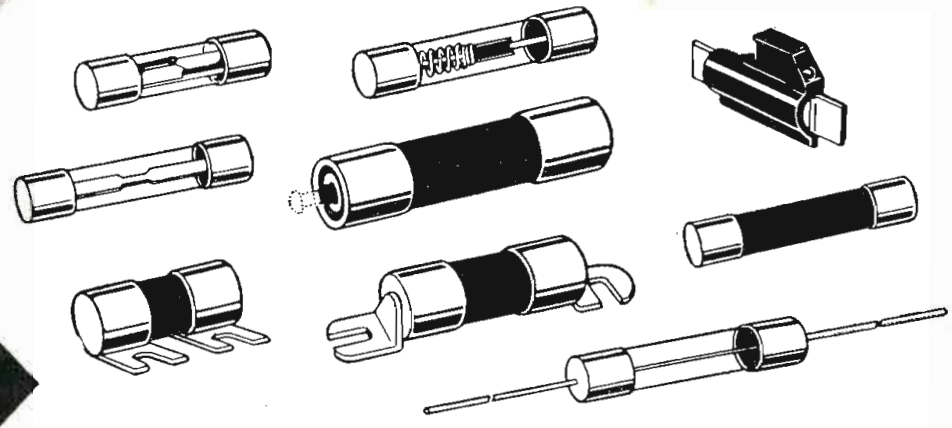
Caldwell-Clements, Inc.

Let BUSS FUSES Help Protect Your Reputation

As a User of High Quality Materials

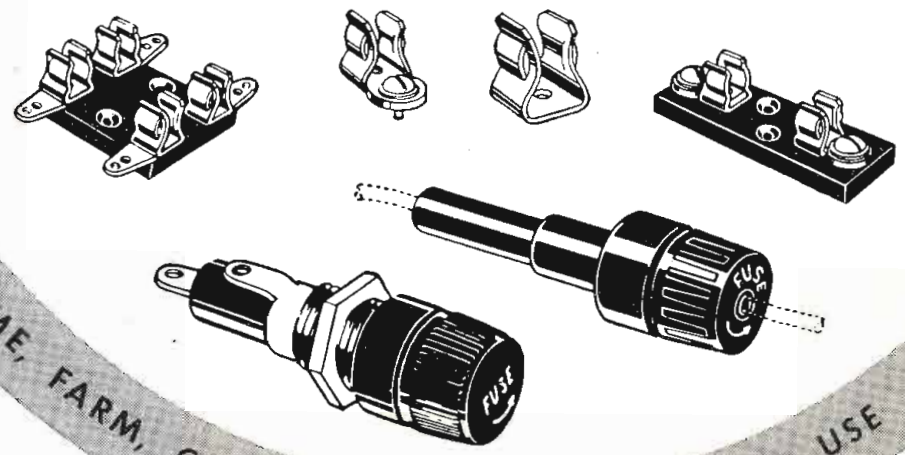
MANUFACTURERS OF A COMPLETE LINE OF FUSES

For
TELEVISION • RADIO • RADAR
INSTRUMENTS • CONTROLS • AVIONICS



FOR HOME, FARM, COMMERCIAL AND INDUSTRIAL USE

plus companion lines of BUSS Fuse Clips, Blocks and Fuse Holders. Made in many types to make it easy to select the fuse and fuse mounting needed to give required protection.



The makers of BUSS Fuses take every precaution to be sure that the highest standards of quality are maintained. EVERY BUSS FUSE IS ELECTRONICALLY TESTED. A sensitive testing device rejects any fuse that is not correctly calibrated, properly constructed and right in all physical dimensions.

This insistence on perfection is the reason why you can always rely on BUSS Fuses. Manufacturers and service men the country over have learned they can depend on BUSS Fuses for the right protection under all service conditions.

Here's another reason why it pays to standardize on BUSS Fuses: You can get all your fuses from one source. The line is complete — dual-element (slow blowing), renewable and one-time types . . . in sizes from 1/500 ampere up.

If you have a special problem concerning electrical protection, let our engineers help you select the right fuse — or design a new fuse, or fuse mounting, to meet your needs. Our staff of engineers and laboratory are at your service.

SEND THE COUPON *for complete facts . . .*

BUSSMANN Mfg. Co. (Division of McGraw Electric Co.)
University at Jefferson, St. Louis 7, Mo.

Please send me bulletin SFB containing complete facts on BUSS small dimension fuses and fuse holders.

*Name*_____

*Title*_____

*Company*_____

*Address*_____

*City & Zone*_____ *State*_____ 452 TT

Germanium Diodes

(*Continued from page 43*)

Sparking Elimination

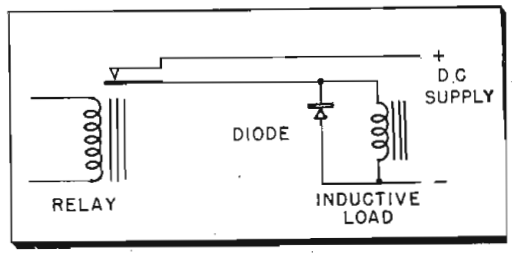


Fig. 12: Contact sparking can be practically eliminated by the use of a germanium diode connected across the load. With the relay contact closed as shown very little current is drawn by the diode because the voltage drop across the load is in the back direction for the diode. When the relay contact opens, the magnetic field in the load inductance collapses. This causes a forward voltage to appear across the diode and the diode conducts. Sparking is eliminated because the inductive energy of the load is dissipated in the diode forward resistance rather than in the relay contact gap. For most low voltage communication type relay loads a single IN51 or IN48 will be satisfactory. For higher voltage loads use type IN52 or IN63.

Heavy Loads

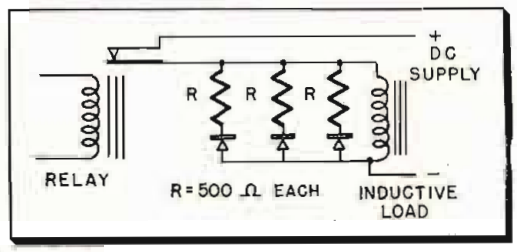


Fig. 13: For large relay of motor loads several diodes are connected in parallel, still preventing contact sparking. The series resistors help distribute the current more evenly among the several parallel diodes.

Microammeters

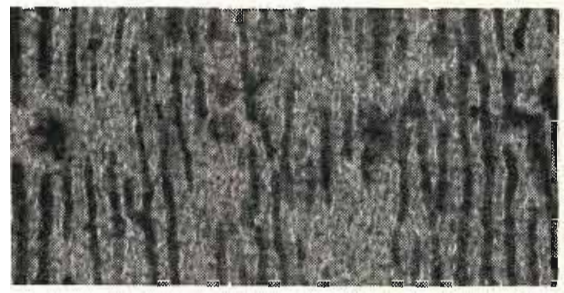
CIRCUIT	DC SCALE V	DC SCALE μa	RECTIFIED METER RES. ACROSS A-B	FULL SCALE AC μa	FULL SCALE AC MV
A — 13 K, 0-2.5 V — HALF WAVE	2.5 2 1.5 1 0.5	30 23 13 6.5 2.0	1,400	165	230
B — 27 K, 0-2.5 V — SERIES SHUNT	2.5 2 1.5 1 0.5	30 24 17 10 4	3,600	75	260
C — 13 K, 1.3K, 0-2.5 V, 1.3K — CENTER TAP	2.5 2 1.5 1 .5	30 22 14 7 4	3,100	160	450
D — 53 K, 0-2.5 V — BRIDGE	2.5 2 1.5 1.0 .5	30 23 17 10 3	6,700	42	270

Figs. 14 a, b, c and d: The meter rectifier circuits shown are suggested for a 30 μa 2000 ohm meter. They may be transposed to either 20 μa or 50 μa by changing the sensitivity in direct proportion. For example, if the full scale with a μa 30 meter is 2.5 v., then the full scale sensitivity with a 20 μa meter will be

(*Continued on page 102*)

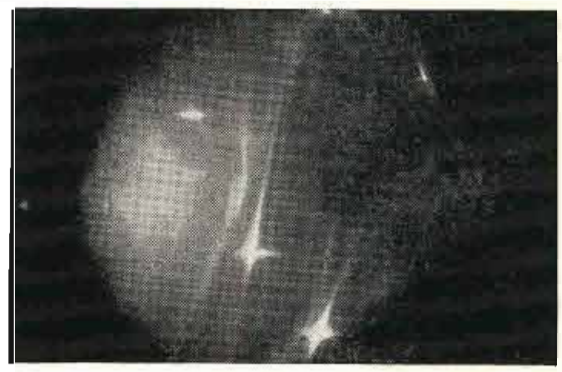
Electrons probe the future

1 Electron micrograph of an alloy of aluminum, nickel, cobalt and iron. Magnification 20,000 diameters.



2 Cooled from high temperature in a magnetic field, the alloy becomes a powerful, permanent magnet. Note changed structure. Black bars reveal formation of precipitate parallel to the applied field. Each bar is a permanent magnet.

3 A Bell scientist adjusts electron diffraction camera. Electrons are projected on the specimen at glancing angles. They rebound in patterns which tell the arrangement of the atoms . . . help show how telephone materials can be improved.



4 Diffraction pattern of polished germanium reveals minute impurities which would degrade the performance of a Transistor.

In 1927, Bell Laboratories physicists demonstrated that moving electrons behave like light waves, and thus launched the new science of electron optics.

Now, through the electron beams of the electron microscope and electron diffraction camera, scientists learn crucial details about the properties of metals far beyond the reach of optical microscopes or chemical analysis.

At the Laboratories, electron beams have revealed the minute formations which produce the vigor of the permanent magnets used in telephone ringers and magnetron tubes for radar. The same techniques help show what makes an alloy hard, a cathode emit more electrons and how germanium must be processed to make good Transistors.

This is the kind of research which digs deep *inside* materials to discover how they can be made better for your telephone system . . . and for the many devices which the Laboratories are now developing for national defense.

BELL TELEPHONE LABORATORIES

Improving telephone service for America provides careers for creative men in scientific and technical fields.

(Continued from page 100)

2/3 × 2.5 or 1.7 v. This simple ratio does not hold for higher meter currents due to the change in diode resistance. The meter resistance for the three sensitivities is assumed to be 2000 ohms. The ac sensitivity, the series resistance and the rectified meter resistance (i.e. with zero series resistance) may each vary ± 15 percent depending upon the individual diodes. All data shown is based on IN51 diodes, although any other diode with equal or better forward and back resistance will give about the same characteristics. There is some pointer vibration near full scale in all circuits using the 3 in. undamped meter.

Plug-in Assembly

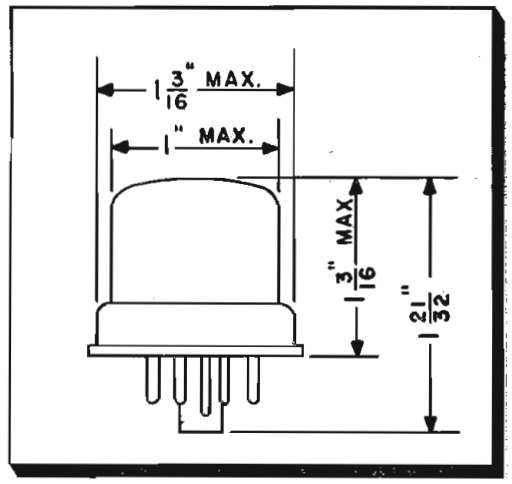


Fig. 15: Where the increased sensitivity of the 4 diode bridge rectifier shown in Fig. 14 d is desirable, a plug-in hermetically sealed assembly may be used. Some typical units are the type G9B, IN73 and IN74 with overall dimensions shown.

