TELE-TECH
& Electronic Industries

A AH CMA CMC CMV

DTR DBM DB D CRO

F G GD I M UA MA

PH OSCG OP OHM N

PI PF RD REC RF S TLM

VA V VH TT T

VAR VI VU W WH

INSTRUMENTS & METERS

Cornerstones of the Electronic Industries

eptember • 1954

dwell-Clements, Inc.

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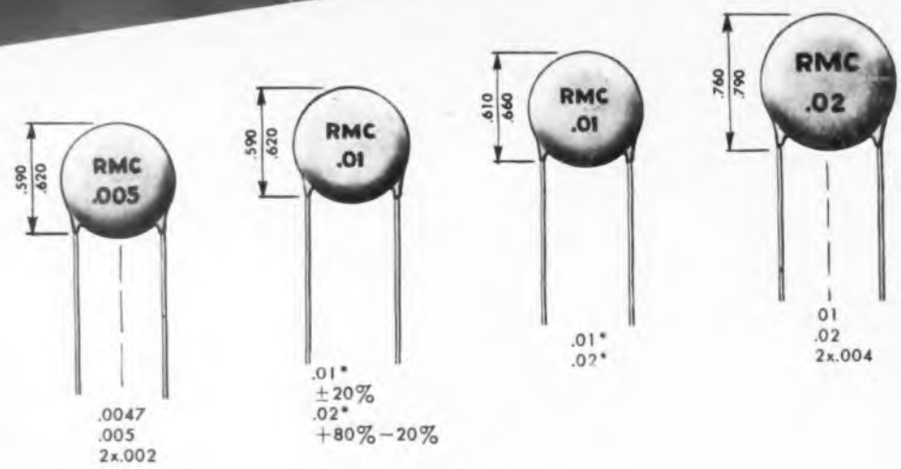
UNEXCELLED FOR BY-PASS OR FILTERING APPLICATIONS

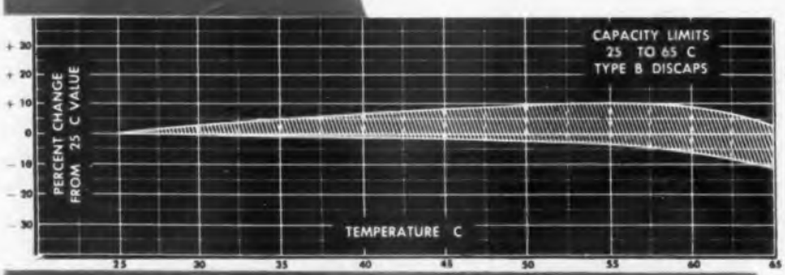
RMC HEAVY DUTY DISCAPS



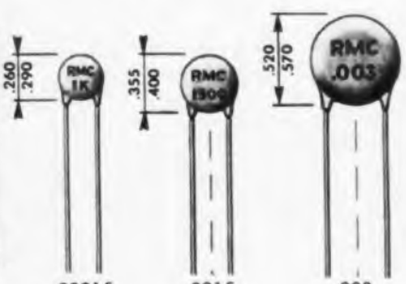
SPECIFICATIONS

GUARANTEED MINIMUM VALUE

POWER FACTOR: 1.5% Max. @ 1 KC (initial)
POWER FACTOR: 2.5% Max. @ 1 KC (after humidity)
WORKING VOLTAGE: 1000 V.D.C.
TEST VOLTAGE (FLASH): 2000 V.D.C.
LEADS: No. 22 tinned copper (.026 dia.)
INSULATION: Durez phenolic—vacuum waxed
INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms
AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms



TYPE B
1000 V.D.C.W. By-Pass Series
*Rated at 500 V.D.C.W. Flash test 1000 V.D.C.



DISCAP CERAMIC CAPACITORS

RMC

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

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.
DISTRIBUTORS: *Contact* Jobbers Sales Co., P. O. Box 695, Fairlawn, N. J.

TELE-TECH
& Electronic Industries

SEPTEMBER, 1954

FRONT COVER: METERS AND TEST INSTRUMENTS—In laboratories, factories, broadcast stations, as a matter of fact everywhere in the electronic industries, measuring devices play a vital role in furthering the state of the art. The meter symbols shown between the ever present, and ever necessary, signal generator and oscilloscope are those presented in the "Circuit Symbols" section of the June 1954 Electronic Industries Directory issue of *Tele-Tech*.

DEPARTMENTS

TELE-TECH & ELECTRONIC INDUSTRIES*, Vol. 13, No. 9. Published monthly by Caldwell-Clements, Inc. M. Clements, President; M. H. Newton, Assistant to President; John J. Borghi, Vice President and Secretary; M. B. Clements, Treasurer. Acceptance under section 34.64 Postal Laws and Regulations authorized at Bristol, Conn., June 9, 1954. Additional acceptance at New York, N. Y. 75¢ a copy. 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.

CALDWELL-CLEMENTS, Inc.

Publication Office, Bristol, Conn.

Editorial/Business Offices 480 Lexington Ave., New York 17, N. Y., Tel. Plaza 9-7880

An Announcement

of the Utmost Importance to Engineers Doing Research and Design Work in the Entire Audio Frequency Range.

Burnell and Co., Inc.

is proud to announce the development of *an entirely new product*—

ROTOROID®

a Variable Toroidal Inductor (patent applied for)

ROTOROID will prove to be a valuable aid in the solution of many engineering problems — in research and design — and opens new possibilities for production which were previously impractical or impossible.

ROTOROID

- . . . is a continuously variable, stepless toroidal inductor which can provide a 3:1 range of maximum to minimum inductance in 180° rotation of a shaft.
- . . . employs no mechanical resistance contacts and is therefore free of noise and wear.
- . . . requires no DC saturating currents and thereby eliminates the need for circuitry.
- . . . is applicable over the entire audio range (from approximately 300 cps). ROTOROID is not limited to any stock value of nominal inductance. It is available in any value of inductance now available in regular toroids.
- . . . is hermetically sealed and is vibration and shock-proof, can be chassis or panel mounted.

Write Department G for further information.

Burnell & Co., Inc.
Yonkers 2, New York

PACIFIC DIVISION: 720 Mission Street, South Pasadena, California

An outstanding feature of ROTOROID is that, at maximum inductance, it provides the full Q of the toroid it contains. Thus, the user is at once able to take advantage of the high Q characteristics of toroids while at the same time having available a variable inductor not previously available in a toroid.

Applications: Virtually unlimited. Just a few of the many possible uses of ROTOROID are:

- **Tunable Audio Oscillators**
- **Variable Z Devices**
- **Servo Systems**
- **Telemetering**
- **Adjustable Selective Networks**
- **Variable Phase Shift Networks**
- **Variable Filters**
- **Electro-Mechanical Control Systems**

Availability: Immediately available: ROTOROIDS VTI-16 and VTI-3 which are equivalent in electrical characteristics to Burnell toroids TC-16 and TC-3 in cases 2¼" in diameter, 3-1/16" long. Soon to be available: two miniature types equivalent to Burnell toroids TCO and TC-6.

FIRST IN TOROIDS AND RELATED NETWORKS

Facts and Figures Round-Up
September, 1954

ELECTRONIC INDUSTRIES **TOTALS**

1953-54 GOVERNMENT ELECTRONIC CONTRACT AWARDS

Below is a summary of the classifications and dollar value of electronic equipment selected from contracts awarded by government procurement agencies in the one year period June 1953 to June 1954.

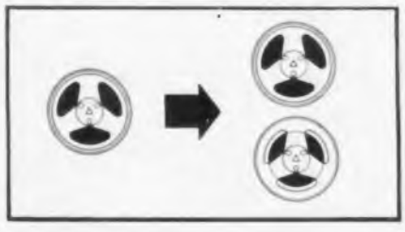
A	
Accelerometers	$ 961,120
Actuators	3,165,618
Actuator Parts	264,838
Adapters, amplifier	136,261
Alternators & Voltage Controls	365,849
Altimeters	1,051,710
Ammeters	54,530
Amplifier Assys, motor	130,454
Amplifiers	12,910,019
Analyzers	1,030,834
Anodes	679,956
Antennas	1,875,020
Antenna Assys	164,436
Antenna feeds	43,572
Antenna Supports	151,834
Auto Pilots	6,039,490
Auto Pilot Components	2,862,078
Automatic Pilot Systems	1,942,682
B	
Batteries	28,591,742
Battery Chargers	191,300
Bridges	28,946
Brush Assys	50,668
C	
Cable	8,144,765
Cable Assys	76,140
Cable, transducer	252,000
Cable, submarine	434,313
Cable, telephone	352,317
Calibrators	56,709
Capacitor-Resistors	131,251
Capacitors, variable	251,516
Cathodes	26,641
Cavities	141,965
Cavities, tuned	30,030
Check Sets, radio sonde	104,320
Code Practice Equip.	140,320
Coils, Misc.	29,521
Communication Facilities	279,470
Communications Vans	1,624,163
Components, vector magnetometer	114,805
Components, radio set	153,159
Compound Insulating	130,900
Computers, wind zone	74,423
Computing Equipment, electronic	30,520
Connectors	1,808,334
Connectors Assys	39,851
Connectors & cords	29,937
Connectors, plug	176,916
Connectors, receptacles	39,081
Connectors, shell	58,464
Consoles	329,390
Controls	3,687,326
Control Panels	951,166
Controls, radio set	1,289,871
Control Systems, gunfire	90,863,885
Converters	594,850
Cores	37,170
Core Mounts	35,264
Counter Measure Xmitting Sets	218,715
Countermeasures Receivers	98,640
Couplers, directional	192,582
Cutting Equipment Ultrasonic	100,000
Crystal Holders	112,395
Crystal Kits	44,388
Crystal Units	192,458
D	
Delay Lines, Solid	177,676
Demagnetizers	8,976
Dials	48,785
Dials, tuning	52,690
Digitalized Readout Equipment	92,143
Diodes	132,500
Driftmeters	1,009,107
Dummy Loads	232,243
Dynamotors	1,000,584
E	
Exciters	502,950
Electrocardiographs	60,000
F	
Facsimile Sets	49,303
Filters	211,481
Fire Control Elements	16,525,074
Flight Simulators	5,600,491
Fluxmeters	189,253
Frequency Meters	309,383
G	
Generators	979,627
Generator Sets	1,756,813
Gyros	142,345
H	
Hand Sets	207,841
Handsets-Headsets	663,606
Hardware Kits	30,196
Headphones, radio set	148,970
Headsets	48,455
Homing Groups	30,000
I	
Ignition Analyzer Kits	45,462
Impedance Bridges	76,133
Inspection Units	82,735
Instrument Landing System	44,684
Insulation, sheet	66,405
Insulation, tape	44,427
Insulators	122,505
Intercoms	1,345,356
Intercom, stations	74,558
Intervalometers	275,869
Inverters	155,701
J	
Jack Box Assys	40,392
Jacks, telephone	55,250
Jet Instrument Trainers	585,292
Junction Boxes	159,685
K	
Keyboxes	54,029
Keyers	1,163,539
Kits, antenna capacitance simulator	193,573
L	
Leads, electric	123,693
Light Assys	32,632
Line Kits, transmission	45,597
Loudspeakers	124,075
Loran	36,000
M	
Magneto Assys	31,082
Mag. Sound Recorders	32,324
Master Indicators, directional gyro	10,592,939
Measuring Sets	37,192
Meters	3,587,901
Meters, frequency	101,086
Microlinks	17,900
Microphones	123,847
Microphone, simulator sets	75,178
Milliammeter	1,594
Millivoltmeters	2,006
Mixers, cavity tuner	40,356
Mobile Trainers	150,000
Motors	109,051
Motor Generators	3,343,052
Mountings, circuit	79,432
Mounts, vibrator	255,081
Multimeters	363,460
O	
Oscillator Filter Elements	27,952
Oscillators	1,161,654
Oscillograph Processing System	108,983
Oscilloscopes	972,467
P	
Panel Assys	80,875
Panel Boards	30,181
Panel, Mountings	34,326
Panels, general control	774,597
Panoramic Adapters	62,199
Paper, electro sensitive	31,400
Plotting Boards	63,490
Plugs	78,120
Plugs, telephone	49,200
Positioning Mechanisms	195,478
Potentiometers	279,268
Power Supplies	603,475
Power Units	240,090
Preamplifier Strips	34,972
Probes, r-f	34,680
Public Address Systems	66,903
Q	
Q Meters	54,543
R	
Radar Beacons	66,610
Racks	171,773
Radar Components	480,667
Radar, GCA	215,877
Radar Sets	3,691,756
Radio Attachments	632,414
Radio Compasses	4,701,204
Radio Compass Units	44,179
Radio Phonographs	26,164
Radios, portable	31,786
Radio Receivers	601,957
Radio Set Controls	29,640
Radio Sets	6,615,828
Radiosondes	3,307,503
Radio Telephones	42,460
Radio Telephone Systems	471,040
Radomes	322,706
Range Instruments	413,523
Reactors	39,810
Receptacles	60,381
Receptacles & Plugs	31,584
Receivers	8,319,670
Receivers, double synchros	137,570
Receiver-Transmitters	4,995,598
Recorders	31,584
Recorder-Reproducers	1,232,016
Recorders, sound	78,000
Recording Units	300,967
Records, pulsed photographic	88,029
Rectifiers	248,345
RF Assys	2,535,396
Reflectors, radar	39,158
Regulators	2,148,641
Relay Box Assys	331,543
Relay Equipment	256,364
Relays, solenoid	81,996
Repeaters	380,709
Reproducers, sound	121,121
Resistance Bridges	70,362
Resistors, variable	77,741
Rheostats	163,107
Room Screens	132,900
Rotors	209,358
S	
Sharan Trainer	1,199,345
Sidebands, single radio	1,031,350
Simulators	1,475,135
Signal Tracers	26,524
Slotted Lines	73,432
Solder	196,250
Solder, silver	86,991
Solenoids	241,227
Sonar Sounding Sets	148,154
Spare Parts, meters, crystals, etc.	5,339,136
Spectrographs	71,906
Squadron Guidance Equipment	28,407
Stabilizers, gyro	167,447
Standards, frequency	67,466
Summation Bridges	177,406
Suppressors, noise	172,745
Switches	1,752,376
Switch Assys	62,036
Switches, disconnect	84,800
Switches, rotary	204,596
Switchboards	397,287
Switchgear	568,973
Switch Boxes, relay	132,056
Switches, control stick	85,253
Synchros	1,100,072
Synthetic Quartz	146,447
T	
Tape, magnetic	44,998
Target Indicator Equipment	100,000
Target, radar reflecting	135,182
Test Equipment, instrument	39,258
Testers	3,004,919
Test Sets	3,217,181
Test Sets, radar	60,962
Test Stands, generator	1,337,232
Telegraph Monitors	118,740
Telegraphs	125,689
Telephone Central Sets	4,896,080
Telephones, sound powered	1,207,144
Telephone Sets	1,545,372
Telemetering Equipment	104,062
Telemetering Systems	225,505
Telereaders	39,945
Teletypewriter Equip.	4,843,709
Temperature Controls	155,182
Terminal Boards	45,096
Terminal Boxes	346,138
Terminal Sets	202,686
Terminals, telegraph	982,517
Theater TV	65,174
Thermocouples	31,252
Test Sets, crystal unit	86,826
Thermostats	60,707
Timing Systems	214,286
Tower Section Sets	129,253
Tracking Systems, 3-D	101,122
Trainers signal	6,227,716
Transducers	9,191
Transformers	2,847,958
Transistors	748,177
Transmission Systems, range data	40,907
Transmitters	7,603,272
Transmitters, altitude	45,442
Transmitter-Receivers	287,650
Transmitter, Elements	73,572
Transmitter Kits	139,162
Transmitters, marker beacon	139,162
Tubes, electron	31,569,889
Tubes, magnetron	45,600
Tuners	413,737
Tuning Assys	252,237
Tuning Drives	151,875
Tuning Units	87,403
TV Equipment, underwater	211,895
W	
Wattmeters	168,577
Waveguides	155,076
Wire	802,820
X	
X-Ray Machines	69,649
X-Ray Units	42,042


EXTRA-THIN CONSTRUCTION
STRENGTH TO SPARE
SCOTCH
BRAND
Magnetic Tape
90
Extra Play
INCREASED FREQUENCY RANGE
Made in U.S.A. by MINNESOTA MINING AND MANUFACTURING COMPANY, Saint Paul 6, Minnesota
No. 190 A
Scotch Magnetic Tape Extra Play

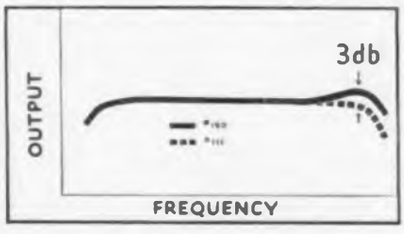
New *Extra Play* tape gives 50% more recording time!

A revolutionary development for radio stations, recording studios—in fact all users of magnetic tape! New "Scotch" Brand Extra-play Magnetic Tape 190A makes it possible to record entire symphonies, lengthy news and sports events without stopping for reel change. With 50% more tape on each reel, new Extra-play tape offers the same recording time found on 1½ reels of standard tape.

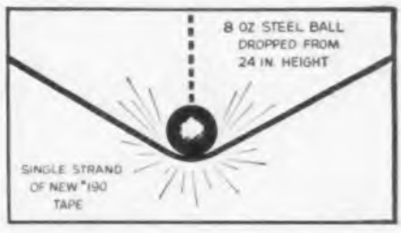
Exclusive feature of new "Scotch" Brand 190A tape is a thinner magnetic coating. Made of high-potency oxide, the new coating has been reduced from standard 0.6 mils to 0.3 mils and the high frequency range extended appreciably. A 30% thinner tape backing offers more uniform hi fi response with crisper, cleaner tones, yet maintains "Scotch" Brand's reputation for sturdy, long-life tape construction.



EXTRA THIN TAPE—50% thinner, more potent oxide coating, 30% thinner backing permit more 190A tape to be wound on standard-size reel. Result: one roll of new tape does job of 1½ reels of standard tape.



INCREASED FREQUENCY range of new Extra-play tape enables tape machines to produce recordings with greater hi fi response than formerly possible with most conventional magnetic tapes.



STRENGTH TO SPARE—New 190A tape stands up under even grueling steel ball drop test. Naturally it's tough enough to withstand severe stresses of sudden machine stops, starts and reverses.

NEW! REG U.S. PAT. OFF. SCOTCH BRAND *Extra Play* Magnetic Tape 190A

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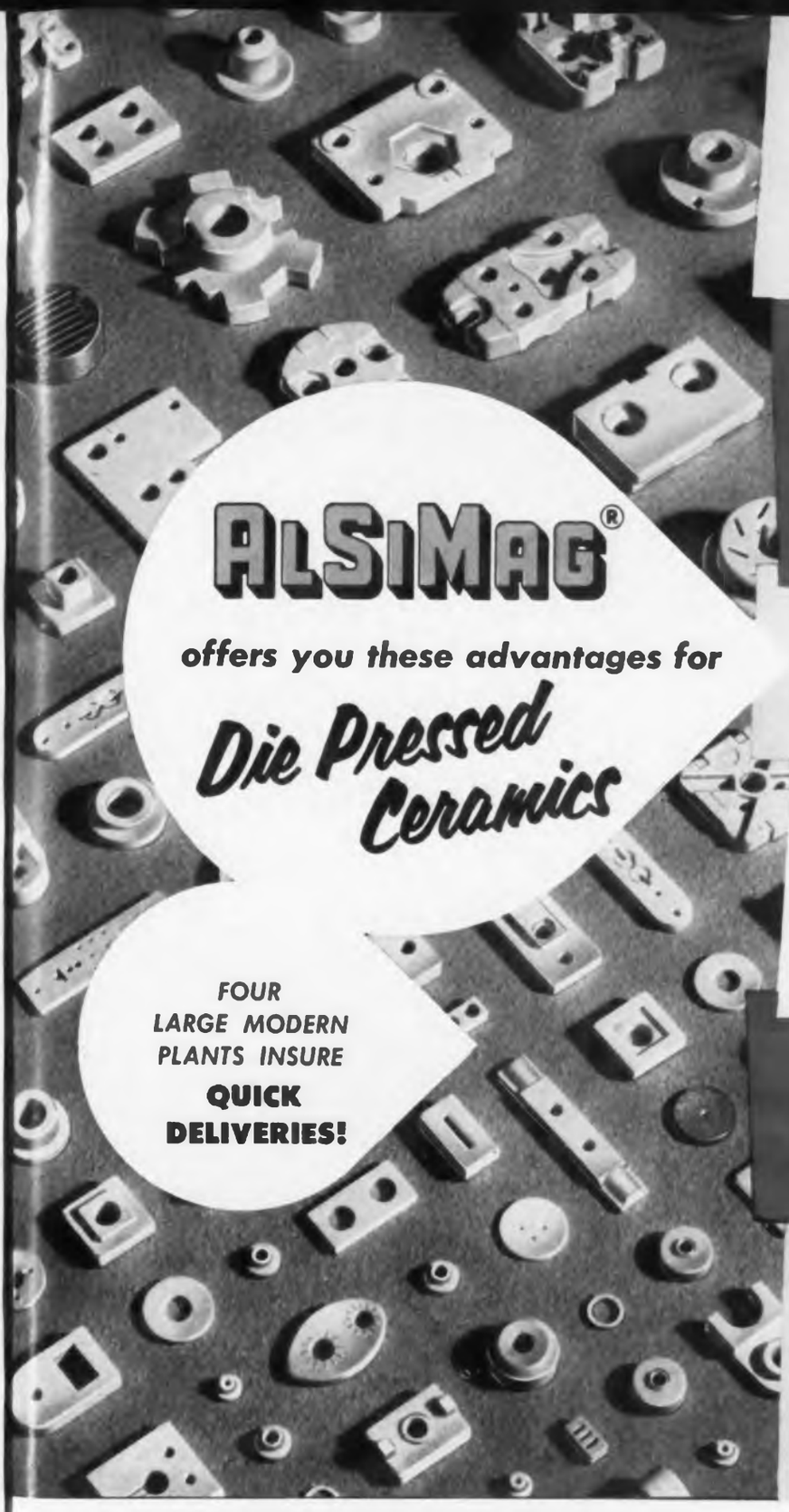

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***FOUR LARGE MODERN PLANTS INSURE* QUICK DELIVERIES!**

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for convenient point-to-point wiring . . .

MINIATURIZED 5 AND 10 WATT WIRE-WOUND RESISTORS!

AXIAL LEAD Blue Jackets®

Here are two *truly miniaturized* self-mounting wire-wound power resistors to simplify your TV and industrial electronic production where space is a factor. They're ideal for point-to-point wiring, terminal board mounting, and processed wiring boards, where they fit in admirably in dip-soldered subassemblies.

Axial lead Blue Jackets are rugged vitreous enamel power resistors built to withstand the severest humidity performance requirements As for *economy*, these newest members of the Sprague Blue Jacket family are low in cost . . . eliminate need for extra hardware . . . save time and labor in mounting!

You can get these outstanding new Blue Jacket Resistors without delay in any quantity you require. Sprague Engineering Bulletin 111 gives full data on these and all other commercial Blue Jacket Resistors. Send for your copy.

SPRAGUE ELECTRIC COMPANY
233 Marshall Street, North Adams, Mass.

SPRAGUE TYPE NO.	WATTAGE RATING	DIMENSIONS L (inches)	D	MAXIMUM RESISTANCE
27E	5	1⅛	5/16	17,500 Ω
28E	10	1¾	5/16	35,000 Ω

Standard Resistance Tolerance: ±5%

SPRAGUE

PIONEERS IN ELECTRIC AND ELECTRONIC DEVELOPMENT

NORTH ADAMS, MASSACHUSETTS

EXPORT FOR THE AMERICAS: SPRAGUE ELECTRIC INTERNATIONAL LTD., NORTH ADAMS, MASS. CABLE: SPREXINT

As We Go To Press...

GE Announces Plans For Transistor Production

The General Electric Co. has announced that it is tooling for mass production of high frequency transistors.

Dr. W. R. G. Baker, GE v.p. and general manager of the Electronics Div., said that plans for large quantity production of the transistors has been made possible through development of a "rate-grown" method of producing essential transistor elements. This method is expected to cut costs of transistors to the point where they can compete with vacuum tubes.

William Engeler, GE design engineer, checks first step in production of rate-grown transistors—crystal growing in furnace. Some 2000 units are made from single crystal ingot

Briefly, the method consists of introducing special impurities, gallium and antimony, and varying the heat controls during the crystal growing process. By this method, as many as 100 wafer-thin layers of specially treated germanium in a six-inch ingot are formed. The ingot is then diced into bars each several thousandths of an inch long with a layer through the center. The layer does the work of a grid. The sections of the bar on either side take the place of the cathode and plate of the tube.

Actual production will begin in 1955 at the company's Syracuse, N.Y. plant. See p. 118 for further details.

Use of TV in Warfare Demonstrated

Use of TV in warfare to give commanders a view of front-line operations was demonstrated publicly for the first time from Fort Meade, Md., in a color TV broadcast over the NBC-TV network, Aug. 11. The demonstration was staged by the Army Signal Corps with the cooperation of the Radio Corp. of America and the National Broadcasting Co. Participating in the demonstration were General Matthew B. Ridgway, Chief of Staff, U. S. Army; Lieut. General Floyd L. Parks, Commander, Second Army; Maj. General George I. Back, Chief Signal Officer, U. S. Army; and Brig. General David Sarnoff, Chairman of the Board of RCA.

The demonstration coincided with the 20th anniversary of the first proposal for military uses of TV. That proposal was reportedly taken to Washington in 1934 by General Sarnoff. Out of it developed plans for wide-spread applications of TV as a weapon of defense on land, in the air and on the sea.

Televised information from the "battlefield" was relayed to a "command post of the future," for viewing by the regimental commander. The "eyes" of the operation was experimental combat TV equipment, portable cameras of which were in the hands of Signal Corps personnel accompanying the assaulting troops. Remote TV interrogation was used.

Columbia Introduces "Kilosphere" Loudspeaker

The kilosphere, a small device no larger than a candy bar yet containing more than one thousand minute loudspeaker outlets, is Columbia Records latest innovation in music reproduction, according to an announcement by James B. Conkling, President of the company. Twin "K" speakers, with more than 2000 outlets, will be incorporated in Columbia's latest 1954 models of its famous high fidelity "360" phonograph as well as in the new Columbia Bell & Howell table model tape recorder, Mr. Conkling stated.

Developed by Columbia's Department of Engineering and Development, the "K" speaker is a perforated metal oblong with more than 500 tiny apertures, encased in a thin plastic foil. Each of the apertures acts as a loudspeaker when the covering membrane of foil is set into vibration by electric signals from the phonograph system.

Since electric force is applied over the entire "K" speaker instead of at a single point, as in conventional cone speakers, the 1000 tiny speakers all operate in exact phase. Distortion due to variations in phasing is thus eliminated and the clean, brilliant reproduction of high frequencies is made possible.

19-IN. COLOR TV

Model 19CT1 color TV set introduced by Motorola features new CBS picture tube with 205 sq. in. viewing area. Price of set is $895

Color TV Price Cut 50%

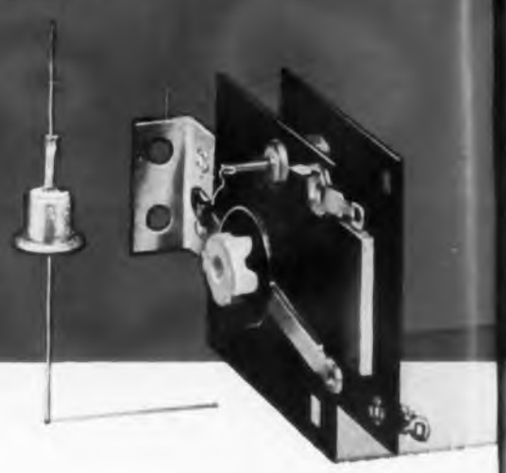
Radio Corp. of America has announced that the price of its 15-in. color TV receiver has been cut 50%. The new price is $495. To protect purchasers who paid the higher original price, the company will rebate the difference.

MORE NEWS on page 12

G. E.'s LATEST CONTRIBUTION TO

GE STACKED

CUSTOM BUILT TO PROVIDE 143 POWER COMBINATIONS!



★ **Smallest unit size yet developed!**

★ **Most reliable performance of any rectifier within this category!**

★ **Hermetically sealed for lifetime use!**

The following germanium rectifier stacks, each occupying a volume of only 1.62" x 2.5" x 6.00", are typical of the 143 standard stacks in G. E.'s new rectifier line.

CIRCUIT	D.C. OUTPUT (55°C Resistive Load)
Half Wave	2 amps @ 280 volts or 3 amps @ 190 volts
Full Wave Center Tap	2 amps @ 280 volts or 3 amps @ 190 volts
Full Wave Bridge	1 amp @ 565 volts or 3 amps @ 210 volts
Three Phase Half Wave	1.12 amps @ 420 volts or 4.5 amps @ 140 volts
Three Phase Bridge	1.3 amps @ 575 volts or 2.6 amps @ 280 volts
Three Phase Star	1.8 amps @ 280 volts or 3.6 amps @ 140 volts

★ ★ ★

Plus IMMEDIATE DELIVERY

General Electric leads the industry again! Announcement of this revolutionary G-E Stacked Germanium Rectifier opens up new avenues of power progress that were heretofore thought impossible to travel. Now, the amazing total of 143 power combinations has been provided with this one product! Your specifications requiring series or parallel stacks in single or polyphase circuits are custom-completed at G-E's factory.

This unit is smaller, weighs less, is more reliable, lasts longer, has better power ratings than any other dry rectifier made *any place by any other company.* AND, G.E. offers you *immediate delivery.*

Designed and built to deliver new *power performance,* the G-E Stacked Rectifier is 75% less by volume and weight than any other comparable dry type rectifier. And, rectifier losses are reduced to one-third or less of those encountered with any other type of rectifier. You can count on extreme reliability . . . tested for compliance to 10,000-hour standards. Note also that there are no forming or aging effects.

WRITE US TODAY! GET ALL THE FACTS ON THIS IMPORTANT NEW PRODUCT!

General Electric Company, Section X4894,
Electronics Park, Syracuse, New York

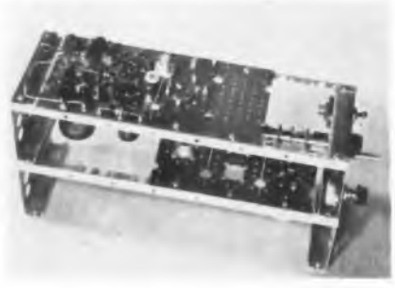
★ ★ GENERAL ELECTRIC

As We Go To Press . . . (Continued)

DuMont Announces Universal Breadboard

Circuit design engineers concerned with the building of model circuits will be interested in a universal breadboard assembly recently announced by DuMont Labs.

As shown in the accompanying picture, the unit consists of a chassis frame and an assortment of phenolic sub chassis designed so that tubes and components can be mounted quickly and conveniently.



Flexible breadboard speeds circuit design

Design of the units is aimed at producing "modular" sections in which circuit conditions would approximate those of actual production. DuMont engineers also pointed out the advantage of this system in making the primary layouts for printed wiring.

New Philco Speaker and Color TV Tube Announced

Concurrent with its entry into the phonograph field, Philco has announced the development of an electrostatic speaker to be used as a tweeter in its high-fidelity players. It employs 16 vertical columns arranged to form a half-cylinder. Sound is diffused over a 180° pattern.

The company's new president, James H. Carmine, revealed that a 21-in. single-gun color TV tube had been developed. The rectangular tube, which produces a 250 sq. in. picture, does not require a shadow mask. Because of its simple construction, it is expected to cost only about 15% more than equivalent black-and-white tubes in mass production. Philco will not make any color sets this year.

Reports unconfirmed by the company say the tube employs secondary emission from one phosphor to index the electron beam for proper registration of the right color at a given time. The phosphor is reportedly placed on the face in separate lines for each color. Scanning is either at right angles to vertical lines, or "wobbled" across three horizontal lines.

COMPUTER HANDLES POWER PROBLEMS

A new ac network calculator, built by the Westinghouse Electric Corp. at a cost of $400,000, was recently put into service by the Franklin Institute, in cooperation with seven major power companies in Penn., N. J. and Delaware. The utilities will use this computer to help solve the complex problems involved in maintaining their power systems.

Plan U.S.-Alaska Cable

Plans for an underwater telephone cable system linking the forty-eight states with Alaska have been announced by the Long Lines Dept. of American T. & T. An appli-

cation filed with the F.C.C. sets the terminal points of the cable as Port Angeles, Washington and Ketchikan, Alaska, a distance of 800 nautical miles. Present telephone service between Alaska and the U. S. is provided over 13 radio and land line circuits.

Bill to Study Transatlantic TV Passed

Congress has passed and sent to the President a bill which would set up a commission to study the proposed establishment of a transatlantic TV system and to promote the use of radio-TV telecommunications between free nations. The nine-man commission would operate with a $250,000 appropriation, and include two senators, two representatives, and at least one member from both the communications industry and education.

The House report referred to the NARCOM plan which utilizes VHF-microwave relays linking islands to span the Atlantic. Details of this plan were first revealed in "Global Microwave System for TV and Communications," Nov. 1952 TELE-TECH & ELECTRONIC INDUSTRIES.

Low-Cost Color TV

Emerson is now offering color TV receivers for sale at a retail price of $695. The new receiver, the Emerson Model C-501, incorporates a 15-in. picture tube, which is now being produced in limited quantities.

MORE NEWS on page 14

As We Go To Press . . . (Continued)

CHECKING MAGNET QUALITY

This recording hysterisigraph in the Carboloy Dept. of GE in Detroit makes a complete record of a magnet's entire hysterisis loop automatically. Any part of loop is explored at will

"Tinkertoy" Pays Dividends

Mechanically produced electronic equipment has shown many superior qualities compared to equipment produced by conventional means, according to the Navy's Bureau of Aeronautics. In a directive issued to the Navy departments responsible for design and procurement of electronic equipment, BUAER recommended that contractors be encouraged to use mechanized production techniques wherever possible, and particularly in the manufacture of mobile equipment.

1,000,000th Transistor Observed at Raytheon

The millionth germanium junction transistor produced at the Raytheon plant in Newton, Mass. was the occasion for a review of the progress made in improving transistor reliability in the past few years.

The company officials pointed out that with nearly a million transistors in operation, field failures are now running at less than 2% per year.

In the line of new developments, Raytheon spokesmen foresaw production of power output and radio frequency transistors late in the year, with the first transistorized portable and pocket radios appearing in 1955.

Checking out finished transistor at Raytheon

MORE NEWS on page 18

COMING EVENTS

Aug. 25-Sept. 4—National Radio Show, Earls Court, London. (Preview for overseas guests on Aug. 24)

September—First International Scientific Radio Union, Amsterdam, Holland.

Sept. 1-16—Golden Jubilee Meeting of the International Electrotechnical Commission, University of Pennsylvania, Philadelphia, Pa.

Sept. 5-9—International Frankfort Fair, Frankfort, Germany.

Sept. 8-11—Symposium. on Propagation Standards and Problems of the Ionosphere, sponsored by the NBS Central Radio Propagation Laboratory. Boulder (Colorado) of the NBS.

Sept. 13-24—International Instrument Congress and Exposition. Commercial Museum and Convention Hall, Philadelphia, Pa.

Sept. 15-17—IRE-MIT Symposium on the Information Theory, co-sponsored by the AIEE and URSI, Massachusetts Institute of Technology, Cambridge, Mass.

Sept. 16-18—Joint Electron Tube Engineering Council General Conference, Chalfont-Haddon Hall, Atlantic City, N. J.

Sept. 28-30—1954 National Packaging and Materials Handling Competition, sponsored by the Soc. of Industrial Packaging and Materials Handling Engineers. Chicago Coliseum, Chicago, Ill.

Sept. 30-Oct 1—5th Annual Meeting and Exhibit of the Professional Group on Vehicular Communications of IRE. Rice Hotel, Houston, Texas.

Sept. 30-Oct. 1—Fall Assembly Meeting of the Radio Technical Commission for Aeronautics. Willard Hotel, Washington, D. C.

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

Oct. 4-6—Tenth Annual National Electronics Conference, Hotel Sherman, Chicago, Ill.

Oct. 11-15—AIEE Fall General Meeting, Morrison Hotel, Chicago, Ill.

Oct. 13-15—Joint Meeting of RTCM and IRE Professional Gp. on Communications Systems. Somerset Hotel, Boston, Mass.

Oct. 13-17.—1954 Annual Convention, Audio Engineering Society. Hotel New Yorker, N. Y.

Oct. 18-20—RETMA Radio Fall Meeting, Hotel Syracuse, Syracuse, N. Y.

Oct. 18-22—42nd National Safety Congress and Exposition, Conrad Hilton, Congress, Morrison and La Salle Hotels, Chicago, Ill.

Oct. 21-23—8th New England Conference of the American Soc. for Quality Control. Ten Eyck Hotel, Albany, N. Y.

Oct. 26-28—2nd National Conference on Tube Techniques, sponsored by the Working Group on Tube Techniques of the Dept. of Defense. Western Union Auditorium, 60 Hudson St., N. Y. C.

Oct. 27-30—30th National Convention of the National Assoc of Education Broadcasters. Hotel Biltmore, New York.

Nov. 4-5—East Coast Conference on Airborne and Navigational Electronics, sponsored by the Baltimore section of IRE and IRE Professional Group on Aeronautical and Navigational Electronics. Sheraton-Belvedere Hotel, Baltimore, Md.

Nov. 10-11—AIEE Conference on Electronic Instrumentation and Nucleonics in Medicine, Morrison Hotel, Chicago, Ill.

Nov. 10-12—18th Annual Time and Motion Study and Management Clinic, sponsored by the Industrial Manage- Society. Sherman Hotel, Chicago, Ill.

Nov. 12-13—National Symposium on Quality Control Methods in Electronics, sponsored by the Professional Group on Quality Control of IRE and Electronic Technical Comm. of the American Soc. for Quality Control. Hotel Statler, New York.

Nov. 18-19—6th Annual Electronics Conference, sponsored by the Kansas City Section of IRE, Hotel President, Kansas City, Mo.

Nov. 21-22—Automatic Control Equipment Exhibition. Waldorf-Astoria Hotel, N. Y. C.

Nov. 29-Dec. 4—First International Automation Exposition, 242nd Coast Artillery Armory, New York, N. Y.

Dec. 8-10—4th Annual Eastern Joint Computer Conference and Exhibition, jointly sponsored by the AIEE, IRE, and ACM. Bellevue-Stratford Hotel, Phila. Pa.

ACM: Assoc. for Computing Machines.
AES: Audio Engineering Society.
AIEE: American Institute of Electricaal Engineers.
IRE: Institute of Radio Engineers.
ISA: Instrument Society of America.
NACE: National Assoc. Corrosion Engineers.
NARTB: National Assoc. of Radio and TV Broadcasters.
RETMA: Radio-Electronics-TV Manufacturers Assoc.
RTCM: Radio Technical Commission for Marine Services
URSI: International Scientific Radio Union

Polarad NTSC Color TV Equipment consists of fully integrated units that combine ease of operation with maximum flexibility.

COLOR BAR GENERATOR—PT-203 Provides color TV test signals, NTSC standards, for color TV equipment, networks and components. Supplies complete composite video signal in the form of seven fundamental color bars simultaneously with seven gradations of gamma bars. White dot pattern superimposed on both color and gamma bars. Color test pattern can be used for adjustment of both color transmitter and receiver circuitry. Internal switching permits 19 different test patterns.

COLOR SYNCHRONIZING GENERATOR—PT-201 Furnishes NTSC color TV subcarrier frequency component and contains divider network to yield 31.5 KC signal. Provides driving, blanking and synchronizing pulses, as well as vertical and horizontal dots for linearity checks. Used to drive color bar generators, or any other NTSC color TV generating equipment. Utmost stability assured by driving all pulses from leading edge of crystal controlled oscillator. Unit may be locked to synchronize with 60 cps line. **Also available** as a separate unit, PT-202 Subcarrier Frequency Generator to modify any existing standard (B/W) synchronizing generator in accordance with NTSC color TV standards.

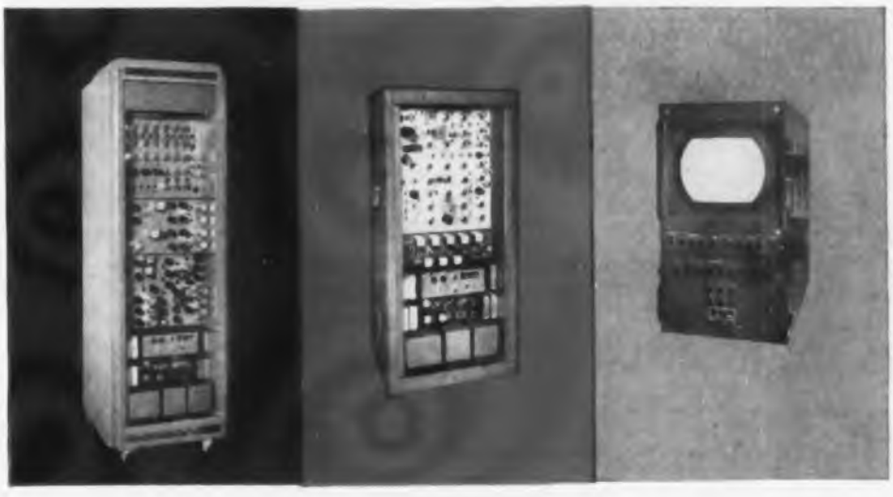
COLOR TV VIDEO MONITOR—M-200 Compact, rugged instrument consisting of two portable units. Uses 15 inch RCA tri-color Kinescope. Checks quality of NTSC color video signals in studio, on transmission or in factory. Excellent synchronizing stability. Displays highest definition transmitted pictures with exceptionally good color rendition. All controls on front panel. Instrument may be rack mounted or employed as field test equipment.

ALSO AVAILABLE An NTSC color TV Flying Spot Scanner, furnished as a completely packaged unit supplying a standard color video signal. For further information, contact your nearest Polarad representative or write directly to the factory.