E-I Characteristic

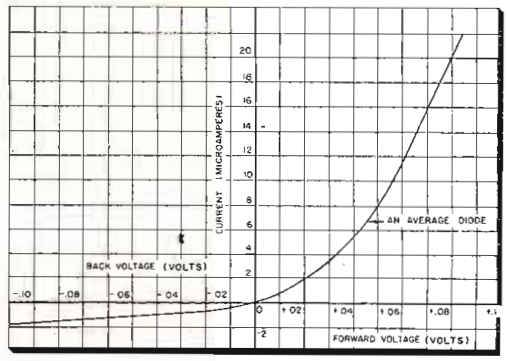


Fig. 16: Typical low voltage-current characteristic of type IN48 at 25°C.

(Continued on page 104)

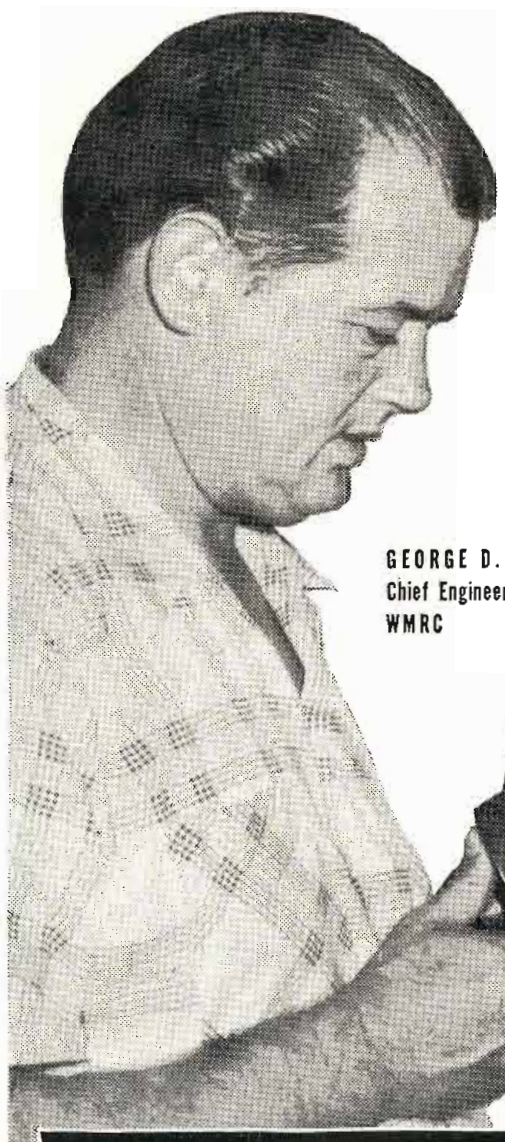
Condensed Specifications for Some Germanium Diodes

Type	MAX. Forward Resistance (Ohms) at +1 V.	MIN. Back Resistance (Ohms) at —50V.	MAX. Inverse Voltage (Volts)
IN48	250	60,000	85
IN51	400	30,000	50
IN52	250	333,000	85
IN63	250	1 meg.	125
IN65	400	250,000	85
IN69	200	59,000	75
IN70	333	122,000	125
IN72	Tested for efficiency at 500 MC.		
IN73	Balanced quad. Very closely matched.		
IN74	Balanced quad. Very closely matched.		
IN75	400	1 meg.	125

RETIRED...

*One Eimac 3X2500A3 . . . after 11,000 hours of FM broadcast service on 94.9 Mc

Before Eimac tubes are put out to pasture, they earn their retirement. Here's a typical story:



GEORGE D. TATE
Chief Engineer
WMRC

TEXTILE BROADCASTING COMPANY
Radio WMRC Station
AFFILIATED WITH AMERICAN BROADCASTING CO
5000 WATTS DAY AND NIGHT
GREENVILLE, S. C.

Eitel-McCullough, Inc.
San Bruno, California

Dear Sirs:

Thought you may be interested to know that we have just retired one of your 3X2500A3 tubes with a little over 11,000 hours of use.

This tube was used in our FM Station which operates on 94.9 Mc. with an ERP of 79,000 watts; this means an input of 10,5000 watts which in my opinion is pushing any pair of tubes for FM service.

This tube had to operate at a plate current of 1.35 amps. at 3900 volts.

We are highly pleased with this tube.

Very truly yours,

Radio Station WMRC-WMRC-FM

George D. Tate

George D. Tate
Chief Engineer

FOLLOW THE LEADERS TO Eimac TUBES
THE POWER FOR R-F

* For complete technical data on the 3X2500A3 or 3X2500F3 triodes...or any other Eimac tube, write:

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

EXPORT AGENTS: FRAZAR & HANSEN • 301 CLAY STREET • SAN FRANCISCO 11, CALIFORNIA

(Continued from page 102)

Eff. Characteristic

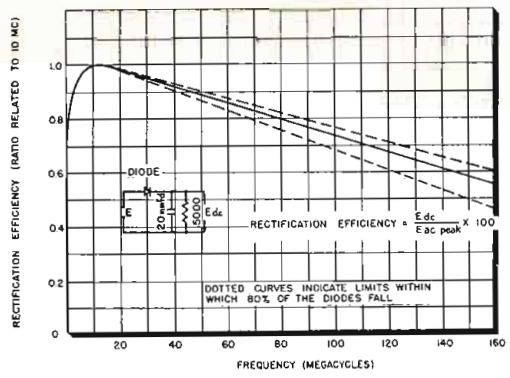


Fig. 17: Typical rectification efficiency-frequency ratio characteristics of types IN48, IN52, and IN63 at 25°C.

I-Temp Characteristic

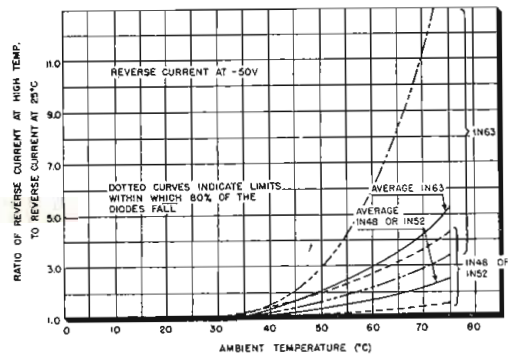


Fig. 18: Typical reverse current-temperature ratio characteristics with respect to 25°C.

E-Temp. Characteristic

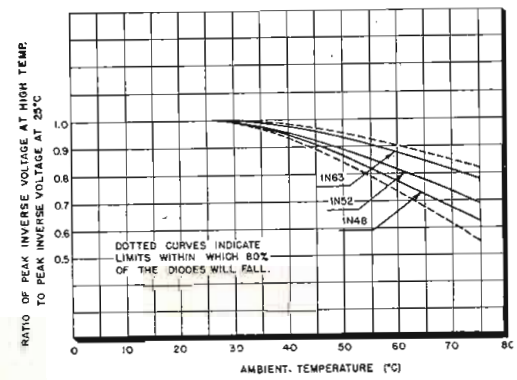


Fig. 19: Typical peak inverse voltage-temperature ratio characteristics with respect to 25°C.

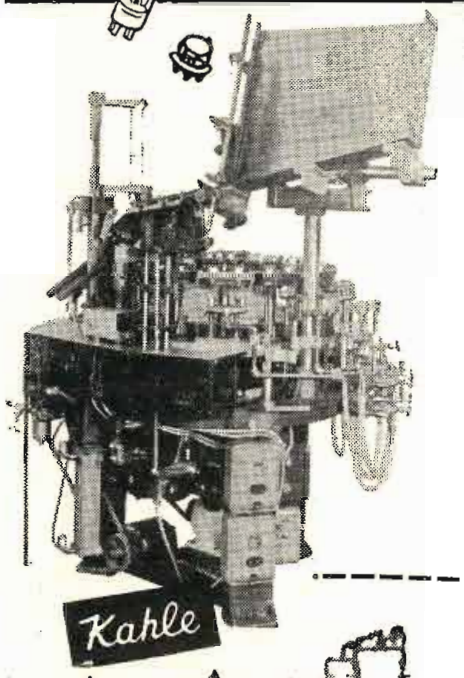
Fansteel Organizes Rectifier-Capacitor Division

Production, engineering and sales of selenium rectifiers and tantalum electrolytic capacitors have been formally integrated into the Rectifier-Capacitor Div. of Fansteel Metallurgical Corp., North Chicago, Ill.

Glen Ramsey, who for several years has been manager of the rectifier division, is now general manager of the rectifier-capacitor division. O. S. Aikman is sales manager, assisted by Robert T. Morrison, sales engineer. E. W. Lincoln is manager of production planning; James H. Hall is manager of product engineering; Florian Schardt is manufacturing superintendent and W. E. Brown is chief inspector.

Kahle equipment for manufacturing sub-miniature, miniature, power and cathode-ray tubes

FOR SUB-MINIATURE TUBES

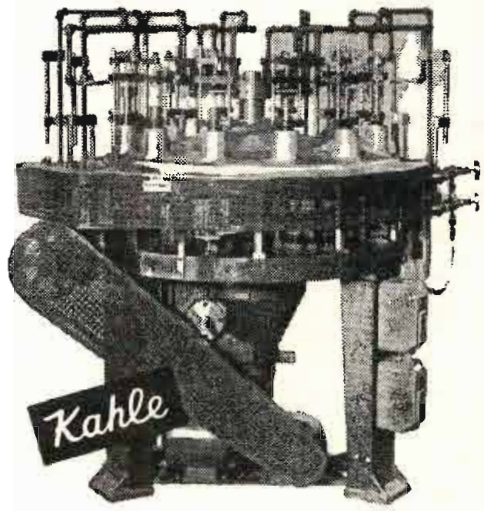


#1934 AUTOMATIC BULB MAKING MACHINE

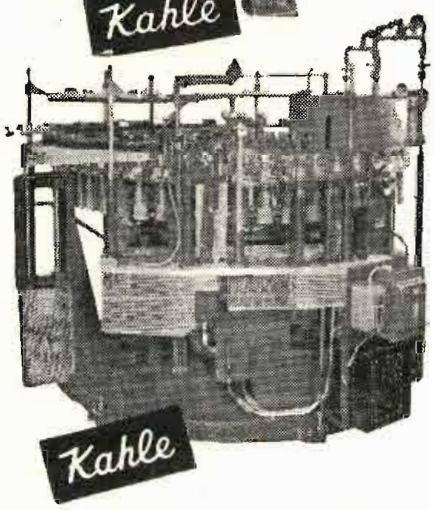
Precise constriction and tubulation. Fully automatic including feeding and unloading. Cap. 2000 per hour. For flat, square, and round bulbs.

#1384 12-HEAD BUTTON STEM MACHINE

Upper and lower molds on every head. Dual motor drive. Indexing and head rotation are by separate motors. For oblong, square, and round buttons, etc.