Polarad

COLOR TV

equipment for studio and laboratory



COLOR BAR GENERATOR PT-203
OUTPUT SIGNALS: Composite Video (2 outputs) (Sync. negative & positive)
SIGNAL INFORMATION
7 Bars of Color
7 Bars of Gamma Gradations
White Dot Pattern (Vert. and Hor.)
EXT. VIDEO INPUT FOR MIXING
2 Volts neg. polarity

COLOR SYNCHRONIZING GENERATOR PT-201
OUTPUT SIGNALS
Synchronizing Signal (Neg.)
Camera Blanking Signal (Pos., Neg.)
Horizontal Drive Signal (Neg.)
Vertical Drive Signal (Neg.)
Composite Video Output (Neg., Pos.)
NTSC Color Subcarrier Freq.
(3.579545 mc/s)

COLOR VIDEO MONITOR M-200
Signal Polarity—Positive, Negative, Balanced
Input Video—0.25 to 2.0 Volts, peak to peak
Input Impedance—66 mmf across 2.2 megohms
Resolution—250-300 lines (Full Utilization of NTSC Color Signal Bandwidth)
Linearity—Better than 2% across raster Horizontal and Vertical

Polarad ELECTRONICS CORPORATION 100 METROPOLITAN AVENUE, BROOKLYN 11, NEW YORK

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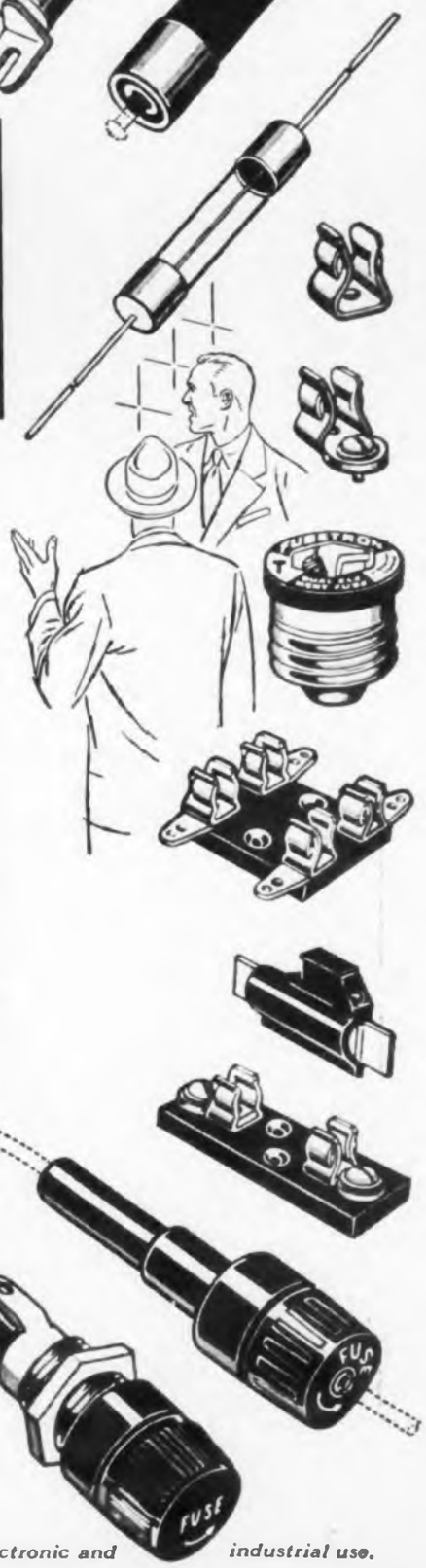
You'll find that by obtaining all your fuses from one source you can save time and money by simplifying your purchasing, stock handling and records.

Why BUSS fuses give "trouble-free" protection.

To make sure of dependable electrical protection under all service conditions, — every BUSS fuse normally used by the Electronic Industries is tested in a sensitive electronic device that rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

Should you have a special problem in electrical protection . . . over 39 years of research and practical experience is available to you when you turn your electrical protection problem over to BUSS. The facilities of the world's largest fuse research laboratory will be brought to bear on the problem — helping you select the fuse or fuse mounting best suited to your needs.



BUSSMANN Mfg. Co. (Div. McGraw Electric Co.)
University at Jefferson, St. Louis 7, Mo.

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Company .....

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FOR MORE INFORMATION MAIL THIS COUPON

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

As We Go to Press . . . .

New Company Formed

A new IT&T subsidiary, Farnsworth Electronics Co., has been formed at Fort Wayne, Ind. to take over the research and production activities in the fields of industrial and defense electronics formerly carried on by IT&T's Capehart-Farnsworth Co. Division. Dr. Harvard L. Hull, former v.p. and general manager of R & D at Capehart-Farnsworth, becomes president of the new firm.

WLAC-TV Joins Network

Station WLAC-TV, Nashville (Old Hickory), Tenn. has been connected to the Bell Telephone System's network TV facilities. Network programs now reach 303 stations in 194 cities in the U.S.

Reduced Royalty Rates

Reduction in the patent royalty rates on radio sets, black-and-white TV receivers, black-and-white TV kinescopes, electron tubes, and certain commercial radio apparatus have been announced by R.C.A. The reductions become effective Jan. 1, 1955. The cuts range from 25% on commercial radio apparatus to 56% on those sound radio receivers employing tubes.

Station Modifications for Color

FCC regulations require TV stations to make certain modifications in order to broadcast programs originated in color. An alternative is to remove the chrominance components from the color signal received from the network. Field Bulletin 20 released by Allen B. DuMont Labs. describes a simple filter which attenuates the color subcarrier 23 db, while having little effect on the sidebands.

High-Strength Tape

"Scotch" brand magnetic tapes No. 111 and "High Output" No. 120 are now nationally available on high-strength polyester backing as well as on conventional acetate backing, according to an announcement by Minnesota Mining & Mfg. Co., St. Paul, Minn. Designated "Scotch" magnetic tapes No. 111 AM and "High Output" No. 120 AM, the two new tapes are identical in magnetic characteristics to their acetate base counterparts. Labeled "PE" backing, the new plastic base is recommended for humid environments.

MORE NEWS on page 24

evolution of an idea... how KEYSTONE shortens the interval from **theory** ...

a hot new electronic idea with important uses but involved transformer **problems** which threaten to bog down the ultimate mass production... but schedules must be met. A smart engineer turns to KEYSTONE'S **reply sheet**... quickest way to filling the most exacting transformer requirements of all military and commercial units. KEYSTONE evaluates the conditions and custom engineers the correct type transformer... putting it into immediate **production**... exclusive KEYSTONE techniques and internal flexibility cut your costs through faster deliveries of precision custom-built units... which have proven to be the economic **solution** to leading electronic manufacturers' most difficult applications.

"KEYSTONE is correct for every application."

...to **practice**

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keystone PRODUCTS COMPANY

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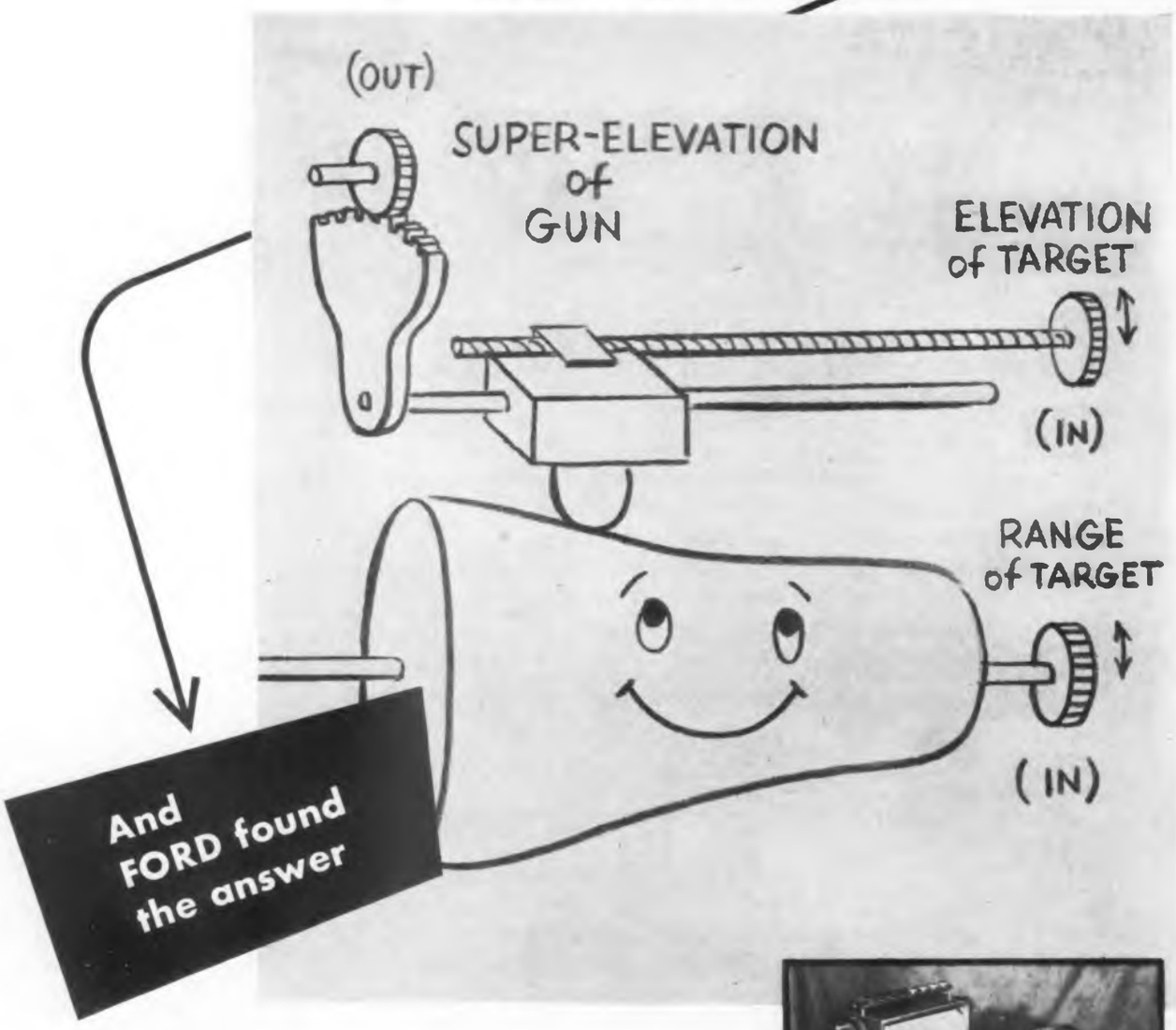
HOW TO TAP THE BRAIN
of a piece of metal



In making computers, such information as mathematical functions can be stored in a precision-cut cam, thus allowing its follower to be displaced in accurate reply to the input position of the cam. Ford Instrument Company designs and makes cams of all sizes and shapes to achieve these results. To manufacture such cams with the precision demanded, the engineers of Ford Instrument have devised remarkable automatic machines which, by following a carefully plotted ink line on a roll of paper, cut the exact shape into the metal. Then, careful point-by-point checks, sometimes as many as 2000 measurements, insure finest accuracy.

If you have a cam problem—call on Ford Instrument Company.

You can see why a job with Ford Instrument offers young engineers a challenge. If you can qualify, there may be a spot for you in automatic control development at Ford. Write for brochure about products or job opportunities. State your preference.

28

FORD INSTRUMENT COMPANY

DIVISION OF THE SPERRY CORPORATION

31-10 Thomson Avenue, Long Island City 1, N. Y.

CUT TV COSTS, MAINTAIN QUALITY WITH G.E.'S NEW 600-SERIES TUBES!

Now, for the first time, designers can have "series-string" economy at no sacrifice of TV reliability!

- ★ **Every G-E 600-Series Tube has same heater warmup time. Greatly reduces tube failures, because voltage will not build up excessively in some tubes while others are warming up more slowly.**
- ★ **All filaments are 600-ma. They employ special large-diameter wire, with fewer bends for better insulation against heater-cathode shorts.**
- ★ **24 G-E 600-Series types are ready now! More coming.**

QUALITY TV performance—costs sharply reduced! G-E tube-design service brings you both benefits with the new 600 Series. Now, by means of "series-string" design, you can *save* on transformer and circuitry . . . yet maintain highest standards of receiver dependability, with service callbacks at a minimum.

Meet today's stiff TV competition at its own price level, but with far superior performance! Use G-E 600-Series Tubes, *designed for "series-string" operation.* List at right shows wide range of types available. Others soon. Get full information from *Tube Department, General Electric Company, Schenectady 5, N. Y.*

COMPARE HEATER-WIRE THICKNESS AND NUMBER OF BENDS!

G-E 600-SERIES 3AU6

Wire diameter .00366" (coated diameter approximately .009"). 4 strands, with only 3 bends.

STANDARD 6AU6

Wire diameter .00226" (coated diameter approximately .008"). 6 strands, with 5 bends in all.

CHECK YOUR CIRCUIT NEEDS AGAINST THIS LIST!

G-E 600-Series Tubes	Prototypes
3AL5	6AL5 12AL5
3AU6	6AU6 12AU6
3BC5	6BC5
3BE6	6BE6 12BE6
3BN6	6BN6
3BY6	6BY6
3CB6	6CB6
5AQ5	6AQ5 12AQ5
5BK7-A	5BK7-A
5J6	6J6
5T8	6T8
5U8	6U8
5V6-GT	6V6-GT 12V6-GT
6S4-A	6S4
6SN7-GTB	6SN7-GTA
12AX4-GTA	12AX4-GT
12B4-A	12B4
12BH7	12BH7
12BK5	6BK5 25BK5
12BQ6-GA	6BQ6-GA 25BQ6-GA
12BY7-A	12BY7
12L6-GT	25L6-GT
12W6-GT	6W6-GT 25W6-GT
25CD6-GA	25CD6-G

Other types to follow soon

GENERAL ELECTRIC

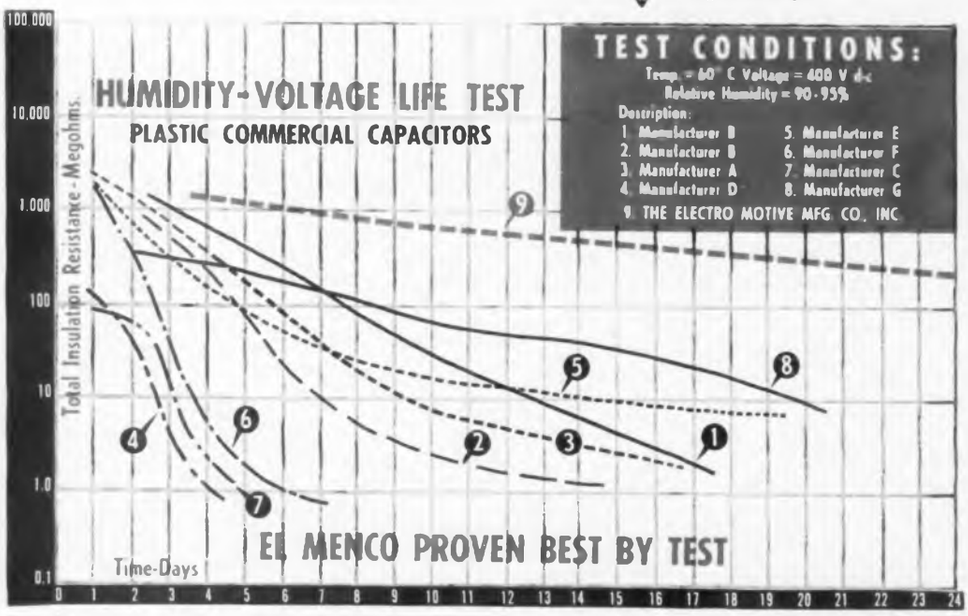
162-1A4

...how good is BEST?

BEST { ... *By TEST!* ... *By PERFORMANCE!* * }

These curves are authentic recordings taken from actual results obtained from a nationally known independent testing laboratory.

and here's proof!



* CERAMIC CASED PAPER DIELECTRIC CAPACITORS —

* More than 60 million of these capacitors have been used by nationally known radio and television manufacturers with no reported field failures. These ceramic capacitors are available in 200, 400, 600 and 1000 working voltage ratings.

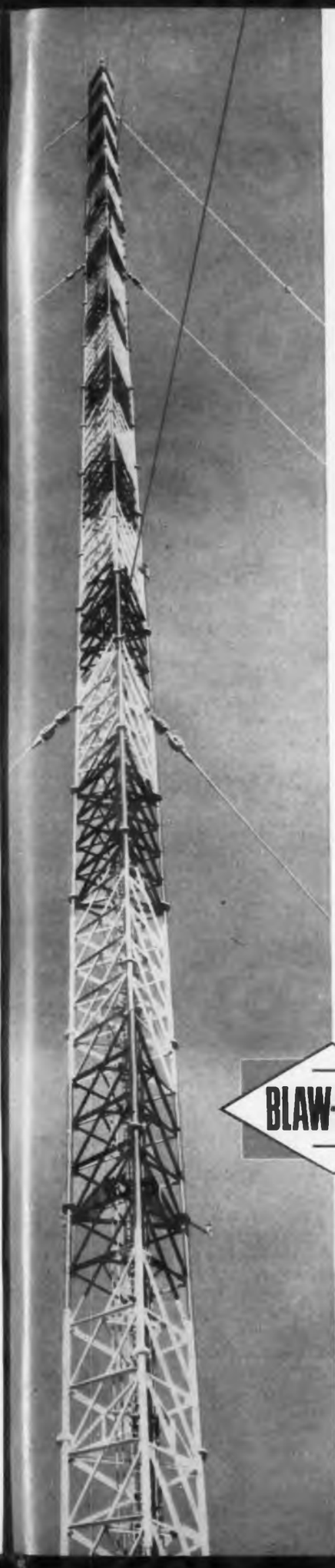
Write for sample and catalog on your firm's letterhead.

Jobbers and Distributors are requested to write for information to Arco Electronics, Inc., 103 Lafayette St., New York, N. Y.

MOLDED MICA **El-Menco** **MICA TRIMMER**
CAPACITORS

Foreign Electronic Manufacturers Get Information Direct from our Export Dept. at Willimantic, Conn.

THE ELECTRO MOTIVE MFG. CO., INC. **WILLIMANTIC, CONNECTICUT**



. . . 1088 foot guyed tower designed for triple service

With their new Blaw-Knox tower, and operating on channel 5 to full maximum power of 100,000 watts, WMCT in Memphis, Tennessee, has increased their coverage 100%.

The 1088 foot tower is a triangular guyed type with insulated base and sectionalizing insulators at the 640 foot level.

This special design tower does triple duty. The lower part is used as an AM radiator for WMC. In the portion above the insulator and just below the top is mounted an 8-bay FM antenna for WMCF. On top of the tower is a 6-bay super turnstile antenna for television station WMCT.

In addition to this main tower, they use three Blaw-Knox self-supporting 315 foot towers in nighttime directional operation . . . plus a 310 foot guyed tower for an auxiliary. So at this one station they have a total of five Blaw-Knox towers.

This unusual installation is typical of how we are prepared to cooperate with you on any antenna tower problem you may have.

For more information on the many types of Blaw-Knox Antenna Towers, simply write for your copy of Bulletin No. 2417. Or, for prompt service send us your inquiry, specifying height of tower and type of antenna.

BLAW-KNOX COMPANY
BLAW-KNOX EQUIPMENT DIVISION • TOWER DEPARTMENT
PITTSBURGH 38, PENNSYLVANIA

BLAW-KNOX

ANTENNA TOWERS

Guyed and self-supporting types—for AM • FM • TV • microwave • communications • radar

Distributed by GraybaR

Looking skyward, note the solid round corner legs and the double laced structural angle bracing. Insert shows the triple unit compression cone base insulator.

As We Go to Press . . . .

New Audio Felts

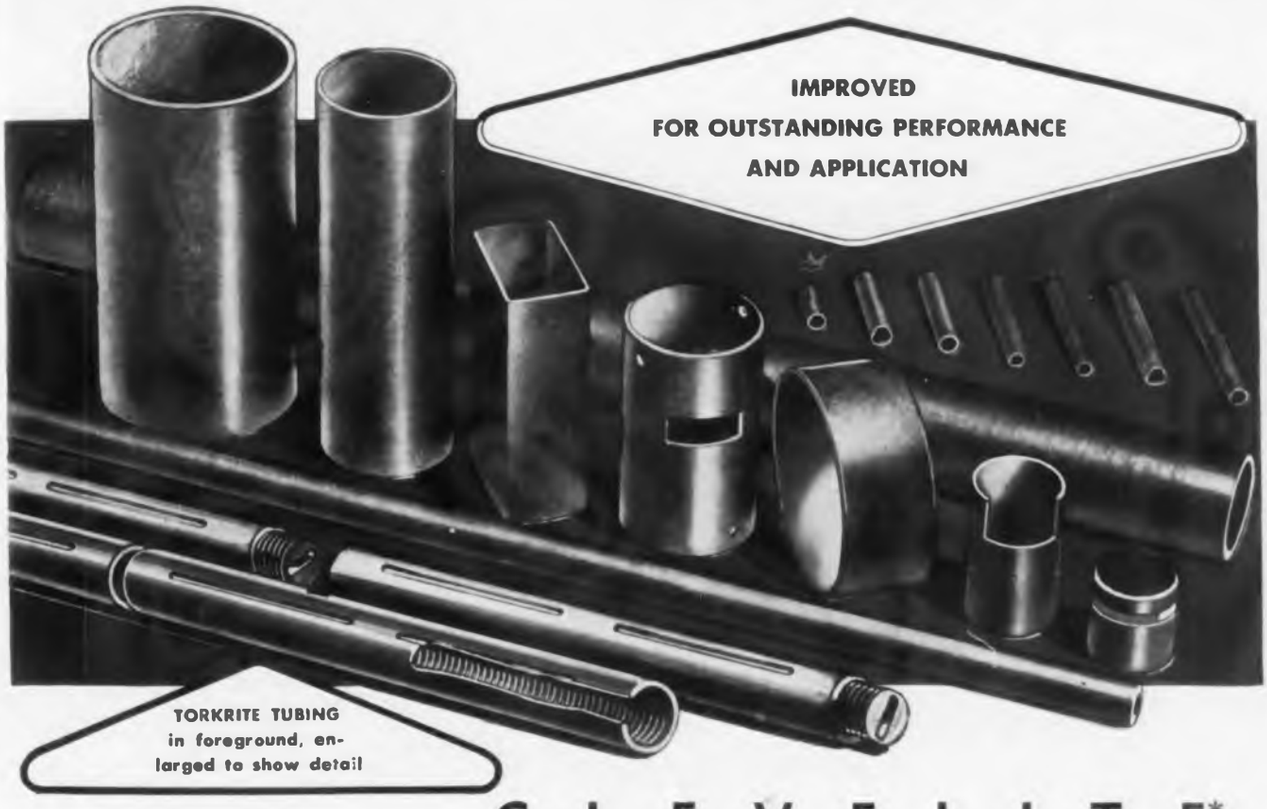
Three new applications of felt designed to provide major improvements in the acoustics of high fidelity audio systems have been announced by the American Fel Company of Glenville, Conn. Th new products are: Acoustical Fel for dampening speaker chambers Latex Impregnated Felt for float-mounting record players and turntables; and "Acousti-Pad" to b used as a supplemental pad for record players and changers.

Acoustical Felt for effectively controlling unwanted sounds in high fidelity audio systems is a new use for an old established product Known as "K" Felt, it has long been in use as acoustical insulation in airplanes. Now it is planned to utilize felt's damping qualities for improving acoustical enclosures or chambers of high fidelity loud speakers. Acoustical Felt (mothproofed and flame-resistant) will be available in 10 yd. rolls, 1 yd. wide and ⅜ in. thick. Price is $6.00 a yd.

Closeup showing application of latex impregnated felt on motorboard for float-mounting record players and turntables

Latex Impregnated Felt, a felt strip with die-cut crescent arches, shock mounts record players and turntables, to eliminate vibration and to reduce feed back. This will be available in ½ x ¾ in. cut strips at a list of 45¢ a foot or in cartons containing 100 feet (20 five-foot lengths) at $45.00 per carton.

"Acousti-Pad" is a micro-porous rubber material resembling felted rubber. It is said to improve tone quality thru better stylus tracking, reduce vibration and feed back, reduce stylus noise on poor recordings, and reduce rumble and turntable noise. It also cushions record fall on changers. "Acousti-Pads" for an 8 in. turntable will list for $2.00, for 10 in. turntable $2.25, and for 12 in. turntables at $2.50. Pads for 17 in. transcription tables will retail at $5.00 each. Ingalls Electronics Co., 30 West Putnam Ave., Greenwich, Conn. is national distributor.



TORKRITE POSSESSES MANY ADVANTAGES

Torkrite affords unmatched recycling ability. After a maximum diameter core has been recycled in a given form a reasonable number of times, a minimum diameter core can be inserted and measured at 1" oz. approximately.

Torkrite has no hole or perforation through the tube wall. This eliminates the possibility of cement leakage locking the core or cores.

Torkrite permits use of lower torque as it is completely free of stripping pressure.

With Torkrite, torque does not increase after winding, as the heavier wall acts to prevent collapse and core bind.

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

★ ★ ★

Fast, Dependable Delivery at all times.

★ ★ ★

CLEVELITE*

LAMINATED PAPER BASE PHENOLIC TUBING

In seven specific grades, Clevelite is one of the finest and most complete lines of tubing available to the electronic and electrical industries.

Grade	Application
Grade E	...Improved post-cure fabrication and stapling
Grade EX	...Special grade for TV yoke sleeves
Grade EE	...Improved general purpose
Grade EEX	...Superior electrical and moisture absorption properties
Grade EEE	...Critical electrical and high voltage application
Grade XAX	...Special grade for government phenolic specifications
Grade SLF	...Special for very thin wall tubing having less than .010 wall

High performance factors, uniformity and inherent ability to hold to close tolerances, make Clevelite outstanding for Coil Forms, Collars, Bushings, Spacers and Cores.

Competent Research and Engineering facilities are always available to aid in solving those tough and stubborn design and fabrication problems. May we help you?

WHY PAY MORE? For Good Quality . . . call CLEVELAND!

*Reg. U. S. Pat. Off.

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

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

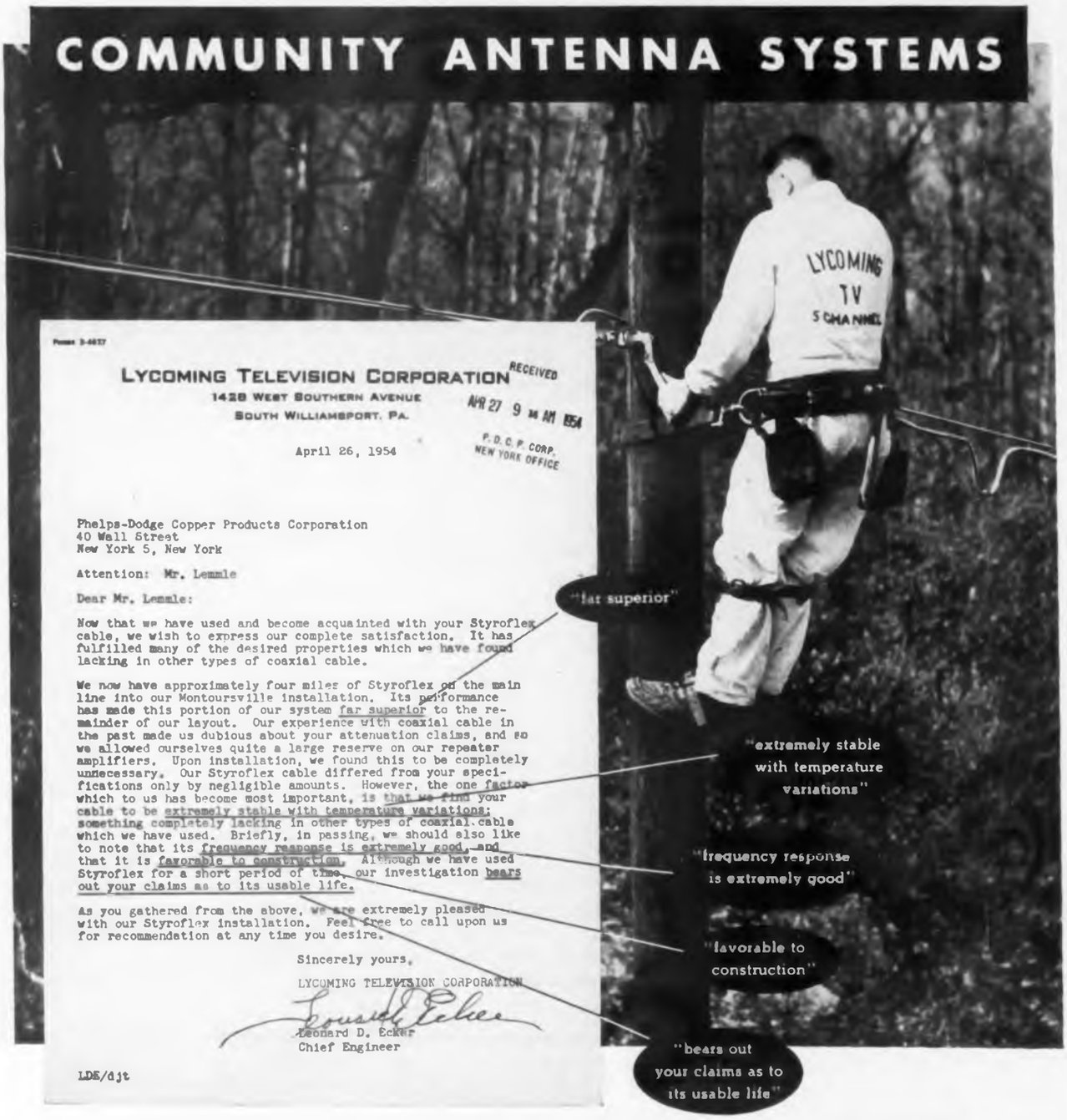
REPRESENTATIVES

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, 5715 N. RAVENSWOOD AVE., CHICAGO
WEST COAST IRV. M. COCHRANE CO., 408 S. ALVARADO ST., LOS ANGELES

Styroflex Coaxial Cable

FIRST CHOICE AGAIN FOR

COMMUNITY ANTENNA SYSTEMS



LYCOMING TELEVISION CORPORATION
1428 West Southern Avenue
South Williamsport, Pa.

RECEIVED
APR 27 9 30 AM 1954
P. D. C. P. CORP.
NEW YORK OFFICE

April 26, 1954

Phelps-Dodge Copper Products Corporation
40 Wall Street
New York 5, New York

Attention: Mr. Lemmle

Dear Mr. Lemmle:

Now that we have used and become acquainted with your Styroflex cable, we wish to express our complete satisfaction. It has fulfilled many of the desired properties which we have found lacking in other types of coaxial cable.

We now have approximately four miles of Styroflex on the main line into our Montoursville installation. Its performance has made this portion of our system far superior to the remainder of our layout. Our experience with coaxial cable in the past made us dubious about your attenuation claims, and so we allowed ourselves quite a large reserve on our repeater amplifiers. Upon installation, we found this to be completely unnecessary. Our Styroflex cable differed from your specifications only by negligible amounts. However, the one factor which to us has become most important, is that we find your cable to be extremely stable with temperature variations; something completely lacking in other types of coaxial cable which we have used. Briefly, in passing, we should also like to note that its frequency response is extremely good, and that it is favorable to construction. Although we have used Styroflex for a short period of time, our investigation bears out your claims as to its usable life.

As you gathered from the above, we are extremely pleased with our Styroflex installation. Feel free to call upon us for recommendation at any time you desire.

Sincerely yours,

LYCOMING TELEVISION CORPORATION

Leonard D. Ecker
Chief Engineer

LDE/djt

"far superior"

"extremely stable with temperature variations"

"frequency response is extremely good"

"favorable to construction"

"bears out your claims as to its usable life"

PHELPS DODGE COPPER PRODUCTS CORPORATION

40 WALL STREET, NEW YORK 5, N. Y.

SERVING the ☆ARMED FORCES is our most important Business!

...of the U. S. A.

☆ . . in the *Air!*

☆ . . on the *Sea!*

☆ . . on the *Land!*

LORAL has delivered annually many millions of dollars worth of **ELECTRONIC** and **ELECTRO-MECHANICAL MILITARY EQUIPMENT*** designed, developed, manufactured .... *on time!*

Including

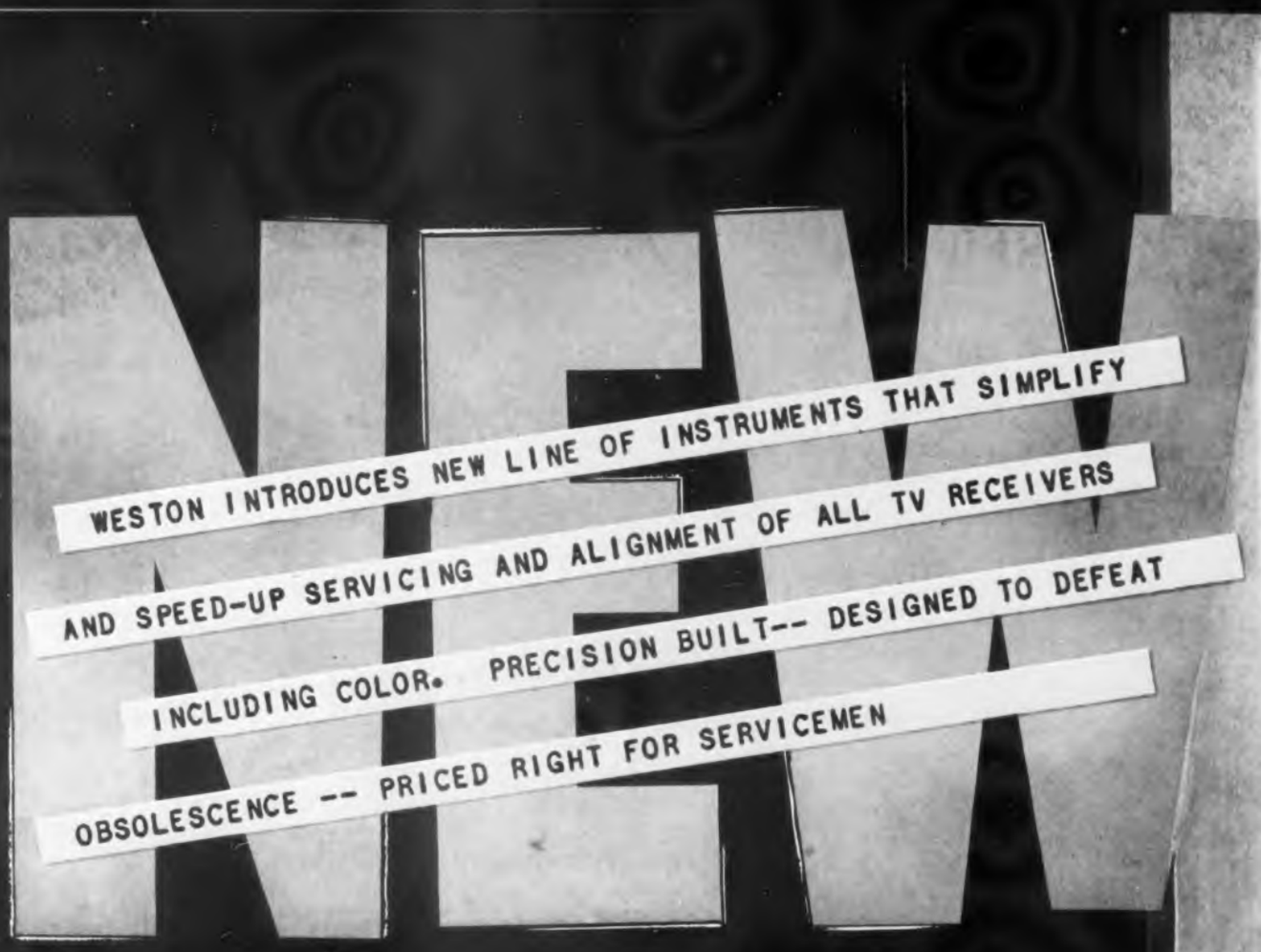
- **AIRBORNE NAVIGATIONAL EQUIPMENT**
- **COMMUNICATION SYSTEMS**
- **RADAR EQUIPMENT**
- **TEST EQUIPMENT**

● *Write Dept. T-954 for Facilities Brochure*

LORAL *Imprint of Integrity*

ELECTRONICS CORPORATION

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



WESTON 980 LINE TV TEST EQUIPMENT

In the new 980 Line, WESTON offers TV technicians not only a group of superior, up-to-the-minute instruments, but a new, *greatly simplified* and *time-saving method* of TV receiver alignment as well.

The instruments in this line represent a completely new approach in test equipment design and operation . . . instruments that set entirely new standards in *performance* . . . in *operating simplicity* . . . in *value!*

In the new simplified method of alignment which they provide, it is no longer necessary to connect the calibrator to the receiver. This simplified hook-up eliminates the spurious markers and receiver oscillations encountered with conventional hook-ups. Further, there is no disappearance of markers at trap resonant frequencies. And there are many other advantages, too; all enabling you to do a *better alignment job*, in *one-half the usual time*, and at *far higher profit*.

980 Line instruments are available to TV technicians through leading distributors. Literature giving complete information gladly sent on request. Return the coupon today.

MODEL 985 CALIBRATOR

—a time-saving instrument for TV shop, engineering laboratory, and industrial alignment applications. Negative and positive Z-axis markers are provided for wave-form pattern analysis. Extremely useful for making linearity adjustments, calibrating signal generators, and determining signals of unknown frequencies. Generated markers are visible even at sound trap frequencies. Generated frequencies are *fundamentals* . . . not harmonics. Simultaneous multiple marker insertion . . . no distortion of response curve . . . fewer connections to TV receiver.

MODEL 983 OSCILLOSCOPE

—a high gain, wide band oscilloscope. Band width of 4.5 megacycles allows accurate display of video frequencies, including pulse wave forms and color synchronizing bursts. High sensitivity of 17 millivolts per inch makes it ideal for setting resonant traps, as a general null indicator, signal tracing in low level stages, phase measurements as well as for sweep frequency visual alignment of TV receivers. Has provisions for internal calibration, internal phased sine wave, and Z-axis intensity modulation. Reversal of polarity of both horizontal and vertical signals accomplished by means of toggle switching. Identical vertical and horizontal amplifiers . . . direct coupling used throughout.

MODEL 984 SWEEP GENERATOR

—for efficient trouble shooting and lab practice in problems of sound and video IF circuits, associated trap circuits, TV tuners, video amplifiers and all-purpose visual alignment. RF OUTPUT: Frequency modulated signal, TV channels 2 to 13 inclusive, complete FM coverage available by means of two preset selector positions. FREQUENCIES ARE FUNDAMENTALS OF THE OSCILLATOR FREQUENCY. IF/VIDEO OUTPUT: Frequency modulated signals ranging to 50 megacycles, continuous tuning, signals free from harmonics. SWEEP WIDTH: Full 10 megacycles on all channels. OUTPUT VOLTAGE (RMS): 0.1 Volt, sweep is linear. Output is essentially flat.

MODEL 981 PROPORTIONAL MUTUAL CONDUCTANCE TUBECHECKER

—provides meter measurement of leakage resistance as high as 5 megohms between tube elements . . . nine single circuit, twelve position selector switches protect against obsolescence . . . three toggle switches make it possible to check and compare sections of twin-section tubes at only one setting of selector switch. Transconductance measurements high as 30,000 micromhos with filtered d-c plate, screen grid, and control grid potentials. Precision voltage divider network and switch provides signal voltages of 0.65, 1.3, 2.6, and 5.2 volts peak to peak at a frequency of 5000 cycles. Tubes checked more closely to circuit operating conditions. Better Gm accuracy obtained.

MODEL 982 VACUUM TUBE VOLTMETER

—a self-contained, battery operated Vacuum Tube Voltmeter, particularly adaptable to the Radio-TV servicing industry where the requirements of peak to peak measurements of a-c voltages exclude the use of conventional meters. Makes possible quantitative measurement of all complex wave form voltages utilized in video, sync and deflection circuits with no a-c line interference in critical measurements. Battery operation affords complete isolation from spurious response due to stray a-c fields and circulating ground currents. *Circuit loading on peak to peak measurements eliminated.*

MODEL 980 ANALYZER

—highly versatile, accurate and rugged volt-ohm-milliammeter with a combination of functional ranges which provide a wide range of test measurement applications in the electronic field. D-c sensitivity of 20,000 ohms/volt, a-c sensitivity 1000 ohms/volt. Accuracy 2% d-c, 3% a-c. Range and functional switching greatly simplified by use of a single dial for all ranges and functions.

for TV it's the 980 Line

WESTON

test equipment

WESTON Electrical Instrument Corporation
614 Frelinghuysen Ave., Newark 5, N. J.

Send copy of bulletin TT

Name_____

Address_____

City_____ State_____

A REED IS A REED IS A REED... if it's recorded on Soundcraft magnetic recording tape

A reed is never a flute . . . or a flue pipe. So, to be *sure* of capturing all the haunting brilliance of reed instruments—and the full range of sounds of the entire orchestra — always use Soundcraft Tapes! Why?

Because Soundcraft Tapes, and *only* Soundcraft Tapes, combine:

- Constant depth oxide for uniform middle- and low-frequency response.
- Micro-Polished® coating, a patented Soundcraft process that eliminates unnecessary head wear and gives uniform high-frequency response right from the start.
- Pre-Coated adhesive applied directly to base—firmly anchors the oxide in place.
- Surface-lubrication on *both* sides! No friction, no chatter, no squeal.
- Chemical balance throughout to prevent cupping, curling, peeling, chipping.
- Uniform output of ±¼ db. within a reel, ±½ db. reel-to-reel.

SOUNDCRAFT TAPES FOR EVERY PURPOSE

Soundcraft Tape for all high-fidelity recording.

Soundcraft Professional Tape for radio, TV and recording studios. Splice-free up to 2400 feet. Standard or professional hubs.

Soundcraft LIFETIME® *Tape* for priceless recordings. For rigorous use. For perfect program timing. It's on a base of DuPont "Mylar" Polyester Plastic. A third as strong as steel. Store it anywhere. Guaranteed for a lifetime.

Get the Soundcraft Recording Tape *you* need today. Your dealer has it.

REEVES

SOUNDCRAFT

CORP. Dept. N-9

10 East 52nd St., N. Y. 22, N. Y.

FOR EVERY SOUND REASON

THE WORLD'S FINEST TAPES...YET THEY COST NO MORE

INDUSTRY NEWS

Robert A. Gingrich has been named asst. secretary and asst. treasurer of Hoffman Radio Corp., TV Div., Los Angeles. Other top-level appointments were **Joseph S. McGee**, to the newly-created position of asst. secretary of Hoffman Laboratories Inc., and **R. W. Westerfield** as director of purchasing for the TV division. Mr. Westerfield had previously been associated with the Hallicrafters Co., as special assistant to the president, **Wm. Halligan.** He will now be in charge of all TV and radio procurement at Hoffman.

T. R. Dreyer has been appointed divisional vice-pres. and general manager of American Machine & Foundry Co.'s manufacturing division, in charge of the five AMF plants in Buffalo, Boston, Brooklyn, N.Y., Glen Rock, Pa., and New Haven, Conn.

T. R. Dreyer

D. C. Burnham

Donald C. Burnham has joined the Westinghouse Electric Corp. as vice-pres. in charge of manufacturing, succeeding **T. I. Phillips,** who is retiring after 39 years of service. Mr. Burnham, prior to this appointment, was manufacturing manager of the Oldsmobile Div. of General Motors.

Harry W. Houck has been elected president of Measurements Corp., subsidiary of Thomas A. Edison, Inc. Mr. Houck joined Measurements Corp. shortly after its formation in 1939. The company currently produces standard signal generators and other testing equipment.

B. B. Countryman was named vice-president, purchasing division, at Minnesota Mining and Mfg. Co., St. Paul, Minnesota. He has been director of purchases since 1942, and is a former director and vice-pres. of the National Assoc. of Purchasing Agents. The company also announced the appointment of **I. R. Hansen** to the position of assistant treasurer.

Dominick J. Capano has been elected vice-pres. of S.O.S. Cinema Supply Corp., in charge of TV Studio and film production sales. Another recent promotion is that of William H. Allen to the position of production manager.

(*Continued on page* 34)

Specify . . .

Shallcross

Borohm®

BORO-CARBON RESISTORS

STABLE—Typical average change after 1000 hours load life test 0.2%.

ACCURATE—Within 1, 2, 5% on all standard types.

LOW T.C.—200 p.p.m. per °C above 20K.
100 p.p.m. per °C below 20K.

RUGGED—Epoxy resin coating remains elastic, cannot crack or chip.

Shallcross Borohm resistors are unusually stable, accurate, and long-lived as a result of Shallcross' basic research on carbon films and manufacturing processes. Complete control of the quality and distribution of the boro-carbon film on specially formulated ceramic rods assures minimum film variation within each unit, as well as from unit to unit.

Automatic machine handling of resistors throughout the carbon deposition process prevents contamination. Rigid automatic control of rod and gas temperatures during deposition eliminates soot formation in the carbon film. Resistance for a given size rod is therefore both predictable and reproducible.

Borohm resistors have negligible voltage coefficient, consistent temperature coefficient, and stability proven by temperature cycling, moisture resistance, and load life tests.

For detailed information as to sizes, styles, ratings, and performance test data results write for the new Shallcross Engineering Bulletin L-33.

1929—Our 25th year—1954

SHALLCROSS MANUFACTURING COMPANY

Representatives in principal U. S. cities, Toronto, Canada, and Vancouver, B. C.

518 PUSEY AVE.
COLLINGDALE, PENNA.

INDUSTRY NEWS

(*Continued from page* 32)

Walter J. Maytham, Pacific Coast regional manager for the Westinghouse Elec. Corp., was recently elected a vice-president of the firm. Similar distinctions went to **Dale McFeatters,** of Pittsburgh, Pa., director of information services for the corporation and **Otis O. Rae,** of Atlanta, Ga., southeastern regional manager of the apparatus divisions. **E. V. Huggins,** vice-pres. for corporate affairs, has been named secretary of the corporation.

Robert J. Brown has been appointed manager of sales at G.E.'s Heavy Military Electronic Equipment Dept., Syracuse, N.Y. Other appointments were **Peter J. Schenk,** manager of marketing research and product planning; **Paul J. Fritschel,** manager of product service; and **Fred Gangberg,** manager of marketing administration.

H. Jacobs

R. J. Brown

Herbert Jacobs is the new general manager of Jerrold Electronics Corp., Philadelphia, manufacturer of master antenna systems. He will co-ordinate all departments in the Phila. plant and the seven affiliate companies.

Don Larson was recently named to the post of general manager of the West Coast Electronic Manufacturers' Association, a newly-created post established to meet the increasing need for coordination of the activities of the 165 member companies.

Wayne Graham has been named West Coast divisional sales manager for the Reeves Soundcraft Corp., manufacturers of magnetic recording tape and equipment. He will maintain offices at 1429 N. Vista St., Hollywood 46.

Arthur C. Treece has been appointed manager-marketing of GE's Laminated and Insulating Products Dept., Coshocton, Ohio. He has been with GE since 1922.

A. J. Kendrick, formerly of RCA Victor, has been named eastern manager of the commercial music division of Magnecord Inc., with offices in the RCA building, 630 Fifth Ave., New York.

(*Continued on page* 38)

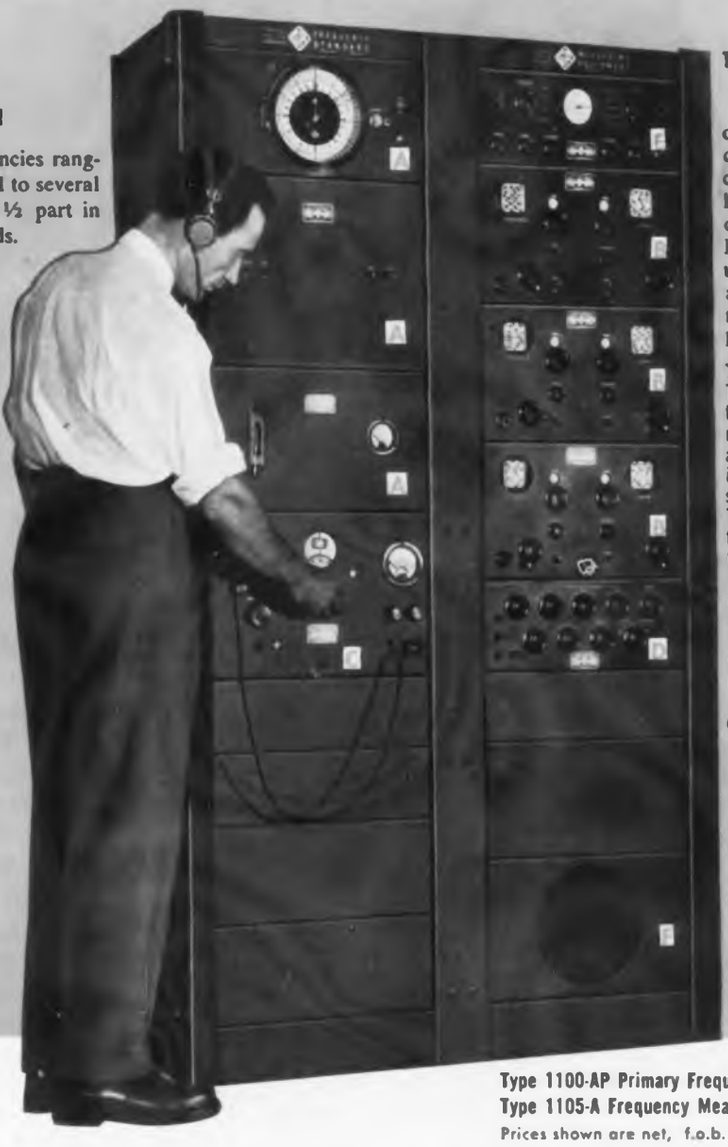
Standard Frequencies

for Measuring 1 part in 100,000,000!

Type 1100-A
Primary Frequency Standard

. . . supplies standard frequencies ranging from one pulse per second to several megacycles . . . accurate to ½ part in 100 million over short periods.

It consists (A) of a 100-kc oscillator, with temperature-controlled quartz bar, multivibrator units for 100 kc, 10 kc, 1 kc and 100 cycles, an a-c operated power supply and a Syncronometer. The Syncronometer's microdial arrangement permits accurate comparison against standard time signals.



Type 1105-A
Frequency Measuring Equipment

directly measures unknown frequencies to 100 megacycles by comparison against one of the hundreds of standard frequencies supplied by the Primary Frequency Standard . . . measurement accuracy is ±0.1 cycles after standardization . . . better than *1 part in 100 million* at higher frequencies.

This equipment consists of:
Three transfer units (B) each containing a heterodyne frequency meter and tuned detector for accurately locating the unknown in terms of one of the 10-kc standard-frequency harmonics. The first three or four significant figures in the unknown are determined in this way.
The Interpolation Oscillator (C) measures the audio-frequency difference between the unknown and a standard 10-kc harmonic, giving the last four figures.
For example, this combined equipment will measure a frequency such as 19,765,839 cycles to ±2 cycles, direct reading, or ±0.1 cycles after standardization.
The Control Panel (D) provides a centralized unit for quickly and conveniently interconnecting all the other elements.
The Comparison Oscilloscope (E) aids in making interpolations, or in checking calibrations with high accuracy.
A speaker (F) mounted on a relay rack is provided for audible monitoring of beat tones.

Type 1100-AP Primary Frequency Standard $2390.00
Type 1105-A Frequency Measuring Equipment $4480.00
Prices shown are net, f.o.b. Cambridge or W. Concord, Mass.

This equipment is the most accurate, commercially-available frequency measuring system obtainable. It supplies usable frequencies of high, known accuracy over an extremely wide range. It incorporates many operating conveniences, and requires little attention or maintenance.

Since 1915 *Manufacturers of Electronic Apparatus for Science and Industry*

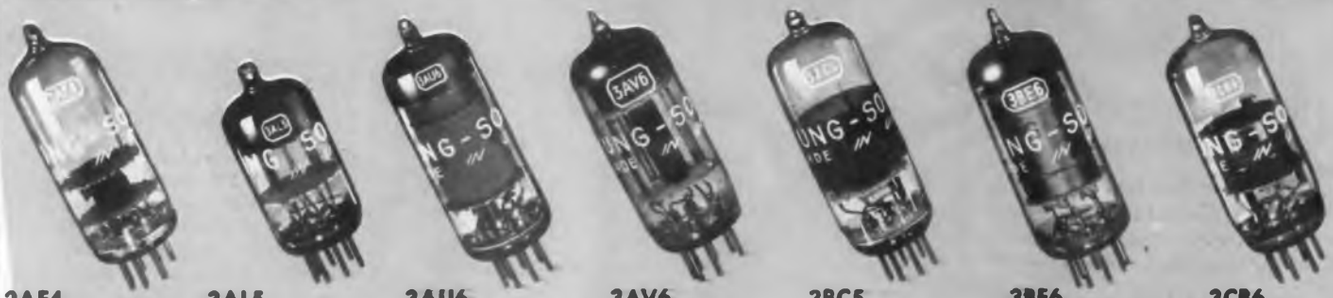
GENERAL RADIO Company

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

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

ADMITTANCE METERS
AMPLIFIERS
COAXIAL ELEMENTS
DISTORTION METERS
FREQUENCY MEASURING APPARATUS
FREQUENCY STANDARDS
IMPEDANCE BRIDGES
LIGHT METERS
MEGOHMMETERS
MODULATION METERS
MOTOR CONTROLS
NULL DETECTORS
OSCILLATORS
PARTS & ACCESSORIES
POLARISCOPES
PRECISION CAPACITORS
PULSE GENERATORS
R-L-C DECADES
R-L-C STANDARDS
SIGNAL GENERATORS
SOUND & VIBRATION METERS
STROBOSCOPES
TV & BROADCAST MONITORS
U-H-F MEASURING EQUIPMENT
UNIT INSTRUMENTS
VARIACS®
V-T VOLTMETERS
WAVE ANALYZERS
WAVE FILTERS

TUNG-SOL TUBES FOR S



2AF4
(Prototype—6AF4)
Heater Volts 2.35
Heater Current 0.6 A

3AL5
(Prototype—6AL5)
Heater Volts 3.15
Heater Curreht 0.6 A

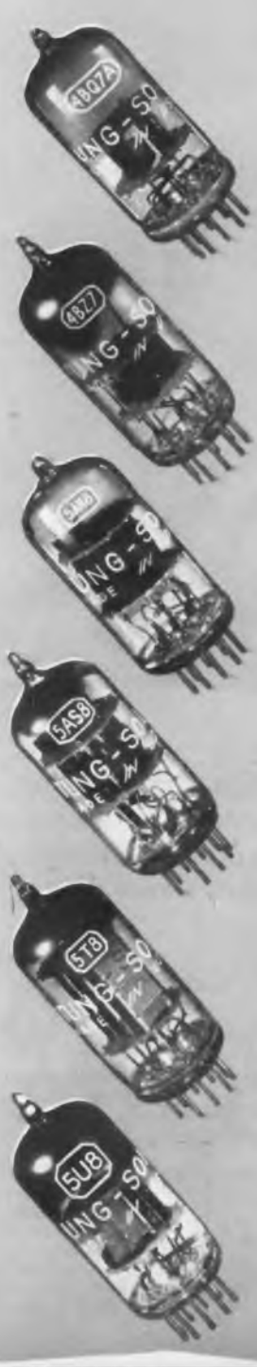
3AU6
(Prototype—6AU6)
Heater Volts 3.15
Heater Current 0.6 A

3AV6
(Prototype—6AV6)
Heater Volts 3.15
Heater Current 0.6 A

3BC5
(Prototype—6BC5)
Heater Volts 3.15
Heater Current 0.6 A

3BE6
(Prototype—6BE6)
Heater Volts 3.15
Heater Current 0.6 A

3CB6
(Prototype—6CB6)
Heater Volts 3.15
Heater Current 0.6 A



4BQ7A
(Prototype—6BQ7A)
Heater Volts 4.2
Heater Current 0.6 A

4BZ7
(Prototype—6BZ7)
Heater Volts 4.2
Heater Current 0.6 A

5AN8
(Prototype—6AN8)
Heater Volts 4.7
Heater Current 0.6 A

5AS8
(Prototype—6AS8)
Heater Volts 4.7
Heater Current 0.6 A

5T8
(Prototype—6T8)
Heater Volts 4.7
Heater Current 0.6 A

5U8
(Prototype—6U8)
Heater Volts 4.7
Heater Current 0.6 A

*Using heaters parallel connected

. . . designed and engineered to highest performance requirements

These are the new Tung-Sol Receiving Tubes for television sets having all of the heaters series-connected across the power line. Thermal characteristics of all the heaters are controlled so that heater voltage surges during the warm-up cycle are minimized, provided of course, that these tubes are used with other types similarly controlled.

Heater ratings are based on 600 milliamperes of current with the heater voltage adjusted for the same power as in the prototype. All other characteristics and ratings are identical to those of the prototype. Use of these tubes provides completely satisfactory receiver characteristics during warm-up.

All of the statistical quality control methods which make the performance of Tung-Sol tubes so outstanding, are utilized in the manufacture of these new types. In performance, uniformity and dependability they will be found fully reliable. For more detailed information, write Commercial Engineering Department, Tung-Sol Electric Inc., Newark 4, New Jersey.

Sales Offices: Atlanta, Chicago, Columbus, Culver City (Los Angeles), Dallas, Denver, Detroit, Newark, Philadelphia, Seattle.

Tung-Sol All-Glass Sealed Beam Lamps, Miniature Lamps, Signal Flashers, Picture Tubes, Radio, TV and Special Purpose Electron Tubes and Semiconductor Products.

SERIES STRING TV SETS

6AU7
(Prototype—12AU7)
Heater Volts 3.15*
Heater Current 0.6 A

12BQ6GT
(Prototype—6BQ6GT)
Heater Volts 12.6
Heater Current 0.6 A

6AX7
(Prototype—12AX7)
Heater Volts 3.15*
Heater Current 0.6 A

12BH7A
(Prototype—12BH7)
Heater Volts 6.3*
Heater Current 0.6 A

6S4A
(Prototype—6S4)
Heater Volts 6.3
Heater Current 0.6 A

12L6GT
(Prototype—25L6GT)
Heater Volts 12.6
Heater Current 0.6 A

6SN7GTB
(Prototype—6SN7GTA)
Heater Volts 6.3
Heater Current 0.6 A

12BY7A
(Prototype—12BY7)
Heater Volts 6.3*
Heater Current 0.6 A

12AX4GTA
(Prototype—12AX4GT)
Heater Volts 12.6
Heater Current 0.6 A

12W6GT
(Prototype—6W6GT)
Heater Volts 12.6
Heater Current 0.6 A

19AU4
(Prototype—6AU4GT)
Heater Volts 18.9
Heater Current 0.6 A

12B4A
(Prototype—12B4)
Heater Volts 6.3*
Heater Current 0.6 A

25CD6GA
(Prototype—25CD6G)
Heater Volts 25
Heater Current 0.6 A

*Using heaters parallel connected

TUNG-SOL RADIO AND TV TUBES, DIAL LAMPS

INDUSTRY NEWS

(*Continued from page* 34)

James H. Carmine, executive v.p. at Philco Corp. for the past five years, has assumed the presidency of the firm. He succeeds **William Balderston,** who was elected chairman of the board following the announcement by **James T. Buckley** that he would decline re-election.

J. H. Carmine

K. Arnett

Keeton Arnett was recently named v.p. for administration at Allen B. DuMont Laboratories, Inc.

Peter J. Jensen has been named manager of manufacturing at Carboloy Dept. of G. E., Detroit, Mich.

James D. Helm, sales manager of special accounts at G.E., Syracuse, N.Y., has also been named sales manager for mobile communications equipment.

John R. Crawford has been named sales manager of the Components Division at Servomechanisms, Inc., Garden City, N.Y.

William R. Sears has been appointed Pacific coast manager of sales promotion and publicity for Sylvania Electric Products Inc. His offices are at 215 Market St., San Francisco. The N.Y. office of Sylvania announces the appointments of **John C. Taylor,** as merchandising supervisor for the Equipment Picture Tube Sales Dept., and **Carroll L. Hasler** as supervisor of sales administration in the Electronic Products Sales Division.

Edward A. King Jr. has succeeded **J. Walton Colvin** as manager of government sales at the Bendix Radio Div. of Bendix Aviation Corp. Mr. Colvin is now marketing manager of the firm.

Lawrence J. Straw is the new general sales manager of the Standard Piezo Co., Carlisle, Pa., crystal manufacturers.

Henry G. Baker will serve as v.p. and general mgr. of the new RCA Victor Television Division. **James M. Toney,** former director of distribution, becomes general mgr., and **Louis J. Collins,** sales mgr., of the newly-created RCA Victor Radio and Victrola Div.

(*Continued on page* 158)

Eimac Klystron Report

Ruggedized X Band local oscillator reflex klystrons

1K015XA · coaxial output
1K015XG · waveguide outpu

Ruggedized Eimac 1K015XA and 1K015XG reflex klystrons

TYPICAL OPERATION
(with flat load)
1K015XA and 1K015XG KLYSTRONS

MODE	7 3/4	5 3/4
D-C Resonator Voltage	250	300
D-C Cathode Current	36	47
D-C Repeller Voltage	−65	−170
Power Output	30	100
Frequency	9000	9000
Electronic Tuning Range	55	40

Reliable X band performance through the **VAST*** punishment of airborne environment plus the features of single adjustment tuning and rapid production are offered only in Eimac 1K015XA and 1K015XG local oscillator reflex klystrons.

- ***VIBRATION**—withstands 10G's of continuous vibration.
- ***ALTITUDE**—arc-guard protection of leads eliminates possibility of flash-over at extremely high altitudes.
- ***SHOCK**—withstands 100G's of impact shock.
- ***TEMPERATURE**—maintains frequency stability through a temperature variation of −20° to 80°C.

RAPID PRODUCTION—simplified design permits rapid, low cost production.

RELIABLE PERFORMANCE—25 to 100 milliwatts power output from 8400 to 9600mc with low power consumption—plus assurance of uncompromising Eimac quality proved through 20 years of electron-power tube design and manufacture.

SINGLE TUNING—one-adjustment tuning without the use of lock nuts.

●*For further information about the 1K015XA, 1K015XG or any of the complete line of Eimac klystrons, including high power UHF-TV amplifiers, contact our Technical Services department.*

EITEL-McCULLOUGH, INC.
SAN BRUNO • CALIFORNIA

Eimac
THE WORLD'S LARGEST MANUFACTURER OF TRANSMITTING TUBES

INDUSTRY NEWS

(*Continued from page* 34)

James H. Carmine, executive v.p. at Philco Corp. for the past five years, has assumed the presidency of the firm. He succeeds **William Balderston,** who was elected chairman of the board following the announcement by **James T. Buckley** that he would decline re-election.

J. H. Carmine

K. Arnett

Keeton Arnett was recently named v.p. for administration at Allen B. DuMont Laboratories, Inc.

Peter J. Jensen has been named manager of manufacturing at Carboloy Dept. of G. E., Detroit, Mich.

James D. Helm, sales manager of special accounts at G.E., Syracuse, N.Y., has also been named sales manager for mobile communications equipment.

John R. Crawford has been named sales manager of the Components Division at Servomechanisms, Inc., Garden City, N.Y.

William R. Sears has been appointed Pacific coast manager of sales promotion and publicity for Sylvania Electric Products Inc. His offices are at 215 Market St., San Francisco. The N.Y. office of Sylvania announces the appointments of **John C. Taylor,** as merchandising supervisor for the Equipment Picture Tube Sales Dept., and **Carroll L. Hasler** as supervisor of sales administration in the Electronic Products Sales Division.

Edward A. King Jr. has succeeded **J. Walton Colvin** as manager of government sales at the Bendix Radio Div. of Bendix Aviation Corp. Mr. Colvin is now marketing manager of the firm.

Lawrence J. Straw is the new general sales manager of the Standard Piezo Co., Carlisle, Pa., crystal manufacturers.

Henry G. Baker will serve as v.p. and general mgr. of the new RCA Victor Television Division. **James M. Toney,** former director of distribution, becomes general mgr., and **Louis J. Collins,** sales mgr., of the newly-created RCA Victor Radio and Victrola Div.

(*Continued on page* 158)

imac Klystron Report

Ruggedized X Band local oscillator reflex klystrons

1K015XA · coaxial output
1K015XG · waveguide outpu

Ruggedized Eimac 1K015XA and 1K015XG reflex klystrons

TYPICAL OPERATION
(with flat load)
1K015XA and 1K015XG KLYSTRONS

MODE	7 3/4	5 3/4
D-C Resonator Voltage	250	300
D-C Cathode Current	36	47
D-C Repeller Voltage	−65	−170
Power Output	30	100
Frequency	9000	9000
Electronic Tuning Range	55	40

Reliable X band performance through the **VAST*** punishment of airborne environment plus the features of single adjustment tuning and rapid production are offered only in Eimac 1K015XA and 1K015XG local oscillator reflex klystrons.

- ***VIBRATION**—withstands 10G's of continuous vibration.
- ***ALTITUDE**—arc-guard protection of leads eliminates possibility of flash-over at extremely high altitudes.
- ***SHOCK**—withstands 100G's of impact shock.
- ***TEMPERATURE**—maintains frequency stability through a temperature variation of −20° to 80°C.

RAPID PRODUCTION—simplified design permits rapid, low cost production.

RELIABLE PERFORMANCE—25 to 100 milliwatts power output from 8400 to 9600mc with low power consumption—plus assurance of uncompromising Eimac quality proved through 20 years of electron-power tube design and manufacture.

SINGLE TUNING—one-adjustment tuning without the use of lock nuts.

● *For further information about the 1K015XA, 1K015XG or any of the complete line of Eimac klystrons, including high power UHF-TV amplifiers, contact our Technical Services department.*

EITEL-McCULLOUGH, INC.
SAN BRUNO • CALIFORNIA

Eimac
THE WORLD'S LARGEST MANUFACTURER OF TRANSMITTING TUBES

superior..

including superb transmission of FCC-approved COLOR sig

HIGH POWER *Plus* **PERFORMANCE**

25 kw low band

50 kw high band

QUIET! Water-cooling of final anodes only assures extremely quiet operation — no noisy "wind-tunnel" roar.

COMPACT! By actual comparison this transmitter requires 60% less space. The aural and visual sections can be separated and subdivided for flexible layout arrangement.

ECONOMICAL! Both aural and visual amplifiers are identical — spare parts are interchangeable.

COMPARE
THESE PRICE TAGS

SERIES 9000 (LOW BAND) 25 KW VHF TELEVISION TRANSMITTER

BY EVERY MEASURE!

- Single 4W20000A tetrode used in both aural and visual amplifiers of 25 KW. Pair employed in aural and visual amplifiers of 50 KW.
- Separate built-in power supplies in both aural and visual amplifiers safeguard against cut-off due to possible failure in either section.
- Exceeds FCC color specifications.
- Low Driving Power! 25 KW Transmitter: only 500 watts.
  50 KW Transmitter: less than 5 KW.
- Compact design permits one-*man tuning*—quickly and easily.
- Simple broadband circuits require minimum tuning with aid of built-in wobbulator and band-pass indicator.
- *No external sideband filter required.* Intermediate level modulation provides simpler attenuation.
- No fuss in tube-changing! Tubes equipped with self-sealing quick-disconnect couplings. Tube-changing time: 30 seconds.
- Trouble-light system indicates and locates breakdowns instantly.

Add up all the features of the Du Mont 25 KW / 50 KW transmitters and compare to other transmitters in this power class. You'll quickly discover that your best buy is Du Mont, from the initial cost view and on an operating cost basis. With a Du Mont installation, more of that high-power money will find its way into *your* pocket.

WRITE... for Bulletin describing in detail the new Du Mont 25 KW (for Channels 2-6) or 50 KW (for Channels 7-13) Television Transmitters.

DU MONT

TELEVISION TRANSMITTER DEPARTMENT
ALLEN B. DU MONT LABORATORIES, INC.
CLIFTON, N. J.

SERIES 12000 (HIGH BAND) 50 KW VHF TELEVISION TRANSMITTER

PRINT IN BINDING

TAPE WOUND CORES

Are you ready for a revolutionary concept in the electrical and electronic industry—the Magnetics, Inc. "Performance-Guarantee" on Tape Wound Cores. Guaranteed to meet your specifications, *and sold at standard prices;* these Cores mean truly economical production of high permeability magnetic devices in your plant.

TABLE A
BASIC PHYSICAL CONSTANTS OF COMMON MAGNETIC MATERIALS

Trade Name	% Ni	% Fe	Other	Grain Structure	Satur. Flux Density Gausses	Resistivity Microhm-Cm	Curie Point °C	Dens. Grams per cc
Hy Mu 80	79	17	4 Mo	"random"	8,700	57	420	8.72
48 Alloy	48	52	....	"random"	16,000	45	500	8.3
Orthonol	50	50	....	oriented	15,500	45	500	8.25
Magnesil	..	97	3 Si	oriented	20,000	48	700	7.65

TABLE B
TRADE NAMES OF SIMILAR MATERIALS

Hy-Mu 80	48 Alloy	Orthonol	Magnesil
4-79 Permalloy	Carpenter 49	Orthonik	Armco Oriented T
Mo-Permalloy	Allegheny 4750	Permeron	Hypersil
Mu Metal*	Hypernik	Deltamax	Orthosil
		Hypernik V	Silectron

Typical of the unusual scope of the material contained in Catalog TWC-100 are Tables A and B, reproduced from Page 4 of "Performance-Guaranteed Tape Wound Cores."

GET THE COMPLETE STORY

A wealth of new and unusual material on Tape Wound Cores is available to you in Catalog TWC-100, "Performance-Guaranteed Tape Wound Cores." Tables A and B of the catalog, reproduced on this page, present a striking illustration of material not to be found compiled together elsewhere.

Data and descriptive details on high permeability materials . . . factory core matching . . . free engineering design services . . . pages of characteristic graphs and tables . . . are yours for the asking. Simply write on your company letterhead.

MAGNETICS inc.

DEPT. TT 7, BUTLER, PENNSYLVANIA

C-A-C

HERM UM IGH SEALED HIELDED TABILITY

HS SERIES TOROIDS
For IMMEDIATE Delivery

TYPE
HS715

DIMENSIONS

Length	2-9/16"
Width	1-5/16"
Height	2-13/16"
Weight	14 oz.
Mounting	2-1/16 x 11/16"
Screws	6/32" studs
Cutout	7/8 x 1/2"

TYPE
HS254

DIMENSIONS

Length	1-29/32"
Width	1"
Height	2-1/4"
Weight	8 oz.
Mounting	1-5/16 x 9/16"
Screws	6/32" studs
Cutout	7/8 x 1/2"

TYPES
HS930 & HS395

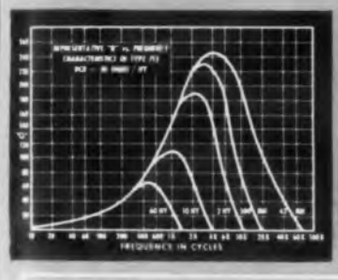
DIMENSIONS

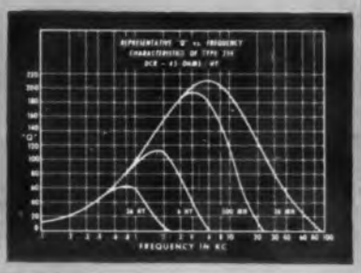
Length	1-9/32"
Width	11/16"
Height	1-23/32"
Weight	4 oz.
Mounting	7/8 x 9/32"
Screws	4/40" studs
Cutout	1/2 x 5/16"

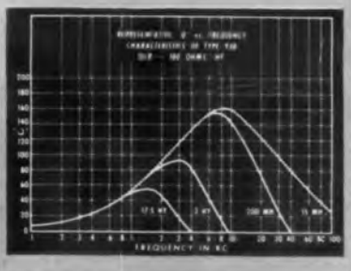
TYPES
HS206, HS848
HS608 & HS073

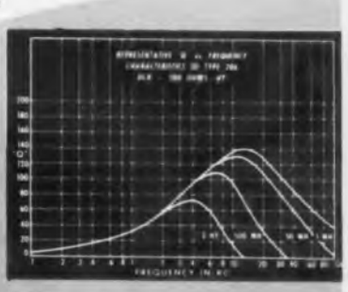
DIMENSIONS

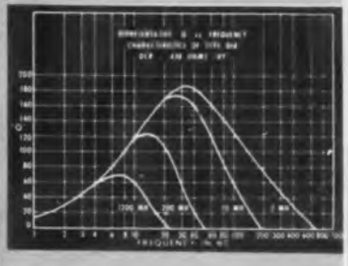
Length	1-1/16"
Width	1/2"
Height	1-1/4"
Weight	1.5 oz.
Mounting	3/4"
Screws	4/40" studs
Cutout	1/2 x 5/16"

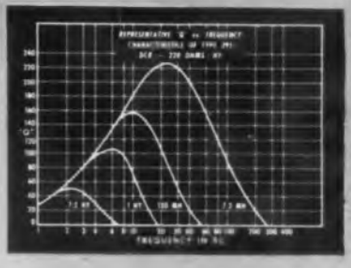


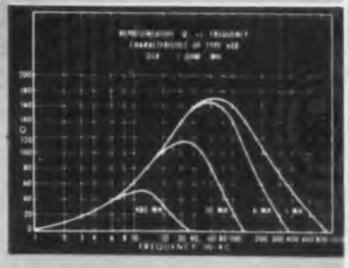


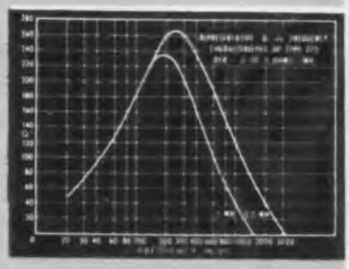












LIST OF STOCKED UNITS

All other values and types on Special Order

Suffix Number	HS 206—	HS 930—	HS 254—	HS 715—
— 1	5.0 MH	5.0 MH	20 MH	24 MH
— 2	6.0 MH	6.0 MH	24 MH	30 MH
— 3	7.2 MH	7.2 MH	30 MH	36 MH
— 4	8.6 MH	8.6 MH	36 MH	43 MH
— 5	10 MH	10 MH	43 MH	50 MH
— 6	12 MH	12 MH	50 MH	60 MH
— 7	15 MH	15 MH	60 MH	72 MH
— 8	17.5 MH	17.5 MH	72 MH	86 MH
— 9	20 MH	20 MH	86 MH	100 MH
—10	24 MH	24 MH	100 MH	120 MH
—11	30 MH	30 MH	120 MH	150 MH
—12	36 MH	36 MH	150 MH	175 MH
—13	43 MH	43 MH	175 MH	200 MH
—14	50 MH	50 MH	200 MH	240 MH
—15	60 MH	60 MH	240 MH	300 MH
—16	72 MH	72 MH	300 MH	360 MH
—17	86 MH	86 MH	360 MH	430 MH
—18	100 MH	100 MH	430 MH	500 MH
—19	120 MH	120 MH	500 MH	600 MH
—20	150 MH	150 MH	600 MH	720 MH
—21	175 MH	175 MH	720 MH	860 MH
—22	200 MH	200 MH	860 MH	1.00 HY
—23	240 MH	240 MH	1.00 HY	1.20 HY
—24	300 MH	300 MH	1.20 HY	1.50 HY
—25	360 MH	360 MH	1.50 HY	1.75 HY
—26	430 MH	430 MH	1.75 HY	2.00 HY
—27	500 MH	500 MH	2.00 HY	2.40 HY
—28	600 MH	600 MH	2.40 HY	3.00 HY
—29	720 MH	720 MH	3.00 HY	3.60 HY
—30	860 MH	860 MH	3.60 HY	4.30 HY
—31	1.00 HY	1.00 HY	4.30 HY	5.00 HY
—32	1.20 HY	1.20 HY	5.00 HY	6.00 HY
—33	1.50 HY	1.50 HY	6.00 HY	7.20 HY
—34	1.75 HY	1.75 HY	7.20 HY	8.60 HY
—35	2.00 HY	2.00 HY	8.60 HY	10.0 HY
—36	2.40 HY	2.40 HY	10.0 HY	12.0 HY
—37	3.00 HY	3.00 HY	12.0 HY	15.0 HY
—38		3.60 HY	15.0 HY	17.5 HY
—39		4.30 HY	17.5 HY	20.0 HY
—40		5.00 HY	20.0 HY	24.0 HY
—41		6.00 HY	24.0 HY	30.0 HY
—42		7.20 HY	30.0 HY	36.0 HY
—43		8.60 HY	36.0 HY	43.0 HY
—44		10.0 HY		50.0 HY
—45		12.0 HY		60.0 HY
—46		15.0 HY		
—47		17.5 HY		

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PHILADELPHIA—Charles R. Hile Co.—Elgin 6-2266
Hillview Rd., Box 144, Paoli, Pa.
BALTIMORE—Charles R. Hile—Boulevard 1202J
(L. G. Korman) 5006 Kenwood, Baltimore 6, Md.
CHICAGO—Gassner & Clark Co.—Rogers Pk. 4-6121
6349 N. Clark, Chicago, Ill.
KANSAS CITY—E. W. McGrade Co.—Delmar 9242
6315 Brookside Plaza, Kansas City, Mo.
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P. O. Box 152, Hamburg, N. Y.
SYRACUSE—Naylor Electric Co.—2-3894
State Tower Bldg., Room 317, Syracuse 2, N. Y
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(Henry Lavin) P. O. Box 196, Meriden, Conn.
NEEDHAM—Henry Lavin Assoc.—3-3446
(Robt. V. Curtin) 82 Curve St., Needham, Mass.
CLEVELAND—Ernie Kohler Assoc.—Olympic 1-1242
8905 Lake Ave., Cleveland 2, Ohio

COMMUNICATION ACCESSORIES COMPANY

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BOOKS

Engineering Analysis

By D. W. Ver Planck and B. R. Teare, Jr. Published 1954 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 344 pages. Price $6.00.

Aptly subtitled "An Introduction to Professional Method," this textbook offers valuable aid in training the engineer to approach technical problems from a sound scientific basis. Using a multitude of examples, from integrating circuits to non-fogging mirrors, the text shows how the engineer should treat new situations. It encompasses the definition of the specific problem, planning the attack, making simplifications, checking results, and learning from the problem experience. Of prime significance is the general technique of translating a physical situation into mathematics, grinding the crank, and then interpreting the result.

Chapter subjects included are application of professional method, understanding principles fundamental to engineering, translation into mathematics, solutions of differential equations checking results, and interpretation of the mathematics. Among the numerous examples are those relating to accelerometers, analogs, cable heating, dynamometers, electrostatic precipitators, fluxmeters, insulation, potentiometers, servos, vibration and many others of interest to electronic engineers. AJF

Color TV Dictionary

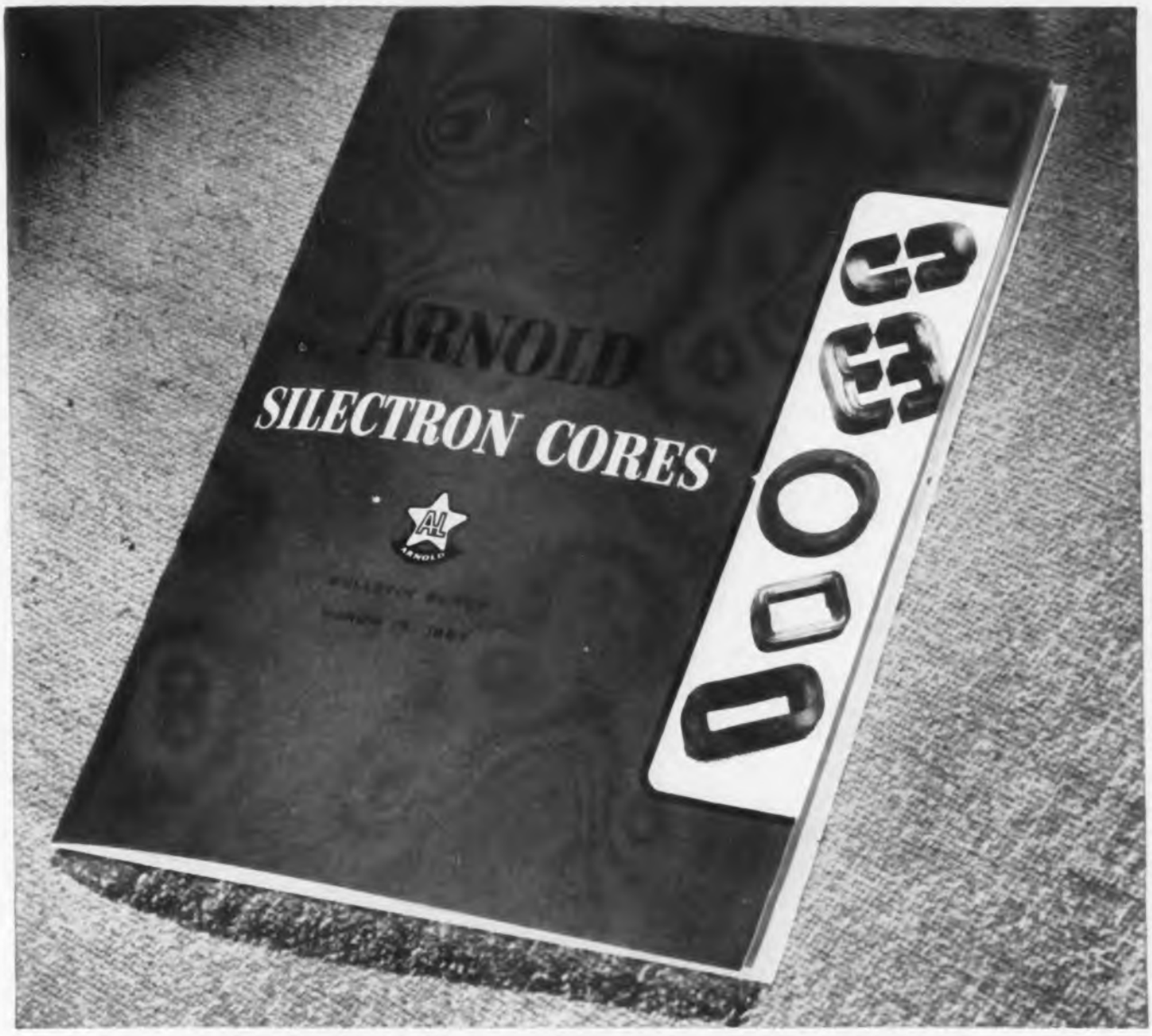
By J. Richard Johnson. Published 1954 by John F. Rider Publisher, Inc., 480 Canal St., New York 13, N.Y. 70 pages. Price $1.25.

The host of new technical terms which were born with the development of the color TV medium are not readily absorbed in the engineer's vocabulary without some omissions in understanding. The importance of achieving full comprehension—or at least having a handy reference where it may be obtained—is underscored by the extensive use of color TV terminology in current electronic literature. Consequently, the publication of this dictionary should be most welcome. It contains some 263 names and terms, and 45 illustrations. Evidently to permit easy usage and to appeal to the widest possible cross-section of readers, the author has made each definition concise, clearly understandable and unencumbered by complex mathematics. The basis of this book are the terms originated by the NTSC. Electronic engineers will no doubt find this compact volume very useful. AJF.

The Dictionary of Business and Industry

Edited by Robert J. Schwartz. Published 1954 by B. C. Forbes & Sons, 80 Fifth Avenue,

(Continued on page 46)



Here's *New Technical Data*

on Silectron cores . . . all shapes and sizes

This new bulletin contains design information on Arnold cores wound from a grain-oriented silicon steel, Silectron. Curves showing the effect of impregnation on core material properties are published for the first time. This 52-page bulletin includes information on cut "C" and "E" cores, and uncut toroids and rectangular shapes. Sizes range from a fraction of an ounce to hundreds of pounds in standard tape thicknesses of 1, 2, 4 and 12 mils.

A new method of tabulating core sizes is introduced whereby cores are listed in the order of their power handling capacity. You'll find this Silectron core bulletin a valuable addition to your engineering files—*write for your copy.*

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W&D 5305

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

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

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

BOOKS

New York. Price $7.95; with thumb index $8.95. 561 pages.

This is an unusual volume which should prove to be of considerable value as a reference source for plants, laboratories and individual libraries. It defines over 45,000 business, trade, industrial and legal terms, most of which have never been included in standard dictionaries or other reference sources. The book was compiled over a five year period and represents the editing of more than 125,000 terms received from over 1100 trade associations in the U.S. In addition to definitions, this dictionary also contains 36 pages of valuable time saving charts and tables on coins and notes of the world; foreign weights and measures; weights of materials; conversion factors; squares and cubes; measurement units etc.

ASTM Standards on Materials for Radio Tubes and Electronic Devices and Electrical Heating, Resistance, and Related Alloys

Prepared by ASTM Committee B-4. Published 1954 by American Society for Testing Materials, 1916 Race St., Philadelphia 3, Penna. 244 pages. Price $2.75.

Of special interest to the engineer who designs, tests or specifies the metal elements employed in electronic devices, the 1954 edition of this compilation includes in their latest form 44 widely used ASTM standards, including 30 test methods; 10 specifications; and 4 recommended practices.