FOR MINIATURE TUBES

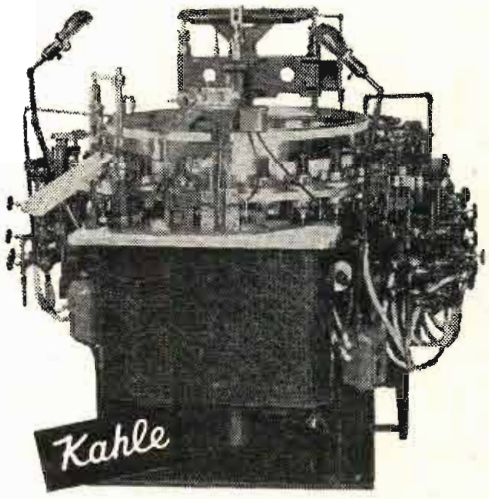


#1463 48-POSITION EXHAUST MACHINE

All degrees of operation from manual to completely automatic. Production limited only by pump equipment or loading speed of operator.

#1197 24-HEAD BUTTON STEM MACHINE

For miniature and sub-miniature tubes. Two upper molds for making tubulated and non-tubulated stems. Dual motor drive. Cap. 1000 per hour. All automatic feeds.



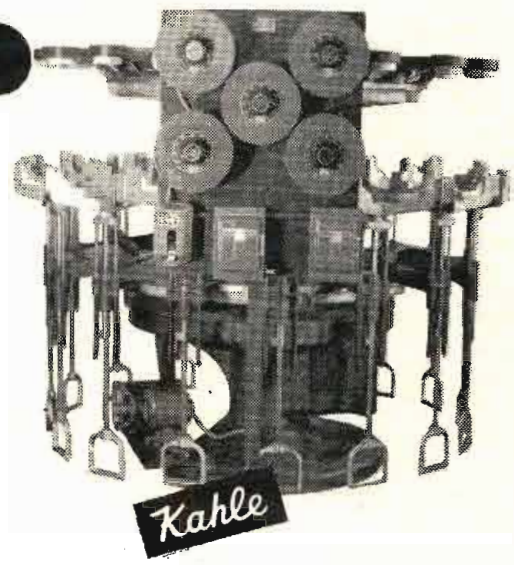
FOR CATHODE RAY TUBES

#1801 16-HEAD SEALING MACHINE

Indexing machine for large tubes; takes all tubes up to 26″ dia. or diag. with all heads filled. Larger tubes on alternate heads.

#1363 16-POSITION BASING MACHINE

Also for other large lamps and tubes. Takes up to 12″ tubes in every position. Larger tubes on alternate positions. Variable speed drive. Foot operated feed.



We welcome your consultation. Write for our new catalog.

Kahle's 40 years of experience mean that standard toolings for all requirements *already* have been tested and approved. Machines for everything from sub-miniature to largest TV picture tubes assembled to exact specifications . . . *at lower costs.*

KAHLE ENGINEERING CO.

1317 SEVENTH STREET • NORTH BERGEN, NEW JERSEY

PERSONAL

I. L. Brandt has been named chief engineer of Taylor Tubes, Inc., Chicago, manufacturer of high vacuum power tubes and other special purpose tubes. He was formerly project engineer for the Continental Electric Co., Geneva, Ill.

Leslie E. Woods, director of industrial relations at Raytheon Manufacturing Co., Waltham, Mass., has been appointed a member of the New England Regional Labor-Management Committee for Defense Manpower. The appointment was made by Maurice J. Tobin, U. S. Secretary of Labor.

Tore Anderson has been elevated to the post of chief engineer of Airtron, Inc., Linden, N. J. Mr. Anderson joined Airtron in 1947 and will be responsible for the design and production of waveguide components.

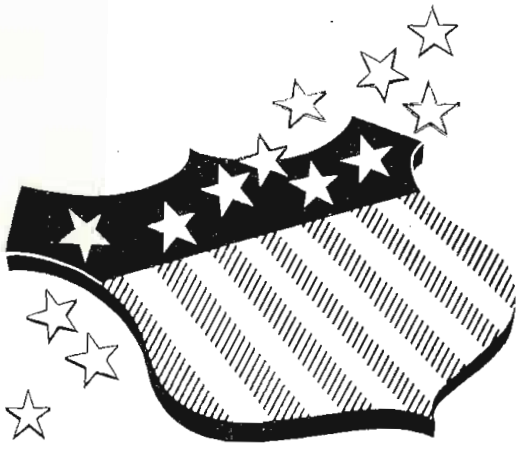
George C. Kent and William E. Daly have joined the staff of Magnecord, Inc. Mr. Kent, former design engineer for Revere Camera Co., was named senior mechanical engineer of Magnecord. Mr. Daly, who was named electrical development engineer, previously worked on magnetic recording head development for Shure Bros.

Robert L. Hammett, formerly a partner in the firm of A. Earl Cullen, Jr., Dallas, Texas, has opened an office for the practice of consulting radio engineering at 230 Bankers Investment Bldg., San Francisco 2, Calif.

Cyrus W. Haller, president of Pioneer Electronics Corp., Salem, Mass., has been elected president of the Victoreen Instrument Co., 3800 Perkins Ave., Cleveland, Ohio, since 1931 active in specialized fields of electronic manufacturing. The Victoreen Company has purchased the Pioneer Electronics operation, and has also acquired 16 acres and 23,000 sq. ft. of manufacturing space at New London, Ohio. Mr. Haller will continue as president of Pioneer Electronics which makes special tubes and Government equipment.

NEW CENTRALAB PRESIDENT

William S. Parsons, vice president of Globe-Union Inc., has been elected president of Centralab, subsidiary of Globe-Union. He was also elected to Globe-Union board of directors



Coming in Tele-Tech for June . . .

An up-to-date, integrated

DEFENSE PROCUREMENT STUDY

Exclusive, Invaluable . . . The Industry's Guidepost to TV-Radio-Electronic Contracting for Military Use

A Master Chart in Supplement Form

The June "Armed Forces Procurement" issue of Tele-Tech will contain a twelve-page supplement crammed with factual, usable information on selling TV-radio-electronic equipment, production facilities, or engineering services for national defense. A central feature of this supplement will be a color chart—suitable for mounting—of electronic procurement agencies and channels of all three services. It will show at a glance the principal offices and personnel responsible for each category and phase of electronic procurement.

Selling and Contracting Procedures

Text material accompanying the chart will cover the "how and where" of selling to the government, as well as a wealth of equally useful information on service-by-service contracting and purchasing procedure.

SELL YOUR DEFENSE "KNOW-HOW" IN TELE-TECH FOR JUNE

The "Armed Forces Procurement" issue of TELE-TECH will have an *exceptionally* forceful impact upon the magazine's thousands of policy-level engineering and executive readers. Take advantage of this unique opportunity to place your company's message before all segments of the industry contributing to defense, as well as the key people directing and implementing the military electronic program. Closing dates are April 25th if proofs are required; May 1st for complete plates.

Tele-Tech's 18,000 Circulation Reaches the Industry's Buying Power Units

TELE-TECH *Caldwell-Clements, Inc.*

480 LEXINGTON AVE., NEW YORK 17, N. Y.

For Manufacturers

(*Continued from page* 45)

plates. In so doing it permits two powerful plate magnets, one opposite the other on internal faces of the hump, to set up magnetic barriers in tandem; what contamination one misses the other catches. Substantial savings have been reported as well hundred pounds of one material used in the compound, for example, normally contains 1/60 lb. of metal filings. This particular ingredient is only 0.1% of the entire formula. Hence, the percentage of ferrous contamination from this source was only 1/60,000 of one percent! Yet, it alone, without additional contaminants from other materials going into the compound, would have been enough to damage the stampers.

To remove the ferrous metal particles from the vinyl compound two as the ability to "press many times more records from a set of stampers than when a contaminated batch of compound is used."

Photorelay Excitation

A 40-watt lamp is often the best light source for a photorelay, reports A. Edelman, Chief Engineer, Photobell Co., 116 Nassau St., New York, N. Y. The lamp can vibrate, shake, turn or be pushed and it still furnishes the required excitation perfectly. On the other hand, a focussed light-beam projector must be accurately adjusted, and only a skilled hand can replace the lamp. Cost-wise and maintenance-wise, the plain lamp is often preferable.

Styroflex Cable Production

Whipple Jacobs, president of Phelps Dodge Copper Products Corporation, today announced that his company had begun to market the new type of coaxial cable[1] that employs aluminum as the outer conductor and sheath. For microwave uses, this cable is built with a central conductor held in the exact center of the outer sheath and conductor by a spiral of interior polystyrene insulation tape which occupies about 12% of the space—the rest being air dielectric. The interior insulating helix is built up of hundreds of extremely thin Styroflex tapes wound on with great precision by a taping machine. The technique of insulating with tape has many advantages:

1. the size of the inner or outer conductor can be changed without much trouble,
2. many new materials which are available in the form of tapes but which cannot be extruded may be used, and

3. the inner conductor is maintained absolutely centralized even at sharp bends within the thickness of one tape, namely 2 to 4 thousandths of an inch, a feature of great importance at 2000 mc.

[1]New Type Coaxial Cable Permits Applications in 1000-10,000 MC Range, B. F. Osbahr, Tele-Tech, Nov. 1951, p. 42.

Bailey of NBS Receives Fleming Award

The Arthur S. Fleming Award, given each year by the Washington Junior Chamber of Commerce, to the man in government service under 36 years of age who has been of greatest service to the nation, has been awarded to Dana K. Bailey of the National Bureau of Standards.

Mr. Bailey received the award for his contributions in the field of radio propagation, and for his extensive service in international relations as technical representative of the U.S. at meetings of the International Telecommunications Union, an organization concerned with the efficient utilization of the radio spectrum, and the International Radio Consultive Committee. His extensive compliations of propagation data have formed the basis for subsequent work on world-wide frequency allocations.

Selenium Replaces Cobalt in Phone Ringers

Employing a two-cell selenium rectifier 7mm in diameter in place of the cobalt steel magnet, the new telephone subset ringer developed by Federal Telephone and Radio Corp., Clifton, N.J., retains existing tooling without modification. The acute shortage of cobalt encouraged this change. The rectifier is connected so that current is alternately passed through each magnetic coil in the ringer. An annealed low carbon stel pole piece completes the magnetic circuit. Tests indicate that the redesigned unit performs satisfactorily in the 16⅔ to 35 cps range over 1,400 ohm loops when not more than four ringers are bridged on the line and when the minimum ringing voltage is 70 v.

Stevens Heads Emerald Manufacturing Co.

George Stevens, president of the Stevens Manufacturing Co., Chicago, has acquired the complete ownership and manufacturing facilities of Mallard Coil Co. He will head the new organization which will be known as Emerald Manufacturing Co. Coils, flybacks, transformers and television components will be the company's principal products.

News of MANUFACTURERS' REPS

Heppner Manufacturing Co., Round Lake, Mich., has appointed Ralph Haffey, 2417 Kenwood, Ft. Wayne, Indiana, a company representative for the Indiana, Ohio and Michigan territories. He was formerly a member of Magnavox's purchasing department in Fort Wayne.

Mandex Manufacturing Co., maker of plugs, sockets and connectors, has named John B. Tubergen, Mandex rep for the Southern California area. He is the newly-elected president of the Los Angeles chapter of "The Representatives" of Radio Parts Manufacturers, Inc.