Materials and subject cover: electrical-heating alloys; electrical-resistance alloys; electric-furnace alloys; radio tubes, electronic devices, and lamps; heat-resisting alloys; electrical contact materials; and thermostat metals. This new addition embodies numerous revisions of existing tests and specifications and much new material prepared since the previous edition. There are 11 new standards included.

BOOKS RECEIVED

R-C/R-L Time Constant

By Alexander Shure. Published 1954 by John F. Rider Publisher, Inc., 480 Canal St., New York 13, N.Y. 47 pages. Price $.90. Basic instructional text presents the development of charge curves, discharge curves and time constants.

"SOLDER . . . its fundamentals and usage"

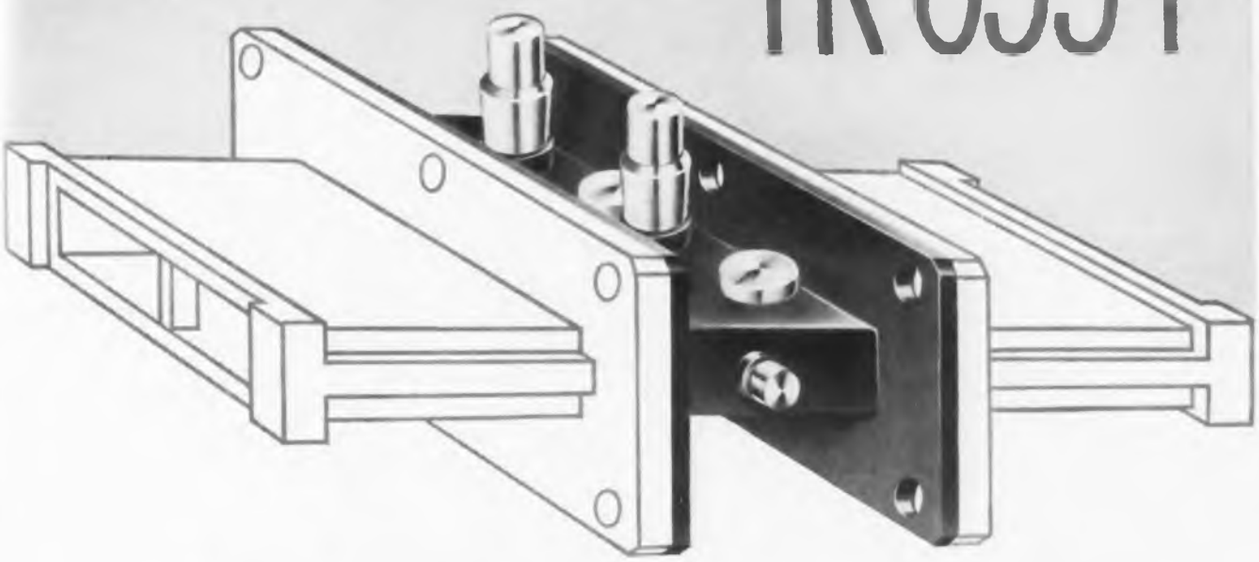
A new 80 page 6 x 9 book written and compiled by Dr. Clifford L. Barber, Research Director of Kester Solder Company, Chicago and Newark. The purpose of this new volume is to rectify the basic literature inadequacies on solder and to provide the solder user with a thoroughly scientific study of the industrial application and usage. Charts, tables and photographs are included. It is offered without charge to interested Tele-Tech readers. Address Kester Solder Company, 4201 Wrightwood Avenue, Chicago 39, Illinois, Dept. TP.

Techniques of Plant Maintenance and Engineering

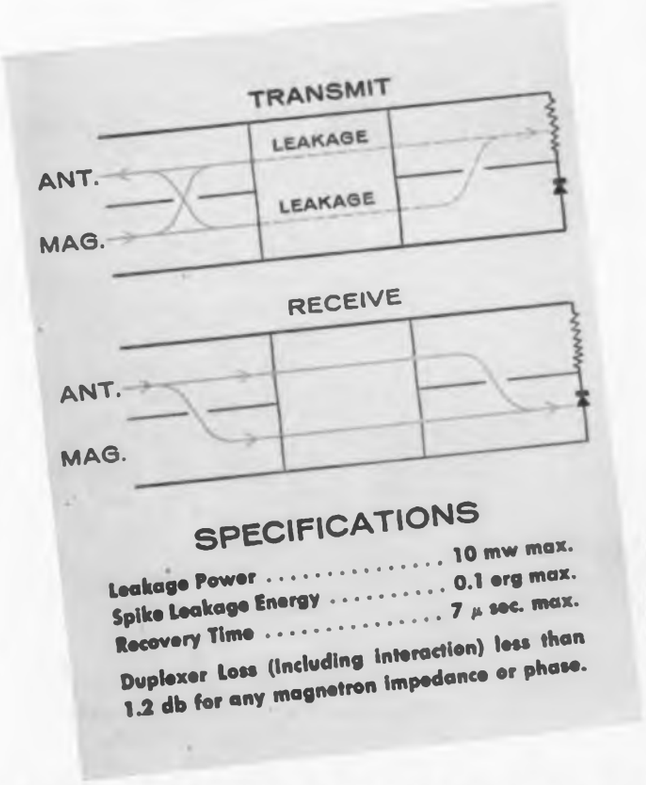
Proceedings of the technical sessions held concurrently with the Fifth National Plant Maintenance and Engineering Show in Chicago, Jan. 1954. Published by Clapp & Poliak, Inc., 341 Madison Ave., New York 17, N.Y. 291 pages. Price $7.50.

SYLVANIA NOW OFFERS

A NEW DUAL TR 6334



For X-Band Balanced Duplexers



SPECIFICATIONS

Leakage Power	10 mw max.
Spike Leakage Energy	0.1 erg max.
Recovery Time	7 μ sec. max.

Duplexer Loss (including interaction) less than 1.2 db for any magnetron impedance or phase.

Here's Sylvania's answer to today's demand for a completely balanced duplexer for use in microwave system design.

Consider these advantages

This new tube is mounted between two readily obtainable short slot hybrid couplers and offers unusually broad band applications (12% band width).

In addition, its simplicity of design permits a reduction in both size and weight, and provides greater crystal protection. For complete information regarding this improved duplexer or other TR and ATR Tubes simply drop a line to Dept. 4E-4409, at Sylvania.

"Another reason why it pays to specify Sylvania."

SYLVANIA

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

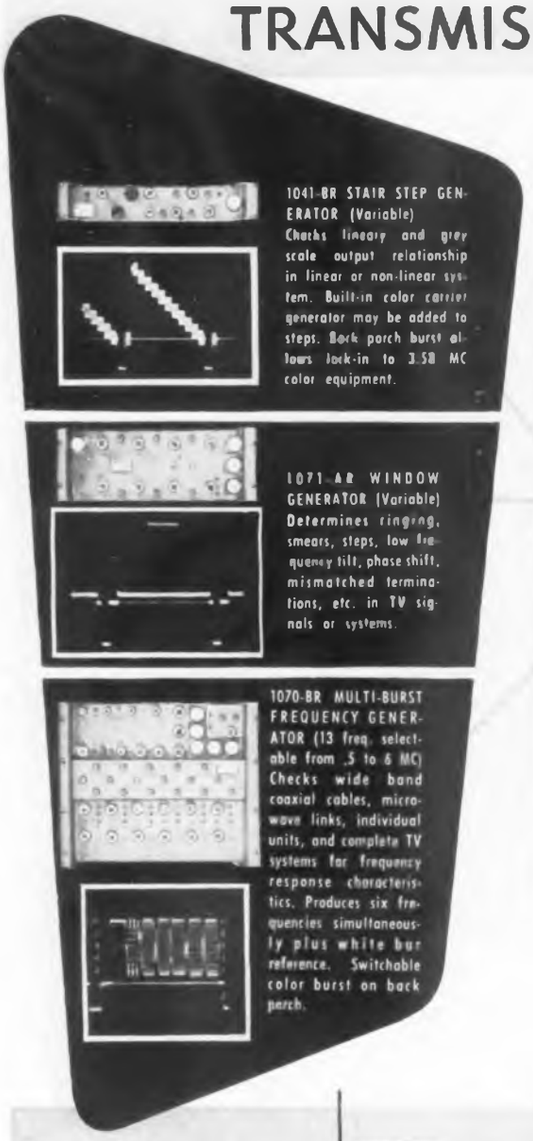
In Canada: Sylvania Electric (Canada) Ltd.
University Tower Building, St. Catherine Street, Montreal, P. Q.

LIGHTING • RADIO • ELECTRONICS • TELEVISION

NEW

TELECHROME INCORPORATED

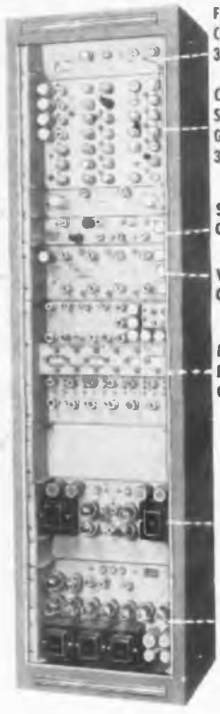
VIDEO
TRANSMISSION TEST EQUIPMENT



1041-BR STAIR STEP GENERATOR (Variable)
Checks linearity and grey scale output relationship in linear or non-linear system. Built-in color carrier generator may be added to steps. Back porch burst allows lock-in to 3.58 MC color equipment.

1071-AR WINDOW GENERATOR (Variable)
Determines ringing, smears, steps, low frequency tilt, phase shift, mismatched terminations, etc. in TV signals or systems.

1070-BR MULTI-BURST FREQUENCY GENERATOR (13 freq. selectable from .5 to 6 MC)
Checks wide band coaxial cables, microwave links, individual units, and complete TV systems for frequency response characteristics. Produces six frequencies simultaneously plus white bar reference. Switchable color burst on back porch.



AUTOMATIC FREQUENCY CONTROL 304AR

COMPOSITE SYNCH GENERATOR 303BR

STAIR-STEP GENERATOR

WINDOW GENERATOR

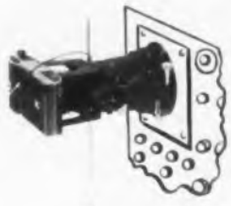
MULTI-BURST FREQUENCY GENERATOR

REGULATED POWER SUPPLY 512AR

REGULATED POWER SUPPLY 613BR

New Telechrome equipment designed to provide test signals for precise checking of video facilities.

This equipment is now in use by major networks, TV stations, and the Bell Telephone System. This type of equipment was recently described by H. Gronberg of NBC before the NARTB Engineering Conference in Chicago. These units are available individually or as an integrated system with 75 ohm or 110 ohm balanced output.



OSCILLOSCOPE CAMERA
MODEL 1521-A (Polaroid Land Type)
for instantaneous 1-to-1 ratio photo-recording of these or other test signals.

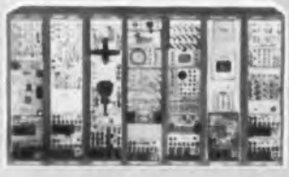
MODEL 608-A HI-LO CROSS FILTER

MODEL 524-D OSCILLOSCOPE

Chromolyzer

Chromascope (Signal Certification)

Phase Slope (Envelope Delay) Curve Tracer



Full facilities
Transmits, receives, monitors, analyzes composite color pictures

Literature on these and more than 100 additional instruments for color TV by TELECHROME are available on request.

TELECHROME INCORPORATED

The Nation's Leading Supplier of Color TV Equipment
88 Merrick Road Amityville, N. Y.
AMityville 4-4446

The pole that need not be climbed

Fastening wires with new tool.

Since telephony began, there has been just one way to install telephone wires on poles: have a trained man climb up and fasten them there. Now Bell Laboratories engineers have developed a special pole line for rural areas. The entire line can be erected without climbing a pole.

The whole job is done from the ground. Light-weight poles are quickly and easily erected. Newly created tools enable men to fasten wires to crossarms 10 to 25 feet over their heads.

This inexpensive line promises more service in sparsely populated places. From original design to testing, it exemplifies a Bell Telephone Laboratories team operation in widening telephone service and keeping costs down.

Key to the new "climbless" pole is this insulator. Ground crews use long-handled tools to place the wire in position and then lock it fast.

Bell Telephone Laboratories

IMPROVING TELEPHONE SERVICE FOR AMERICA PROVIDES CAREERS FOR CREATIVE MEN IN SCIENTIFIC AND TECHNICAL FIELDS

TELE-TIPS

WIVES of our electronic engineering readers have their own special brand of appreciation of electronic artistry. Several of these keen eyed ladies in the interior decoration field spotted the interesting pattern made by circuit symbols on the cover of the June Electronic Industries Directory issue of TELE-TECH, and hastened to apply for rights to reproduce the design on fabrics and wall coverings.

CIRCUIT DIAGRAMS on clothing have a unique appeal. For example, Magnecord has a tie displaying the cascode stage in the M80 tape recorder amplifier. Originally, broadcast station engineers got them free for expressing opinions of the M80. Engineers who have no M80, or no opinion, can get the tie the hard way—by sending $1.75 to the company.

HORSERACE HUSTLERS have taken a fancy to radio. Police recently cracked a ring which enabled a bettor to place a few dollars on a nag's nose *after* he'd won the race. This beat-the-bookie scheme employed a man at the track with a miniature transmitter to notify a cohort outside who the winner was. All this before the track's official announcement. The information was phoned to another transmitter operator who tapped out the winning number. This was picked up by a man in the betting parlor wearing a shock receiver against his skin. Dididididah—and he could feel that No. 4 won, before the bookie knew the race was over.

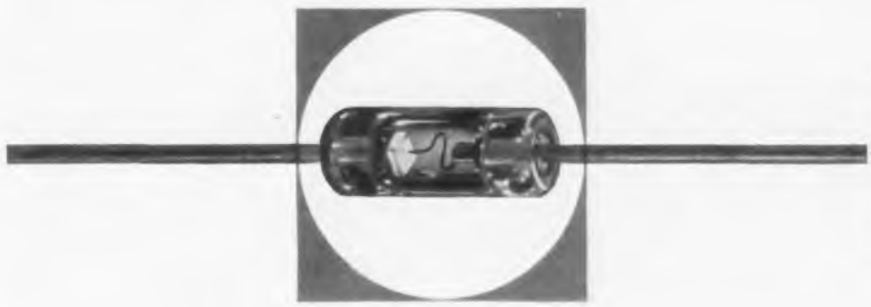
REMINISCENT of eight years ago, when TV was in swaddling clothes, are the new signs of the times being proudly displayed in front of bars: Come In And Watch Color Television.

WHERE'S THE HP? 92% of the nation's six billion horsepower are under the hoods of our cars and trucks, reports *Steelways*. Per capita hp of prime mover engines has risen from 0.5 in 1899 to 39 in 1954.

UHF is so named, according to one wag, because it is the Unhappy Frequency.

(*Continued on page* 54)

Hughes *Fusion-Sealed* Germanium Diodes



ACTUAL DIMENSIONS
DIODE BODY
0.205 by 0.130 inches (maximum)

SHUNT CAPACITANCE:
0.5 μμf (maximum)

AMBIENT OPERATING
TEMPERATURE RANGE:
−78° C to +90° C

Hughes Point-Contact Germanium Diodes are fusion-sealed in a one-piece, gas-tight glass envelope . . . impervious to moisture, fumes or other external contaminating agents. The flexible dumet leads are especially suitable for spot-welding; or they can be iron- or dip-soldered as close as ¼ inch to the diode body—without special precautions.

The germanium crystal is permanently bonded to one lead, the cat whisker is welded to the other, and the point of the cat whisker is welded to the crystal. Hughes diodes are highly resistant to shock and vibration. *Positive* mechanical stability is achieved without risking contamination from fluxes, waxes or impregnants. And—*each diode is thoroughly tested* to ensure the stability of its electrical and physical characteristics. All this means: sturdy, highly reliable diodes.

TYPES—The Hughes line of diodes comprises standard RETMA, JAN, and many special types. Special types are produced according to customer specifications and are tested at high or low temperatures . . . for specific recovery time . . . for matching in pairs or quads.

ELECTRICAL SPECIFICATIONS AT 25° C *unless otherwise indicated*

DESCRIPTION	RETMA or Hughes Type	Clip-in Hughes Type	Peak Inverse Voltage† (volts)	Absolute Maximum Inverse Working Voltage (volts)	Minimum Forward Current @ + 1V (mA)	Maximum Inverse Current @ − 50V (mA)	Maximum Inverse Current Other (mA)	Other Characteristics
HIGH PEAK	1N55B	HD 2052	190	150	5.0		0.500 @ 150V	
	1N68A	HD 2053	130	100	3.0		0.625 @ 100V	
1 MEG TYPES	1N67A	HD 2054	100	80	4.0	0.050	0.005 @ 5V	
	1N99	HD 2055	100	80	10.0	0.050	0.005 @ 5V	
	1N100	HD 2056	100	80	20.0	0.050	0.005 @ 5V	
500K TYPES	1N89	HD 2057	100	80	3.5	0.100	0.008 @ 5V	
	1N97	HD 2058	100	80	10.0	0.100	0.008 @ 5V	
	1N98	HD 2059	100	80	20.0	0.100	0.008 @ 5V	
	1N116	HD 2060	75	60	5.0	0.100		
	1N117	HD 2061	75	60	10.0	0.100		
	1N118	HD 2062	75	60	20.0	0.100		
GENERAL PURPOSE	1N90	HD 2063	75	60	5.0	0.500		
	1N95	HD 2064	75	60	10.0	0.500		
	1N96	HD 2065	75	60	20.0	0.500		
JAN TYPES	1N126*		75	60	5.0	0.850	0.050 @ 10V	Non-JAN equivalent, HD2070; clip-in, HD2066
	1N127**		125	100	3.0	0.300	0.025 @ 10V	Non-JAN equivalent, HD2071; clip-in, HD2067
	1N128***		50	40	3.0		0.010 @ 10V	Non-JAN equivalent, HD2072; clip-in, HD2068
	1N198		100	80	5.0	0.250	0.075 @ 10V	
					These values tested 100% at 75°C			
COMPUTER TYPES	1N191	HD 2077		§	5.0	400K Ω min. between −10 and −50V @ 55°C§		Back resistance recovers to 50K Ω and 400K Ω (200K Ω for 1N192) in 0.5 μsec and 3.5 μsec max., respectively.‡
	1N192	HD 2078		§	5.0	200K Ω min. between −10 and −50V @ 55°C§		
	HD2013				50 @ 1V & 1 @ 0.35V		0.120 @ −3V	0.2 μsec recovery time.°
	HD2014				50 @ 1V & 1 @ 0.35V		0.60 @ −6V	0.2 μsec recovery time.°
UHF	HD2016A				UHF MIXER DIODE			
MISCELLANEOUS	HD2051		125	100	4.0	0.050		1N63 equivalent.

†*That voltage at which dynamic resistance is zero when back voltage rises linearly at 90 v/μsec.*

‡*Back Recovery Time is measured with a forward pulse of 30 mA, followed by a reverse pulse of 35 volts. Loop resistance of test circuit 2500 Ω max.*

°*Recovery time is that point at which the diode voltage reaches −1V after the initiation of a 6V back pulse through 20K Ω from an initial 3 mA forward bias. Total shunt capacitance is 20 μμf.*

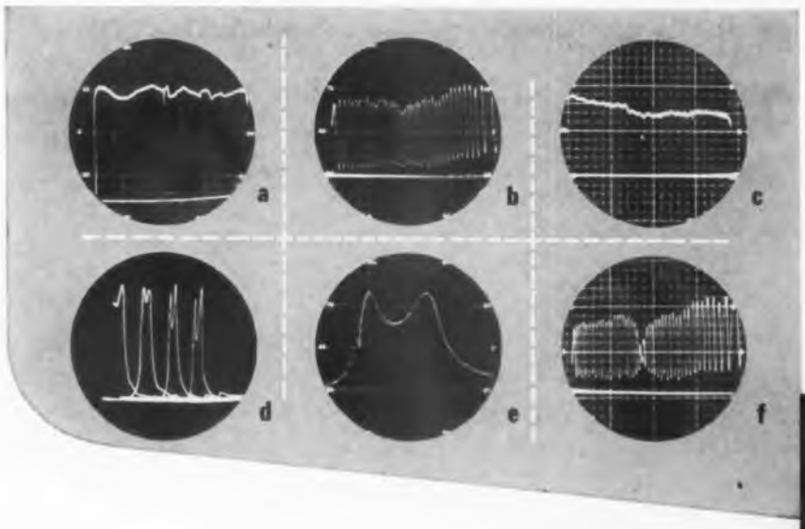
§*Tested at 55°C. Test voltage is a continuous 60 cps sine wave. Peak Reverse Voltage across the diode is 70V. Peak Forward Voltage not less than +2V or Peak Forward Current not less than 20 mA, whichever occurs first.*

**Formerly 1N69A.* ***Formerly 1N70A.* ****Formerly 1N81A.*

Descriptive Bulletin SP2A is available on request.

Hughes SEMICONDUCTOR SALES DEPARTMENT

Aircraft Company, Culver City, Calif. *New York Chicago*



470 to 890 MC. CHARACTERISTICS TAKEN WITH 2144-02 GENERATOR

a) Detected output of sweep generator, showing marker at 650 mcs.

b) VSWR display of unterminated transmission line.

c) VSWR display of terminated transmission line.

d) Preselector responses of UHF tuner at channels 14, 20, 30 and 40.

e) Preselector response of tuner at channel 50, expanded on scope.

f) Input VSWR display of tuner at channel 50.

now sweep over 400 mc. at UHF without tuning

New Kollsman TYPE 2144 Wide Range Sweep Generator

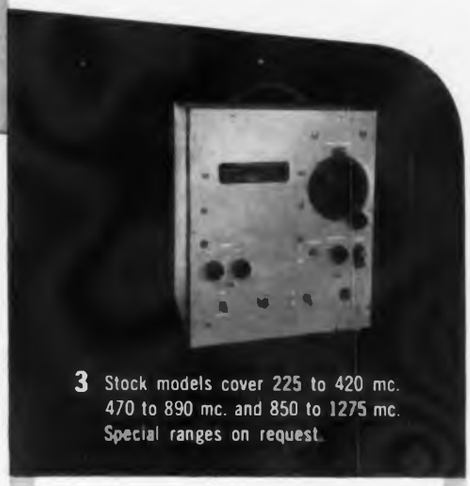
SPECIFICATIONS

Frequency Range	2144-01	225 to 420 mc.
	2144-02	470 to 890 mc.
	2144-03	850 to 1275 mc.
Minimum Power Output		10 milliwatts
Output Impedance		50 ohms
Maximum Source VSWR		1.25
Amplitude Linearity		± 1 db.
Marker Frequency Calibration		5 mc.
Marker Frequency Accuracy	2144-01	± 1 mc.
	2144-02	± 1.5 mc.
	2144-03	± 2 mc.
Sweep Rate		60 cycle
Tube Complement		6AF4, 6J6, OA2, 6X4
Primary Power		117 volts, 60 cycles, 60 watts

Also Available–Step Attenuator TYPE 2171-01

SPECIFICATIONS

Insertion Loss	Less than ½ db.
Attenuation Steps	0, 3, 6, 9, 12, 15, 20, 30, 40, 50, 60, 70, db.
Frequency Range	DC to 1000 mc.
Maximum VSWR	1.2
Other Attenuation Steps Available	



3 Stock models cover 225 to 420 mc. 470 to 890 mc. and 850 to 1275 mc. Special ranges on request.

THE TYPE 2144 SWEEP GENERATOR SIMPLIFIES LABORATORY AND PRODUCTION MEASUREMENTS

- Instantaneous display of frequency response, impedance or VSWR over 400 mc. ,without test equipment adjustment.
- Simultaneous observation of desired and spurious receiver responses.
- Display antenna characteristics over entire operating band.

WITH THESE DESIRABLE FEATURES

- 50 ohm output.
- Low source VSWR and amplitude non linearity.
- Passive variable marker for stable, accurate frequency indication, with easily read dial.
- Oscilloscope horizontal sweep signal and base line retrace blanking.
- 60 cycle sweep rate for easy observation.
- Voltage regulation minimizes effect of line voltage variation.
- Uses only standard plug in tubes.

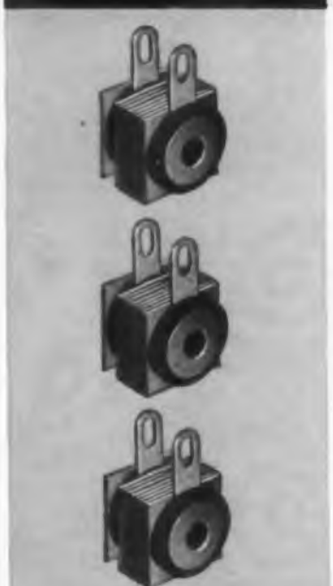
Write FOR COMPLETE INFORMATION ON KOLLSMAN TYPE 2144 SWEEP GENERATORS AND TYPE 2171 ATTENUATORS.

kollsman INSTRUMENT CORP.

80-12 45th AVE., ELMHURST, NEW YORK • GLENDALE, CALIFORNIA • SUBSIDIARY OF *Standard* COIL PRODUCTS CO. INC.

RR Seletron

SELENIUM RECTIFIERS
help keep livestock "Home on the Range"



Type 8Y1 (Illustrated) for half wave applications; 130 volts RMS and 30 MA DC.

The electric fence chargers manufactured by Northern Signal Co., Saukville, Wis., are subjected to extremes of stifling heat or icy cold, yet they must still deliver a measured shock of strong intensity—.0004 seconds on, one second off . . . And frequently when installed in barns they are exposed to ammoniacal fumes.

An important reason why the chargers are proving so effective under such rigorous conditions is that in each control unit is a "*Really Reliable*" RRco. selenium rectifier, Type 8Y1, whose size happens to be only a ½" cubed!

All Radio Receptor rectifiers, ranging from the smallest ones such as 8Y1, all the way up to the large power stacks required by heavy industry, have an inherent ruggedness that makes them ideal for duty under just such adverse conditions as this.

If you'd like data on some specific problem in rectification, drop us a line without obligation. And make sure to request our new 24 page rectifier bulletin No. 177-T2.

We also manufacture Germanium Diodes and Transistors.

Semi-Conductor Division

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Really RR Reliable

TELE-TIPS

(Continued from page 50)

MOSQUITOS are lured to their death in electrified cages by loudspeakers which reproduce certain recorded mosquito buzzing sounds, amplified 500,000 times. Every mosquito seems to have a FM mechanism tuned to a fixed frequency, so different groups evidently not attuned to each other do not understand one another's calls. The female mosquito does all the talking with its hairless antennae. The males with heavily haired antennae just listen. The two types of calls are the love call and lust call, the latter indicating the location of blood by the female. (Males are satisfied with fruit juice.) Thus to clear an area for public health control, love and lust calls are played to lure both males and females.

INFLUENCE OF TV on the 1952 presidential election is discussed in a recent report on a survey conducted by Miami Univ. under a grant by the Crosley Broadcasting Corp. It shows that the campaign was decided more on the basis of personalities than issues. Copies are available from Dr. J. Seibert, Miami Univ., Oxford, Ohio.

PENMANSHIP training program at Minneapolis-Honeywell has resulted in an increase of 20% in the speed of number recognition, 9% improvement in accuracy, and 6% gain in legibility.

PAINLESS DENTISTRY may be in the offing thanks to the ultrasonic tooth drill developed by the Naval Medical Research Institute. Discomforting vibration, heat and noise are reportedly eliminated. A similar drill developed by Cavitron Equipment Corp. and Columbia Univ. operates at 29 kc. The metal tip vibrates 0.001 in., striking a water suspension of aluminum oxide particles which do the actual cutting. Credit for this development belongs to a number of scientists, and to the dogs and cats who have volunteered to have cavities ground in good teeth for the sake of science.

SERIES STRING tubes for TV receiving increased attention. Eliminating transformer cuts set weight by more than 3 lbs.

Perfect Balance!

SMOOTHER, EASIER TV CAMERA CONTROL

NEW

HOUSTON-FEARLESS

CRADLE HEADS

Perfect balance makes the big difference in the terrific new Houston-Fearless Cradle Heads! No matter how the camera is tilted, it is always in absolute balance... resulting in wonderful new ease of operation and remarkable new smoothness never before achieved.

This perfect balance is made possible by the cradle action of the head. When the camera is tilted up or down, the cradle rotates around a constant center of gravity, maintaining positive balance at all times. Added weight, such as long lenses and camera accessories, is easily compensated for by simply moving the camera and the top plate of the head forward or back by means of a lead screw. This adjustment does not require loosening the camera hold-down screws.

The Cradle Head rides on four phenolic-covered ball bearing rollers for smooth, quiet, easy tilting. Panning is also smooth and easy, accomplished by two precision ball bearings in the base. Drag adjustments and brakes are provided on both pan and tilt.

FOR MONOCHROME AND COLOR TV CAMERAS

The new Houston-Fearless Cradle Heads are available in two types: Model MCH for standard black and white cameras. Model CH-1 for the RCA Color TV camera.

Like all Houston-Fearless products, these new Cradle Heads are soundly engineered and precision built of the finest materials to give a maximum of dependable service. Send the coupon below for complete information today.

The HOUSTON FEARLESS Corporation

THE HOUSTON-FEARLESS CORP.
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Send information on ☐ Cradle Heads ☐ Friction Heads ☐ Remote Control Heads ☐ Tripods ☐ Dollies ☐ Camera Cranes ☐ TV Pedestals ☐ Film Processors

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YOU CAN CHOOSE FROM 5 DIFFERENT STYLES OF TANTALEX* CAPACITORS

Looking for tantalum electrolytic capacitors? You'll save time and trouble by checking Sprague's complete selection *first*. Sprague makes more types of tantalum capacitors than *any other manufacturer*.

Sprague Tantalex capacitors provide maximum capacitance in minimum space . . . exhibit no shelf aging under long testing periods . . . have extremely low leakage current. And most important, they give unusually *stable* performance, because they're made with tantalum, the most stable of all anodic film-forming materials.

There's a complete range of sizes and ratings available in Tantalex capacitors . . . from the ultra-miniature 10 mf, 4 volt unit in a case only ⅛" in diameter by 5/16" long . . . to the 7 mf, 630 volt unit in a case 1⅛" in diameter by 2 19/32" long. As for case styles, Sprague makes them all, from tiny tubular and cup units to the large cylindrical types.

For complete details relating to your miniaturization or high temperature problems, write Sprague Electric Co., 235 Marshall St., North Adams, Mass.

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

NEW! TYPE 101D for low-cost transistor circuitry

Especially useful for filter, coupling, and bypass applications in transistor electronics, these foil type miniature Tantalex capacitors were intended for use in hearing aids, pocket radios, and similar uses. Operating temperature range is —20 to +65°C. Request Engineering Bulletin 353.

NEW! TYPE 102D for −55°C to +85°C operation for military use

Here are tubular capacitors hermetically sealed in cases of silver plated copper. Intended for applications from 3 to 150 vdc, their small capacitance drop-off at extremely low temperatures, extremely low leakage current, and low power factor are of particular interest. Request Engineering Bulletin 351.

NEW! TYPE 103D ultra-miniature capacitors for transistor circuitry

Only ⅛" in diameter, and from ⅜" to ½" in length, these are the smallest electrolytics made. Providing relatively large values of capacitance in the very minimum of space in bypass, coupling, and filter applications, they are ideally suited for transistor hearing aids and military amplifiers in which small size is all-important.
Request Engineering Bulletin 352.

NEW! TYPE 104D miniature "cup" capacitor for military use

These low-voltage units consist of a sintered porous tantalum anode housed in a miniature silver thimble, which serves as both cathode and container for the electrolyte. Volume is less than 1/10 cubic inch; operating temperature range —55 to +85°C, and up to 100°C with a voltage derating of 15%. Request Engineering Bulletin 354.

TYPE 100D for −55 to +125°C operation for military use

These hermetically sealed capacitors are available in voltage ratings up to 630 volts at 85°C or 560 volts at 125°C. They are of the sintered porous tantalum anode type, with internal construction to withstand high g shock, severe vibration, and thermal cycling. Request Engineering Bulletin 350A.

WORLD'S LARGEST CAPACITOR MANUFACTURER

SPRAGUE

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TELE-TECH
& Electronic Industries

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STOP WASTING ENGINEERS!

In this age when technological superiority is the keystone of national survival, disturbing evidence of poor utilization of engineering manpower for defense has come to our attention. It is particularly unsettling when we consider that our slim margin of engineers and scientists in the labor force, about 743,000 compared to the Soviet's 550,000, is being whittled away by an aggressive educational training program. Last year 43,000 engineers graduated in the U.S.S.R., but only 24,000 in the U.S., despite the fact that our overall college enrollment is more than double that of the Russians. And let's not kid ourselves that their quality is significantly lower.

Basically we're fumbling the ball on engineering manpower in three ways. First, Selective Service policies are diverting engineers. Second, military policies are discouraging civilian scientists. Third, utilization of engineers in the armed forces is reported to be inadequate.

SELECTIVE SERVICE: Studies by the Engineering Manpower Commission and Scientific Manpower Commission point up the fact that engineers and scientists comprise a scant 1% of the labor force, but make up 3% of the armed forces and are filling 8% of draft quota requirements. Also during the past 15 months some 4000 advanced technical students have been denied deferments after starting their studies. In the words of Howard Meyerhoff, executive director of SMC, "Selective Service policy could not do a more effective job of slowing down our technological progress if the policy were devised in the Kremlin."

While we don't believe that engineers or any other group should be the nation's sacred children, Selective Service should give greater consideration to the vital role engineers play as civilians working on military projects. And so far as equality of sacrifice is concerned, granting an engineering student a deferment to complete his studies does not exempt him from service. His sacrifice may be all the greater because the postponement may make his obligation more difficut when the deferment expires.

CIVILIAN ENGINEERS: It is no secret that a significant number of civilian engineers employed by the government have been dissatisfied with many of the frustrations and irritations of military restrictions. Very recently the House Subcommittee on Military Operations came out with a report criticizing the Department of Defense for inept handling of civilian scientists. In testifying before this committee, Dr. James Killian, Jr., president of Mass. Institute of Technology, described the deterioration in the relationship between the government and scientists. He also noted the "undue regard to what sometimes seems to be a preoccupation with security procedures and policies at the expense of scientific progress."

To correct this serious situation, the government must make such modifications of the security system as will convince engineers that their rights are being adequately safeguarded and their work unimpeded, within the bounds of national safety. Also many secondary irritations, including needless military inspections, rigid insistence on set hours for a working day, inadequate salaries, and denial of officer club privileges, could surely be eased by intelligent planning.

MILITARY ENGINEERS: Scattered reports reach us that the not-too-funny military joke, "I'm a communications engineer, so they sent me to Cooks & Bakers School," is still applicable. How applicable is still a question since the degree of utilization of the engineering talents possessed by members of the armed forces has never been fully studied and publicly reported. But there is sufficient evidence to warrant a quiet investigation of military classification and assignment procedures and accomplishments with regard to engineers and other skilled men in short supply.

In essence we're wasting engineers at a time when technological superiority is the touchstone of survival. Let's get on the ball by:

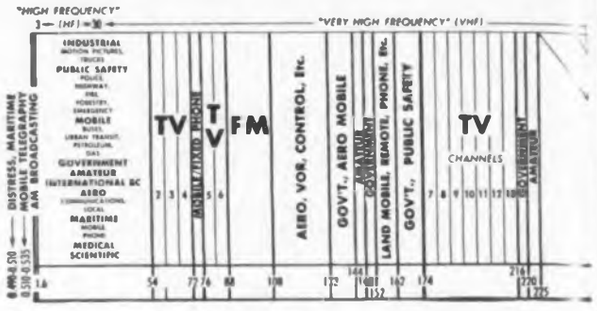
1. Setting Selective Service policies, in conformance with existing law, to allow more engineers to complete their education, or to put their skill to good use on defense projects.

2. Modifying government policies concerning civilian engineer employees to make these men feel enthusiastic instead of frustrated.

3. Making sure that engineers in the armed forces are making use of their skills wherever possible.

RADARSCOPE

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



NEWEST THING in prospect is magnetic "printing," which may well revolutionize the offset, duplication and telemeter-printing fields. System consists of very wide strip of magnetic tape with white coating which passes multiplicity of recording heads. Magnetized tape is placed in solution which deposits black iron powder on white areas having recorded signals.

COLOR TV is slowly gaining some stability. Favorable indication was recent Motorola promise to produce 25,000 color sets by year's end, using CBS' 205 picture tube. Other picture tube makers are ironing out prototype bugs in shadow mask and deflection grid types in anticipation of stepped up production this fall. Speculation is rife on possible impact of hush-hush Philco tube, reported to use phosphor secondary emission indexing system which eliminates any mask but requires more complex timing circuits.

HOMES OF TOMORROW will feature closed circuit TV, quick cooking electronic ovens, electrical heat pumps for heating and cooling, multi-colored wall lighting panels and large flat picture-on-the-wall TV screens, forecasts GE executive Vice-President Roy W. Johnson. (See *Radarscope* disclosure, "TV without CRT," in April 1952 TELE-TECH & ELECTRONIC INDUSTRIES, page 34.)

WATCH FOR one of the largest TV receiver manufacturers to enter the closed circuit TV field.

FIELD SEQUENTIAL COLOR TV isn't completely dead, at least so far as closed circuit applications are concerned. Neither is color TV projection. In hospitals, for example, color of internal organs is important in using video medium for instructing future surgeons. Simplicity of standard black-and-white projection and camera tubes combined with whirling color discs favor field sequential system for certain limited uses.

MAGNETIC RECORDING is still something vague or non-existent to a strikingly large portion of the general public despite considerable promotion by tape and recorder manufacturers. With education will come a greatly expanded market.

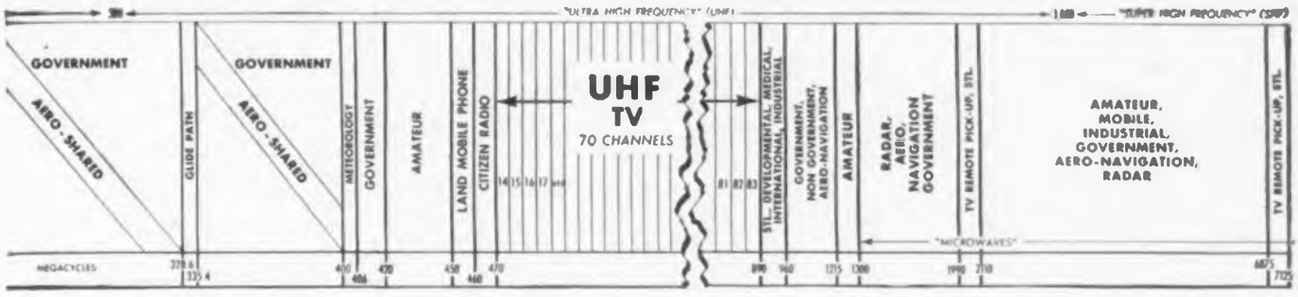
FUTURISTIC WRIST WATCHES displayed at a jewelers convention included a timepiece which receives radio signals broadcast from a central station to keep it accurately synchronized. Another watch detects radioactivity as well as tells time.

"NAILED TO THE FLOOR" TV set price leaders which produce little profit for the manufacturer or dealer are being placed on the market to meet cut-throat price competition. Companies hope consumers will go for deluxe models which have greater margin of profit. Trouble so far is public liking for cheaper sets. Sales rise expected this fall should lift number of set makers out of the doldrums.

ELECTROSTATIC SPEAKERS, also loosely referred to as capacitive and dielectric speakers, are the latest trend in mass produced high-fidelity systems. These units are most useful in tweeter applications. Simple construction promises low costs. Patent coverage is not clear cut, so litigation between big firms using units in their phonographs is a strong possibility.

AUTOMATIC PRODUCTION

Close-up of one station in automatic production system developed by United Shoe Machinery Corp., Boston, Mass. Printed wiring boards with pre-punched holes are conveyed from pallets at left to inserting head. Components on tape belt are fed from reel at upper right. Head automatically cuts and forms component leads and inserts them in holes. Board then moves to next station. See p. 88 for details



INTERSTELLAR SPACE

PROBING THE OUTER REACHES of Space with radio telescopes is becoming an increasingly important activity of modern day astronomers. Distant stars are "seen" by the radio noise they emit. Even astral dust, which hides remote galaxies from the most powerful optical telescopes, can be penetrated by the radio telescope. Within three years, a radio telescope with a dish 250 ft. in diameter will be constructed in Australia under a $250,000 grant by the Carnegie Corp. Together with a similar unit nearing completion in England, radio sources throughout the heavens may be explored and plotted. Going a step beyond examination of space, the International Astronautical Federation recently met in Austria to discuss space platforms and other plans for getting along between here and the moon. One expert on the extraterrestrial optimistically suggested that TV companies might be interested in supporting such a venture since it would be necessary to go into space to establish a universal communications service. He noted that a satellite vehicle revolving at a height of some 345 miles with an inclination of 45° to the equator could telecast over 90% of the earth's surface.

NATIONAL ECONOMY

GROSS NATIONAL PRODUCT is expected to total $358 billion for 1954. Despite the fact that this amount of services and goods produced reflects a decline of $7 billion from the peak year 1953, lower taxes and increased consumer income indicate that 1954 will be a fairly good business year. For the first five months of this year, personal income was at an annual rate of $285 billion, which is $600 million higher than the corresponding 1953 period. Gross national product predicted for 1964 is $500 billion.

AIRCRAFT

FUTURE GROWTH of the aviation industry appears to be closely related to advances made in aircraft electronic systems. Around 1941 there were about 200 low-frequency radio range navigational aids on domestic civil airways, no instrument landing systems available for scheduled operation, and some 23,000 civil and military aircraft flown, reports Stanford Research Institute's *Research for Industry*. Today with 375 omnidirectional ranges and 141 ILS at U. S. airports, over 127,000 aircraft are flown annually in the U. S. This progress has required considerable investments in electronic gear. Before World War II the electronic investment per civil aircraft was about $4000. Today DC-6 radio costs about $30,000. Prewar fighters carried $3000 of electronic equipment. Today the figure is closer to $300,000 for military fighters, and $750,000 on jet bombers. Prospects are for an accelerated growth of airborne electronics due to higher operating speeds, all-weather flying, and new aircraft types.