Ray Bridge has joined the Arthur E. Ackroyd organization, John Hancock Bldg., Boston 16, Mass. as factory sales representatives of radio parts and equipment in the New England area.

C. Curtis Engel, Ridgewood, N. J. has been named representative for Gertsch Products, Inc., Los Angeles, Calif., Keithley Instruments, Cleveland, Ohio, and Kron-Hite Instrument Co., Cambridge, Mass.

Art Cerf & Co. will represent the Bridgeport Brass Co., Bridgeport, Conn., in the sale of TV plastic and aluminum spray. The territory includes New England, New York, New Jersey, Delaware, Eastern Pennsylvania, Maryland, Washington, D. C., and Virginia.

Marshank Sales Co., Los Angeles, Calif., has acquired two new field engineers: Irving R. Stern and William J. Monteforte. They will cover the Chicago territory.

R. Edward Stemm Co., manufacturers' engineering representatives, 5707 West Lake St., Chicago, has added Howard J. Christianson to the staff. His background includes affiliations with the General Electric X-Ray Div., as chief engineer of communication parts, and more recently as head of production for Radio Craftsman, Inc., Chicago.

John I. Moss, formerly head of the Contract Planning section of the Navy Bureau of Ships, has joined the George Petitt Co., 549 W. Washington, Chicago, as industrial sales manager. The Petitt Co. serves as manufacturers' representatives in Illinois, Wisconsin and Iowa.

New York Reps Publishing Buyers' Guide

Harry Finkelstein, vice-president and publicity chairman of the New York Chapter of the Reps, 136 Liberty St., New York 6, N. Y., reports that the new "Reps Buyers Guide" will be ready for distribution shortly. This new guide is so indexed that it will enable Purchasing Agents to seek the names of Reps that handle lines very quickly.

Cincinnati IRE Plans Spring Technical Meeting

The Spring Technical Meeting of the Cincinnati Section of the IRE will be held April 19, 1952 at the Engineering Society of Cincinnati Bldg., 1349 E. McMillan St., Cincinnati, Ohio. Technical papers on color television, UHF tuners, and radio relay systems will be presented. Dr. D. B. Sinclair, national president of the IRE, will speak at the banquet.

Airtron Expands in Linden, N. J.

Airtron, Inc., designers and producers of waveguide and electronic components for aircraft and allied industries, now has three busy plants going in Linden, N. J., having just acquired the Duke Mfg. Co.'s building which provides an additional 23,000 ft. of badly needed space. David Ingalls, president, states that ground will be broken May 1st for an addition to the newly acquired building which will provide an additional 13,000 ft.

SLOTTED UHF ANTENNA

O. O. Fiet, of RCA Broadcast Engineering, views new UHF TV antenna which he helped to develop at Camden, N. J. This antenna, RCA's new commercial model, differs from NBC's installation at Bridgeport in two main respects. The experimental station's antenna is made up of two sections, flanged at the center. The radiator, shown in the picture, is manufactured in one piece. Secondly, the Bridgeport antenna has 4 slots arranged around the circumference of the mast while the commercial version has three. Adjacent slots on the new antenna are staggered 60° to provide a circular horizontal pattern and also to maintain structural strength

Cues for Broadcasters

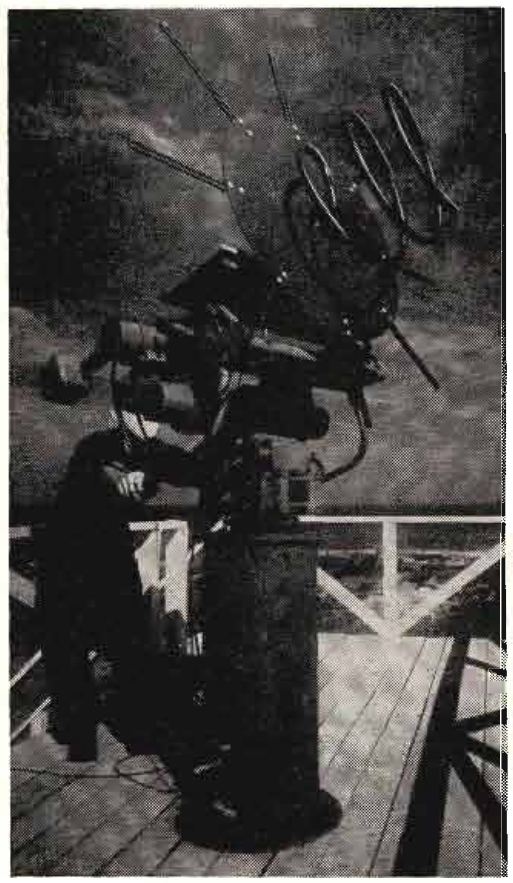
(*Continued from page* 84)

tinues until reset by the operator.

(4) No modifications are required in the receiver to use the device. The volume control setting on the receiver does not effect the operation. This means that when the buzzer sounds and the red signal light comes on, the operator simply turns up the volume to monitor what is on the station. At all other times the volume can be turned off.

The station being monitored is tuned in by observing the minimum plate current reading on the meter. When the station is tuned in the meter will read from 0 to 1 or 2 mils. RL_1 will not be energized because of the very low plate current. Static, or a stronger signal, lowers the plate current. With no carrier present the plate current immediately rises to 6 ma energizing RL_1 which causes RY_2 to become energized. Two of the contacts on RY_2 are used to keep RY_2 energized when this occurs, thus actuating buzzer and red signal light until reset by the operator.

TRACKING GUIDED MISSILES



Official Air Force photo of telemetry antenna used to track path of a guided missile in flight. The antenna receives data transmitted by the guided missile as a modulated r-f carrier. The information is fed to a bank of demodulators and tape recorders where it is separated and stored on multi-track wide-range magnetic tape recorders. See "Uses of Magnetic Tape Recording in Instrumentation and Data Analysis" in the next issue of TELE-TECH.

Graybar to Enter TV Broadcast Field

The Graybar Electric Co. has entered into an agreement with Federal Telecommunication Laboratories, Inc., Nutley, N. J., associate of IT&T, covering national distribution of Federal's TV broadcasting equipment as the first step toward full-scale entry into the television field, announces J. W. La Marque, general communications sales manager for Graybar.

The agreement, which goes into effect immediately, covers Federal's complete

J. W. La Marque, general communications sales manager for Graybar

line of TV transmitting and studio equipments, which include transmitters, auxiliary equipment, antennas, cameras, TV film projectors, all studio equipments, and microwave links.

The new line will feature the Laboratories' latest TV microwave links for operation between cities, between studio and transmitter, and for relaying programs from remote pick-up points to studio locations. Sound diplexing equipment, an exclusive Federal development that permits the transmission of both sound and picture simultaneously over a single radio link, will also be available. Other TV equipment covered by the distributorship includes single and dual flying spot scanners; VHF and UHF transmitters and antennas; and auxiliary units.

IRE at Houston, Texas, May 16-17

Program and plans for the 4th Southwestern IRE Conference and Radio Engineering Show, scheduled for Houston, Texas, on May 16-17 are nearing completion. In making this announcement, general conference chairman G. K. Miller, Schlumberger, Inc., said that an attendance of more than 1,000 was expected for the Texas show.

Among the leading speakers assured for the Conference are: IRE president Dr. Donald B. Sinclair, chief engineer of General Radio Corporation; Commander T. A. M. Craven of Craven, Lohnes & Culver, Washington, D. C.; A. Earl Cullum, consulting engineer from Dallas; John Reinartz, Eitel McCullough, Inc.; and Col. Edwin White, FCC.

Series Discriminator

(*Continued from page 63*)

25 KC used the following components:

C_1	0.0039 mfd.
C_2, C_3	0.01 mfd.
D_1, D_2	Type IN34 crystal
L_1	10 mh (Q of 200)
R_1	224 ohms
R_2	56 ohms
R_3	0 ohms
R_4	280 ohms
R_5, R_6	220,000 ohms

(Component identification symbols refer to Fig. 1.) Peak bandwidth was ±2.5 KC, and operating bandwith for linear response was chosen as ±1.0 KC. Circuits of this type have been designed for operation at various center frequencies from 400 CPS to 10 MC, and results have generally agreed with design predictions.

Many circuit variations are possible, some providing operating or coupling features which are difficult to obtain in the more conventional circuits. Fig. 4, for example, shows a variable-bandwidth discriminator working into a zero-center meter which reads directly in terms of frequency and deviation. The phase detector in this case employs balanced triodes. Center frequency could be varied, if desired, by using a suitable variable or step-type reactance element. However, since the Q of the series resonant circuit varies with frequency, a slight readjustment of the bandwidth control will be required when changing center frequency if the deviation calibration of the meter is to be maintained.

A circuit resembling the conventional Foster-Seeley discriminator is shown in Fig. 5. Care must, of course, be taken in this circuit to balance out phase shift errors. Some of the methods that may be employed for this purpose are tuning, resistance loading, and use of bifilar windings to increase coupling.

The twin series circuit of Fig. 6 is a version that may be of particular interest to the economy-minded FM circuit engineer. For this circuit, inductor L_1 equals L_2, and capacitor C_1 equals C_2. Impedance Z_1 may or may not equal Z_2, but should have the same phasing sense, that is, both may be resistive, inductive, or even capacitive. If reactive elements are used, they must have the same Q. These impedances adjust the amplitudes of the vectors as well as determine the bandwidth. It is interesting to note that coils L_1 and L_2, when correctly phased, can be unity coupled bifilar windings. This is economical in that it permits the use of a common coil form and slug for both windings. Furthermore, if resistors are used for the loading impedances, the dc plate circuit is completed with really good parts economy. Capacitors C_5 and C_6 are

optional. They provide phase ratio detection which may be more immune to noise than the simple detection of the other circuits.

The twin series version is an adaptation of the monocyclic square which was described in detail by the late Charles Proteus Steinmetz.

Split Channel Operation

(*Continued from page* 59)

the design problems can be overcome. Requirements for frequency stability and frequency setting would not be as severe as for 30 KC channels and many of the 60 KC adjacent channel equipments now in use could be used on 40 KC channels

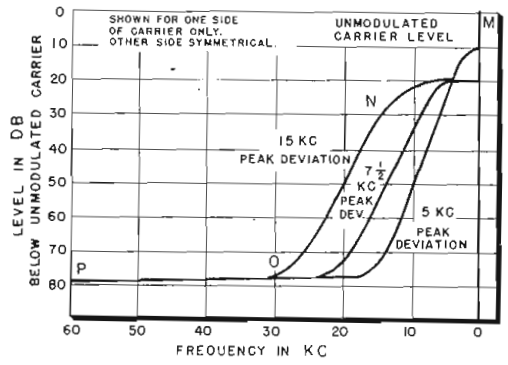


Fig. 10: Voice modulated transmitter sideband distribution for three deviations

without too much increase in interference, if the deviation were reduced. This system would require shifting of the frequency assignment of some of the present channels, which is not required if 30 KC channels were used.

4. Intermodulation interference is increased with split channel operation whether 20 KC or 30 KC.

5. With either 20 KC and 30 KC channel splitting plans, a great deal of thought on the part of the FCC and the industry must be given to how a change-over can be made, especially in the more crowded parts of the band, without too rapid obsolescence of equipment already in use.