THE YEARS AHEAD

ELECTRONIC THINGS TO COME are often the subject of sensational prognostications by semi-technical science fiction enthusiasts and others not much better qualified to envision the technological future. But it is a rare not-to-be-missed event when one of the most brilliant and respected electronic scientists sets down his thoughts on how electronic devices will serve us a quarter-century hence. It is all the more impressive when we realize that 25 years ago when the electronic art was in its early infancy this man foresaw with remarkable clarity of vision the manner in which we would utilize electronics today. So it is with great pride that we herald the forthcoming October issue of TELE-TECH & ELECTRONIC INDUSTRIES containing "The Years Ahead," writen by a pioneer inventor, a founder of the IRE, Dr. Alfred N. Goldsmith. Don't miss it!

TRANSISTORS

Marking a milestone in the growth of transistor production, Charles F. Adams, Jr., left, president of Raytheon Mfg. Co., presents to Mass. Governor Christian A. Herter the millionth transistor produced by the Waltham firm. Raytheon reports that field performance of 1,000,000 units in actual service are showing failures of less than 2% per year, with over 1,000,000,000 operating hours to date

Wide-Band UHF Sweep Frequency

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A central signal source for separate test operations is provided by a generator which sweeps a complete band. Adjustments are made at the individual oscilloscopes

A SWEEP frequency generator which covers the entire frequency band of interest each cycle is for many applications a more useful tool than one with a limited sweep width and separately variable center frequency. In fact, it can be used to replace the latter since the horizontal gain and position controls of the oscilloscope used to view the output allow control of the frequency range of the display from the full band down to a small percentage of the band being swept. The wide-band sweep generator is simpler to use, being merely "on" or "off" and allowing all variation to be performed at the oscilloscope, which is normally convenient to the operator. It is somewhat simpler to construct, especially for the UHF band, since it requires no tuning capacitor, a difficult mechanical problem at these frequencies. It is more versatile, allowing, for example, use of one generator by a number of operators, yet leaving each one separate control of the scope display band; and it is more useful in any case where it is an advantage to view a large percentage of the band at once.

The design techniques for a UHF-TV sweep generator described here are also useful for equipment in the 200 to 2000 MC. The generator presents a continuous display on an oscilloscope screen of 460 to 920 MC, with an output of better than 1 volt into 50 ohms varying less than 1 db over the band (Fig. 6). Using the same design technique, oscillators were also designed and built with sweep ranges of 220 to 440 MC and 750 to 1400 MC.

Oscillator Circuit

The oscillator used is of the modified Colpitts type with a 6AF4 triode, shown in Fig. 7. It has been shown[1] that a circuit of this type allows a triode to oscillate above its "self resonant frequency," defined as the oscillation frequency with the plate and grid short circuited at the tube pins. Fig. 8 shows an approximate equivalent tank circuit which takes into account the internal plate to grid capacity and the internal plate and grid lead inductance. It is assumed here that $C_{pg} = 2.3$ μμf and $L_p + L_g = .020$ μh, and that this circuit alone predicts the resonant frequency of the oscillator. From this circuit and the assumptions on C_{pg} and $L_p + L_g$, the external reactance required can be determined as a function of frequency. This is plotted

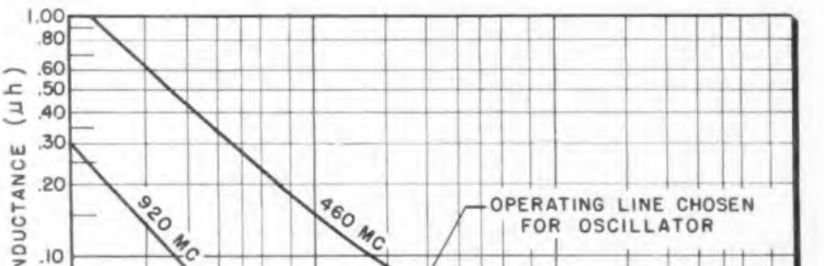
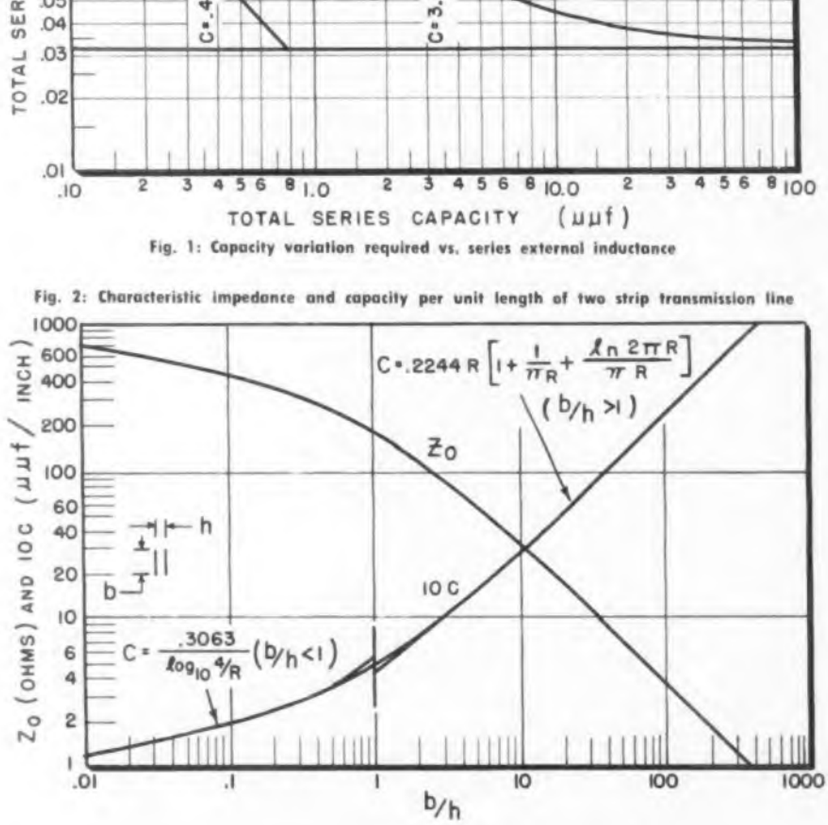


Fig. 1: Capacity variation required vs. series external inductance

Fig. 2: Characteristic impedance and capacity per unit length of two strip transmission line



Generator

n Fig. 9, which shows the self resoant frequency of the 6AF4 to be bout 740 MC.

The external tank circuit consists f a series combination of fixed inductance and variable capacitance. o obtain the input impedance variation required (Fig. 9), the percentge change in capacity needed is an nverse function of the magnitude of he series inductance and a direct unction of the value of minimum apacity. This is demonstrated in Fig. 5, which shows the values of naximum and minimum capacity required as a function of L. The ratio C_{max}/C_{min} approaches four as L becomes large (and C_{min} becomes small).

The above considerations provide some initial restriction on the operating point to be chosen. Naturally, it is desirable to require a small change in capacity. It is also important, however, both that the minimum capacity required not be too small and that the inductance not be too large. Capacities below about ½μμf are difficult to achieve and reproduce controllably due to unavoidable strays and tolerance requirements. Inductances much above ¼ μh become more lossy, are more difficult to reproduce exactly, and require a type of construction which makes reducing the capacity between the two inductances in the tank circuit more difficult. Fig. 5 shows that the limiting factor here, however, is the restriction on C_{min} to ½ μμf, (or the total series capacity to ¼μμf), which occurs at L equal to about 0.12 μh.

It is desirable to use a simple two plate capacitor for a mechanical sweep generator, allowing the motion of one plate to change the capacity by effecting a change of plate spacing. For reasons of balance and elimination of moving contacts, two capacitors in series are used, as shown in Fig. 2. The stators, consisting of two coplanar flat plates, are tied to the plate and grid inductances respectively, and a single plate moves against both stators. This arrangement is shown in Fig. 3. The total external series inductance required will be between 0.03 and 0.12 μh, from Fig. 1 and the above restriction on C_{min}. This places $0.015<L/2<0.060$ μh, orders of magnitude obtainable with short, thin

(*Continued on page* 106)

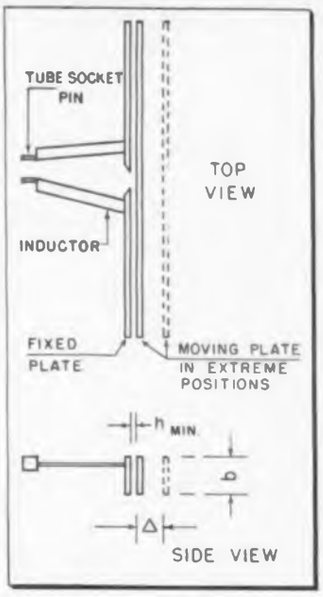


Fig. 3: Oscillator tank circuit assembly

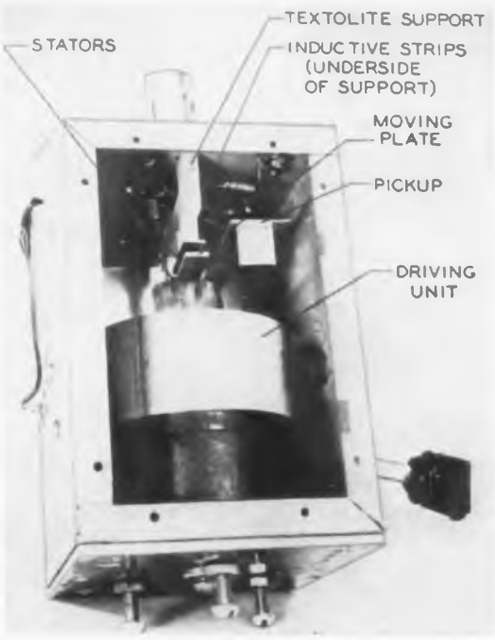
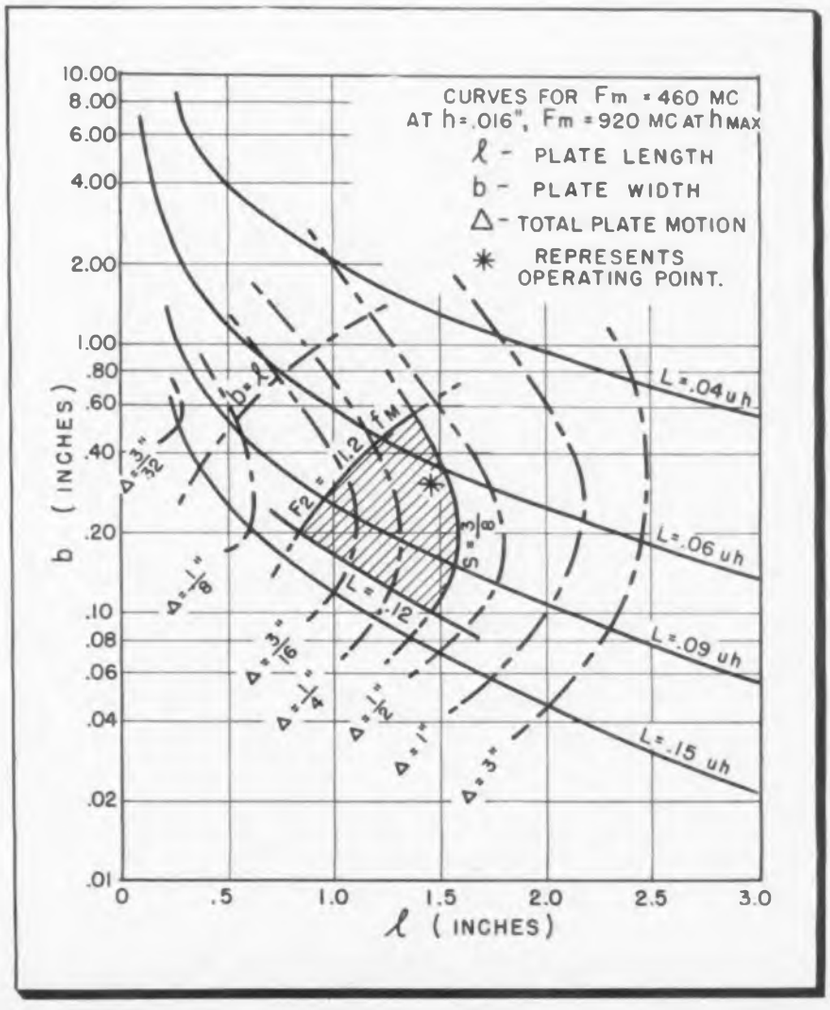


Fig. 4: (r) Oscillator with side plate removed. The stators and inductors are supported by textolite

Fig. 5: Curves of constant series inductance and constant platemotion vs. plate length and width



New Resistor Voltage Coefficient

The variation of resistance with applied voltage is accurately predicted by measuring the harmonics generated due to the resistor's non-linearity

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THE voltage coefficient for a resistor is a measure of the resistance change due to the application of voltage. In the accepted measurement of voltage coefficients, the resistance at $\frac{1}{10}$ of rated voltage and at rated voltage are determined on a bridge. The per-unit change in resistance per change in voltage (at which the measurements are made) results in a voltage coefficient. The appropriate equation is

Voltage coefficient $C_v =$

$$\frac{R_1 - R_2}{R_2} \times \frac{1}{E_1 - E_2} \times 100\,\%$$

where R_1 is the resistance measured at rated voltage (E_1) and R_2 is the resistance measured at 0.1 rated voltage (E_2). In applying rated voltage it is important that heating effects do not enter the picture. Therefore a standard test procedure requires that the rated voltage never be applied for more than 1 sec in approximately 15 sec intervals. In general, voltage coefficient measurements are awkward to make.

Fortunately, voltage coefficient has not been a serious limitation to the application of various resistors in conventional circuits. With the growing importance of pulse techniques in electronic circuits, however, it is likely that the voltage coefficient will be more seriously considered. In all circumstances, it is a measure of a deviation from the ideal resistor.

It is of interest to note that for certain standards a 0.02%/volt voltage coefficient is tolerable for a 1-watt resistor. For a 10,000 ohm 1-watt resistor, the rated voltage is 100 v. and the change in resistance from small voltages to the rated voltage should be less than 2% or 200 ohms. Resistors of lesser wattage ratings are allowed as much as 0.035%/volt for a voltage coefficient.

A technique will be described wherein voltage coefficient can be determined while rated voltage is applied to a resistor. The voltage is ac and because of the non-ohmic nature of the resistor under test, harmonics of the applied voltage are generated. By properly interpreting the measured harmonic content, a voltage coefficient can be established for the resistor at rated dissipation. At the same time, a nonlinearity coefficient (β) can be evaluated for the volt-ampere characteristic of the resistor.

Since the coefficient is determined at rated power conditions, the test parallels actual application. Measurements can be made rapidly and with greater ease; they are stable and reproducible.

The non-ohmic nature of a resistor can be described by assuming it to have a volt-ampere characteristic, at a single internal temperature, of the form

$$i = \alpha v \pm \beta v^3 + \gamma v^5 \ldots,$$

where i is the current flowing as a result of the instantaneous applied voltage and α is the nominal conductance of the resistor in mhos. Since the resistor is passive, the characteristic must pass through the origin and have zero-point symmetry unless partial rectification occurs within the unit.

Therefore, the power series need not contain any even terms under this assumption of a bilateral and passive unit.

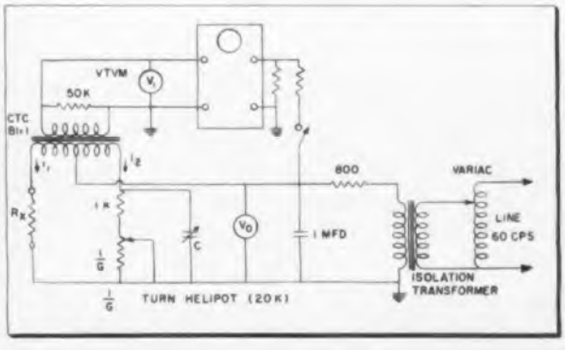
Bilateral Resistors

All of the many resistors tested were, to the limit of resolution, bilateral and passive. The coefficients β, γ, etc., described the nonlinearity; they are positive for resistors having negative voltage coefficients. It has been observed that within the power ratings of any resistor, the β coefficient is predominant for applied voltages with low crest factors. If a voltage

$v = V_0 \sin \theta$, where $\theta = \omega t = 2\pi f t$

is applied to the resistor under test,

Fig. 1: (1) Commercial version of Voltage Coefficient Test Set. Fig. 2: (r) Schematic of basic voltage coefficient apparatus



Tester

the current flowing will be (neglecting harmonics higher than the third),

$$i_1 = (\alpha\ V_o + \beta\ V_o^3\ 3/4)\ \sin\theta - \beta\ V_o^3 \sin 3\theta/4,$$

and it contains a third harmonic component. The comparison resistor, as shown in Fig. 2, will carry a current

$$i_2 = g\ V_o \sin\theta$$

Since the center tapped transformer passes on to the secondary a voltage of the form

$$V_1 = k\ (i_2 - i_1),$$

where k is a transformer constant, g can be adjusted so that

$$g = \alpha + 3\beta\ V_o^2/4 = \alpha$$

This is equivalent to canceling out the fundamental and being left with only the nonlinearity which can be measured as

$$V_1 = k\beta V_o^3\ \sin\ 3\theta/4.$$

The term sin 3θ merely indicates the form of the balance voltage. By measuring β the first order nonlinearity is evaluated and it will be shown to be the most significant one present. Referring to the earlier definition of conventional voltage coefficient, the equation

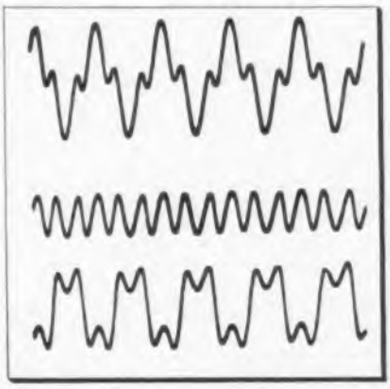


Fig. 3: Two typical third harmonic voltages

Fig. 4: Rear view of voltage coefficient tester

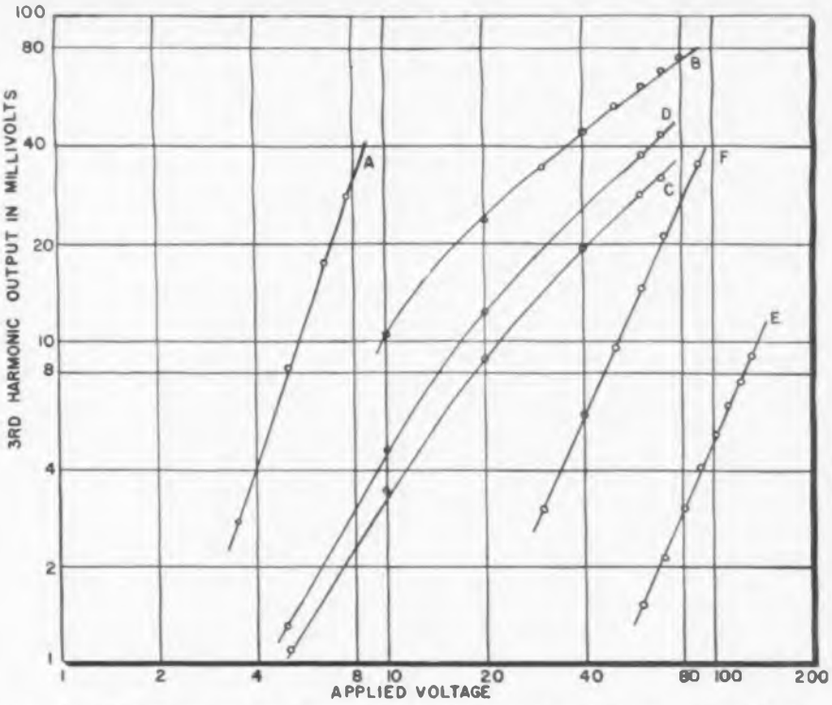


Fig. 5: Third harmonic content measured for A—Thyrite resistor; B—Resistor F ½-2-12; C—Resistor F ½-1-10; D—"C" packed in dry ice; E—Resistor A ½-1-10; F—Resistor B ½-1-10

$$C_v = \frac{R_1 - R_2}{R_2} \times \frac{100}{E_1 - E_2}\ \%$$

can be written as,

$$C_v = \frac{1/\alpha - 1/(\alpha + \beta V_o^2)}{1/\alpha} \times \frac{100}{V_o}\ \%$$

which can be simplified to

$$C_v = \beta\ V_o/\alpha.$$

This voltage V_o is the peak value of the applied voltage and the above equation will give the voltage coefficient in this dynamic technique.

The constant for the transformer was found by measuring the output voltage (V_1) for a 1 ma. unbalanced ac current and it is given by

$$i_2 - i_1 = 0.8 \times 10^{-3}\ V_1.$$

This equation holds for peak or RMS values and if V_1 is in mv, as practically found, the form is

$$i_2 - i_1 = 0.8 \times 10^{-6}\ V_1.$$

Solving for the β coefficient the equation is

$$\beta = 4(0.8)\ 10^{-6}\ V_1/V_o^3$$

where all voltages are peak values or

$$\beta = 1.6 \times 10^{-6}\ V_1/V_o^3$$

for RMS values of voltage.
The voltage coefficient is then,

$$C_v = 3.2 \times 10^{-6}\ V_1/\alpha V_o^2$$

(peak values of voltage are used) and since $(1/\alpha)$ is the reciprocal of nominal resistance the expression can be simplified to

$$C_v = 2.3 \times 10^{-6}\ V_1/V_o^2/R,$$

(RMS volts used)

or if the measurement is made at rated power P_R then

$$C_v = 2.3 \times 10^{-6}\ V_1/P_R$$
$$= 2.3 \times 10^{-4}\ V_1/P_R\ \%,$$

where V_1 is in millivolts (RMS) and P_R is in rated watts.
For example, a ½-watt, 12 K resistor tested with 77.5 v applied resulted in a mean V_1 value of 11.1 mv. The value of C_v is

$$C_v = 4.6 \times 10^{-4} \times 11.1 = 0.005\%;$$

the value of β is

$$\beta = 1.6 \times 10^{-6}\ (11.1)/(77.5)^3$$
$$= 0.382 \times 10^{-10};$$

and the general volt-ampere characteristic is

$$i = 83 \times 10^{-6}\ V + 0.000038 \times 10^{-6}\ V^3$$

Error Correction

It is apparent that the nonlinearity is not great, and an extremely sensitive apparatus is required for its detection. A small error in the determination of β exists due to the neglect of higher order nonlinearities. The third harmonic measured does contain some distortion which will increase as the amplitude of the applied voltage increases. In order to investigate the magnitude of this error, a wave analysis of the harmonic output was made. The results

Coefficient Tester (Continued)

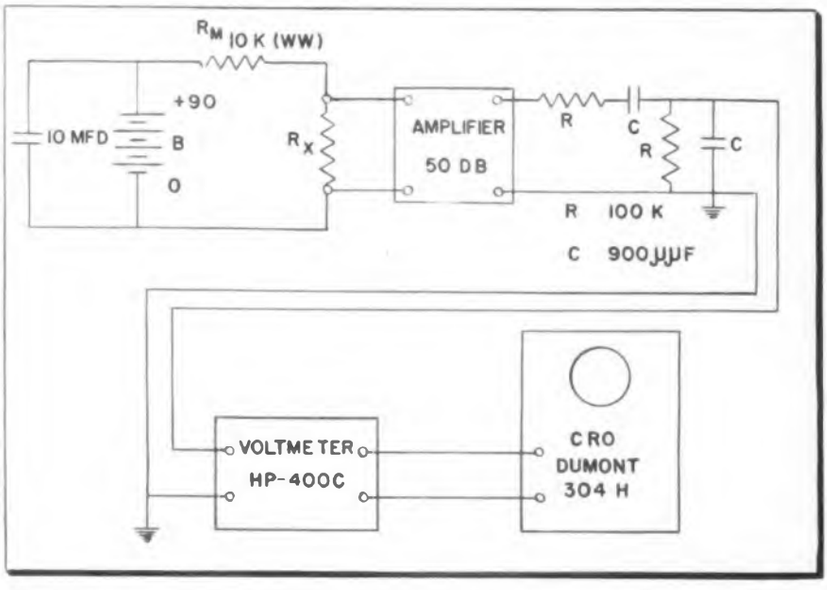


Fig. 6. Noise measurements. Noise voltage generated by resistor is first amplified and filtered

are tabulated below:

Resistor Frequency (CPS)	F1-1-12 Harmonic	100 v. applied % of RMS value
180	3rd	97
300	5th	27
420	7th	10
540	9th	5.6
660	11th	3.1
780	13th	2.1

Resistor Frequency (CPS)	B-½-1-10 Harmonic	70 v. applied % of RMS value
180	3rd	100
300	5th	8
420	7th	2.1

The resistor having the greater non-linearity was responsible for a larger number of harmonics, whereas a moderate voltage coefficient resistor produced essentially a pure third harmonic. The VTVM, although it is an averaging type of meter, gave readings that were within 2% of the 3rd harmonic RMS value. An advantage to using a wave analyser as a voltmeter lies in the fact that the fundamental balancing is not critical. The third harmonic is selected from the large fundamental that may appear in the output.

Scope Interpretation

The harmonics can be observed directly by using a linear internal sweep synchronized to the line frequency as shown in Fig. 3. A Lissajous figure can also be observed by using the line frequency on the horizontal deflection plates. The resulting Lissajous figure as shown in Fig. 7 is a rotated "S" shaped curve typical of a fundamental and third harmonic starting in phase. The Lissajous figure can be made to have no area, indicating that there are no miscellaneous phase shifts. It is interesting at this point to consider the possibility of these generated harmonics being caused by periodic temperature variations. If a resistor has sufficiently small mass and a high temperature coefficient, its resistance may follow the instantaneous power variations, which are double frequency in nature. The current flowing in this resistor would contain a distinct third harmonic. Such temperature effects have not been observed in the resistors studied to date. Since there is no area to the Lissajous figure, the fundamental and third harmonics are in phase. This is an unlikely condition if the thermal inertia of the resistor is significant. No appreciable change in measured third harmonic was observed for a frequency variation from 50 to 500 CPS using the described apparatus with a high voltage coefficient resistor. In addition, temperature coefficients were measured for all resistors under test. For many, the temperature coefficient changes sign and there is no observed relation between temperature coefficients and harmonics generated.

The temperature coefficients were obtained by measuring the room temperature (23° C.) resistance and then placing the resistor in a hot box maintained at 80° C. As the resistor came up to temperature its resistance was "tracked" in order to detect any change in the sign of the coefficient. The final resistance (80° C.), when compared with the cold resistance, gave a qualitative indication of the mean temperature coefficient of resistivity.

A wire wound resistor having a coefficient of 190 parts per million per ° C. indicated no third harmonic at rated power even though the temperature coefficient is comparable to that of certain composition resistors. It appears that the harmonics generated are due only to voltage coefficient effects.

The sign of the voltage coefficient can be determined by examining the third harmonic wave form as balance is approached (Fig. 3). By increasing the comparison resistor, or, decreasing the linear current, a depression is observed in the peaks of the fundamental, which by referring to the derived equations are indicative of a $+\beta$ (negative C_v), or the fundamental and 3rd harmonic start in phase. As the current i_2 is further decreased the output signal goes through an all harmonic state and then proceeding to the other side of balance, the third harmonic "peaks" the fundamental waveform. This is equivalent to the two starting 180° out of phase. For all composition resistors tested it was observed that the β factor is positive or the voltage coefficient is negative.

Apparatus

The apparatus is sketched in Fig. 2. The current flowing into the resistor under test is compared to that of a wire wound variable resistor by subtracting the currents in a transformer. When the fundamental components cancel the harmonics generated by the test resistor are measured by a voltmeter and observed on a cathode ray oscilloscope. The transformer is a well balanced, well shielded, high quality grid input transformer (150 ohms to 50,000 ohms). Power for driving the resistor under test is obtained from the ac line (60 CPS), controlled by a variable transformer and filtered of miscellaneous line disturbances.

Third and higher odd harmonics included in the power line supply will not disturb the apparatus since these harmonics are applied symmetrical to the resistor under test

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Designing An Electro-Thermal Relay

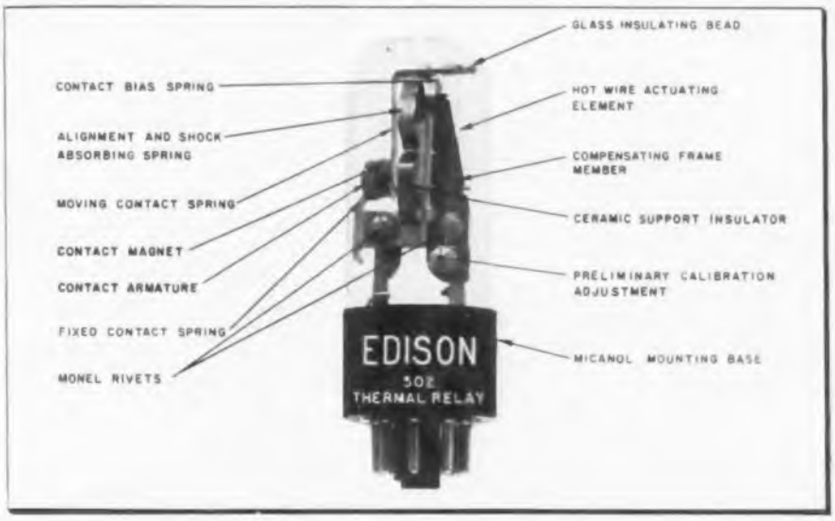

Fig. 1: Hermatically sealed thermal relay employing direct expansion element of hot wire type

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A review of the considerations followed in developing a thermal relay capable of time delays adjustable from a fraction of a second to several minutes

A thermal relay has been defined as one which operates on the heating effect produced by the flow of an electric current rather than by magnetic action or induction. This definition makes certain differences between thermal and magnetic relays immediately apparent. In the first place, magnetic materials as such need not be employed in the construction of a thermal relay. Secondly, contact operation in the thermal relay is brought about by a rise in temperature rather than by a change in magnetic induction. Where high conductivity wire is employed in the exciting coil of the magnetic relay in order to produce maximum ampere turns for a given input power and winding cross section area, a high resistivity alloy is usually used for the heating coil of the thermal relay.

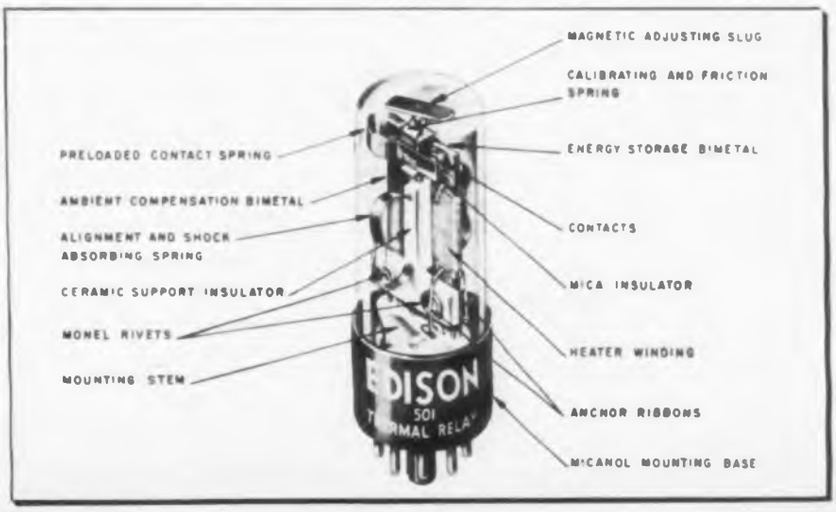
The time constant of electro-magnetic relay structures seldom exceeds one second. On the other hand, thermal time constants in the order of minutes are readily obtainable with relatively small elements and it is this inherent delay characteristic of the thermal relay which has led to its extensive use in the many and varied applications where time delay relays are required. Relays which employ the thermal principle are not restricted to delay applications however and those with negligibly small operate times often compete favorably with electromagnetic types.

Thermal Expansion

While many different schemes have been employed in thermal relay construction, our scope here must be limited to the simple but important class of relays in which the expansion or deflection of an actuating element is directly made to do the work of moving the contacts and to produce contact operation at some time during the heating cycle.

A relay employing a direct expansion element of the hot wire type is shown in Fig. 1. Here the change in length resulting from the temperature rise of the expanding wire is mechanically amplified and made to operate the contacts. The small thermal mass of the wire makes rapid operation possible and relays of this type may be set to operate anywhere from a few tenths of a second to three seconds. Materials selected for the expanding element must have a high temperature coefficient of expansion, high electrical resistivity and high creep strength at the maximum operating temperature of the wire. Where ambient compensation must be provided linearity of the expansion coefficient over the ex-

Fig. 2: Thermal relay in which motion of a bimetal strip directly produces contact operation



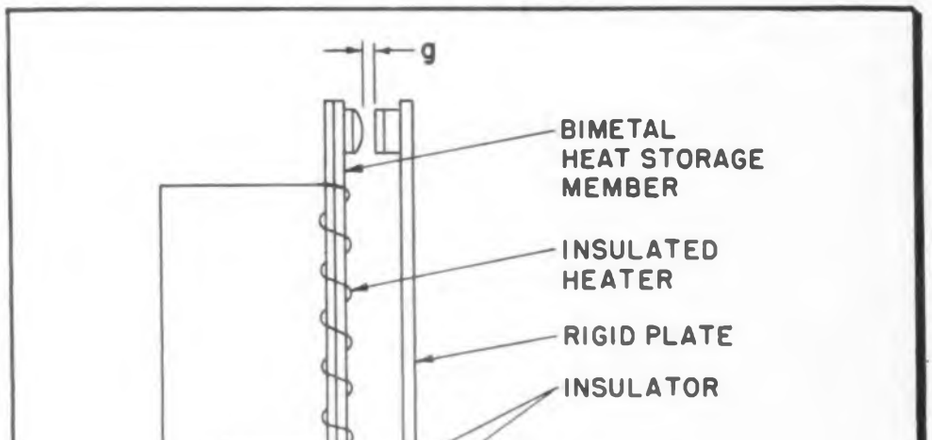


Fig. 3: (l) Bimetal element at left bends in proportion to heat until contact is made. Fig. 4: (r) Relay in which heater voltage has little effect on timing

Thermal Relay (Continued)

pected operating range in both the actuating and compensating elements is essential. Typical metals employed are the chrome-nickel and nickel-iron alloys.

In Fig. 2 we have shown a typical relay of the bimetal type in which the motion of the bimetal strip directly produces contact operation. The bimetal has been found to be a highly satisfactory heat storage means particularly in relays operating in the timing range of from a few seconds to about ten minutes. The deflecting elements used are usually of the Invar-stainless steel variety and these provide high deflection rates and good stability.

Both of the relays illustrated are ambient compensated and both are hermetically sealed in size T-9 shells of the type used in the manufacture of radio receiving tubes. The design in each case provides for adjustability of their timing characteristics after sealing.

Bimetal Operated Relays

For our purpose here we will emphasize and discuss in some detail the considerations which apply to the design of bimetal operated relays of the time delay type. Much of what follows is basic however and therefore applicable to thermal relays as a class. Our approach will be to examine the simple configuration shown in Fig. 3 and then in the light of this examination to discuss the more practical structure of Fig. 2.

We have in Fig. 3 a simple bimetallic element mounted cantilever fashion to an insulating block at its lower end and carrying a moving contact at its free end. A second and non-deflecting member is also mounted to the block and carries the fixed contact at its upper end. A heater winding is wrapped around the bimetal member and electrically insulated from it. If now a current is allowed to flow through the heater the bimetal will begin to store up heat energy and as it does so its temperature will rise and it will gradually bend. After a predetermined time interval the contacts will close. This we refer to as the Operate Time —the interval between the application of the heater voltage and relay contact operation.

Mathematical Analysis

Now, the exact mathematical analysis of the thermal behavior of even the simple structure shown in Fig. 3 would be quite complex. Fortunately, however, certain simplifying assumptions may be made which greatly reduce the work involved without introducing errors of consequence.

$$\theta - \theta_a = \frac{W}{A\alpha}\left(1 - \epsilon^{-\frac{t}{pvc/A\alpha}}\right) \quad (1)$$

If for convenience we set,

$$pvc/A\alpha = \lambda \quad (2)$$

We may write,

$$\theta = \theta_a + \frac{W}{A\alpha}\left(1 - \epsilon^{-\frac{t}{\lambda}}\right) \quad (3)$$

Where

W = power input to heater winding in watts.
P = ave. density of bimetal in gms./cm³.
V = total volume of bimetal in cm³.
C = ave. specific heat of bimetal in watt-secs./gm° C.
A = total surface area of bimetal in cm².
α = coefficient of heat transfer to surroundings in watts/cm.² ° C.
θ = temperature of bimetal at any time t in ° C.
θ_a = temperature at t_0 or ambient temperature in ° C.
t = time in seconds.
λ = thermal time constant.

Those familiar with electrical circuitry will recognize Eq. 3 as being analogous to that defining the instantaneous voltage across a capacitor being charged through a series resistance from a battery source.

Examination of these equations will lead to a number of interesting conclusions. We find to begin with that the temperature time curve will be exponential and that the maximum temperature rise will be equal to $\frac{W}{A\alpha}$, that is, this rise will be directly proportional to the power input to the bimetal and inversely to the heat loss coefficient and the surface area which is dissipating this loss. The thermal time constant λ, defines one of the basic characteristics of the thermal relay and warrants closer attention. Eq. 3 tells us that λ is equal to the number of seconds required for the bimetal to attain 63% of its ultimate temperature. The importance of this constant lies in the fact that its numerical value is related to the practical limits of timing to which a relay of the type under consideration may be adjusted. Thus greatest reliability of contact operation occurs in the timing range from t_1 to t_2 on the curve of Fig. 5 and we would find that for timings much below or above these values small variations in ambient temperature would result in large percentage changes in the operate time. Similarly, any mechanical shift in the structure resulting in a small gap change would produce the same result. Moreover, as the operate point is raised above point B the sensitivity of the operate time to heater voltage becomes increasingly great. The actual usable timing range will, therefore, be determined primarily by the time constant of the structure employed and its dimensional stability. Contact erosion or build-up during operating life, the ambient temperature and voltage range over which the relay must operate, and the degree of repeatability of operating time required are additional controlling factors.

Eq. 2 defines the time constant in terms of the physical characteristics of our simple relay. We note that it has the dimensions of time and further that it is directly proportional to the volume of the bimetal and to its density and specific heat and inversely to the heat loss coefficient and the surface area. This being so a greater mass of metal in the actuating element does not necessarily result in a longer time constant. Instead, this factor will depend primarily upon the ratio of volume to surface area. It follows from this that where this ratio can be increased, as for example by doubling the thickness of a thin rectangular strip, the time constant will be almost doubled. On the other hand doubling the width of the strip will but slightly alter the ratio and produce a negligible increase in its value. In this connection it is interesting to note that attempts to miniaturize a thermal relay of a given construction by scaling down its linear dimensions will result in a reduction of the ratio of V/A, since V is reduced faster than A, and therefore a reduction in λ. We note also that while P, V, C and A depend entirely on the material of which the bimetal is made and upon its shape, the heat loss coefficient α, is determined principally by the thermal conductivity of the gaseous medium through which heat is transferred to the walls of the relay and to the surroundings.

Thermal Conductors

This relationship of the loss coefficient to the time constant may, be taken advantage of in the case of hermetically sealed relays to obtain either shorter or longer operate time ranges than those possible in air without altering the size of the heat storing bimetal. Thus for short timing relays α is made large by employing a good thermal conductor such as hydrogen while for long delay times the relay may be pumped down to a high vacuum and α thus reduced to a minimum. Other stable gases with higher molecular weights such as nitrogen and argon may be employed when intermediate timing values are desired.

In practice, time constant ratios of 8 to 1 are readily obtained in this way for a given size actuating element. By altering the bimetal thickness as well as the gas fill the time constant ratio may be further increased and a value of 30 to 1 is easily achieved.

Some idea of the advantages resulting from the use of gas conductivity for the adjustment of thermal time constant may be obtained when it is realized that the simple substitution of hydrogen for air in the case of short delay relays makes it possible to increase the bimetal thickness by a factor of 2.5. The effect of the increased stiffness thus obtained is to move the fundamental resonance frequency of the bimetal from approximately 50 cps to 125 cps or well above the 0-55 cps range specified in MIL-E-5272, Procedure III.

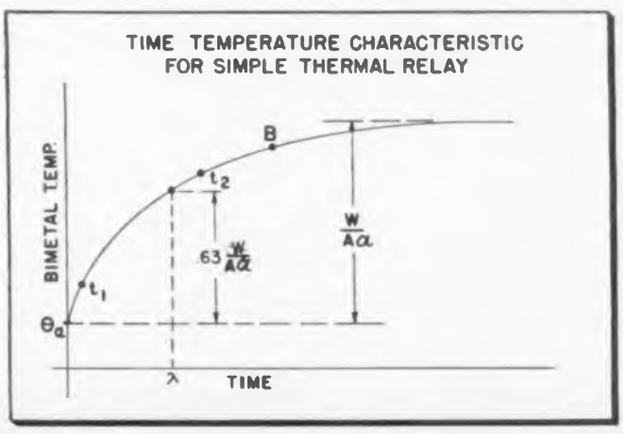
Saturation Temperature

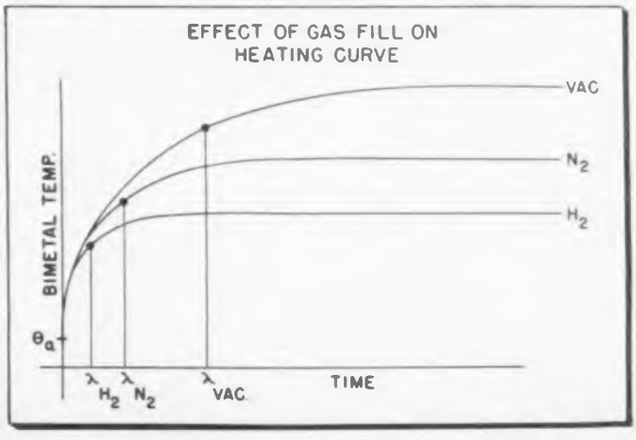
Fig. 6 shows the effect of changing the gas fill within the relay enclosure for a given size bimetal. Note that for a given heater power the saturation temperature attained increases as α decreases. Thus for the unity coupling case where the gas does not play a role in the transfer of heat from the heater winding to the bimetal, vacuum relays may be operated at lower heater power than gas filled types having comparable gap spacings.