The author wishes to express his indebtedness to a number of his associates in making this study. Particularly to Mr. G. A. Kious for his assistance in making the field tests, Mr. R. P. Gifford for much of the work on graphic analysis, and Mr. C. M. Heiden for overall guidance in the project.

In Part I of this article appearing in the March issue of TELE-TECH, for clarity the first paragraph on page 65 should be amended to read as follows: A receiver, B, with a selectivity of about 100 db at ± 20 KC as measured by the 20 db quieting method, was obtained. It has been a common belief that such a receiver would give acceptable adjacent channel operation even on 20 KC spacing. As an additional check, a second receiver, B, was modified to have approximately the same i-f selectivity using multiple tuned i-f transformers.

1. C. A. Priest, C. M. Heiden and D. C. Pinkerton, "Narrow Band FM Doubles Number of VHF Channels For Mobile Use," *Tele-Tech*, Sept. & Oct. '50.
2. H. H. Davids, "Selectivity and Desensitization of Communication Receivers," *FM and TV Radio Communication*, Sept. '51.

Electrostatic Relays

(Continued from page 37)

unit area of the ribbon. For this reason, fast electrostatic relays are limited to subminiature sizes.

Although neither the ribbon length nor the tension enter explicitly into Eq. (8) above, they enter indirectly through the requirement the $(B_0 x_0) < 0.6$. Substituting appropriately,

$$x_0^2 < 9\, a^3\, h\, Y/V^2;$$

$$x_0 < 0.67\, t_c \sqrt{Y/D}$$

This equation completes the design information relating the closing time, the applied potential, and the dimensions of the relay.

As an example, consider a relay with a spacing of 0.002 in., an aluminum alloy ribbon with a density of 3 and 0.0001 in. thick, and actuated with 500 v. The calculated closing time is 12 μsec., but the calculated stable length is only a little more than ⅛ in., using the maximum safe tension in the ribbon. If the thickness of the ribbon is increased to 0.0004 in., while the voltage is halved, the closing time is nearly 50 μsec., but the ribbon length is now about 0.5 in., a perfectly reasonable size for modern subminiature assembly techniques.

It was pointed out in the beginning of this article that one of the advantages of electrostatic construction is the ability to operate from high frequency sources directly. This implies that these relays may be used directly in conjunction with vacuum tubes in low voltage circuits, since the output voltage from the tube can be stepped up to the relay operating potential in an extremely simple air-core transformer. In switching low voltage dc potentials with a relay of this type, actuation with r-f power carries the additional advantage that the actuating voltages, which are capacitively coupled into the contact circuits, in the simple designs shown, can easily be filtered out. (Similarly, a relay switching r-f currents had best be operated on dc.)

Damping Problem

One of the major problems associated with the actual design of a ribbon relay is that of damping the mechanical motion of the ribbon, after it has been snapped against the contacts by the electrostatic field. Several solutions have been advanced, none of them wholly satisfactory. For dc operation, one of the contacts can be used to short the deflecting plate to the ribbon

through a small condenser which recharges, after a short delay, through a resistor in the line to the plate. This brings the deflecting voltage down to very small values for a short interval after the ribbon strikes the contact; during this interval the tension forces in the ribbon absorb its kinetic energy. As the ribbon comes to a halt, the potential on the deflecting plate rises again to balance these tension forces, and hold the ribbon in the deflected position. For r-f operation, the plate voltage on the driving oscillator tube can be shunted off for a few microseconds by the same device. Alternatively, the change in capacity between the plate and the ribbon, as the latter deflects, can be made to detune the transformer secondary, and so to diminish the voltage on the deflecting plate as the ribbon approaches the contacts.

Filling Relay with Fluid

One other solution to the damping problem, which also trades speed for ruggedness, is to fill the relay with a viscous fluid of high dielectric constant, high breakdown strength, and a density as nearly equal to that of the ribbon as possible. This reduces the forces on the ribbon occasioned by transverse acceleration of the relay (since these are proportional to the difference in density between the ribbon and its ambient material), and also reduces the voltage required to deflect and hold the ribbon, by virtue of the high dielectric constant. The effective mass of the ribbon, and hence the closing time, are increased very greatly, however.

Suitable fluids for this work are currently expensive curiosities of chemistry, but the quantity required to fill one relay is so minute that even a very expensive filling will not increase the cost of the relay appreciably above the cost of evacuting it.

Although any extended discussion of practical applications would be premature, the small size and weight, the low actuating power, and the hermetic sealing suggest aircraft applications, particularly in gliders, sounding balloons, and other special types where power supplies are precious and vibration is not a problem. The high speed suggests uses in computers and telemetering devices. By driving the ribbon at its resonant frequency, chopping of thermocouple voltages and other dc amplifier inputs at 20 to 30 kc becomes practical.

This paper was first presented before the National Electronics Conference in Chicago, Ill., Oct. 22-24, 1951.

Harmonic Generation

(*Continued from page* 61)

megacycles because of the length of the connection. Furthermore, a grounded cathode, or more accurately, a common cathode multiplier is impractical because of the cathode lead inductance. Further, the geometry of the tube requires the output circuit to be connected between the anode and screen grid rather than between the anode and cathode. The circuit of Fig. 5 has therefore been designed, and with it it is possible to obtain very satisfactory frequency multiplier performance up to the highest frequency at which the tube will function as a straight amplifier, that is, about 1100 MC and about 1600 MC pulsed.

From the equivalent circuit in Fig. 6 it can be seen that the feedback occurs because of the passage of the anode-to-cathode current through the input or grid cathode circuit. An explanation of the functioning of the feedback in greater detail has already been given elsewhere, [7, 8] but its principal characteristic is that it is current feedback and is not obtained by any external coupling means between the output and input circuits. Also, the magnitude of the feedback voltage developed across the input circuit is virtually independent of the impedance of the output circuit. It therefore follows that the feedback will be present to about the same extent whether the output circuit is tuned to the fundamental frequency or to a harmonic frequency.

In practice, the amount of feedback is adjusted by varying the length of the stub between the open end of the grid conductor and the movable shorting bar or by varying the ratio of the capacitances of C_1 and C_2. Normally a stub length of about $\lambda/8$ is required for stable operation when $C_1 = C_2 = 0$, or somewhat less if the circuit is provided with C_1 and C_2 in an adjustable form. The amount of positive feedback is roughly proportional to C_1/C_2. Increasing both C_1 and C_2 and maintaining their ratio constant will lower the resonant frequency of the circuit without changing the feedback appreciably. The ratio C_1/C_2 required for a given amount of feedback depends not only on the stub length but on the ratios of the diameters of the coaxial lines.

Regarding the limit to the amount of feedback that can be used, this would seem to depend on the kind of service intended. A continuous reduction in driving power required is obtained even if the feedback is increased beyond the point where

self-oscillation persists when the drive is removed. In cw or FM-CW service it may therefore be permissible to use this much feedback. On the other hand, the linearity of (r-f output)/(r-f input) suffers as the feedback is increased, and in certain applications this might be inadmissible.

The situation is illustrated graphically in Fig. 7, showing that when the feedback is just large enough to cause self-oscillation the driving power required is still finite and appreciably large. Only when the feedback is increased considerably

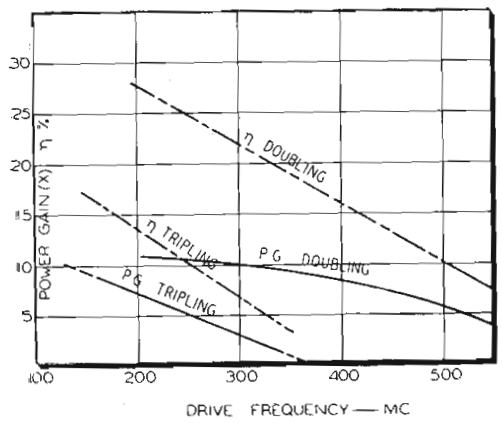


Fig. 8: Performance of 4X150G multiplier shown in Fig. 5

beyond this point will the circuit give maximum output with the drive removed. This is the feedback adjustment for most efficient self-oscillation. The efficiency (n) curves in Fig. 8 represent about 90% of the maximum efficiency when driven to saturation.

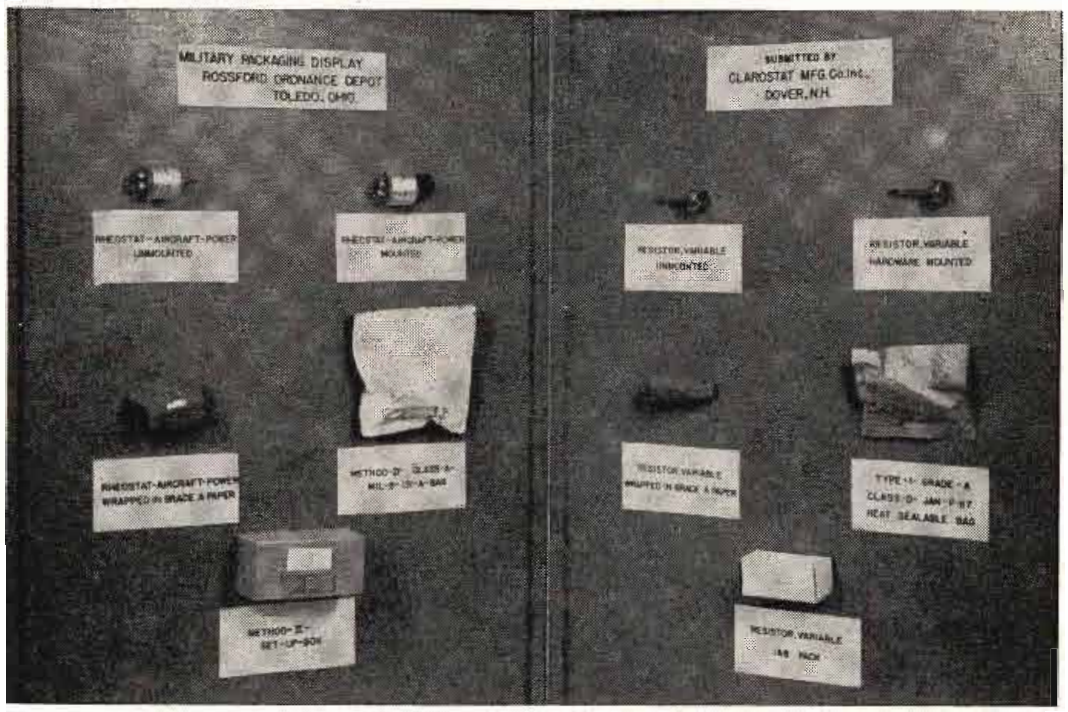
It will be seen from Fig. 8 that the power gains are considerably superior to those in Fig. 4, due partly to the reduction in input circuit losses in the tube itself, but mainly to the introduction of positive feedback. There is still a frequency ceiling however, and the efficiency vs. frequency curves do not differ appreciably in the two cases. This is because r-f losses, and especially electron transit time losses, cause a broadening of the plate current pulses energizing the output circuit and a corresponding decrease in harmonic content.

An examination of the equivalent circuit indicates that at driving frequencies lower than about 300 MC, it is feasible to dispense with the transmission line input circuit and use instead a parallel wire arrangement or lumped inductances in the form of small coils coupled together in the appropriate manner, as shown in Fig. 9. This would result in a more compact physical layout.

It should be emphasized that the numerical values of the power gain

(*Continued on page* 120)

MILITARY PACKAGING DISPLAY BY CLAROSTAT



Shown above is a portion of a compact display on military packaging submitted by the Clarostat Mfg. Co., Inc. of Dover, N. H. and which recently went on exhibition at the Rossford Ordnance Depot, Toledo, Ohio. Depicted are the successive packaging steps required for aircraft power rheostats and for variable (potentiometers) resistors. Steps include: mounting hardware, wrapping in grade A paper, placing in heat sealable bag in accordance with military specifications, and boxing.

and efficiency shown in Fig. 4 and Fig. 8 represent the condition where the efficiency is 90% of the value that can be obtained by increasing the driving power indefinitely, or to the value giving the highest efficiency. The relation between drive and efficiency is always an inverse one, and in the case of the positive feedback multiplier, large power gains are obtainable if the efficiency is allowed to drop. This is shown in Fig. 10 for the condition where there is enough feedback to allow feeble oscillation with the drive removed. In order to draw curves of power gain and efficiency vs. frequency, it is necessary to choose a specific condition which is independent of frequency. The condition where the efficiency is 90% of the highest attainable value was chosen because it represents a reasonable compromise between gain and efficiency that may be useful in practice. These remarks apply also to the curves in Fig. 4, although not to the same degree. For example, when frequency tripling from 150 MC to 450 MC with the 4X150A without positive feedback, a power gain of 7 times can be achieved if the efficiency is allowed to fall to 17%, corresponding to a power output of 31 watts for 150 watts plate dissipation.

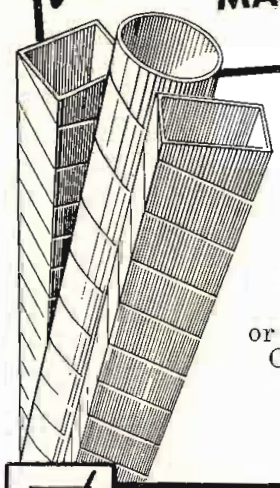
Regarding the operating voltages etc., on the tube's electrodes, it is assumed in the foregoing that optimum grid bias is used according to well-established formulae.[1]

These two tubes with their special circuits offer substantial advantages

(*Continued on page* 123)

PRECISION PAPER TUBES

SET THE STANDARD WITH *Laboratory Control* OF ALL MATERIALS



By use of up-to-date laboratory equipment, Precision is able to test materials thoroughly that are used in making paper tubes of superior grade. Better heat-dissipation, insulation and moisture-resistance are some of the important results—a stronger, lighter coil form with more winding space, as well. Any size, shape, length, ID or OD, of dielectric Kraft, Fish Paper, Cellulose Acetate or combinations.

Send specs. for sample and ask for new Mandrel List of 1,000 sizes.

PRECISION

PRECISION PAPER TUBE CO.

2057 West Charleston Street, Chicago 47, Ill.
Plant No. 2, 79 Chapel St., Hartford, Conn.
Also Mfrs. of Precision Coil Bobbins

REDUCE TESTING TIME TO A MINIMUM WITH THIS SIMPLIFIED GRAYHILL TEST CLIP. MERELY SLIP THE LEAD BETWEEN THE SPRING TYPE PRONGS. NO OPENING OR CLOSING OF JAWS . . . NO LOST MOTION. LEAD HELD SECURELY. ASK FOR SAMPLES AND GIVE THEM A TRY!

Grayhill

GET DETAILS—
Write for the Grayhill Catalog now.

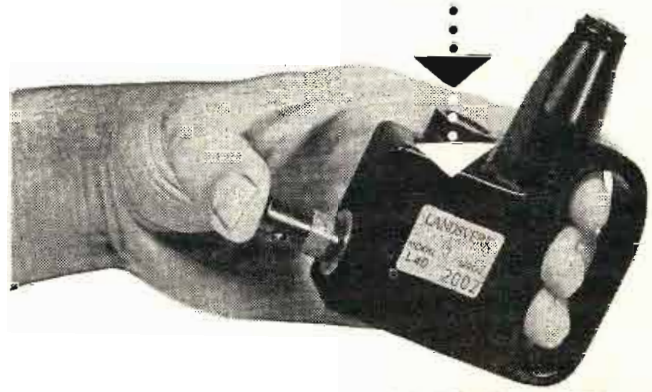
4542 West Madison Street,
Chicago 24, Illinois

---

wherever there's a **guess**

instead of a **know**

..... **label it**



with AVERY **Kum-Kleen**®

LAID ON *labels*

HOW to label . . . Pressure-sensitive Avery Kum-Kleen Labels are quickly and easily applied—*Laid on* with a fingertip touch...they're self-adhesive and stick to any clean, smooth surface without moistening, soaking or heating... will not pop, peel or curl even under conditions of extreme temperature and humidity.

Avery designs and prints Kum-Kleen labels to any size, shape and color desired...supplies individually die-cut labels mounted on backing sheets or on rolls for high-speed labeling by Avery Label dispensers.

WHY label . . .

Wherever there's an *unanswered question*—a *guess* instead of a *know*, or a *hesitation* on identification or procedure—Label it with Avery Kum-Kleen Labels and save time, labor and costly mistakes!

WHAT to label . . .

NAMEPLATES • TRADEMARKS
GUARANTEE LABELS
INSTRUCTION LABELS
APPROVAL SEALS
HOW-TO-USE COPY
DIAGRAM LABELS
MASKING LABELS
INSPECTION LABELS
REPAIR RECORDS

WHERE can you use these labels in your business?

For Example . . . One electronic manufacturer uses Kum-Kleen Labeling to identify component parts and to give vital information to the users of a radio-active meter. Chances are there's some way these labels can be of help to *you* in *your* business.

WRITE now for samples and further information.

AVERY ADHESIVE LABEL CORP.

117 Liberty St., New York 6 • 608 So. Dearborn St., Chicago 5
1616 So. California Ave., Monrovia • Offices in Other Principal Cities

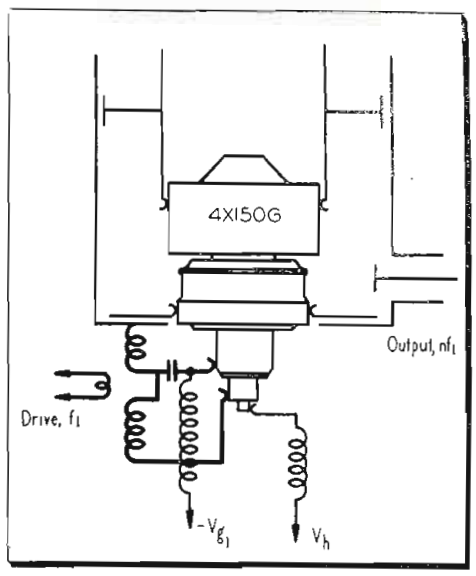


Fig. 9: Alternative arrangement of Fig. 5 for driving frequencies below 300 MC

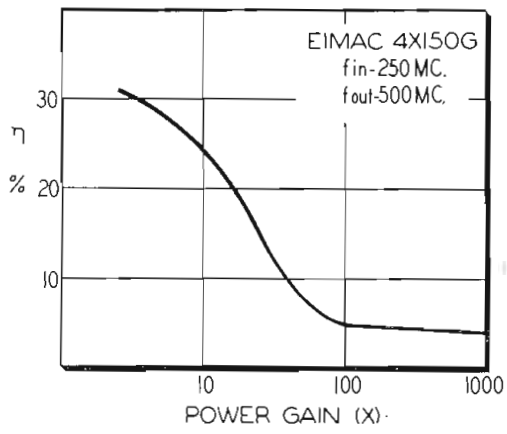


Fig. 10: Inverse relation of plate efficiency and power gain for circuit of Fig. 5.

over the previous practice of using triodes as frequency multipliers and are of special benefit in the increasing number of applications in which it is necessary to drive a final amplifier operated in the 1000 MC range from a crystal oscillating at less than 100 MC. In these applications the equipment designer is always faced with the problem of reducing the number of stages to a minimum, and this is equivalent to choosing a frequency multiplier having the greatest possible power gain for a given multiplication factor.

1. Terman—Radio Engineers' Handbook
2. Scott and Black—Harmonic Generation, Proc. IRE, April 1938
3. Sterky—Frequency Multiplication and Division, Proc. IRE, Sept. 1937
4. Brown—Harmonic Amplifier Design, Proc. IRE, August 1947
5. Dow—A Recent Development in Vacuum Tube Oscillator Circuits, Proc. IRE, Dec. 1931
6. Reinartz—A Fundamental-Reinforced Harmonic Generator, QST, July 1937
7. Preist—Pulsed R-F Tetrode Amplifier for 1000 MC. Band, Tele-Tech, May '51, p. 48
8. Preist—Coaxial Tetrode as a TV Amplifier at VHF and UHF, Tele-Tech, Jan. '52, p. 52

Facsimile Telegraph Grows

About 5,000 facsimile telegraph transceivers are scheduled for installation by Western Union in subscriber offices throughout the country during 1952. This will bring the total number of Desk-Fax units in service up to 10,000.

As We Go to Press . . . .

VHF-UHF-SHF TUBES

General Electric has announced a new ceramic, air-cooled, 1 kw UHF transmitting tube, the GL-6183, a direct replacement for the water-cooled GL-6019. Also scheduled for early appearances are: a 5 kw, 900 MC tetrode designed primarily for civilian applications; 150 watt, 900 MC tetrode, for military applications; 500 watt, 400 MC triode, military applications; 2,500 MC ceramic tube, 2C39A; several new counter measure tubes; and tubes for SHF communications, featuring ceramic and metal construction.

COMPUTER

Raytheon is planning to show a new computer in Boston during April.

UHF TRANSMITTER

Allen B. DuMont Labs has introduced a new 5 kw UHF transmitter selling for $69,450. An interesting feature of the equipment is the Eimac Klystron amplifier which has its cavity separate from the tube proper, and requires only 50 watts of driving power. Its design became possible through the development of a new ceramic insulation material. The 50 watt exciter is expected to be capable of driving final amplifiers up to 50 kw.

TELEMETERING RECORDER

Ampex has introduced the Model 500 tape recorder, which has been designed for telemetering and ballistic applications. The half-inch tape records four channels of information at 30 and 60 in./sec. Frequency response is 200 cps to 80 kc (3 db down) and flutter is less than 0.1% peak-to-peak. Novel features are vacuum pump system which holds tape against capstan, and elliptoid heads. Selling price is $14,000.

NEW TYPE WAVEGUIDE

Substantial savings in production costs, critical materials and skilled manpower is expected to result from Federal Telecommunication Labs' novel plumbing for microwave circuitry. This advance in the art is based on the use of a ground plane system that acts as a radio mirror for a conductor supported above it. In effect, a parallel wire system is created in which perfect symmetry is obtained without elaborate machining. The new wiring can be produced directly from diagrams by etching the circuits on a dielectrically coated base plate or by employing stamping

(*Continued on page* 128)

Opportunities for Engineers

electronic engineers

Join a company of new ideas and skilled men

As a leader in the field of electronic research and development, MELPAR constantly deals in new ideas and works with skilled men whose initiative and ability are an active factor in the development of these ideas.

We want to add to our distinguished group of engineers men whose background entitles them to the substantial salaries, advancement and recognition that is an integral part of MELPAR policy. Work is in pleasant Alexandria, just outside Washington, D.C., in a modern plant with extensive laboratory facilities.