Since both the time constant and the saturation temperature attained by the heated bimetal are dependent upon the residual gas pressure within the relay enclosure, it is of great importance that the structure be thoroughly out-gassed during

(*Continued on page* 139)

Fig. 5: (l) Greatest reliability of contact operation occurs in the range from t_1 to t_2. Fig. 6: (r) Effect of changing gas fill for given size bimetal





The Geodimeter—an Electronic

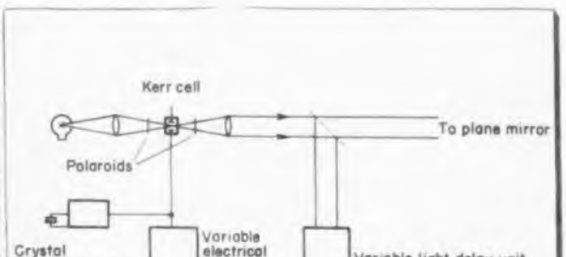


Fig. 1: (l) Geodimeter. Photo tube unit is at right, large container (c) holds high voltage transformer and rectifiers. Fig. 2: (r) Diagram of unit

A high degree of accuracy is claimed for this Swedish electronic equipment which computes point-to-point distances from the phase difference between light waves

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FOR accurately determining the position of points in the field for mapping purposes, it has been customary to start from a base line, the position of which is exactly determined by astronomical methods and the length of which is measured directly with a carefully calibrated tape. From the terminal points on this base line the angles to a third point are then determined, which together with one terminal point of the base line determine the first side in a chain of triangles. At significant distances from the base line, errors occur because the angles are added progressively. Furthermore, certain data are difficult to obtain as it is not always possible to set out a base line of sufficient length.

The methods of determining distances with the help of radio waves has been tried out, but the difficulties are considerable, since it is difficult to determine the rate of propagation at the frequencies employed with sufficient accuracy. Moreover, the presence of electrically conducting objects in, or close to, the direction of measurement gives rise to appreciable errors that are difficult to check.

A Swedish geodesist, Dr. Erik Bergstrand, demonstrated at the end of the 1940's that it was possible in practice, by employing light, to carry out direct determinations of length with the high degree of accuracy necessary in geodetic measurements. The advantages resulting from the use of light are considerable, inasmuch as the rate of propagation of light waves is very accurately known.

Operating Principles

The principle of the geodimeter (Fig. 1), the name adopted for the improved Bergstrand instrument, is based on a modification of the method employed by Fizeau more than 100 years ago. Thanks to the recent introduction of modern electronic and optical devices, however, the sensitivity and accuracy have been increased to a very high degree in measuring 35 to 40 km.

The light ray employed for the measurements is divided up into flashes by means of a Kerr cell (Fig. 5) and a crystal-controlled high frequency generator; 10,000,000 such flashes being transmitted per second. After reflection in a reflecting device located at the other end of the section measured, the flashes are received by the geodimeter's receiver in which a highly sensitive photoelectric cell converts the light impulses into electrical impulses. See Fig. 2. The distance is ascertained by measuring time taken by the light ray in its passage over the measured section. Since the speed of propagation of light is accurately known and the flashing frequency is well defined by the crystal-controlled generator, the accuracy in the determination of the distance will also be very high. The geodimeter is equipped with a built-in calibrating device by means of which the effect of instrument errors is considerably reduced.

In order to explain more clearly the principle of the instrument one can think of making the following experiment.

The apparatus set up sends out a pulsating light beam (Fig. 3) that is reflected from the mirror and sent back to the instrument. The photomultiplier, or receiver, is connected to the voltage of the Kerr cell, or transmitter, in such a way that the sensitivity of the photomultiplier is synchronized with the light output from the Kerr cell. Thus maximum output of light from the Kerr cell coincides with maximum sensitivity of the photomultiplier. If now the photomultiplier is detached from the geodimeter and brought up to where the light beam leaves the instru-

"Eye" for Measuring Distance

ment, maximum deflection will be read on an indicating meter connected to the photomultiplier, because the phase of maximum light coincides with the phase of maximum sensitivity of the photomultiplier.

Phase Measurements

If the photomultiplier is moved along the path taken by the light beam, the indicating meter will show a minimum some distance away from the Kerr cell. This is because the phase of maximum light no longer corresponds with the phase of maximum sensitivity, due to the delay in time of the light beam to reach the photomultiplier. As the photomultiplier is moved further away along the light path a successive number of maximum and minimum indications will be noted, all the way out to the mirror and all the way back again. The distance from the geodimeter to the mirror and back can then be expressed in a number of whole cycles, and a fraction of a cycle, because it is not likely that the distance to be measured coincides with a number of whole cycles. The measurement of the distance can then be divided into two operations, that of measuring the number of whole waves and that of measuring the length of the partial wave. The former is quite simple and shall be explained later on. The latter is measured as follows.

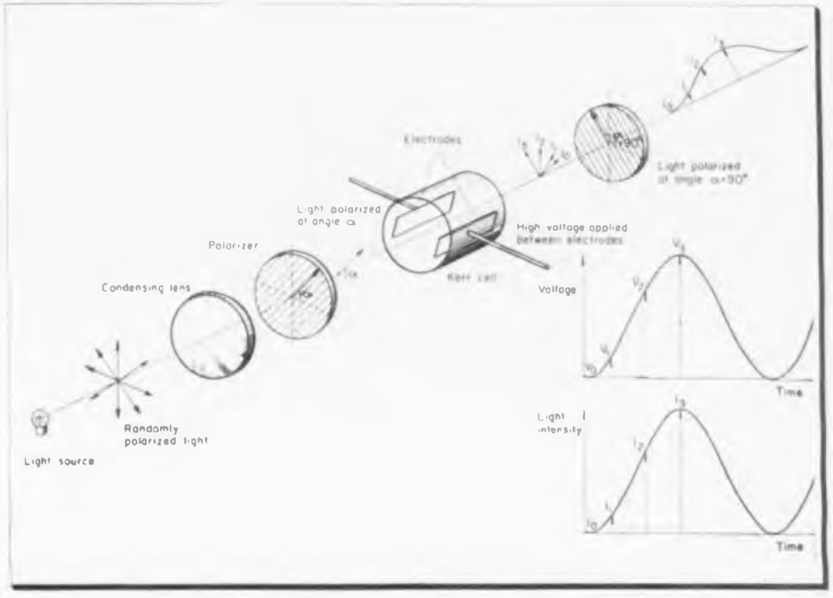

Fig. 3: Method of modulating light beam. Receiver sensitivity is also varied at same frequency

The synchronizing voltage pulse from the Kerr cell to the photomultiplier is run through a variable electrical phase delay line. The phase delay could be adjusted until the indicating meter again reads maximum, and then the phase delay in degrees is the same as the length of the partial wave in degrees. The length of the partial wave could then conceivably be read directly on the dial of the phase delay line. It is very difficult, however, to read a maximum or minimum on such a meter, due to light intensity fluctuations from changing atmospherical conditions.

To avoid this, two photomultipliers can be used, placed half a wavelength apart along the axis of the received beam. (Wavelength means of course the length of the light beam pulsations, not the wavelength of light.) When these photocells are being moved along the beam, or when the delay line is varied, one cell will indicate an increasing voltage and the other a decreasing voltage. The point where the two voltages are equal will then be very easy to determine accurately with a sensitive bridge galvanometer. It is very difficult to use two cells, however, because at the frequency used, a half wave is 15 meters long and because it is very unlikely to find two photocells that are perfectly matched.

180° Phase Shift

One cell might possibly be used if it could be moved back and forth from one measuring point to the other quickly enough. In the geodimeter this is done electrically. The synchronizing voltage pulse, taken from the Kerr cell and applied to the photomultiplier, is moved half a wavelength in phase one hundred times per second. To "move" an

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Fig. 4: (l) Schematic diagram of null indicator

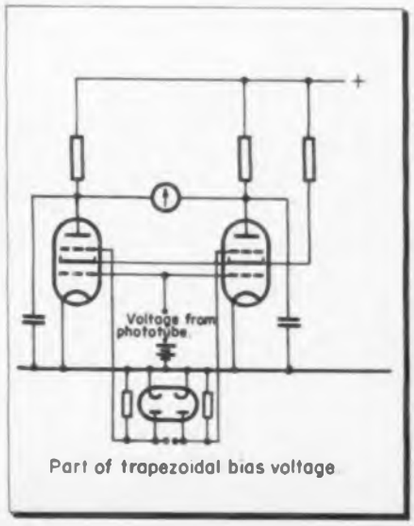

Fig. 5: (r) Kerr cell—polaroids, condenser, lamp

Compandors Boost Performance of

Fig. 1: New compandor unit employs only two tubes. Plug-in construction allows easy replacement

Application of the compandor to physical or carrier-derived circuits can effect an increase of 22 db in the signal-to-noise ratio, eliminating the need for expensive line work

The compandor is a device for improving the intelligibility of speech transmission circuits by increasing the signal-to-noise ratio. It was originally developed for use with transoceanic radio circuits in the early 1930's, but until recently its use has been restricted by prohibitive installation costs. Improvements have now brought the cost and complexity of individual units within a range where, within the next few years, we can expect a wide-spread increase in their use.

Since the compandor can effect a practical improvement in signal-to-noise ratio of about 22 db, its use can often eliminate the need for extensive line work, which is otherwise the only means of bringing presently substandard physical or carrier derived circuits up to usable quality. The device can also often permit the installation of new carrier channels on lines which would otherwise require expensive retranspositions to keep cross-talk within required limits.

Compandor Action

Design of carrier systems with compandors as an integral part of each voice channel also permits relaxation of design requirements for various channel and system filters or amplifiers, with consequent economies in equipment manufacturing.

The miniaturized compandor manufactured by Lenkurt is designed for general purpose use in all of the above mentioned applications—presently installed circuits—new carrier circuits—and new carrier equipment. The complete unit, as shown in Fig. 1, is only 3¼ in. wide, 2 in. high, and less than 10 in. deep. Only two tubes are required. Test points on the front of each unit facilitate testing for routine maintenance and trouble shooting, and the entire unit can be quickly removed from its mounting and replaced by another. An interchangeable resistance hybrid or four-wire termination arrangement plugs into each unit. Four complete compandors plug into a rack-mounted shelf which occupies only 3½ in. of rack space and also contains necessary fusing and alarm circuitry.

To obtain the maximum benefits available from the use of compandors, it is necessary to appreciate both the advantages which can be obtained from its application, and the manner in which compandor action may limit use of the device on certain types of circuits.

Compandor Theory

One of the basic principles of transmission engineering is that the effect of noise coming into the line between terminals can be reduced without increasing the net loss of a circuit if the transmitting level is increased and a loss of the same amount is inserted at the receiving end. Noise is then reduced by the same amount as the inserted loss.

The compandor takes advantage of this principle, without the need for higher power amplifiers, by decreasing the range of intensities in transmitted signals. For weak signals the compandor increases the level at the sending end and decreases it in the same ratio at the receiving end. Strong signals are changed little or not at all since in this case there is usually adequate signal-to-noise ratio. But for this change in intensity range, crosstalk between systems (as distinguished from noise or crosstalk into one system) would not be effectively reduced.

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Although the average noise improvement from available compandors is rated as 22 db, the actual improvement obtained in any particular case is a function of how noisy the circuit is without a com-

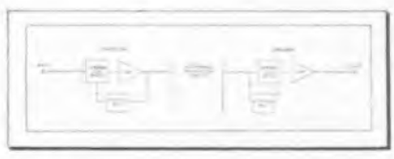
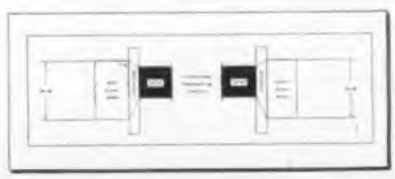


Fig. 2: Block diagram of Type 5090A compandor

Fig. 3: Compressor and expandor functions



Voice-Frequency Circuits

pandor, and of how loud the user is talking. With a very loud talker on a very noisy circuit there could conceivably be no improvement. This condition is approached when speech and noise are of equal intensity at the input to the expandor.

To fully appreciate both the possibilities and the limitations of the use of a compandor on all types of channels transmitting various types of intelligence, it is necessary to understand how the device produces an improvement in signal-to-noise ratio.

Operation

The compandor is basically a four-wire device, treating each direction of transmission separately. Each compandor unit consists of a compressor (in the transmitting branch) and an expandor (in the receiving branch). Thus a channel must have a compandor at each end for proper operation.

The basic equipment of a compandored circuit is illustrated in Fig. 2 for one direction of transmission. The reverse direction is, of course, identically equipped. Here you will note that at each end part of the signal (compressor output or expandor input) passes through a rectifier which in turn controls the operating point of the variable loss device.

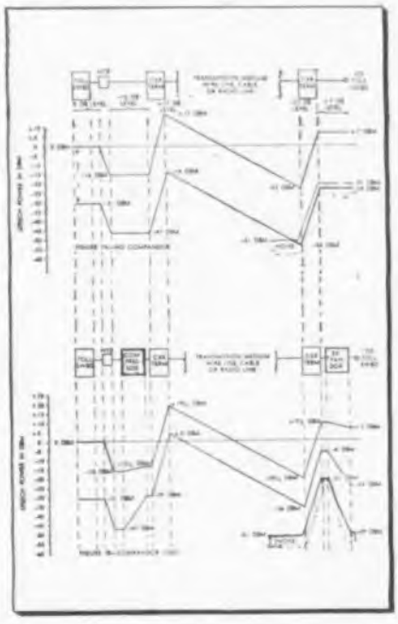
The effect of a compandor on a range of input signals is illustrated in Fig. 3. An input intensity range of 56 db is compressed to one-half or 28 db for transmission between terminals. At the receiving end of the circuit these signals pass through an expandor and the original intensity range of 56 db is restored.

Compandor operation is illustrated more completely in Fig. 4 where the compression and expansion of signals in a compandor is indicated for two different speech powers.

Noise Advantage

The two examples of carrier channel operation, one with and one without a compandor, shown in Fig. 4, indicate how the compandor permits operation over circuits otherwise too noisy for use. A line noise intensity of −51 dbm has been assumed at the input to the carrier terminal. The noise can be either crosstalk or random induced effects. Gains and losses are shown for a high intensity signal of 0 dbm at the 0 level point and a low intensity signal of −31 dbm at the 0 level point.

In the upper part of Fig. 4, where compandors are not used, the low intensity signal reaches the input of the receiving carrier terminal 3 db below the assumed noise power. Since the line noise is amplified in the carrier terminal by the same amount as the transmitted signals, the noise would reach the listener 3 db higher than the signal. For the high intensity signal the margin is only 28 db instead of the desirable 47 db minimum.



In the lower part of Fig. 4, signals of the same intensities are shown transmitted over the same carrier channel equipped with a compandor. Instead of going directly into the carrier terminal, the signals first go through a compressor where they are amplified. The amount of amplification depends upon the signal power. The low intensity signal now reaches the receiving carrier terminal at an intensity 18 db higher than previously. The line noise power is still −51 dbm. Both the signal and the line noise are amplified equally in the carrier terminal, but in this case they both enter the expandor instead of going directly to the toll switchboard. The desired signal enters the expandor with an intensity of −6 dbm and the noise enters the expandor with an intensity of −21 dbm. Since signals are attenuated by an amount proportional to their power (in this case 18 db attenuation for the desired signal, 28 db for the noise), the expandor serves to increase the margin between signal and noise. For the same signal which was 3 db below the noise in the circuit without a compandor, the circuit with a compandor provides a signal-to-noise ratio of 25 db. Except for increasing the signal-to-noise ratio, the action of the compressor and expandor is not apparent to the listener. Note that here the higher intensity signal is now 56 db above the noise level—a highly acceptable circuit.

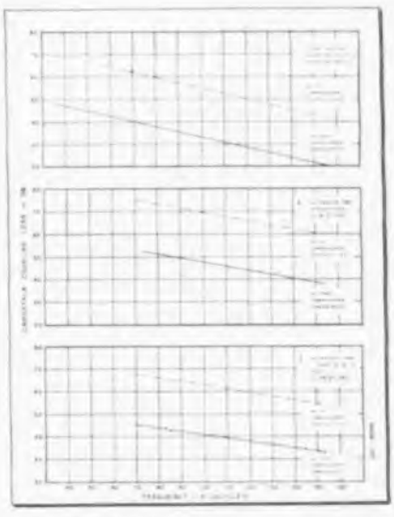


Fig. 4: (1) Noise levels seen graphically with and without compandor equipment

Fig. 5: (above) RMS crosstalk coupling on 50 mi. section of a typical C transposed lead

Gain Varies

In the example mentioned here, it has been assumed that the action of the compandor is determined by a single tone. In operation, of course, the action is dynamic; compressor gains and expandor losses change constantly as the intensity of the transmitted intelligence changes. Compressor gain and expandor loss

(*Continued on page* 143)

Measuring Time-Delay in Pulse C

New test gear enables designers and users of time delay pulse equipment to make measurements of time intervals to within a few milli-microseconds

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DESIGNERS and users of time-delay pulse equipment are faced with the problem of making accurate measurements of time intervals to within a few milli-microseconds. While a number of methods have been devised to give this order of accuracy, a pressing need exists today for specific equipment and methods conveniently applicable to pulse circuitry, and it is in that light that the following discussion should prove of considerable value.

For purposes of simplification, we will confine ourselves to discussion of the passive electro-magnetic delay line.

Equipment

For accurate time measurements, using this method, the following equipment is required:

1. A crystal-controlled time-mark generator with markers of 0.1 and 1.0 μsec.
2. Three continuously variable delay devices. Two such devices with a 0-50 μsec range with coarse and fine controls; one with its dial calibrated in terms of time.
3. A pulse generator with a 10-kc repetition rate, and with variable pulse width, rise time and amplitude.
4. An oscilloscope with an accurately scribed graticule.

All of the above equipment, except the oscilloscope, may be conveniently combined into one unit as shown in Fig. 1. A block diagram of the complete system is shown in Fig. 2. By feeding the markers into the Z-axis of the oscilloscope, the sweep is intensity-modulated. It is necessary to have sufficient amplitude and proper shaping of the markers in order that they may have adequate definition.

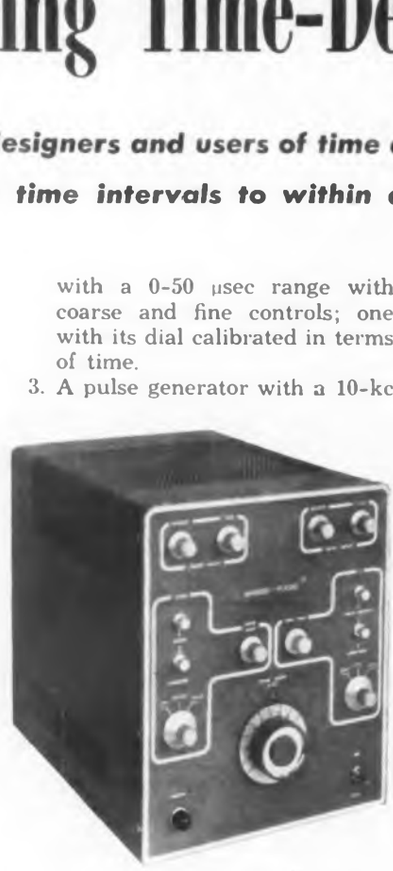


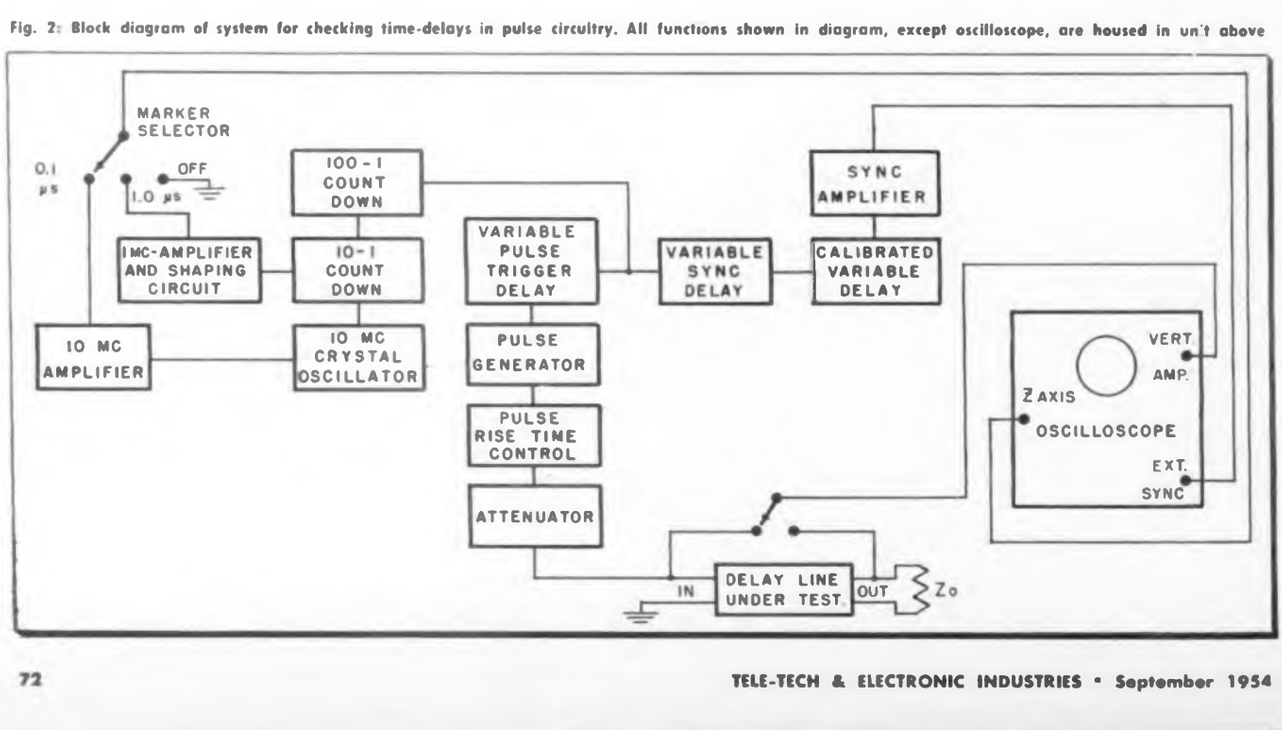
Fig. 1: Marker-Pulser for delay-line testing

The calibration of the variable calibrated delay is set and checked by observing the zero and the 0.1 μsec points on its dial. With the dial set at zero, delay the sweep trigger by adjusting the fine sync-delay control until a 0.1 μsec marker lines up with any vertical reference line on the oscilloscope screen. Adjust the calibrated delay dial, which also delays the sweep, until the next 0.1 μsec marker is exactly lined up with the same reference line on the graticule. This point on the dial is marked.

Re-calibration

If the calibrated delay is a linear device, it is only necessary to divide the dial into ten equal divisions so that each one of these divisions will represent 10 milli-microseconds.

Fig. 2: Block diagram of system for checking time-delays in pulse circuitry. All functions shown in diagram, except oscilloscope, are housed in unit above



Circuits

Provisions should be included in this variable delay for resetting to the initially inscribed dial scale. In this manner, it is possible to periodically check and correct, if necessary, the calibration of the delay dial.

If all pulses were ideal pulses, having instantaneous rise and decay times, the point on the input and output pulses chosen as a time reference, would be of no importance, regardless of the service the delay line performed. Unfortunately, from a practical viewpoint, the ideal pulse cannot be generated nor can the delay line exactly reproduce it at its output terminals. In other words, all pulses have finite rise and decay times. Therefore, the points on the input and output pulses between which time is measured must be compatible with the service the delay line is to perform.

Fig. 3 illustrates three individual time measurements made on the same delay line; the rise and decay times are exaggerated for clearness. The 50% point of the input pulse was used as a reference for the time between A-B. The time A-C was measured between the 50% points of the input and output pulses. The time measurement D-E was made center to center, with respect to time, of that portion of the input and output pulses above the 50% point of the input pulse. It is readily seen that there is considerable time difference between these measurements. However, each of these measurements are valid provided the proper measurement is associated with the proper delay-line usage.

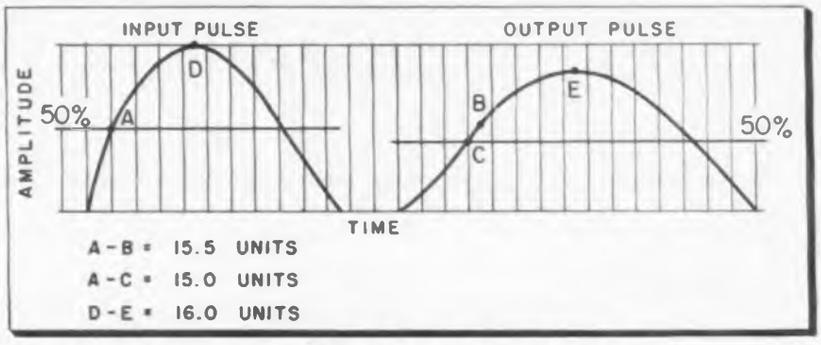


Fig. 3: Three time measurements on same delay line. Rise and decay times are exaggerated

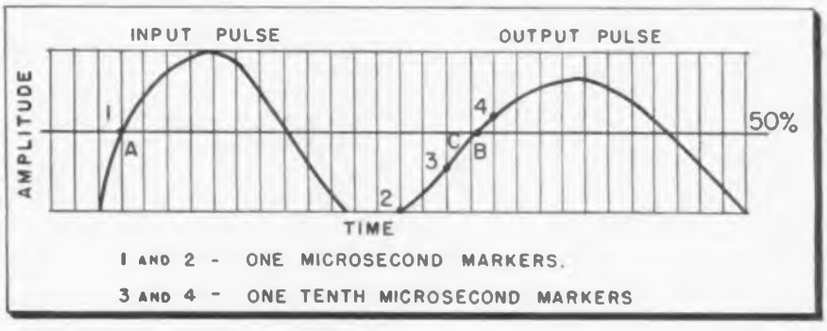


Fig. 4: Reference points for marker adjustments as seen against background of scope graticule

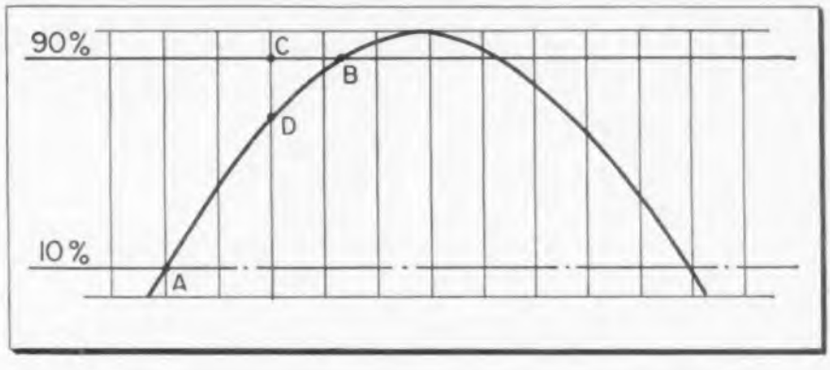


Fig. 5: Reference points for measurement of pulse rise time. Decay time will be identical

Delay Line Functions

The measurement A-B would be used if the delay line were to function as a trigger delay and the circuit being triggered fired at a voltage level equal to the 50% point of the input pulse. Time A-C would be correct if it were a video-delay measurement. The time D-E would apply if the delay line were to be employed to open a gate circuit and if the gated signal was to appear in the center of the gate.

Since the procedure for each measurement is identical, measurement A-B will be described in detail. The pulse rise time, width, and amplitude must be adjusted to be as nearly identical as possible to the actual pulse that will drive the delay line in the circuit for which it was designed. This is necessary since these three quantities have a pronounced effect on the performance of the delay line. If they are badly adjusted, an individual time measurement will be in error by many milli-microseconds.

The two most critical quantities in the pulse are rise time and pulse width. If the rise time is too fast there will be high-frequency components, of large amplitude, in the pulse that will lie beyond the pass band of the delay line. If the delay line is a low-pass device with sharp cutoff characteristics, the above condition will cause severe ringing on the pulse because of the excessive high-frequency component and sharp cutoff condition. The required band width of the delay line is related to pulse-width by: Band Width x Pulse Width = K. If the pulse width is too narrow there will be excessive insertion loss in the delay line. It is also required that all necessary precautions be taken in order to reduce the effects, on the delay line, of stray constants added by the test circuit. This is accomplished by the use of short, shielded, and properly terminated leads.

Refer to Fig. 4. With the oscilloscope switched to the input of the delay line, adjust the fine pulse-trigger delay and fine sync delay until a 1.0 μsec marker is on a vertical reference line and the 50% point of the leading edge of the input pulse. Switch the oscilloscope to the output of the delay line and count the number of 1.0 μsec markers that appear between the input- and out-

(*Continued on page* 160)

CUES for BROADCASTERS

Practical ways of improving station operation and efficiency

Improved Remote Control for Push Button Transmitters

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IN the article by Philip Whitney entitled "Remote Control for Push Button Transmitters" (Feb. 54), there is a "fail safe" feature that has been overlooked; and, with minor changes, can be incorporated in the unit. By referring to the original circuit it can be seen that failure of the relay power supply, or failure of the capacitor associated with the "off" relay, would make it impossible to turn off the transmitter by remote control. Due to the fact that capacitors and rectifiers do deteriorate in time, it is felt that protection against this type of failure should be included in the unit.

The changes necessary to afford this protection would be to change the control relay to a double pole relay, remove the capacitor and resistor associated with the "off" relay and use the front instead of back contacts on the "off" relay.

The circuit as modified operates as follows: When voltage is applied to the remote control line it closes the control relay which, in turn, closes both the "on" and "off" relays. The "off" relay will remain closed as long as the control relay is closed, but the "on" relay will close only momentarily until C-1 is discharged and then it will open.

Momentary operation of the "on" relay is accomplished through use of the R-1, C-1 charging circuit. When the control relay is open C-1 will charge up to full voltage through R-1, when the control relay is closed, the accumulated charge in C-1 closes the "on" relay and holds it closed for the short period of time it takes for C-1 to discharge. Resistor R-1 must be large enough to limit the current below the holding current needs of the relay, otherwise the relay would remain closed.

As far as the "off" relay is concerned, it may be possible to eliminate it completely if the contacts on the control relay are heavy enough to handle the transmitter "off" circuit directly. Its purpose is merely to break the transmitter "off" circuit whenever the control relay opens.

A question might come up in the reader's mind about the possibility of operating both the "on" and "off" relays from one set of contacts on the control relay. This could be done, but, if C-1 shorted while the transmitter was on the air and the control circuit opened, both relay coils would effectively be in series across the power supply and enough current might flow to keep them from releasing.

$$$ FOR YOUR IDEAS

Readers are invited to contribute their own suggestions which should be short and include photographs or rough sketches. Typewritten, double-spaced text is requested. Our usual rates will be paid for material used.

Multispeed Turntable & Needle

STEPHEN POPP, Studio Supervisor, WIL, St. Louis 8, Mo.

WE needed a system, fool-proof and error proof for 33, 45, and 78 rpm records. We use the same transcription arm and stylus (one mil) for LP and standard 2, or 2.5 mil, grooved 78 rpm. With only 8 grams pressure on records the arm does not jump out of grooves—unless table is hit.

The GE reluctance cartridge (RPX-046) and the GE RPJ-004 one mil stylus give the same fidelity for all records. We believe any variable reluctance cartridge and one mil stylus will do the same job. The pressure can be adjusted to 8 grams. We have ours mounted on the Gray 106SP transcription arm used in conjunction the Gray 602 equalizer, and Gates CB 14 table which combines the mercury AC switch and speed selector. Thus it is not necessary to slip disc (which results in very little cloth wear on turn table and less wear on motor and rubber drive wheels) and the record or ET can be spun in by pushing switch handle toward speed desired. This turntable also has provision for changing from 33-1/3 rpm to 45 rpm by slipping a plug into 33-1/3 rpm spindle through the top of the turntable rim.

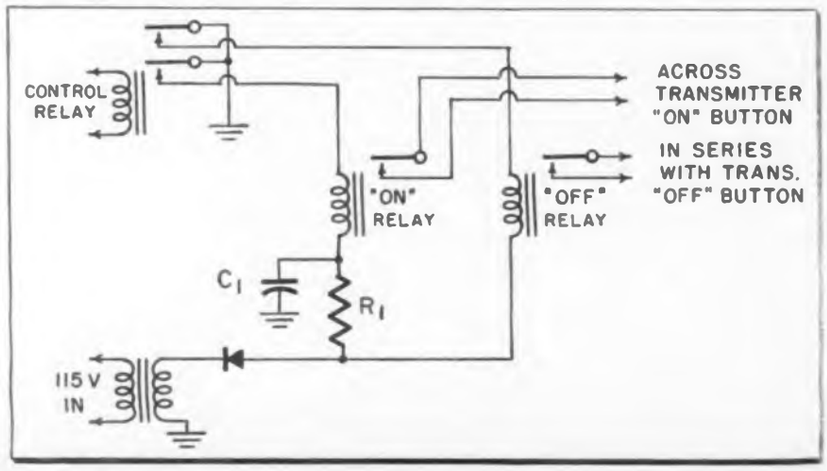
After operating this system for approximately 162 hours per week for the last four months, we feel we should pass along this information as it may be of some help to some broadcaster. We are still using same stylii and with only 8 grams pressure they may go for a long time yet!

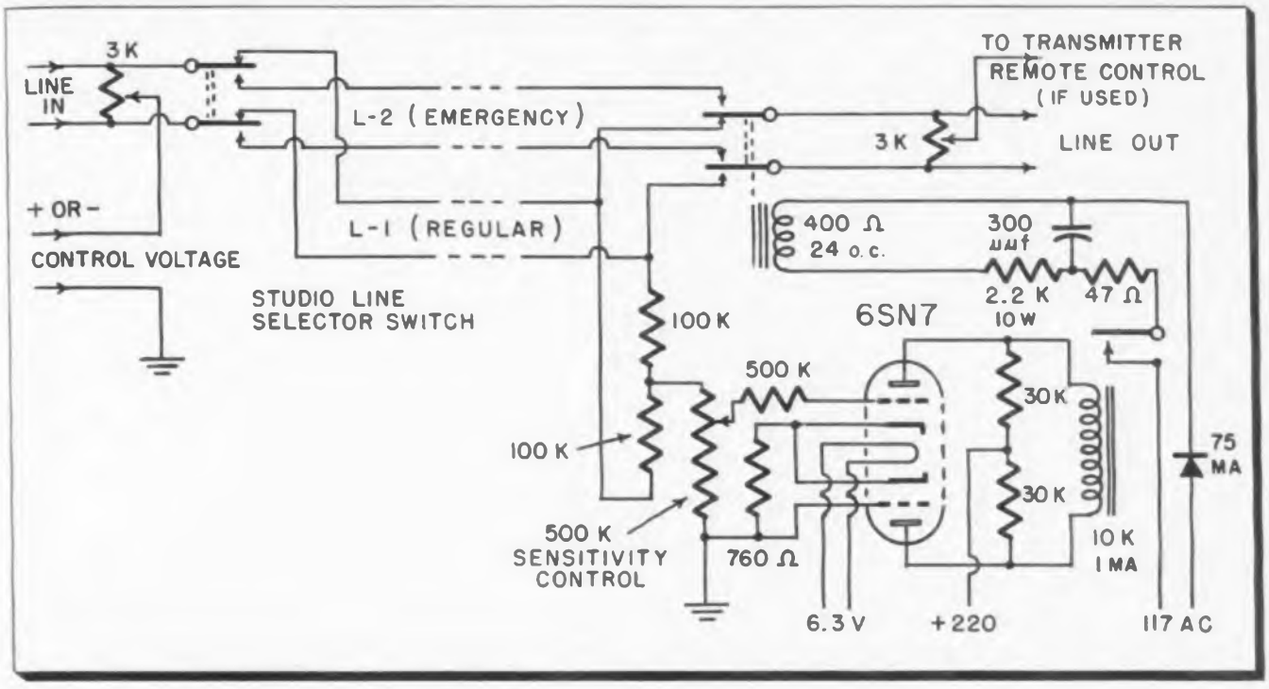
Automatic Program Line Changeover Circuit

G. HAROLD BREWER, Chief Engineer, WARK, Washington, D.C.

THIS changeover device was designed as part of WARK's remote control system to change automatically the program and control circuits to the emergency loop in the event of line failure. The changeover unit is installed at the transmitter end of the lines, and

Improved remote control "fail safe" circuit offers protection against component failure





Automatic changeover circuit switches program and control circuits simultaneously to emergency loop in case of line failure

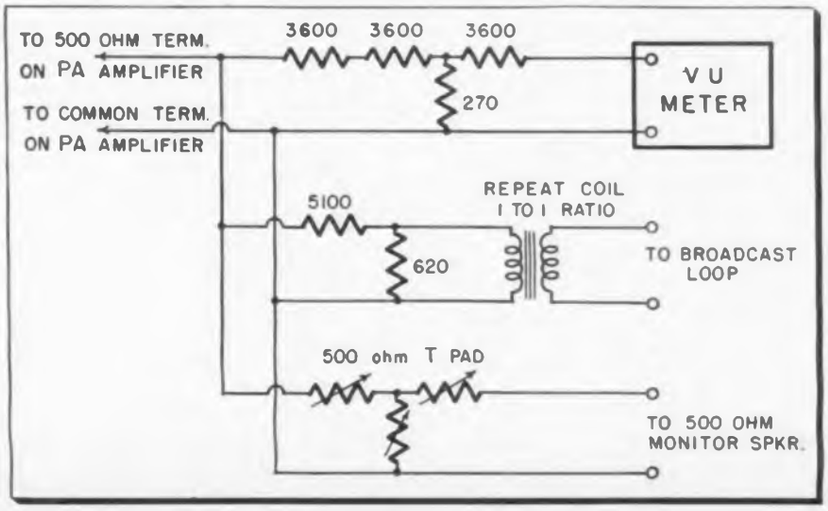
the grid circuit of the 6SN7 tube senses the presence of the remote control hold voltage, keeping L-1 normally in service. However, if this voltage drops out due to line failure, or if the operator at the studio operates his line selector to L-2, (the emergency loop,) all relays in this unit open, changing the service to L-2. The studio operator in this manner actually changes both ends of the line at once. The circuit has been designed to operate on either a negative or positive voltage of 15 volts or more. The sensitivity control in the grid circuit of the 6SN7 tube is adjusted for positive operation of the relays on the lowest line voltage used. The filter condenser in the line relay power supply circuit has been made large enough to prevent the circuit from operating during polarity reversals of line voltages, on a control system using this principle.

This circuit may also be used on any lines that are not used for control or with control voltages, by using a hold voltage on the line in a similar manner. The line center-tapped potentiometers when adjusted for minimum line noise on each end of the line have no effect on the line performance and in many cases may actually tend to reduce any line noise present.

In the event of a tube or component part failure in the changeover circuit, all relays will fall out, placing the emergency circuit, L-2 in service. Program service may then be restored by the studio operator, by the operation of his line selector switch at the studio, to the L-2 position.

The circuit indicated in the diagram, shows application to a program line which has been simplexed for remote control purposes. Such an application may be desirable since both services, program and control, may be switched to an emergency loop, simultaneously.

Emergency remote set-up uses PA amplifier connected to broadcast loop through this circuit



Emergency Remote Equipment

T. A. HILDEBRAND, Chief Engineer, KBMY, Billings, Mont.

WE were called upon to broadcast a disc-jockey show from a downtown store window for promotion purposes. None of our remote equipment had facilities for turntable inputs, so a good public address amplifier which had the required inputs was rented and connected to the broadcast loop as shown. All the components were mounted in a metal utility box with the VU meter mounted on the front. The bass tone control was locked in its normal position with cellophane tape and the treble control locked in a similar manner but with the treble slightly boosted to over-

(*Continued on page* 100)

Fig. 1: Needle-like projections are test probes

Plating Quantity

A non-destructive method of measuring the internal silver plating on waveguides and similar plated tubing permits rigid quality control and assurance of proper operation

*By MARTIN DAVIDSON and NICHOLAS S. RAHAL**

ACF Electronics, 800 N. Pitt St., Alexandria, Va.

*This article was prepared while Messrs. Davidson and Rahal were with the National Bureau of Standards.

THE quantity of internal plating on stainless steel L-band waveguides can be conveniently measured externally by the electronic instrument described here, which was developed for the Navy Dept. by NBS. The test method, which is non-destructive, is based on the difference in electrical conductivity of the base material and the plated material.

Stainless steel is used as base material in fabricating rectangular L-band waveguides to obtain a favorable strength-per-unit-weight relationship, compared to other materials, such as bronze. The conductivity of the stainless steel used is 1/48th that of silver, hence internal plating is mandatory for electrical reasons. Ambient conditions of use are such that corrosion is a serious factor. Thus there is a necessity for determining if adequate amounts of internal plating are present at all parts of the waveguide. The buyer's specification for these guides calls for a stainless steel wall thickness of 0.037 in. Type 321 or type 347 steels, which are 18-8 stainless steels are specified for the base material. The normal cross-section dimensions inside the guide are 6.5 by 3.25 in. The waveguide sections may have a length of as much as 10 ft. The types and amounts of platings desired are shown in Fig. 3.

DC Conductivity

The situation presented in Fig. 3 and in Table 1 with regard to the relative conductivities and thicknesses of the respective layers of metal indicates that a direct measurement of the dc conductance between a pair of points will give sufficiently sensitive indications, within reasonable limits of error, of the amount of silver deposited upon the nickel plated stainless steel wall. Values of conductivity in the table are given with respect to the conductivity of stainless steel in order to simplify the marking and interpretation of the indicating meter scale. In terms of these units, it is seen that the specified composite of the three metals has a relative conductance of 143 units. If the amount of deposited nickel were to vary by $\pm 50\%$ the error in the indication of the amount of silver present would be only $\pm 5\%$. A tolerance of ± 0.005 in. in the thickness of the steel base would have the same effect.

To measure the local conductance of the waveguide wall, a known

M. Davidson

N. Rahal

amount of direct current is made to flow through it by using a pair of pointed metallic probes as electrodes. Hereinafter these will be referred to as the "Current Probes." By measuring the potential between any other two points in the neighborhood of the current probes the conductance can be determined, provided current flow is laminar throughout the material, and provided the linear dimensions of the material are several times greater than the current probe spacing. Laminar or two-dimensional current flow is obtained by making the current probe spacing much greater than the thickness of the waveguide wall.