If you have had experience in any of the following fields we would like to hear from you:

Computers • Radar Beacons • Telemetering
Sub-miniaturization • Microwave Receivers
• Microwave Transmitters
• Millimicrosecond Pulse Circuits
Research in Underwater Sound Systems.

Send resume to:
PERSONNEL DIRECTOR, Dept. T.T.

MELPAR, INC.
Subsidiary Westinghouse Air Brake Co.
452 Swann Ave. Alexandria, Virginia

WANTED ENGINEERS

Excellent opportunities with eastern manufacturer for permanent positions with good pay, advancement, work with highly professional staff. Our work does not depend on defense alone. We need the following skills: (Write in compete confidence)

PHYSICISTS
RADAR CIRCUITRY
COMMUNICATIONS
MICROWAVE

BOX 452 — TELE-TECH
480 Lexington Ave.
New York 17, N. Y.

ENGINEERS

Unusual Opportunities and Salaries

Exist on project and product engineering work for Graduate Engineers with Design, Development and Product experience in any of the following:

Analogue Computers	Servo Mechanisms
Radar	Electronic Circuits
Communication Equipment	Aircraft Controls
Hydraulics	Instrumentation
Electronic Packaging	Printed Circuits
Pulse Transformers	Fractional H P Motors

Vacuum Tube Techniques

Submit Résumé To Employment Office

SPERRY
GYROSCOPE CO.
DIVISION OF THE SPERRY CORP.
GREAT NECK, L. I., NEW YORK

WANTED
Engineers and Scientists

Unusual opportunities for outstanding and experienced men.

These top positions involve preliminary and production design in advanced military aircraft and special weapons, including guided missiles.

IMMEDIATE POSITIONS INCLUDE:

Electronic project engineers
Electronic instrumentation engineers
Radar engineers
Flight test engineers
Stress engineers
Aero- and thermodynamicists
Servo-mechanists
Power-plant installation designers
Structural designers
Electro-mechanical designers
Electrical installation designers
Weight-control engineers

Excellent location in Southern California. Generous allowance for travel expenses.

Write today for complete information on these essential, long-term positions. Please include resume of your experience and training. Address inquiry to Director of Engineering.

NORTHROP AIRCRAFT, Inc.
1037 E. Broadway, Hawthorne
(Los Angeles County) California

TV Tours Plant Facilities

Stockholders of the Foote Mineral Co. of Exton, Pa., recently viewed operations on their 81-acre property via closed circuit TV. Four image orthicon field cameras at strategic locations covered such activities as processing lepidolite ores to obtain lithium. Supplemented by TV films of N. Carolina quarrying operations, the camera outputs were fed over the RCA installed and operated system to 12 receivers placed in the meeting hall.

Nonlinear Elements

(*Continued from page* 47)

instead of all these, only liquid or solid state varistors exhibiting a high frequency response due to an electrical control mechanism. Such varistors are detectors and crystal diodes, but also thyrites[7] and polaristors.[8] Furthermore, let us neglect the crystalline semiconductors, silicon and germanium because their picture has been well explored in connection with the development of transistors.

There exists, however, another type of liquid and solid semiconductors which cover the field of the so-called "Polaresistivity." This new field may be characterized by the fact that the peculiar properties of crystalline semiconductors—with a grain of salt—are transformed from the atomic or molecular aspect so to speak into the macromolecular or microscopic region. In other words, instead of preoccupying ourselves with atoms and the configuration of electrons in their shells, we consider microscopically small particles in colloidal suspensions, either in liquid or solid state. Since we are then free to select a great variety of particles, we are not handicapped by the limited number of natural or synthetic products.

Part Two will appear in the May issue.

REFERENCES

1 C. L. Snyder, E. Albers-Schoenberg, and H. A. Goldsmith, "Magnetic Ferrites, Core Materials for High Frequencies," Elec. Mfg., Dec. 1949
2 Ferroxcube Engr. Bull., Ferroxcube Corp. of America, New York, N. Y.
3 W. C. Cady, "Piezoelectricity," McGraw-Hill Book Co., New York, N. Y., 1946
4 W. P. Mason, "Piezoelectric Crystals and their Application to Ultrasonics," van Nostrand Co., New York, N. Y., 1950
5 S. Roberts, "Dielectric and Piezoelectric Properties of Barium Titanate," Phys. Rev., vol. 71, pp. 890-895, June, 1947
S. Roberts, "Dielectric Constants and Polarizability of Ions in Simple Crystals and Barium Titanate," Phys. Rev., vol. 76, pp. 1215-1220, Oct., 1949
6 H. Jaffe, "Titanate Ceramics for Electromechanical Purposes," Ind. and Eng. Chemistry, vol. 42, pp. 264-268, Feb., 1950
7 F. Ashworth, W. Needham, and R. W. Sillars, "Silicon Carbide Non-Ohmic Resistors," IEE Journ., vol. 93, p. 385, 1946
8 H. E. Hollmann, "Semiconductive Colloidal Suspensions with Nonlinear Properties," Journ. Appl. Phys., vol. 21, pp. 402-413, May, 1950

BULLETINS

Audio Attenuators

Cinema Engineering Co., Burbank, Calif. has issued a new 1952 catalog, No. 18-A, entitled "Audio Attenuators", 16 pages with two-color cover. Data includes 10 pictures, 16 tables and 10 diagrams.

Voltage Transformers

Sola Electric Co., 4633 West 16th St., Chicago 50, Ill., has published a constant voltage transformer catalog. This new 22-page booklet, "Number CV-142" is the only complete guide to both the standard regulators and the four new types, which have been added to the Sola line since the last complete catalog was issued. These four new types are: the harmonic neutralized type CVH, the plate and filament type CVE, the adjustable harmonic neutralized type CVL and the television receiver Type CVA.

Metal-Clad Plastic Laminates

Metal-clad Insurok plastic laminates (T-725 and T-812) for printed or etched circuits are described in a bulletin published by the Richardson Co., 2791 Lake St., Melrose Park, Ill. These laminates, possessing a unique combination of properties, are said to perform well in critical HF applications.

Insulators

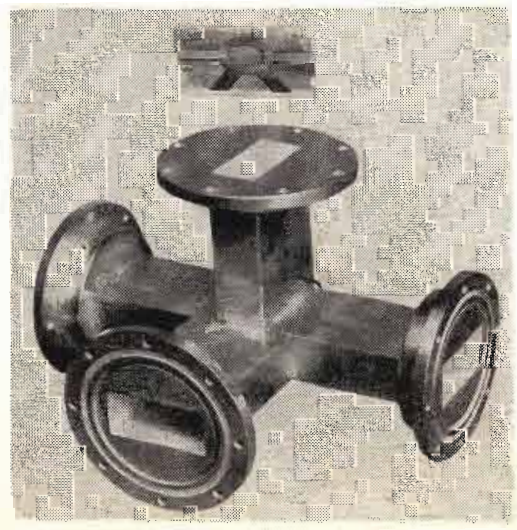
"Stand-Off Insulators" is the title of a new bulletin published by Thor Ceramics, Inc. 225 Belleville Ave., Bloomfield, N. J. It describes Thor's complete line of standard steatite units used in the construction and installation of HF equipment

As We Go To Press

(*Continued from page* 125)

and embossing techniques. Small size and light weight (several hundred times lighter than conventional plumbing) immediately suggest aircraft and mobile applications. The low cost of printed microwave circuits advances the possibility of less expensive radio relays for the expanding cross-country television networks.

As an example of the marked difference in size between conventional microwave plumbing and the newly developed printed circuit, two magic "T" waveguides are compared. The conventional unit below weighs approximately 15 lbs. while the new wiring weighs only a few ounces



TELE-TECH

CLOSING DATES

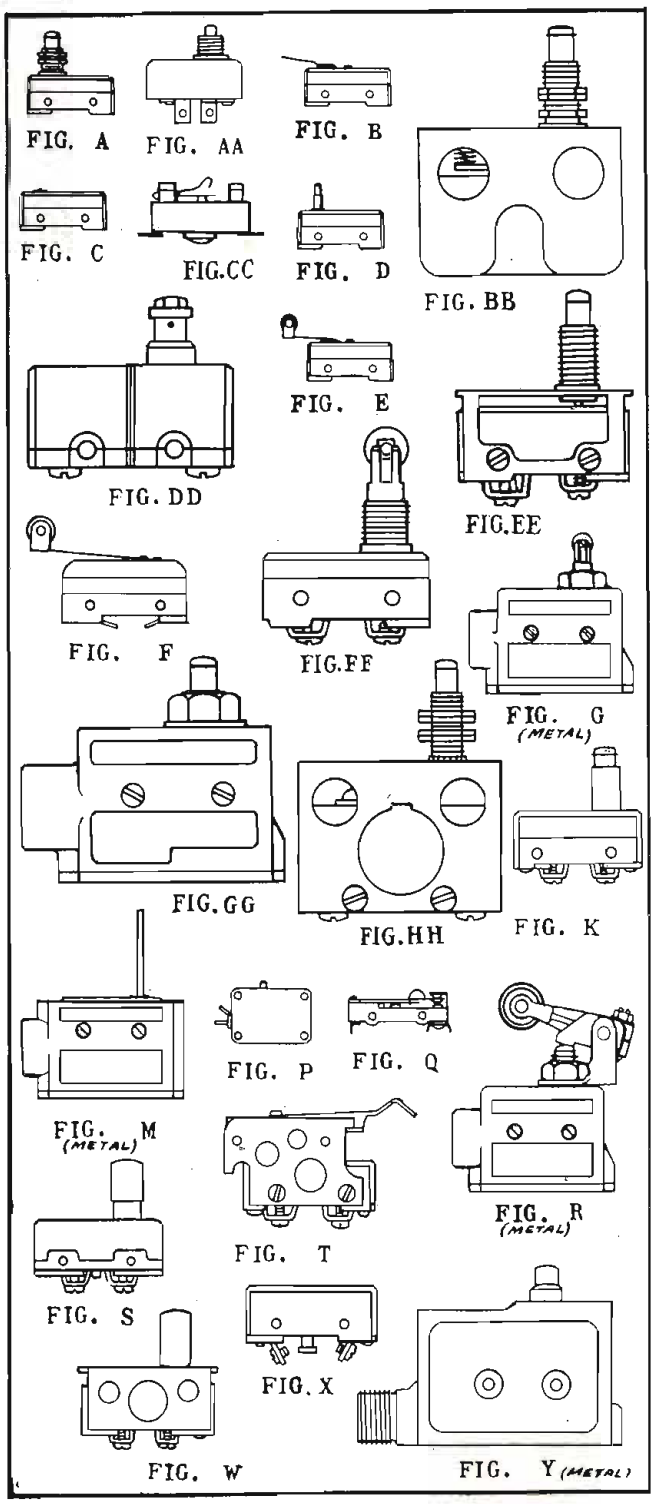
25th of second month preceding date of issue, for all ads requiring proofs, composition, foundry work, key changes, etc.

1st of preceding month for complete plates only—no setting.

20th of preceding month—Publication Date. Cancellations not accepted after 1st of preceding month.