The expression for the potential difference between any two points in an infinite plane current sheet generated by a source and sink of equal strength is

$$E = \frac{I}{2 \gamma \pi t (2.54)} \ln \frac{r_2 r_3}{r_1 r_4} \qquad (1)$$

where E is the potential difference in volts,

I is the current in amperes,

γ is the conductivity in reciprocal microhm-centimeters,

t is the thickness of the sheet in inches,

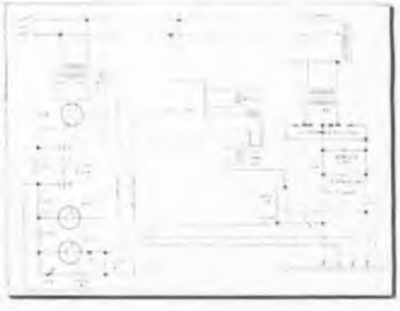


Fig. 2: Plating indicator seen schematically

Fig. 3: Plating thicknesses for waveguides

r_1 is the distance in inches from the current source to the potential point nearest it,

r_2 is the distance from the current sink to the potential point nearest the current source,

r_3 is the distance from the current sink to the potential point nearest it,

r_4 is the distance from the current source to the potential point nearest current sink,

and the logarithm is taken to the base e.

If the probe is symmetrical ($r_2 =$

Indicator for L-Band Waveguides

r_4 and $r_1 = r_3$) then the expression becomes:

$$E = \frac{I}{\gamma \pi t (2.54)} \ln \frac{r_2}{r_1} \qquad (2)$$

Probe Design

In the simplest and most useful probe configuration the potential probes are aligned with the current probes. The current probes are pointed brass rods spaced two inches apart. The potential probes are hard steel needles which occupy intermediate positions. (See Fig. 1.) These needles are spring-loaded and project slightly beyond the current probes in order to ensure good contact when the entire probe assembly is in position for measurement. The spacing of the potential probes (1 in.) is determined on the basis of the potential plot of Fig. 4. This shows the variation of potential in the current sheet along the line between the current probes. The upper end-point of the plot represents a practical limit of potential imposed by the necessity of maintaining a finite current probe contact area. The tips of the current probes must be somewhat blunted in order to keep the contact resistance low since currents as high as 5 amps may be passed.

The position of the potential probes is chosen first, so as to obtain a high potential difference and, second, so that small variations in the probe point spacing which may occur as a result of handling and wear will have a minimum effect on the reproducibility of readings. To fulfill the latter condition the potential probes should not be placed in the region next to the electrodes where the potential gradient changes rapidly.

Circuit Design

Measurements can be obtained with this type of probe assembly on either a constant current or constant voltage basis. If 1 amp of constant current is used for a set of measurements for example, the potentials measured in the case of the waveguide under consideration vary from approximately 300 μv for the unplated waveguide to approximately 80 μv for a properly plated guide. By using a storage battery, a rheostat, an ammeter, and a dc vacuum-tube microvolt-meter, potential measurements on a constant-current basis can be readily made.

The advantage of the constant-potential type of measurement, which is used in the Waveguide Plating Indicator, described, is that the current which is required to maintain constant potential across the potential probes is directly proportional to the conductance of the material and hence will vary directly with the quantity of plating. This permits the use of a linear direct-reading meter scale.

By using the simple servo techniques of self-balancing, the Indicator is made to read directly, and is automatized to such an extent that only an indicating meter and power switch occupy the front panel. The instrument is completely devoid of operating adjustments. The operator need only place the probe on the

(*Continued on page* 136)

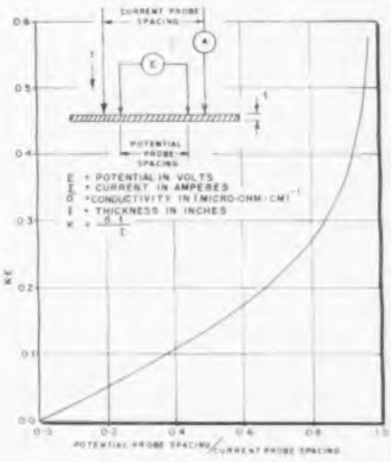


Fig. 4: Probe spacing is determined by potential

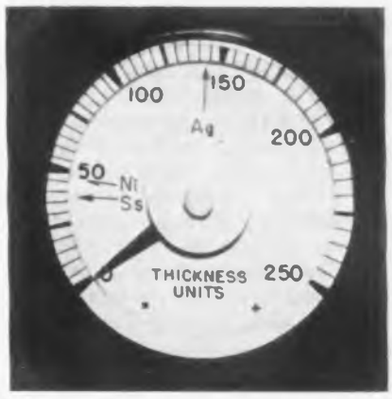


Fig. 6: Meter scale is in units of 0.001 in.

Fig. 5: Checking plating of L-band waveguide

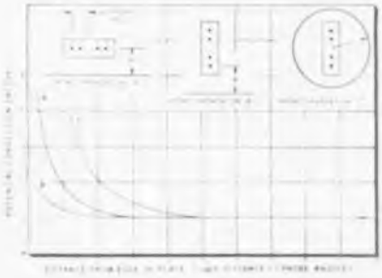


Fig. 7: Correction factors for small dimensions

TABLE 1 EFFECT OF METAL CONDUCTIVITY ON TOTAL CONDUCTANCE OF WAVEGUIDE WALL

Metal	Absolute Conductivity (Microhm-cm)$^{-1}$	Relative Conductivity with respect to Stainless Steel	Nominal Thickness in L-band Stainless Steel Waveguide (inches)	Contribution to nominal Conductance of Completed L-band Waveguide (Thickness units)*
Stainless Steel	0.0128	1	0.037	37
Nickel	0.128	10	0.001	10
Silver	0.614	48	0.002	96
Total Nominal Conductance in Thickness Units for L-Band Waveguide				143

*One thickness unit equals 0.001 inch of 18-8 Stainless Steel of nominal conductivity

Tunable CW Magnetron

Fig. 1: Complete magnetron assembly has two outputs and tuning cavity coupled to anode cavity

Complete data on developmental UHF-TV transmitting tube features coupled-cavity tuning. Stable operation adjustable over 60 MC range achieved at outputs up to 20 kw

By D. E. NELSON, Tube Department, Radio Corp. of America, Harrison, N. J.

THE RCA developmental magnetron described here was designed to give 10 kw. of continuous-wave power at a frequency of 825 MC. Early in the development it was decided that the tube should be tunable, and the present model includes a tuning cavity coupled to one of the magnetron cavities. An adjustable diaphragm varies the capacitance of the tuning cavity and permits tuning over the range of 785 to 845 MC.

The tube is designed to be plate modulated for UHF TV transmitter service. Frequency control during plate modulation is maintained by the injection-locking system developed by L. L. Koros.[1] This system has been successfully applied to a 1 kw. magnetron providing an incidental phase modulation of less than 25° for 85% plate modulation with an injection power equal to 10% of the peak magnetron power.

Anode

The vane-type anode having ten resonators with conventional double ring strapping, shown in Fig. 2, is similar in design to that used in a 1 kw. FM magnetron previously described.[2] The unstrapped anode capacitance is 13.5 μμf, the strap capacitance is 14.3 μμf, and the inductance-to-capacitance ratio (L/C) is 47. This anode is designed for use with a magnetic field of 400 gausses; the ratio of this magnetic field to the characteristic magnetic field of the anode (B/B_0) is 2.6. The diameter of the anode is 1.625 in., and the diameter to the back of the resonators is 4.825 in.

The untuned pi-mode frequency of the anode is 831 MC and that of the n = 4 mode is 1350 MC. The mode separation, therefore, is 62%. The unloaded Q of the anode is approximately 2000. The tube is normally loaded to provide an external Q of 75 to 100. For values of Q within this range, the circuit efficiency is 95 to 97% and the bandwidth is 8 to 11 MC.

The anode is watercooled by means of a waterjacket around the anode shell.

Coupled-cavity tuning is used, primarily because it provides good performance at low cost. This type of tuning does not require close spacings and, therefore, eliminates the necessity for precision drive mechanisms. The disadvantage of this tuning method is the possibility of oscillation in one of the two additional pi-modes which are introduced.

Tuning is accomplished by means of a reentrant cylindrical cavity coupled to one of the magnetron anode resonators, as shown in Fig. 3. The tuning-cavity capacitance is varied by the movement of a diaphragm which approaches the center post of the cavity. Because the diaphragm is stressed beyond its elastic limit, a bellows is provided in back of the diaphragm to complete the vacuum envelope.

A set of cold-test tuning curves is shown in Fig. 4. As mentioned above, the coupled-cavity tuning introduces additional pi-mode resonances above and below the main tuning curve. Evaluation of cold-test data was necessary to obtain a tuning-cavity geometry which would insure operation in the main mode.

Valuable information concerning

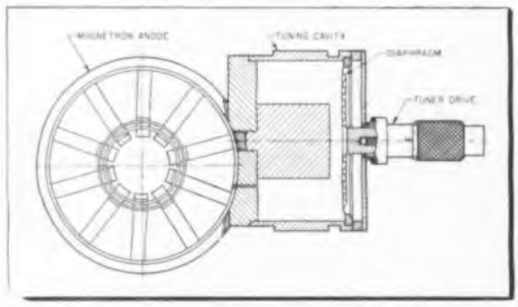
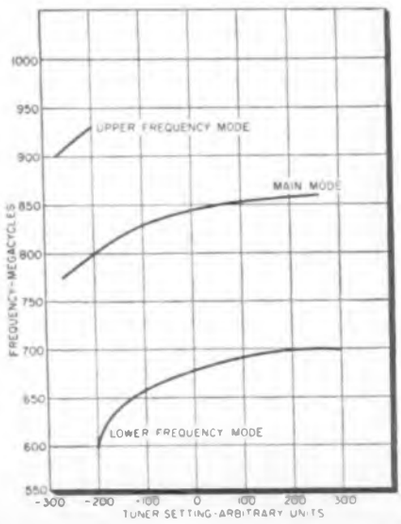
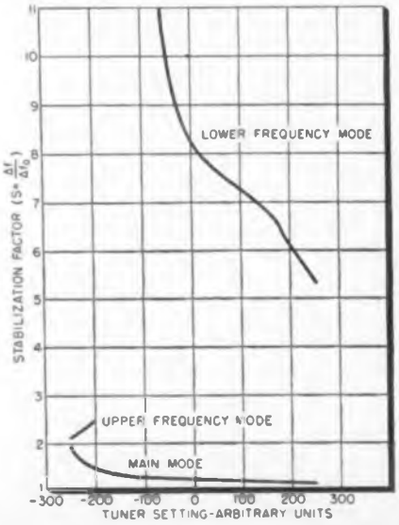


Fig. 2: (l) Ten-cavity, vane-type anode Fig. 3: (r) Tuning cavity is coupled to anode resonator

Fig. 4: (l) Cold-test curves show mode operation Fig. 5: (r) Stabilization in three π-modes





Designed for UHF

the mode in which the magnetron will operate may be obtained from cold-test measurements of the stabilization factor S. This factor may be defined as the ratio of the energy stored in the anode and the tuning cavity to the energy stored in the anode.[3] Fig. 5 shows the variation of stabilization factor in the three pi-modes of operation. The tube usually will operate in the mode having the lowest stabilization factor provided the output circuit and the load have a bandwidth covering the frequencies of all the modes. If, however, the load or output circuit has limited bandwidth, the tube tends to operate in the mode having the highest ratio of loaded Q to stabilization factor (Q_L/S). This mode selection criterion is based on the fact that if a multi-mesh, self-oscillatory system has possible more than one mode of resonance, it will operate in the mode which requires a minimum dissipation from the power sources present in the system.

The stabilization factors of the three pi-modes were varied primarily by changes in the diameter of the cavity center post and, to a lesser extent, by changes in the length of the cavity and the center post. Changes in the iris produced marked changes in the tuning ranges but permitted little control of the stabilization factors.

Output Connection

The output connection utilizes a conventional glass-kovar seal designed to work into a 52-ohm 3⅛ inch coaxial line. The kovar parts used in the output lead are copper plated after the glass-to-metal seals are made. The output assembly is shown at the right and left in Fig. 1. This assembly is r-f brazed into a stud projecting from the anode, and may be removed if a seal fails or if a change in the degree of coupling is desired. This seal has been used with the magnetron operating into a matched load at a continuous power output of 20 kw.

Cathode

The oxide-coated nickel-mesh cathode which was originally used operated satisfactorily at power outputs of 2 to 4 kw., but its operating temperature was too high to provide adequate life, even when the heater input power was reduced to zero. At a power output of 10 kw., the end shields of the cathode began to emit, and this emission increased progressively. After a few hours' operation

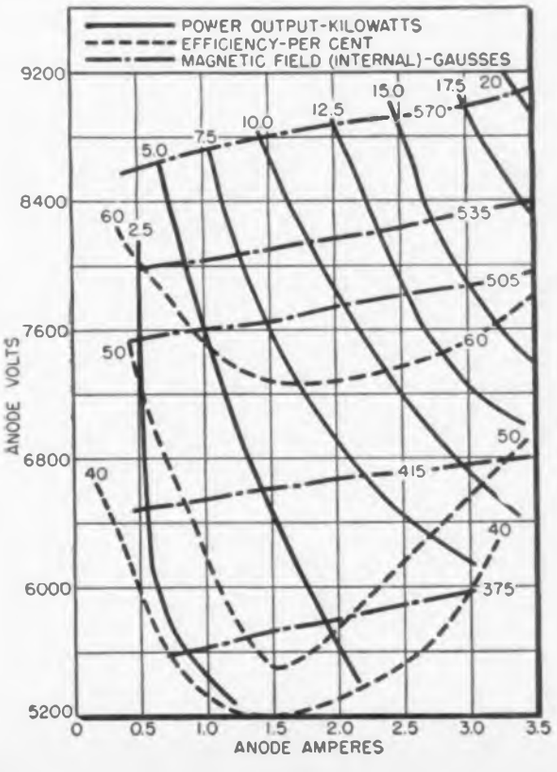
Fig. 6: Cathode is mounted in top cover assembly

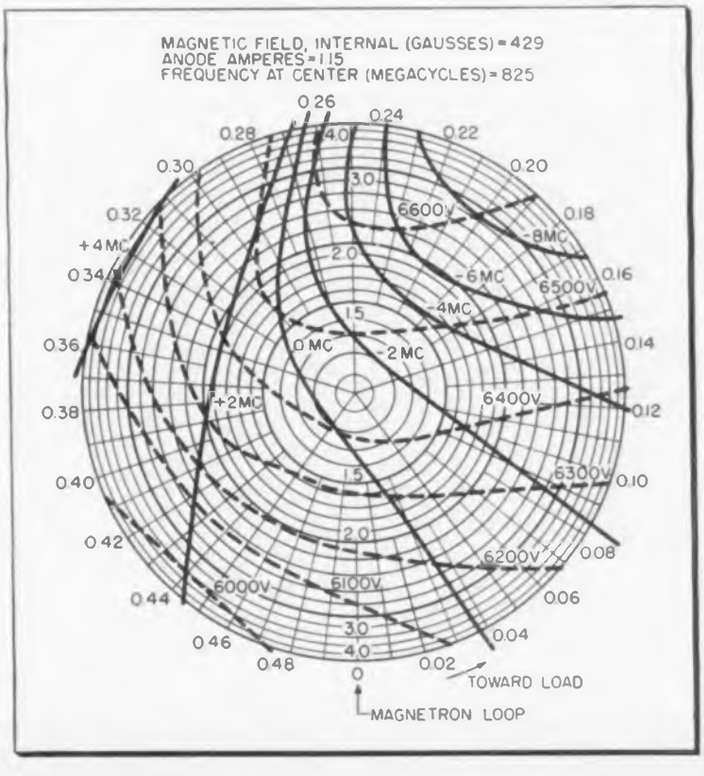
at 10 kw., the leakage current from the end shields became so great that oscillation ceased. Heavier cathodes and cathode leads were used to obtain greater conduction cooling, but the improvement was disappointingly small. Because it was desired to avoid the necessity of water-cooling the cathode, a thoria-dispenser-type cathode which could operate at higher temperatures was substituted.

A thoria-cathode, top-cover assembly is shown in Fig. 6. The cathode consists of an outer cylinder 0.700 in. in diameter and 2½ in. long, which is perforated with several hundred 1/32 inch-diameter holes and an inner cylinder, spaced 0.100 in. from the inner surface of the perforated sleeve, which provides a

(*Continued on page 150*)

Fig. 7: (l) Performance chart for new magnetron Fig. 8: (r) Rieke diagram shows loading considerations





Frequency Response

Upper frequency limit is found to be determined by ratio of wavelength to magnetic oxide particle size

By ***WALTER T. SELSTED & ROSS H. SNYDER***
Ampex Corporation
Redwood City, Calif.

THE frequency response characteristics of magnetic recording tape itself are essentially unlimited, since the magnetic medium can accept magnetic flux impressions at an extremely high rate, a rate whose upper limit may reasonably be estimated at many megacycles, since the medium is a form of powdered iron.

The practical limit to frequency response of the magnetic tape medium is, at the present time, much less than this. One limit is imposed by the minimum wave length which can be recorded and reproduced, which represents the highest frequency which can practically be handled by the equipment.

This minimum wave length may be determined by the ratio of wave length to tape surface roughness and magnetic oxide particle size, if an infinitely small reproducing gap be assumed.

The minimum wave length may also be determined by the smallest output signal from the playback head which will yet maintain the necessary signal-to-noise ratio in a given application Reduced penetration of the magnetic coating occurs as recording frequency increases, and this, with other effects, results in a declining response toward the upper band-pass limit, despite the effect of increasing rate of flux change, so that, regardless of our ability to keep gap size small with relation to minimum wave length on the tape, the output voltage from the playback head may decline toward the upper end of the spectrum to the point where, when related to irreducible system noise, it is unusable.

For presently available tape coatings, this point of minimum wave length is approximately 0.000125 in. measured longitudinally along the tape. This may be taken as representing a full wave length, beyond which a further reduction in recorded wave length will result in output from the playback head very rapidly approaching zero. At a tape speed of 100 ips, for example, the frequency at which these effects limit response is 800 kc.

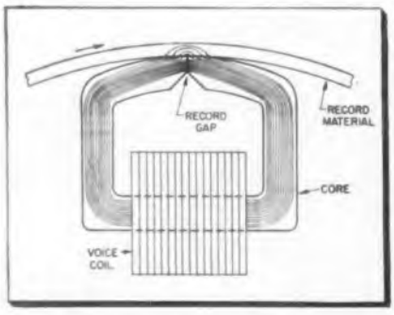
Skew Effects

There is still another practical limitation on useful frequency response which at the present time appears even more commanding. A very small amount of skew in the manner in which the tape passes the record and playback heads, at very short recorded wave lengths, introduces gross reductions in high frequency output. The magnitude of this effect may be judged from an example.

$$\phi = \tan^{-1} \lambda - y/x$$

Where

ϕ = the angle of skew



Lines of flux in record head and gap

λ = the wavelength on the tape

y = gap size

x = track width

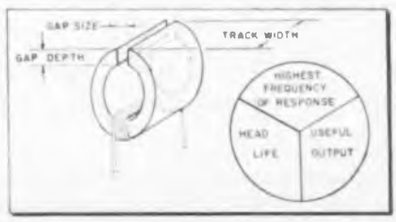
Now, tape in current production is held to widths of ¼ in., +0, −0.004 in., a variation which is remarkably small and involves extreme precision in manufacture. It is, nevertheless, large in proportion to the effects we are considering here, and this should be borne in mind, even though for the purposes of this example it is ignored.

From the above it may be seen that even if we deal with a gap size of 0.0001 in., with tape ¼ in. in width, in a transport mechanism producing zero skew in the tape guidance, ϕ becomes $\tan^{-1}$ 0.0001, and ϕ is 20 in. of arc. Alignment of record and playback gaps would, then, necessarily be held to tolerances much less than this, since 20 in. of misalignment is that degree of skew which will produce zero output at the minimum (0.000125 in.) wave length. This means that if either end of the gap were as much as 25 μin. off the ideal centered position, the head output would be zero at the desired highest usable frequency. The practical result of imposing such impractical tolerances is that the output from recorded frequencies in the vicinity of the 0.000125 in. wavelength will vary grossly in amplitude with time and position. Such commonly encountered factors as the mechanical history of the tape, temperature, humidity, width variations in the tape, and warpage of the transport mechanism will all greatly aggravate the effect.

Three Considerations

Aside from those factors which must be considered in attaining the maximum extension of frequency range, we must also consider the practical requirements for useful head life and useful output, all three of which are inter-related. Every application dictates its own division among the characteristics of head life, useful output, and highest frequency of response, and in every different application good engineering practice requires the optimizing of these for the application. For example, in direct magnetic recorders for audio purposes, a tape velocity of 7½ ips can produce a frequency response of plus or minus 2 db from 50 to 10,000 cps plus or minus 4 db from 30 to 15,000 cps, with signal-to-noise above 55 db on a wide-band basis, using ¼ in tracks, with a head whose gap size

Design of record head hinges on three factors



Characteristics of Magnetic Tape

is 0.00025 in., gap depth 0.035 in. A realistic life expectancy for such a head is of the order of 10,000 hrs. Thus, extremely desirable characteristics in every direction are realized by appropriate arrangement of design parameters. (See Fig 4.)

S-to-N Ratio Limits

Direct recording methods are most widely used for audio purposes because they offer the highest signal-to-noise ratio with wide-band frequency response, commensurate with tolerable equipment and medium costs. In this type of recording the signal-to-noise ratio limit is imposed by the nature of the tape itself. It is true that even wider band-pass and higher signal-to-noise ratios may be obtained with the use of redundant FM recording systems, but at vastly increased cost.

The maximum signal level to which signal-to-noise ratio is referred is generally taken as that point at which total harmonic distortion (primarily third) is 3% due to the approach of tape saturation. The background noise, which in the case of present day red oxide tapes is approximately 65 db below the 3% point measured on a conventional wide-band basis, is due primarily to minute variations in the residual magnetic flux surrounding the particles of oxide. These vary slightly in size, slightly also in permeability, resulting in random noise output from the heads, whose sensitivity is to the rate at which these flux variations occur. Its characteristic is that of "white noise." It is generally far less objectionable to listeners than clicks and pops which are associated with dust particles and electrostatic effects on phonograph records. A secondary source of noise associated with magnetic recording is known as "modulation noise" or "noise behind the signal" and is due in part to non-homogeneity of the tape coating, and in part to the flutter of the tape drive system. Since flutter is speed change, the rate at which flux changes across the magnetic playback gap occur is altered by flutter effects, the alteration appearing as noise when a flux pattern exists on the tape, but not in its absence, hence this type of noise appears only in the presence of recorded signals and proportion to it, and is not included in the basic noise of the system in the absence of signal. Non-homogeneity of the tape can be due to coating difficulties and non-uniform distribution of oxide-binder mixture—there is, after all, a limit to the precision with which the coating may be mixed and applied. The contribution to modulation noise which is made by non-uniformity of coating has been progressively reduced by tape manufacturers in recent years.

Amplitude Variations

Non-uniformities in tape which cause major or minor amplitude variations are of varying degrees of importance to the different recording methods mentioned. Variations in the amplitude of reproduced sig-

(*Continued on page* 134)

Preview of International Instrument Show

THE First International Instrument Congress and Exposition, sponsored by the Instrument Society of America, will be held at the Commercial Museum and Convention Hall, Philadelphia, Penna., Sept. 13-24, 1954. Featured will be equipment exhibits by 450 domestic and foreign companies, the Instrument Maintenance Clinic, and an extensive technical paper program arranged by 12 technical societies in cooperation with ISA.

Commercial Museum & Convention Hall, Philadelphia, where Instrument Show will be held Sept. 13-24

The Exposition by 450 firms will be held on Sept. 15-21, closed on Sept. 19. The complete exhibit represents 70,000 sq. ft., and admission is free.

The Instrument Maintenance Clinic will run for three consecutive days starting Sept. 17. Four simultaneous schedules of instruction will be presented at the Univ. of Pennsylvania. The Clinic is open to members of ISA and cooperating societies (including IRE, AIEE, ASME and American Institute of Physics) without charge. Non-members will be charged $5.00. Clinic registration can be made by writing to P. V. Jones, Manager, Instrument Society of America, 1319 Allegheny

(*Continued on page* 116)

Air view of the National Bureau of Standards' Central Radio Propagation Lab at Boulder, Colorado. Buildings in the background, also part of center, are portions of the NBS-AEC Cryogenic Engineering Lab

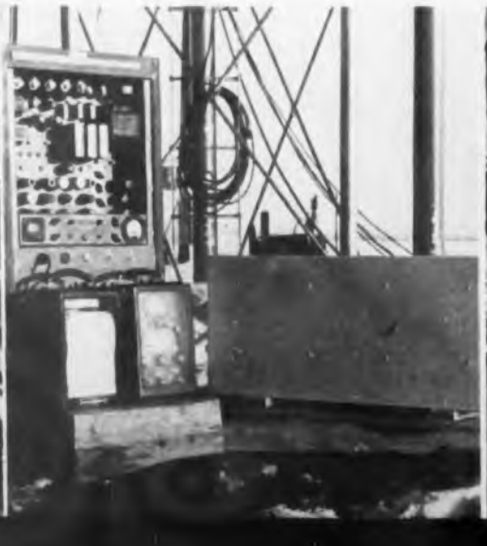
Radiosonde is suspended from a free balloon and telemeters data on weather conditions

NBS Spurs Research

Mobile research unit is used to determine the range of transmitted signals and interference

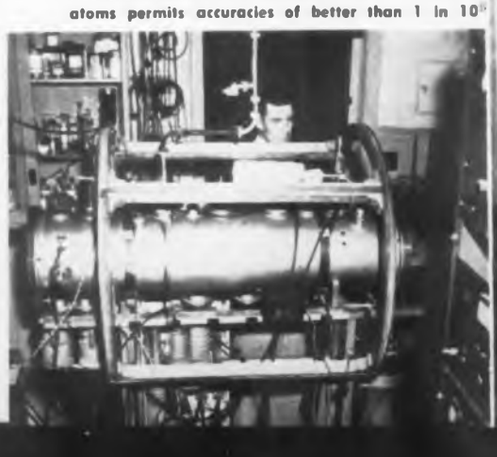
Analogue computer for solving the radio refractive index equation, a product of CPRL research

(l) NBS model antenna range is largest of its kind. V-structure supports target transmitter at vertex.
(r) NBS' frequency standard is more accurate than earth's rotation, needs periodic corrections



(l) Microwave components of NBS refractometer. In operation, unit is raised to top of 500 ft. tower.
(r) Microwave refractometer measures the refractive index of lower atmosphere for propagation study

NBS atomic beam clock. Controlled beam of cesium atoms permits accuracies of better than 1 in 10^{9}



Three giant Wurtsburg antennas at Gun Barrel Hill, Colorado, NBS field station, are arranged to receive signals of a certain frequency radiated from the sun and to track the sun across the sky

NBS radio broadcasting station WWV, Beltsville, Md. Signals reach all parts of the world

Station WWV. Transmitted signal is controlled to accuracy of two parts in 100 million

in Radio Propagation

New laboratories to coordinate government operations

AS the nation's central agency for collecting radio propagation data, the Central Radio Propagation Laboratory (CRPL) of the National Bureau of Standards, analyzes and disseminates information that aids reliable global aviation, all-weather shipping and harbor control, and worldwide communications. The Laboratory's studies of frequency allocation and interference affect the establishment and operation of AM, FM, and TV broadcast stations. Data on ultra-high-frequency radio propagation and the development of improved microwave methods are important to the Weather Bureau and military aerologists for use in upper-air temperature, humidity, and wind measurements. Accurate measurement methods and standards maintained by CRPL are essential to studies in many branches of engineering and physics. Also, many industrial applications of radio require CRPL standards and measurement techniques. In order to more effectively serve these interests, the National Bureau of Standards is establishing a new multimillion-dollar radio research laboratory in Boulder, Colorado.

Radio propagation studies were formally begun at the Bureau in 1909 with the measurement of low-frequency radiations. The studies were extended to include higher frequencies after the basic demonstrations of ionospheric reflection of radio waves in 1926. Full achievement of the value of systematic collection of radio propagation data was not accomplished until the Combined Chiefs of Staff (U. S. Armed Forces) established the "Interservice Radio Propagation Laboratory" (IRPL) at NBS in the spring of 1942.

Although the need for coordination was apparent, the magnitude of the task was too complex to achieve success in one organizational step. Accordingly, on May 1, 1946, the Central Radio Propagation Laboratory was established as one of the technical divisions of the National Bureau of Standards. A Radio Propagation Executive Council, organized to formulate general policy, included representatives of the Army, Navy, Air Force, FCC, CAA, Coast Guard, State Department, and the radio industry. Besides the existing IRPL functions, the new Laboratory assumed the duties of the NBS Radio Section. These included the maintenance and development of radio standards, the operation of radio broadcasting station WWV, and

(*Continued on page* 152)

Three-cavity klystron transmitter on top of Cheyenne Mt., Colo. aids tropospheric research

NBS field station near Boulder is WWV monitor, also acts as ionosphere probing station

NBS microwave adjustable frequency standard, for calibrating secondary standards

Designing Scale Model Aircraft

Part One
of Two Parts

Accurate predictions of antenna performance depend on precise duplication of the physical contours and electrical characteristics of the aircraft

By ROBERT F. BLAINE
Creative Engineering Corp.
10816 Burbank Blvd.
N. Hollywood, Calif.

Fig. 1: (l) Test range with dish antenna in rear. Fig. 2: (r) Radiation is scribed in control room

DURING the last ten years or so, the use of scale model aircraft to obtain radiation pattern information on scale model antennas has become an increasingly important part of the aircraft antenna designer's technique. It can be shown theoretically that certain conditions may be imposed using Maxwell's equations which describe the propagation of radio energy, keeping constant relationships between physical sizes and frequencies involved. If these conditions are properly met on scale model antennas on scale model aircraft, reasonably accurate radiation pattern information can be obtained. (The procedure is seen in Fig. 2) If the aircraft is scaled down in size and if the size—wavelength—of the incident energy is also scaled down in the same ratio, all other factors (except the conductivity of the skin of the aircraft) can be allowed to remain as they would be in the full scale aircraft. To preserve the applicability of these equations, as the aircraft is scaled down in size the conductivity of the aircraft skin should be changed in the inverse ratio. In other words, the conductivity of the surface of the aircraft should be increased in the same ratio. This is an almost impossible condition to meet, particularly if the scale factor is, say, 2 to 1 or greater, and it is one of the problems which is not even approximately solved today. This shortcoming will be discussed later as some model making techniques are outlined.

Equipment

To begin with, a typical outlay of equipment as generally used for recording scale model radiation patterns from a model aircraft consists of a fixed directional transmitting antenna supplied with energy from a suitable signal generator, a nonmetallic support of a design which allows the model to be rotated and which support itself can be rotated, either rotational motion being independently controllable so that the model in effect can be "viewed" from any angle by the transmitting antenna. For recording, a detector, amplifier, and a suitable recorder linked by servo systems to the model and the tower rotators are provided.

Supporting Tower

One of the most important pieces of equipment is the tower, or support for the model. This constitutes the highly critical immediate environment in which the antenna is examined. Ideally the aircraft and antenna combination should be examined under conditions equal to their flight in free air, separated from all factors which could cause reflection or refraction of the radio waves. It is desirable to use a tower which is as nearly "transparent" as possible, simulating air. Towers made of fiber-glass reinforced resin as used in radome structures and having plastic gears, shafts, and bearings for accomplishing the rotational motions, together with certain other provisions such as high resistance audio cable have been found to be satisfactory for scale model antenna studies.

Most generally the models used in a number of leading antenna laboratories measure around 2 to 8 ft. in major dimensions, corresponding to scale reductions of, say, $\frac{1}{50}$th to $\frac{1}{10}$th. (See Fig. 1) The scale size of the model depends on the frequencies to be used in the measurements and those frequencies are in turn governed to considerable extent by the size of the tower on which the model is supported. This size imposes limits on such variables as separation between the transmitting antenna and the model antenna being investigated, distance above ground, and others. Frequencies in the order of 1000 MC, corresponding to a wavelength of 11.8 in., and higher are usually required to minimize the effects of ground reflections and the reflections caused by nearby objects such as the tower's own base, there being practical limits on the size of these plastic structures. A tower in use at a number of laboratories active in pattern measurement is shown in Fig. 1 with some of the basic relationships between the principal elements of an antenna pattern range shown. A model of approximately $\frac{1}{20}$th scale is shown mounted on the tower.

for Antenna Analysis

Because of the nature of the plastic structure of this type of tower there is a weight limitation on models. Generally 50 or 60 lbs. is considered near the limit if the model is reasonably well balanced. Unbalanced models may have to be kept to as little as 25 lbs., in some instances, to obtain smooth and satisfactory motion. Here wind velocities may become a factor as the surfaces of a good sized model present considerable resistance to the breeze. Gust loads may rise to troublesome levels.

Copper Clad Models

Models in use most generally today are of two general structural types. Hollow wood elements with metallized copper surfaces predominate and formed sheet copper elements are called for in some cases.

Fig. 3: Jet model has copper metallized skin

The former type is built of fine grain medium weight wood, formed and contoured from accurate templates, and a "skin" is then applied as copper foil or by flame spraying zinc and then copper evenly over the surface. (Fig. 4 and 5) The application of molten metal on wood requires a special technique in order to avoid subsequent separation because of weather changes, moisture, handling, soldering, and other conditions. This bond has been attained and today gives very satisfactory results.

The metallized copper skin on wood type of model at first had many shortcomings, but today the techniques developed by at least a couple of western model making laboratories provide acceptable conductivity factors for most pattern work, and accuracy of high order. Small scale model antennas can be easily installed, moved, or changed with a minimum of laboratory time and weights as low as 28 lbs., for models with almost 10 ft. major dimensions are in use. Soldering can be done by using careful cleaning and proper flux. Removing excess flux is not difficult and should be done as the virgin copper is very susceptible to oxidation—corrosion. Ordinary medium to low wattage irons, preferably of the smaller size, work well and a light quick touch is best.

Models built up from soft copper sheet, formed in somewhat the same way as the body and fender man works, are in some use, but this method leaves quite a bit to be desired in both scale accuracy of contour and in certain strength requirements at stressed or attach points. They furthermore frequently run into pretty high cost brackets if accuracy is critical for the studies involved.

Deposited Copper

Also in the second general type classification are models built by a variation of the lost wax process wherein contours are established on plastic or wax and the copper skin is deposited electrolytically to a desired thickness. Keeping the thickness of the electroformed skin constant poses a somewhat complicated problem, especially where a complex configuration of the model's surfaces exists. The cost of this type of electroforming is very high as a rule, and complex models using it are apt to cost as much as $20,000 or more for scale sizes with major dimensions in the 6 ft. class. Better techniques and cleaner aircraft configurations are acting to improve this cost somewhat.

Fig. 4: Cut outs simulate glass windows

On the other hand, models of wood with metallized skin, even to such close scale tolerances as .005", are costing laboratories between $1000 and $3000, depending on size and complexity.

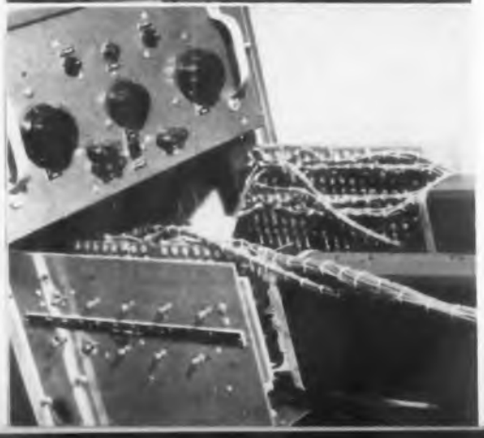
With some emphasis being put on larger models for pattern work, a new method is coming into use which involves the use of plastic foam, "sandwich" elements with fiber glass reinforced polyester resins, and either of the metal skin applications mentioned above. Some of the techniques involved are fairly complex, but the gain in size-weight advantage is almost unbelievable. Models with spans or lengths as great as 20 ft. are being made possible at weights well under 100 lbs. Costs, especially where complex electroformed skins are applied run very high—on the order of $35,000—reflecting also the high man-hour factor of the method.

Fig. 5: Super-Constellation to 1/50th scale

The detail and dimensional accuracy of any scale model can be only as great as that given in the engineering data and prints furnished the model-maker. Because templates are used in the process of fabricating virtually every model regardless of what type of construction is used, their preparation is of prime importance, toward both time saving and accuracy of patterns. Herein lies one of the keys to fast model fabrication and of course, cost.

Really good liaison between engineering and the antenna test group (including its model makers) can avoid losses in time and gains in model costs. An accurate model can be made from two or three well done drawings, if they simply give all key dimensions, angles, and sufficient well chosen profiles and section cut lines.

Part Two Will Appear In The October Issue



Portable Calibrating

Periodic re-calibration of production line indicating instruments is made possible by this mobile unit which has an accuracy 5 to 10 times the instruments being tested

By FRED J. LINGEL
Electronics Laboratory
General Electric Co.
Syracuse, N. Y.

QUALITY production of electronic devices requires maintaining accurate production test equipment and a very important factor in this equipment is the electrical indicating instrument. In normal use, most instruments will maintain their accuracy for a number of years. However, in production test panels this may not be the case. Here because of abnormal conditions such as mechanical shock in moving test setups, possible exposure to motor and transformer fields, extreme overloads due to faulty units, etc., the indicating instrument may be damaged.

This damage may often go unnoticed at the time, although the instrument may be off calibration by as much as 20%. Errors of this type may be caused by broken pivots or jewels, bent pointers, off balance, pulled down magnets, shorted multiplier resistors, etc.

Minimizes "Down Time"

To help insure accurate production test equipment, it is advisable to periodically check the indicating instruments against standards which have an accuracy 5 to 10 times the instruments under test. This check should preferably be made with the test panel in its normal operating location for two reasons. First, to minimize "down time" during check and second, to make certain all the factors which could normally influence the reading are acting on the instrument at the time of check. Some of these factors are panel material, meter position, heat and magnetic fields.

A portable calibration standard to check the production test units was designed and constructed by the Electrical Section of GE's Electronic Laboratory. One unit of this type has been in use by the Government Equipment Dept. at Electronics Park for over two years. A second unit recently completed is in use at the Utica Works.

Fig. 1: (top left) Portable calibrating standard
Fig. 2: Meters are sponge-mounted in shelf
Fig. 3: Meters can be removed for remote checks
Fig. 4: Resistors are easily accessible

Description

The portable calibrating cart is designed for in-place voltage and current checks of small panel meters and test equipment. It contains 0.2 of 1% standard meters with all necessary controls and power supplies.

Ranges:
AC volts 1.2; 3; 6; 12; 30; 60; 120; 300; 600; 1200 (60 or 400 cy)
AC amperes 15; 30
DC amperes 1.2; 12; 30; 60; 120
DC milliamperes 1.2; 12; 60; 120; 300; 600
DC Microamperes 60; 120; 600
DC volts 1.2; 3; 6; 12; 30; 60; 120; 300; 600; 1200

VTVM check may be made by means of a precision attenuator for additional ranges of 0.0012 v. to 0.12 v. full scale on 60 or 400 CPS.

Ohm checks for multimeters may be made by means of precision resistors with values of 1; 10; 100; 1000; 10,000; 100,000; 1 meg.; 10 meg; 100 meg.

Cabinet

All the equipment is contained in a steel cabinet, 3 ft. x 5 ft. x 19 in. with a 2-ft. projecting shelf for the instrument standards as shown in Fig. 1.

Ball bearing type rubber tired wheels are provided for easy motion to the various positions. The Variac control panel and standard instrument box are removable as a unit and may be mounted adjacent to the meters under test where space does not permit rolling the whole cart. The weight of the complete unit is approximately 1000 lbs.

Standards

The standard meters are normally mounted in a wooden case in the shelf portion of the cart on a sponge rubber pad, as shown in Fig. 2. The

Standard Checks Test Panel Accuracy

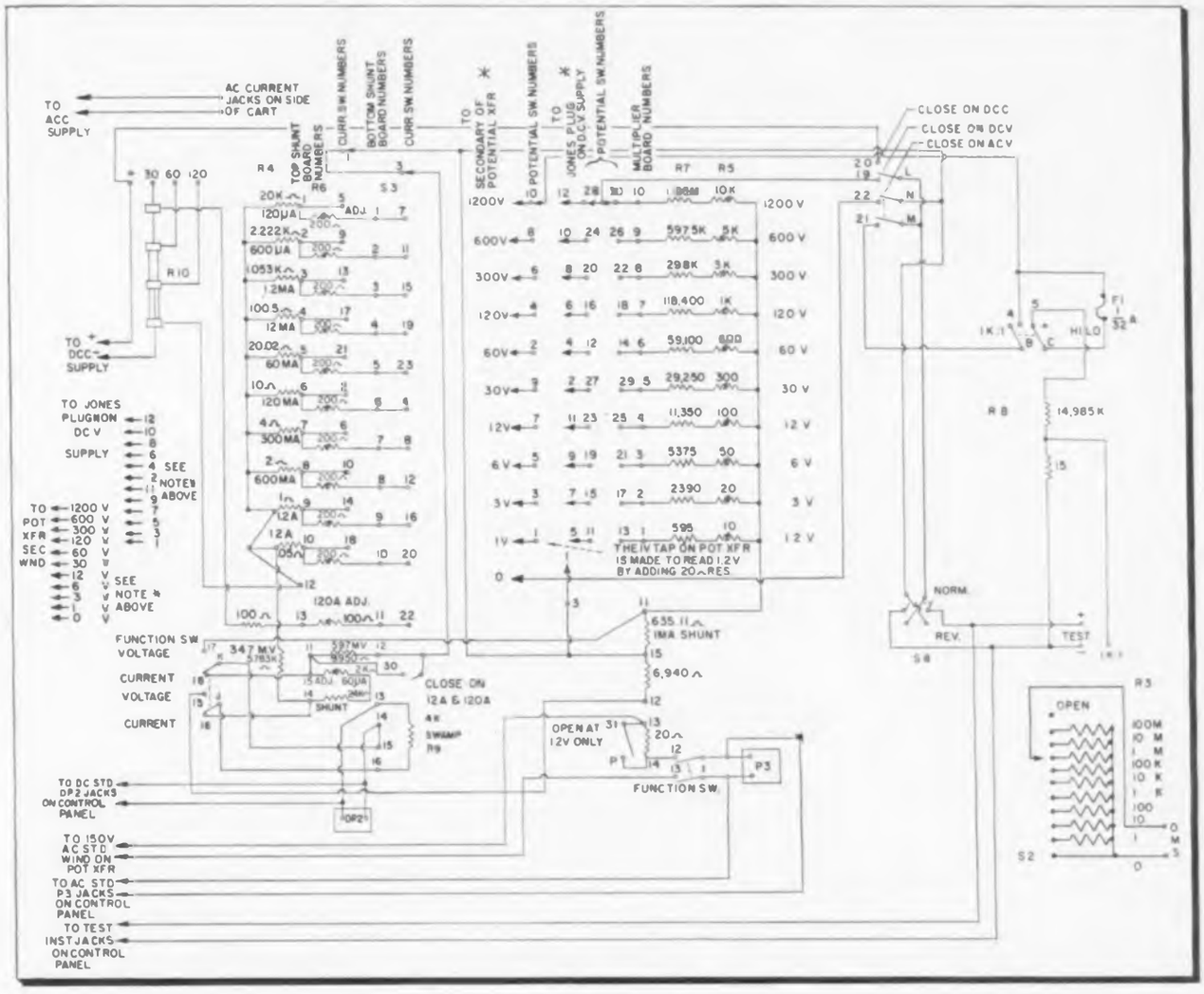


Fig. 5: Schematic diagram of measuring circuit and secondary power distribution

shelf portion of the cart is recessed to keep the standards horizontal and to permit the addition of lighting such as by a small fluorescent lamp along the top underside of the shelf.