Advertisers—April 1952

IMMEDIATE DELIVERY OF *Top Quality* MINIATURE SWITCHES



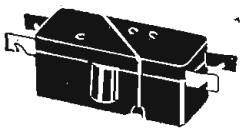
This list of brand new standard brand miniature switches represents only a few of many types in stock at Wells. Large quantities of most types are on hand for your immediate requirements. Write or wire for quotations on switches not listed.

Stock #	Type #	Contact	Fig.	Price
4MC2	2MO3.1A	NO	P	.50
4MM2	ACZ101BB	SPDT	W	.85
4MC17	B-1	NC	Y	1.45
4MC16	B-1T	NC	DD	.90
4MC7	B-14	NO	HH	1.70
4MD62	B-R	SPDT	C	.70
4MD63	B-RS36	SPDT	D	.80
4MD23	BD-RL32	SPDT	B	.95
4C51	BZ2FTC1	SPDT	C	.75
4ML4	BZRQ41	SPDT	W	.85
4MD51	BZ-R37	SPDT	C	.70
4MD2	BZE7RQT2	SPDT	GG	1.70
4MD21	BZ-7RST	SPDT	D	.80
4MD38	BZE2RQ9TN1	SPDT	G	2.65
4MD6	CUM 24155	NO	E	.80
4ML1	D	NO	BB	1.50
4MC12	D in case	NC	Y	1.45
4MD60	G-RL	NO	B	.80
4MC11	G-RL 5	NO	B	.80
4MD61	G-RL35	NO	B	.80
4MC32	HRO 7.1P2TSP1	NO	K	.65
4MC19	HRO7.4P2T	NO	S	.60
4MD8	HRRC 7.1A	NC	C	.55
4MD27	HRRO 7.1A	NO	C	.60
4MC31	LN-11 H03	SPDT	M	1.70
4MC18	MLB 321	SPDT	B	.95
4MD1	MLR 643	NC	B	.70
4MD55	PS 2000	SPDT	C	.85
4MC28	RC71P2T	NC	A	.70
4D129	RD71AT2	SPDT	C	.75
4MD22	R02M	NO	E	.80
4MC28	R02M12T	NO	E	.80
4D87	R07 8586	NO	K	.70
4MC25	R-RS	NC	D	.50
4MD9	SW-186	NC	D	.50
4MC10	WP3M5	NC	AA	.50
4MC4	WP5M3	NC	AA	.50
4MD53	WP5M5	NC	AA	.50

Stock #	Type #	Contact	Fig.	Price
4MC27	WZ2RST	NC	D	.55
4MD16	WZ7R	NC	C	.55
4MC15	WZ7RQT2	NC	A	.70
4MD36	WZ7RST	NC	D	.55
4MC23	WZE7RQTN	NC	R	3.75
4MD54	WZR8X	NC	X	.80
4MC9	WZR31	NC	C	.65
4MD57	WZR31	NC	T	.70
4MD31	WZRD	NC	C	.55
4MD19	WZRL8	NC	B	.70
4ML3	WZRQ41	NC	W	.65
4ML2	WZV7RQ9T1	NC	G	2.25
4MC21	X757	NC	C	.55
4MD37	XC1A	NC	C	.55
4MC5	XD45L	SPDT	B	.95
4MD4	YZ	NO	C	.75
4MD40	YA2RLE4D13	NO	B	.70
4MD24	YZ2YLTC1	SPDT	B	.95
4MC1	YZ2YST	SPDT	D	.60
4MD13	YZ3R3	NO	C	.60
4MD56	YZ3RLTC2	NO	B	.80
4D79	YZ3RT	NC	C	.60
4D127	YZ3RW2	NC	F	.80
4MC14	YZ3RW2T	NO	F	.90
4MD49	YZ7RQ9T6	NO	FF	.85
4MD32	YZ7RST	NO	D	.60
4MC13	YZ7RA6	NO	EE	1.00
4C116	YZRE4	NO	C	.65
4MC20	YZRQ4	NO	S	.60
4MC22	Z	NC	Y	1.45
4MD52	Blue Dot	SPDT	E	.90
4C73	Blue Dot	SPDT	D	.80
4MC8	Red Dot	NC	C	.65
4MD18	Open Type	SPDT	Q	.50
4MD39	Green Dot	NO	B	.80
4MC29	Green Dot	NO	D	.55
4D84	Green Dot	NO	B	.80
4MD26	Precision	SPDT	B	.95

SWITCHETTE

All Rated 10A-230 VAC



Stock #	Mfr. Type #	Contacts	Terminals	Price
41SF3	CR1070C103-A3	N.C.	SIDE	$0.53
41SF2	CR1070C103-B3	N.O.	END	.53
41SF9	CR1070C103-F3	1-N.O. 1-N.C.	SIDE	.53
41SF12	CR1070C123-B3	N.O.	END	.53
41SF10	CR1070C123-C3	1-N.O. 1-N.C.	END	.53
41SF5	CR1070C123-D3	N.C.	SIDE	.53
41SF4	CR1070C123-J2	SPDT	END	.53
41SF11	CR107 C124-M4	SPDT	SIDE	.53
41SF1	CR1070C128-C3	1-N.O. 1-N.C.	END	.53

MANUFACTURERS AND DISTRIBUTORS:
Write for Catalog

SEeley 8-4143

WIDE SELECTION OF ELECTRONIC COMPONENTS AT WELLS
- **Resistors** • **Condensers** • **Wire and Cable**
- **Co-ax Connectors** • **Rectifiers** • **Transformers** • **Chokes**
- **Micro Switches, Toggles** • **Antennas** • **Accessories**
- **Electronic Assemblies** • **Dial Light Assemblies**

Order Direct or Through Your Local Parts Jobber.

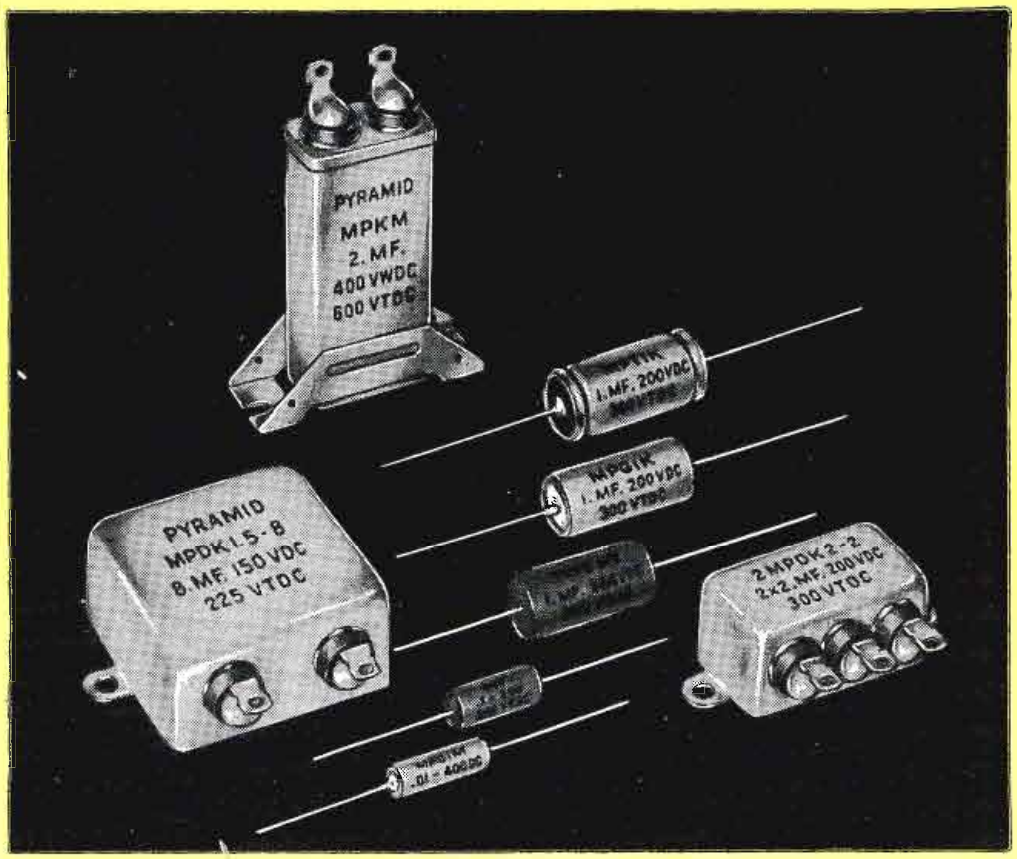
WELLS SALES, INC.

833 W. CHICAGO AVE., DEPT. T, CHICAGO 22, ILL.

Now in **MASS PRODUCTION...**

PYRAMID ULTRA-COMPACT

metallized paper capacitors



PYRAMID Series M CAPACITORS use a specially-prepared metallized paper, providing all-important savings in size and weight....Pyramid now produces large quantities of these capacitors in a wide variety of cardboard or hermetically sealed metal containers.

Your letterhead inquiries are invited

PYRAMID ELECTRIC COMPANY • 1445 HUDSON BLVD., North Bergen, N. J.

VHF-TV-UHF

RCA-6166

RCA-6166

(Typical Operation in Class B or Grid-Modulated Class C Television Service, Grid-Drive Circuit, 54 to 216 Mc)

DC Plate Voltage	5800 volts
DC Grid-No. 2 Voltage	1200 volts
DC Grid-No. 1 Voltage*	—130 volts
Peak RF Grid-No. 1 Voltage	375 volts
DC Plate Current*	3.45 amp
Driver Power Output (Approx.)*	800 watts
Power Output (Approx.)*	12,000 watts

RCA-6181

(Typical Operation in Class B or Bias-Modulated Class C Television Service, Cathode-Drive Circuit at 900 Mc)

DC Plate Voltage	1800 volts
DC Grid-No. 2 Voltage	475 volts
DC Cathode-to-Grid-No. 1 Voltage*	75 volts
Peak RF Grid-No. 1 Voltage	120 volts
DC Plate Current*	1.7 amp
Driver Power Output (Approx.)*	200 watts
Useful Power Output (Approx.)*	1200 watts

*At synchronizing level

RCA-6181

NEW forced-air-cooled *TV* power tetrodes

THE new RCA-6166 and 6181 . . . developed for TV and radio services . . . represent the successful application of forced-air cooling to power tetrodes designed to operate at high efficiency at the higher frequencies. The use of forced-air cooling simplifies transmitter design and effects substantial operating economies.

Both tubes feature coaxial-electrode structures, and are particularly suited to operation in circuits of the coaxial-cylinder type.

The RCA-6166 VHF tetrode uses a time-proved thoriated-tungsten filament that permits substantial savings in filament power.

The RCA-6181 UHF tetrode has an indirectly heated, low-temperature, coated cathode of the matrix type for long serviceability. Further, it features seals between a low-loss ceramic and a high-conductivity metal to provide high-efficiency uhf performance.

For complete technical data on these or any other RCA tubes, write RCA, Commercial Engineering, Section DR57, Harrison, New Jersey . . . or contact your nearest RCA Field Office . . .

FIELD OFFICES: (East) Humboldt 5-3900, 415 S. 5th St., Harrison, N. J. (Midwest) Whitehall 4-2900, 589 E. Illinois St., Chicago, Ill. (West) Madison 9-3671, 420 S. San Pedro St., Los Angeles, Calif.

RADIO CORPORATION of AMERICA

ELECTRON TUBES — **HARRISON, N. J.**