The AC meter is a General Electric 0-150 volts; 60-400 cycles; P-3 with a fundamental accuracy of ±0.2% of full scale. A special potential transformer provides the necessary additional ranges and output voltages to give an overall accuracy including the meter of ±0.4%.

A precision voltage divider has its output connected directly to the 1K:1 binding posts to eliminate stray pick up. This direct connection helps make possible accurate VTVM checks down to 1.2 mv full scale.

The dc meter is a G.E. 0-50 microammeter with a fundamental accuracy of ±0.2% of full scale. Ring shunts with Standard Electric Time 100 a. jack connections are provided for the 30, 60 and 120 a. ranges. The 30 a. shunt was made from 3 parallel 20 in. sections of 0.128 in. D. manganin wire and the 60 a. shunt from 2 parallel 12 in. sections of 0.160 in. D. manganin wire. The 120 a. section uses a standard 500 mv 100 a. shunt.

The remaining current and voltage range shunts and resistors are connected in circuit by means of G.E. type SB-1 transfer switches to give an overall accuracy including the meter of ±0.4%. The millivolt drop on the dc current range is 1200 mv for the ranges 60 μa thru 12 a. and 600 mv for 30, 60 and 120 a.

Adjustable Multipliers

Each dc voltage multiplier is provided with a small wire wound adjustable series resistor for adjustment. Each current range has a 200 ohm adjustable resistor in the mv circuit for calibration of each individual range. These adjustable resistors are mounted on the sides of the sliding shelf as shown in Fig. 4. Here they are easily accessible for adjustment yet completely enclosed

Calibrating Standard (Continued)

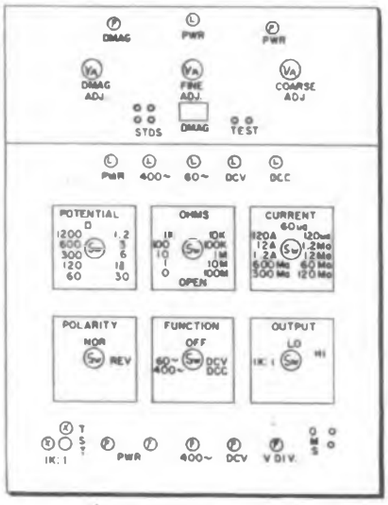


Fig. 6: Front panel layout of calibrating cart

within the cart walls when the cart is in use.

A double range 15/30 AC Ammeter, a G.E. P-3 may be connected in circuit when necessary for high ac current checks. Other ac standards up to 120 a. with or without a current transformer may also be used. AC current standards are normally not supplied, except the 15/30 ammeter.

A Leeds & Northrup instrument switch provides quick connection to ±1.0% composition resistors for ohmeter checks in the range of 1 ohm through 100 megohms.

A detailed diagram of the measuring circuit and the secondary power distribution is shown in Fig. 5.

Remote Checking

The Variac control panel and Standard meters may be removed from the cart for remote checking of small panel meters in test units as shown in Fig. 3. This procedure is followed where it is inconvenient to move the whole cart. When operated in this way, the Function and Range switches are set on the cart and the Coarse and Fine controls set at the remote position. A 12-conductor cable plugs into the back of the Variac control panel and connects to the cart. This provides the necessary power, range resistors, etc.

The standards may also be removed for checking or for shipping separately when the cart is moved by truck between buildings.

All power supplies are self contained and operate from any convenient 15 a., 110 v, 60 cps single phase outlet. All voltages and currents are continuously adjustable from the same control panel with both coarse and fine control Variacs. The fine control Variac is connected to the output of the coarse control and feeds the primary of a 10 v filament type transformer. The 10 v secondary is then connected in series with the power supply input to permit constant percentage fine control over the full range of the coarse control Variac. This facilitates accurate setting of instrument readings over the full range of the cart. Front panel layout and markings are shown in Fig. 6.

Voltage Regulation

Ample input voltage regulation is provided by a large capacity Sorenson model 1000S voltage regulator.

Important circuits are fused from the front of the panel and pilot lights are provided to help insure correct control settings for the various tests.

For maximum safety, the cart chassis is grounded to the 3rd wire of the 3-wire 110 v plug. All circuits

(*Continued on page* 126)

New Automatic Electronic Assembly System

AUTOMATIC assembly of electronic equipment may be the outcome of a machine development which has recently been demonstrated by the United Shoe Machinery Corp., 140 Federal St., Boston, Mass. The experimental conveyor-type machine automatically inserts resistors, capacitors, jumper wires, and eyelet-type terminals in printed circuit wiring boards. Operating at the rate of 9600 boards in an 8-hour day, United's experimental automatic assembly machine is readily adjustable to provide for changes in circuitry and components. It is mechanically straightforward and rugged equipment, designed to handle standard electronic components with simplicity of change-over and maintenance.

In its present state of development, printed wiring boards up to 5 x 8 in. are loaded by hand onto pallets or frames by which they are conveyed to each of the several inserting stations. At each of these stations, a pallet is stopped and one component automatically inserted in any desired location on the board. As it now stands the experimental machine will insert only resistors, tubular and disc ceramic capacitors, jumper wires, and eyelets. However, if United's concept of automatic assembly in the electronic field as shown in the experimental machine meets the requirements of the industry, it is expected that the now incomplete development will be carried further.

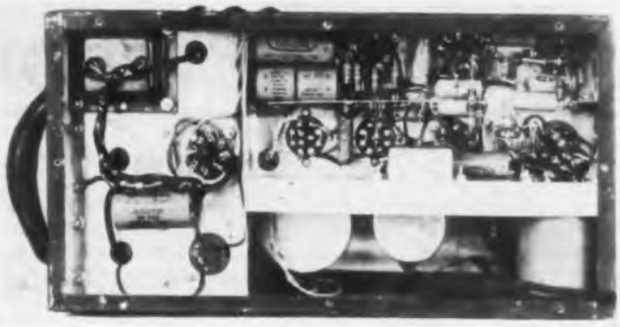
The complete system for automatic assembly of electronic equipment as United now sees it will include means for automatic placement of PW boards in the pallets, additional inserting heads for tube sockets, coils, and other components, as well as stations for dip soldering, testing, and pallet unloading, together with provision for automatic return of pallets to the loading station.

An important part of United's experimental system is the "belting" of pigtail components in order to

(*Continued on page* 128)

System for automatic assembly of electronic equipment employs several stations to insert various components in printed wiring boards

Key to automatic insertion of axial lead components is belting machine which feeds parts through lead straightening and taping sections. Belted components are then wound on reel



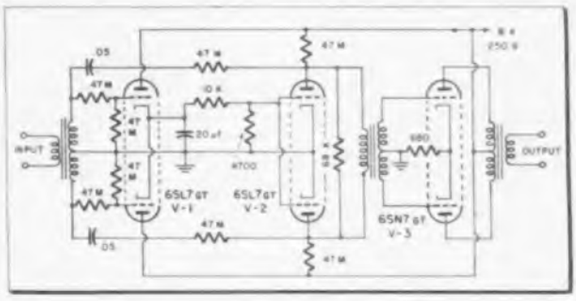


Fig. 1: (l) Underside of compact remote amplifier. Fig. 2: (r) Volume limiter for remote line is useful for 20 db input range

Remote Unit for Sportscasts

Communications type volume limiter and amplifier keep constant level even when excited voice peaks vary over 15 db. Compact unit easily constructed

By ED MILLER, Technical Director
KWEI, Box 791
Weiser, Idaho

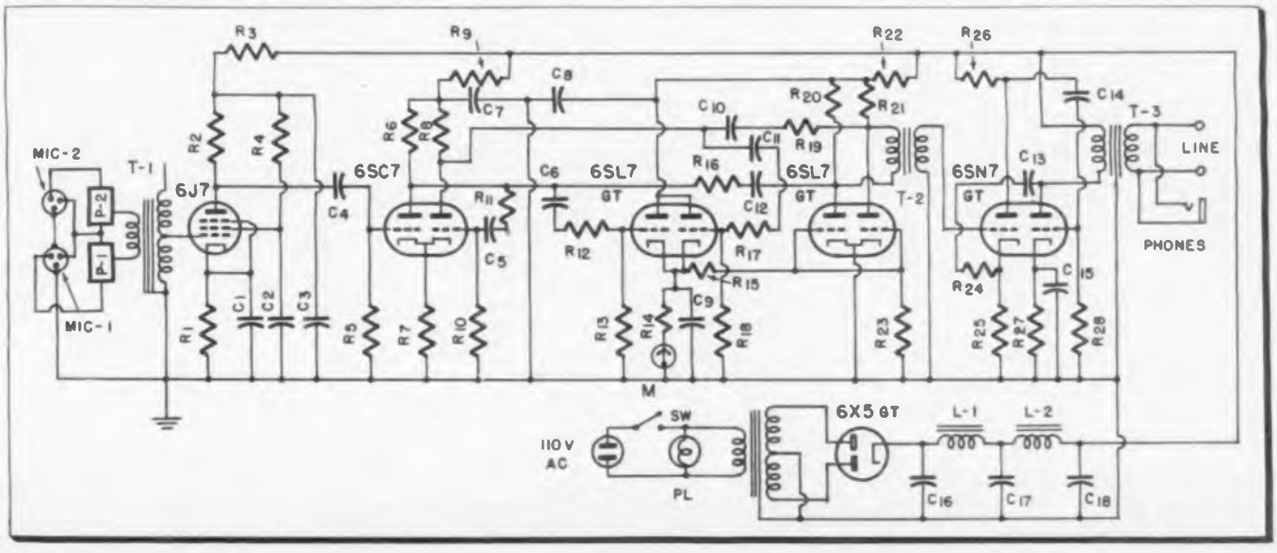
FOR the engineer in a small broadcast station, the play-by-play sportscast is often the most difficult to handle manually. Stations generally are equipped with a volume limiting amplifier just preceding the transmitter audio system, but this provides only about 5 db of compression for an output increase of 1.5 db. While this is ample for musical programs and general studio performances, it is not sufficient for play-by-play sportscasts where excitement and enthusiasm often cause the average voice peaks of the sportscaster to vary as much as 15 db.

A volume limiter such as shown schematically in Fig. 2 can be used to great advantage placed in the remote loop under these conditions. It is the forward acting type developed primarily for communications systems, but adapted for broadcast by using push-pull circuitry to allow better low frequency response without the compression transient that is produced in the single ended version. A forward acting compressor is to be preferred because it can be adjusted to provide an output with negligible increment over an input range of up to 20 db. It can be placed in the remote line, either at the broadcast station or at the remote location. The latter is desirable because it will guard against over-driving the remote line, something that must be considered when the remote program must be transmitted over a carrier-current loop.

For convenience in transporting and setting up the remote gear, the number of physical units should be kept to a minimum—preferably one. Figs. 1, 3 and 4 show a remote amplifier which includes the limiter described, associated amplifiers and the power supply built into one compact case. As is shown in the

(*Continued on page* 132)

Fig. 3: Complete circuit of remote limiter-amplifier used to keep constant level at sports broadcasts. See text for complete parts lists



New Components & Equipment

WWV RECEIVER

A receiver constructed to receive radio stations WWV and WWVH, time and frequency standard stations of NBS, is crystal controlled, having six bands at 2.5, 5, 10, 15, 20, and 25 MC, selectible

by panel switch. The circuit features dual conversion and narrow band i-f stages for maximum selectivity and image rejection. Four i-f stages insure adequate sensitivity for good reception under the most difficult conditions. A cathode coupled crystal oscillator circuit controls fine tuning for the six plug-in crystals. **Shasta Div., Beckman Instruments Inc., P. O. Box 296, St. A., Richmond, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

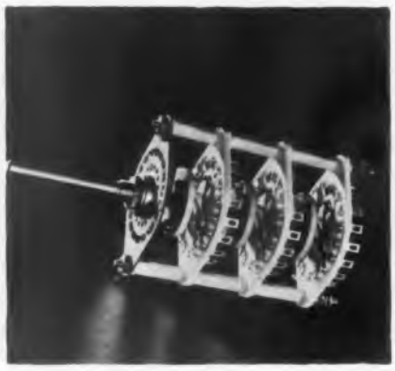
VOLTMETER

The Model 104 voltmeter for carrier system installation and maintenance measurements, covers the frequency range from 5 to 150 kc and has a frequency calibration accuracy of ±1 kc. Signal measurement range is −80 +42 dbm at 600 ohms impedance. Signal

measuring accuracy is ±2 db over the range −70 +42 dbm. Input impedance is 10,000 ohms in the pass band, and higher in the rejection band. Response is down 3 db at 300 cps off resonance, 45 db at 1,500 cps off resonance. Reads direct in dbm, and is designed for operation into an unbalanced 600 ohm line. **Sierra Electronic Corp., 1050 Brittan Ave., San Carlos 2, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

ROTARY SWITCH

The Type JV-9000 series power switch is designed to meet the requirements of medium high power, accuracy, and long life needed in transmitter, industrial control and balancing, laboratory test-



ing, power supply converter, and other special applications. Rated at 750 w at sea level (7½ amps, 60 cps, 115 v ac), 375 w at 35,000 ft. Has been used up to 20 MC. Breakdown point, 3,000 v RMS—60 cps. The unit is available in 1 pole 2 to 17 positions per section or 3 pole 2 to 5 positions per section up to six sections. **Centralab, Div. of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.**—TELE-TECH & ELECTRONIC INDUSTRIES.

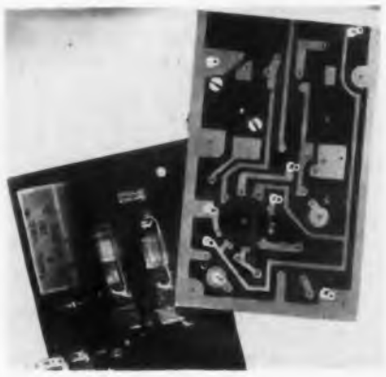
TRANSFORMERS

Linear differential transformers, designed to detect and measure linear displacement, have output with core displacement of 0.05 v per thousandth in., i.e., 0.001 v will indicate a movement of

0.00002 in. Designed for medium audio frequencies at input voltages from 3 to 10 v. Used with oscillators, oscillographs, oscilloscopes, or vacuum tubes, the units enable electrical measurement of mechanical motion in such applications as temperature and pressure variation bellows, contour surface wear, membrane motion, etc. **Gudeman Co., 340 W. Huron, Chicago 10, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES.

ETCHED CIRCUITS

"Flying M" etched circuits eliminate hand wiring by etching the desired pattern on a metal clad laminate. It is said that that the process, in many instances, saves labor costs up to 50%; and also



reduces weight and space. "Flying M" etched circuits are now in use in amplifiers, tape recorders, vacuum tube voltmeters, TV receivers, signal generators, hearing aids, transmitters, and other electrical and electronic devices. The producers of these circuits also offer many pre-fabrication services. **Miller Dial & Name Plate Co., 4400 N. Temple City Blvd., El Monte, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

POLAR RELAY

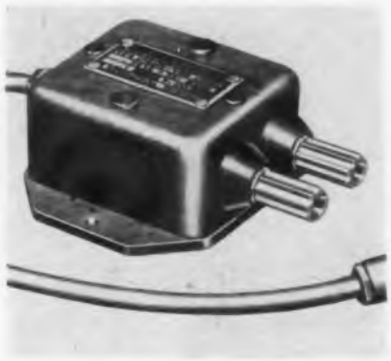
The series PTW polar relay, developed as an improved replacement for the W.U. type 17 relay, measures 2 1/16 in. in height plus ⅝ in. projection of the banana-type plug connections. The unit can be quickly and easily adjusted to

meet specified performances. Coils are in four sections. Sensitivity as low as 2 ma can be obtained by placing all coil windings in series-aiding. "Break-to-make" travel time, when the armature is in transit touching neither contact, varies with the degree of energization of the operating windings. **Automatic Electric Co., 1033 West Van Buren St., Chicago 7, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES.

New Electronic Products

COUPLING UNIT

Type 564-A coupling unit enables coupling an external oscillator in the new type 260-AQ meter for Q measurements in the audio and supersonic ranges. Input impedance—when



connected to the Q Meter—is 500 ohms; output impedance—provided by voltage injection circuit of Q meter—0.3 ohms; frequency range 1 kc to 50 kc; input voltage requirements—variable up to 22 v. Case is 1¼ x 2½ x 3¾ in. Provides binding posts for connecting the external oscillator; also a coaxial cable and BNC connector to the Q meter. **Boonton Radio Corp., Boonton, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

SERVO CONTROL MOTOR

The Model 1050 servo control motor, just introduced, was designed to operate Borg "Micropots," but can be used in other servo applications. The unit is approximately 1½ in. in diameter, 1½ in. long with a ½ in. shaft extension. Minimum locked rotor torque is 0.82

oz.-in. in either direction when operated at 115 v. Mounts firmly with three mounting screws tapped into the housing. Induction type, 2 phase, 115 v, 400 cps, 5500 rpm no-load speed. **Borg Equipment Div., The George W. Borg Corporation, 120 S. Main St., Janesville, Wis.**—TELE-TECH & ELECTRONIC INDUSTRIES.

CAPACITOR

A new alkyd resin, molded case capacitor of the "postage stamp" type was recently introduced for radio, television and various types of electrical and electronic equipment. Temperature range is

up to 100°C with full rated voltage. The "Mylar" dielectrics have an insulation resistance of 50,000 megohms minimum, 300 percent more capacity, and equal or exceed all other electrical requirements in JAN-C-91. The company now has two molds capable of producing eight sizes. **Condenser Products Div., New Haven Clock and Watch Co., 7517 N. Clark St., Chicago, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES.

TV TUBE TESTER

The recently announced TV-20a television tube tester is an improved version of the TV-20. The new unit has listings of all recently announced color TV tubes, increased sensitivity to all types of internal leakage and gas, and a rugged new leatherette case. The instrument can test an entire set of TV tubes in a few minutes. Has no roll chart, practically no set-up. Further it has a large 4-in. meter, a positive "gas" detection circuit, dynamic conductance, and automatic "line" compensation. **American Scientific Development Co., P. O. Box 104, Fort Atkinson, Wis.**—TELE-TECH & ELECTRONIC INDUSTRIES.

POTENTIOMETER

"Jeco" precision potentiometers can check voltage ratios to an accuracy of 5 parts per million, angular rotation 8 parts per million in 360°. The units can be built to operate continuously at 200° C. and to withstand shocks up to 100 G's or more in any direction without momentary opens. It is said that these potentiometers, for a given diameter and kind of wire, can have up to 5 times the total resistance of other such units of the same dimensions. Sizes range from 1⅛ in. to 15 in. in diameter. **Jarvis Electronics Corp., 6058 W. Fullerton Ave., Chicago 39, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES.

CONSOLE RECORDER

The Model F6C console recorder has a direct-writing oscillograph. Frequency response with compensated amplifiers is flat from 0 to 80 cps. Suitable for many computers now on the mar-

ket. Six charts speeds are available: 0.5, 1.0, 2.5, 5.0, 10.0, and 25 mm/sec. with an electrically operated 10-1 changer. Oscillograph is available for curvilinear ink recording, curvilinear electric recording, or rectilinear ink recording. Console is available with ac, dc, high gain, dc low gain, or strain amplifiers. **Photron Instrument Co., 6510 Detroit Ave., Cleveland 2, O.**—TELE-TECH & ELECTRONIC INDUSTRIES.

OVEREND TENSION

A new overend tension for winding fine wires in multiple is said to maintain higher winding speeds and reduce wire breakage at the start of winding. A compensator takes up slack after the coil is wound and the arbor stopped. Mounting makes tension-to-line adjust-

ment easy. The devices can be used with the Universal No. 102 winder on fine wires from 38-50 (B&S) in producing spool wound coils, and the Nos. 104, 107, and 108 coil winders for producing paper insulated coils. **Universal Winding Co., P.O. Box 1605, Providence, R.I.**—TELE-TECH & ELECTRONIC INDUSTRIES.

New Test Instruments For

IMPEDANCE BRIDGE

The vector impedance bridge, recently announced, measures impedance, capacity, inductance, resistance, and transformer turns ratios. An internal source provides the signal for the unit.

Salient features are direct reading of vector magnitude and phase angle. Because the phase arm presents 1,000 ohms impedance regardless of position of phase switch, the phase arm and magnitude can be varied without interaction. The prominent reactive component can be determined as capacitive or inductive by noting the position of the function switch that null is detected. **Republic Engineering Co. Inc., Beltsville, Md.**—TELE-TECH & ELECTRONIC INDUSTRIES.

VOLTMETER

The Model 615 digital vacuum voltmeter is a 1% instrument with a digital display of information. Performance specifications: Ranges, ac and dc, 0-3, 10, 100, 300, 1,000 v, with auxiliary

probe, 0-30,000 v dc. Resistance, 0-100, 1,000, 10 K, 1000 K, 10 megohms. AC frequency response; 30 cps to 50 mc (with auxiliary probes). Input impedance, 10 megohms. Power Supply Requirements, 115 v, 60 cps. Indicator, 3-digit counter with illuminated decimals and polarity sign. Approximate weight, 7 lbs. Case size, 8½ x 11 x 7½ in. **Hycon Mfg. Co., 2961 East Colorado St., Pasadena 8, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

VOLTAGE MULTIPLIER

The Model 620 extra-high voltage multiplier enables measurement of alternating potentials up to 60 kv peak with all types of company voltmeter (and other makes) and serves as a po-

tential divider with most CRO's for displaying high potential waveforms. An applied voltage is attenuated 10,000 to 1 with 2% accuracy between 60 cps and 6mc. Connection is made to an associated instrument by a 6 ft. cable. Input capacitance is 3.8 μμf. Shunt resistance is above 10^6 megohms. **Ballantine Laboratories Boonton, N. J.**,—TELE-TECH & ELECTRONIC INDUSTRIES.

SURVEY METER

The Model 2582 "Samson" self-contained, battery-operated, ionization type survey meter has been announced for surface measurement of any low-level alpha, beta, or gamma contamination (C-14, I-131, S-35, radium etc.). It features a 40 cu. in. ion chamber with a 0.5 mg/cm² rubber hydrochloride win-

dow protected by a stainless steel grill. Three alpha ranges cover any count rate from 0 to 12,500 counts/min. corresponding to radium gamma ranges of approximately 0 to 18 milliroentgens/hr. The unit will detect alphas with energies as low as 1.0 mev; betas as low as 15 kev. **Nuclear Instrument & Chemical Corp., 223-233 W. Erie St., Chicago 10, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES.

OSCILLOSCOPE

Model ES-520,5 in. general-purpose oscilloscope has a push-pull vertical and horizontal drive, 20 mv/in. vertical sensitivity, 50 mv/in, horizontal sensitivity; a 3-step, frequency-compensated, vertical input attenuator; vertical frequency

response of 20 cps to 500 kc within 2 db. Vertical square wave response is from 20 cps to 50 kc; frequency response, 20 cps to 200 kc within 3 db (at full gain); 1 v, peak-to-peak, vertical, built-in calibrator. Internal linear sweep 10 cps to 30 kc. Negative and positive sweep sync. **Precision Apparatus Co., Inc., 92-27 Horace Harding Blvd., Elmhurst 6, L. I., N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

PANEL METERS

Panel meters will be made with dc ranges showing any practical scale from 300 μa to 800 ma. These sealed, ruggedized units will be available in two sizes, 2½ in. and 3½ in. Pre-production approved by the Government. Current production at two company plants. The

introduction of the new units does not effect manufacturing commitments which include over 700 sizes and ranges of standard panel, instruments for industrial customers; nor, a line of electronic test equipment for radio-TV service technicians. **Simpson Electric Co., Div. American Gage & Machine Co., 5200 W. Kinzie St., Chicago 44, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES.

The Electronic Industries

ANALYZER

Model 901 transconductance analyzer and circuit simulator can measure transductance under all kinds of operating voltages. Further, it can reproduce any type of static or dynamic tube

characteristics. Simple push button switching applies the appropriate voltages to each tube element from a highly regulated power supply. The instrument is entirely self-contained, and does not require accessories. Detailed information is available at **New London Instrument Co., P. O. Box 189, New London, Conn.**—TELE-TECH & ELECTRONIC INDUSTRIES.

TESTER

The Model 631 volt-ohm-milliammeter and vacuum tube voltmeter combination comprises a single unit with the following characteristics: 34 ranges; V-O-M, 10 ac-dc v. Six direct current

resistances from 0.1 ohms to 150 megohms-decibel and output readings. VTVM, four, including 1.2 volt range for grid voltage and accurate discriminator alignment. First division mark at 0.02 v. Sensitivity, V-O-M, 20,000 ohms/v on dc, 500 ohms/v on ac; VTVM, 11 megohms. One switch selects all ranges. **Triplett Electrical Instrument Co., 122 Main St., Bluffton, Ohio.**—TELE-TECH & ELECTRONIC INDUSTRIES.

MULTI-TEST AMPLIFIER

Model 2000 is a VSWR amplifier with multiple test functions that features crystal current measurement for monitoring CW levels. Has 100 μa Weston meter; dual channel inputs that

eliminate continuous cable changes, sensitivity 0.3 mv for full scale deflection, 60 db range calibrated to ±0.1 db/10 db step, crystal or bolometer inputs, plug-in filter units from 250 to 2500 cps. The culmination of extensive research, it is said, the unit affords greater ease of operation with faster and more accurate readings. **Waveline, Inc., Greenbrook Rd., Caldwell, N.J.** — TELE-TECH & ELECTRONIC INDUSTRIES.

DIGITAL VOLTMETERS

Automatic digital voltmeters have been designed in standard models ranging from 2 to 5 in-line digits in voltage ranges from 1 mv to 1,000 v with automatic ranging indicated by moving decimal point. Input impedance, 1,000

megohms; accuracy, 1 digit; average reading time, less than 1 second. Models may be specified to operate printers, electric typewriters, or IBM punches. Only 10 vacuum tubes control stepping switches to balance input voltage against reference. Dimensions: standard rack and panel, 5¼ x 19 in. **Electro Instruments, Box S, Old San Diego Station, San Diego, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

PRESSURE BALANCE

Type 37-103 precision pressure balance provides a laboratory standard for precise calibration of pressure pickups with accuracy comparable to the highest quality manometers. A visual digital readout counter with digits to

1,000 makes possible immediate readings. Readings can be held when required, or attached to electrical tabulating devices through a built-in electrical analog dc 10 v output. Three types of readings are possible—differential pressure, gage pressure, and absolute pressure. **Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

OSCILLOGRAPHS

Multichannel direct-reading oscillographs, recently announced, feature four and six channel systems. An electrically controlled chart drive enables instantaneous speed selection. Range of sixteen accurate chart speeds from one

cm/hr. to 250 mm/sec. is possible Speeds are selected by front panel control or by an accessory remote control unit. Both inkwriting and combination ink and electric writing units are available. Electro-dynamic penmotors record static and dynamic phenomena from dc to 100 cps when used with amplifiers. **Brush Electronics Co., Equipment Dept. RT-1, 3405 Perkins Ave., Cleveland 4, Ohio.**—TELE-TECH

New Test Instruments

VTVM

The new Model VM-1 is a true peak-reading vacuum tube voltmeter capable of measuring pulses with very short duty cycles. Designed to operate over the band width 50 CPS to over 100 MC, the instrument can be used to measure positive peak, negative peak, or peak-

to-peak voltage of a wave form. Voltage range of the unit is 100 v full scale; with available multipliers, to 30 KV. The measuring elements are housed in a probe to allow direct connection to the voltage source. **Gertsch Products Inc., 11846 Mississippi Ave., Los Angeles 25, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

SPECTRUM ANALYZER

The FXR spectrum analyzer, designed for greater accuracy and convenience in microwave spectrum analysis, applies push-pull deflection to both horizontal and vertical plates. The r-f heads are interchangeable, and the r-f amplifier has a center frequency of 20 MC.

With the use of a cascade input, overall gain is 110 db. Visual indication of spectra is provided by a 5 in. oscilloscope tube with a sweep rate of 10 to 20 CPS. Frequency dispersion is 1 to 10 MC/in. with pulse lengths of 0.2 to 2.0 μsecs. **F-R Machine Works, Inc., Electronics & X-Ray Div., 26-12 Borough Place, Woodside 77, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

TRANSISTOR ANALYZER

A new instrument, called the transistor analyzer, has been developed which can directly measure the circuit constants of transistors while they are in operation. The unit is small, light weight, and portable, and can be used to test any type of junction transistor

at low frequencies. Generally, small signal T-equivalent-circuit parameters are the basis for transistor operation analysis and design. The new instrument makes direct measurements of these parameters. **Armour Research Foundation of Illinois Institute of Technology, Technology Center, Chicago 16, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES.

IMPEDANCE METER

The Model 541-A (TS-710/TSM) crystal impedance meter is designed to measure directly the effective resonance and anti-resonance of quartz crystal units. It replaces the older Model 460 (TS-537/TSM). It consists of a two-tube resistance-capacitance coupled os-

cillator covering a frequency range of 10 to 1,100 KC in five bands. The three variable adapters have maximum resistance values of 500K, 50K, and 5K. Two other adapters are furnished that enable testing crystal units contained in HC-5 U and octal base holders. **Radio Frequency Laboratories, Inc., Engineering Dept., Boonton 20, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

MODULATION METER

The 205-A FM modulation meter, now in production, has a tuning range of 25 MC to 500 MC. It measures FM deviation plus or minus 0-25 KC, and its KC-calibrated, 3 in. meter is accurate within 10% full scale. The instrument can also be used as a relative field-

strength meter. A built-in speaker is provided for aural checking of transmitter quality, and an oscilloscope connection enables one to "see" the modulation. Dimensions: 7 x 12 x 7¼ in. Weight, 14 lbs. **Lampkin Laboratories, Inc., Bradenton 17, Florida.**—TELE-TECH & ELECTRONIC INDUSTRIES.

VIBRATION ANALYZER

The Model 400 electronic vibration voltmeter is capable of balancing rotating parts at speeds up to 5,000 rpm and tracing any vibration up to 20,000 cpm. Analysis of high frequency vibrations resulting from defective bearings, electric motor torque pulses, transformers,

etc., is made through electronic frequency and displacement circuits which render data on panel meters. Accuracy to 10% is maintained on all three ranges, 0.001 in., 0.01 in., and 0.10 in. full scale. **International Research & Development Corp., 168 E. Hosack St., Columbus 7, Ohio.**—TELE-TECH & ELECTRONIC INDUSTRIES.

New Electronic Equipment

RELAY

Balanced armature, permanent magnet type, very high sensitivity relay is internally shock and resistant mounted. Screw-on cover is gasket sealed. Size, 1¾ in. diameter, 2¼ in. long. Variations,

infinite for 0.2 ma to 10 amps. or 0.1 mv to 500 v. Higher volts or ampere sensitivities with external multipliers. Accuracy, trip point to 1.0%; differential, less than 1.0.% Response time 50 sec. to 5 second time delay. Contacts, SPST or SPDT. Standard rating 5 to 25 ma; dc.; other ratings to ½ amp. Weight, 4 oz. **Assembly Products, Inc., Main at Bell St., Chagrin Falls, O.**—TELE-TECH & ELECTRONIC INDUSTRIES.

COMPUTER

The new Model CRC 102-D retains the small size and easy maintenance of the former Computer Research Corp. CRC 102-A computer. It accepts data from an electric typewriter, punched

paper tape, magnetic tape, or punched cards. All data is entered into the machine, operated on, and printed out in decimal form. A new 200 character-per-second paper tape reader and a new 60 character-per-second paper tape punch are available as accessories which greatly reduce machine filling time and problem change-over time. **The National Cash Register Co., Electronics Div., 3348 W. El Segundo Blvd., Hawthorne, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

VSWR INDICATOR

The Model 110A X-band indicator consists of an oscillator, a wavemeter, a forward and reverse directional coupler with bolometer take-offs for source and reflected power, and a

direct-reading ratiometer having double scales calibrated in VSWR. The accurate wavemeter supplements the approximate calibration of the direct-reading oscillator dial. Frequency coverage, X-band, continuous 8.500-9.600 mc; r-f source klystron type, V 260; accuracy overall, 2%; directional couplers, directivity greater than 40db. Indication of VSWR is shown on two direct-reading scales. The Low scale covers 1.06 to 1.3; the High scale—1.3 to 2.5. **Color Television Inc., 973 E. San Carlos Ave., San Carlos, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

UHF-VHF TUNER

The Model UV 13 is a combination tuner for covering the entire UHF and VHF TV bands allotted by the FCC. When "plugged in" to each other, two complete tuners become one homogeneous unit, or when UHF is not desired, the VHF can be used alone. No stringing, soldering, or adjustment of any

kind is required when the UHF unit is added or removed. A firm mechanical connection is made by tightening two accessible screws. Tuning and dialing are accomplished on one set of concentric dial and knob combinations. **Sarkes Tarzian, Inc., Bloomington, Ind.**—TELE-TECH & ELECTRONIC INDUSTRIES.

POTENTIOMETER

The RL11C wire-wound potentiometer provides two output voltages proportional to the sine and cosine shaft rotation angle. The unit is equipped with ball bearings, precious metal contacts and silver slip rings. It has a 360° continuous mechanical rotation. Standard winding resistance is 16,000 ohms

±10%. At 65°C, the rating is 1.5 w. Life expectancy is 350,000 revolutions, minimum. The output wave is pure sine or cosine. Deviation is less than ±0.5%. **Rawson Electrical Instrument Co., 110 Potter St., Cambridge, Mass.**—TELE-TECH & ELECTRONIC INDUSTRIES.

SIGNAL GENERATOR

The Model B signal generator is designed to check equipment requiring multiple pulse modulated microwave frequency energy with widths and delays that can be accurately controlled. The unit consists of 4 interchangeable r-f heads that provide coverage from 950 to 10,750 mc, with single dial, direct-

reading tuning controls. A direct-reading r-f attenuator is provided in each r-f head. The modulator portion furnishes five independent pulse channels that are adjustable in time and width. **Polarad Electronics Corp., 100 Metropolitan Ave., Brooklyn 11, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Survey of

New Products of the Month

Capsule summaries of latest electronic developments provide handy reference for engineers in the market for new equipment and components

PULSE TRANSFORMERS. The MDT series transformers, by Magnetics Research Co., 142 King St., Chappaqua, N.Y., for driving magnetic drum or tape recording heads, is available in primary-secondary turns to match any head to any driving tube.

CAPACITOR. Miniature model being produced by Hernaseal Co., 1101 Lafayette St., Elkhart, Ind., in a range of 0.4 to 0.8 $\mu\mu$f. Metallized glass rotor is within metallized glass stator directly soldered to standard brass fittings.

PICKUP ARM. Model 190, redesigned to require less mounting space. Retains low vertical mass, static and dynamic balance, absense of arm resonance of original design. Now requires 17 x 17 in. motor board. Pickering & Co., 309 Woods Ave., Oceanside, N.Y.

RATE-OF-TURN TABLE, by Genisco, Inc., 2233 Federal Ave., Los Angeles 64, Calif., improved by strobe monitoring system, has variable range from 0.01 to 1,200°/sec. with low vibrational and rotational oscillation. Flashes controlled to 0.001% of 60 CPS.

METER MECHANISM, by Marion Electrical Instrument Co., Manchester, N.H., to provide instrument stability, etc., employs an end-pivoted coil assembly and a bearing shaft in a shielded magnetic structure to produce 6,000 gauss in a single air gap.

POWER SUPPLY. The "Rodic", mobile transmitter Type RO-2, by Tech Laboratories, Inc., 16 E. Edsall St., Palisades Park, N.J., offers 75% efficiency, 5 to 8% regulation, and surgeless low-starting current. Operates from 6 v battery. Outputs, 520 v 320 ma or 33 v at 320 ma.

CONNECTORS, series VR and VP, made by Viking Electric Co., 1061 Ingraham St., Los Angeles 17, Calif., are miniature hermetically-sealed circular units with a Kovar type glass seal fused to a contact base and steel body. Contacts, gold over silver.

D.C. POWER SUPPLY, PS-3, by Hugo Meyers Co., Inc., 39 West 60th St., New York 23, N.Y., emphasize within 3% voltage output despite input line fluctuations of 90 to 130 v, and within 3% output voltage under continuous operation. Dimensions, 4 x 5 x 8 in.

DELAY LINE, Model V-104, by Control Electronics Co., Inc., 1925 New York Ave., Huntington Sta., New York, provides a variable delay from 0-1.2 μsecs to applied wave forms. Overall accuracy is 5%. Rise time from approximately 0.02 to 0.04 μsecs.

CAPACITORS, electrolytic Types MT and SMT, are low current drain units especially designed by Illinois Condenser Co., 1616 North Throop St., Chicago 22, Ill., for use with transistors, printed circuits, hobby models, etc.

NETWORK BOARD, Model P100, by Instrument Research Co., 371 Harvard St., Cambridge 38, Mass., incorporates 3 resistance and 3 capacitance decade units. Each covers 0 to 1,111,000 ohms in 100 ohm steps. Panel 19 x 21 in.

"VIBRATION LOCK," designed for use on the "MRE" series of electrical connectors by Winchester Electronics, Inc., 15 Crescent St., Glenbrook, Conn., automatically engages the mating connector parts. Lock screws have been eliminated.

ENCASEMENT ASSEMBLY, made by Torocoil Co., 1374 Mobile Court, St. Louis 10, Mo., simplifies mounting toroidally shaped inductors. High impact strength plastic cup with an appropriate disc and machine screw contains the toroid.

POWER SUPPLY, Model ME/PP-11, is a 200 w frequency stabilized unit made by Maryland Electronic Corp., College Park, Md., provides 60 CPS, 115 or 230 v source to operate frequency critical devices requiring 200 w.

METAL PATTERNS. Hammered metal effects in any metal sheet or strip up to 38 inches wide are available at Ridgidized Metals Corp., 657 Ohio St., Buffalo, N.Y., in mill-finish as rolled, colorized, high-lighted, and painted surfaces.

SERVO DEMONSTRATOR UNIT, Model MA-93001, designed for training purposes by Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55, N.Y., includes motors, synchros, and tachometer assembly containing magnetic amplifier, demodulator, stabilizer, and terminals.

SWEEP GENERATOR, Model WR-86A, wide range sweep instrument for designing, testing and servicing UHF TV equipment supersedes two RCA laboratory-type UHF sweep generators according to RCA Tube Division, Harrison, N.J.

METER, Model 721, with 2½ in. square front, made by Burlington Instrument Co., 151 N. Third St., Burlington, Ia., is available with dc or ac movements and as rectifier type instruments, db indicators, and ac voltmeters.

TOROID INDUCTORS, by Mico Instrument Co., 80 Trowbridge St., Cambridge 38, Mass., combine the toroid structure with the characteristics of the new "Ferroxcube" 3C core material and are particularly suited the requirements of small size and wide range of inductance values.

RECORDER-REPRODUCER, Model 5301, offered by Haller, Raymond and Brown, Inc., State College, Pa., provides for simultaneously recording radar and air-ground voice radio signals. Tape record plays back original air situation.

PRESSURE RATIO INDICATOR, Model 1985, developed by Kollsman Instrument Corp., 80-08 45th Ave., Elmhurst, N.Y., computes with a mechanism that consists of two diaphragms that actuate a lever system and a direct-reading indicator.

COUNTING DIAL, Model A-230, miniature, produced by S. A. Asquith Co., 2439 Fletcher Dr., Los Angeles 26, Calif., is designed for use 10 turn or less potentiometers. Requires 1 in. panel space. Continuous rotation in either direction.

TEST SOCKET ADAPTERS, by Pomona Electronics Co., 524 W. Fifth Ave., Pomona, Calif., are 7 and 9 pin test socket and 8 pin octal test socket units for measuring voltage, resistance, audio and video, from chassis top while set is in full operation.

ROTARY SOLENOID, No. BD4 "Ledex", by G. H. Leland, Inc., 4 S. Main St., Dayton 4, O., operates like six other models in current production. New unit is 1 9/16 in. in diam. Available in 25°, 35°, 45°, 67½°, and 95° rotation.

OSCILLATOR, Model G-1, pulse and square wave source, has variable repetition rates from 1 pulse/sec. to 100,000 pulse/sec. in 5 ranges. Rates controlled to 1% accuracy. Rutherford Electronics Co., 3707 S. Roberson Blvd., Culver City, Calif.

MILLIVOLTMETER, 213-A, has high sensitivity, stable zero, direct polarity indication, and features full scale deflection of 1.0 mv dc, zero center movement with plus or minus deflection. Industrial Control Co., Wyandanch, N.Y.

FILTERS. Scientific Specialties Corp., Snow and Union Sts., Boston 35, Mass., have announced three symmetrical high-pass ladder type filters—F51A, F51B, F51C—for use in 52 ohm circuits. Units have transmission line sections for use in unbalanced transmission systems.

SNAP ACTION SWITCH. A sub-miniature unit developed by Electro-Snap Switch & Mfg. Co., 4218-30 West Lake St., Chicago, Ill. for precision applications is in a plastic case approximately 1.0 x ½ x ¼ in. in size. Carries 5 amps at 125/250 VAC—2½ amps at 30 VDC.

TEST PROBES, available at the Technical Sales Department, Allen B. Du Mont Laboratories, Inc., Clifton, N. J. (Types 2607, 2608, 2609) have BNC terminations on the probe cables that match panel terminations of Du Mont Types 303-A, 303-AH, 323, and 329 cathode-ray oscillographs.

PULSE TRANSFORMER, type PT-4, is a four-winding unit with 2:2:1:1 turns ratios, 120 ohms characteristics impedance, 0.03 μsec rise time, 20% droop at 1 μsec, 40% at 2 μsec. Made by Berkshire Laboratories, 688 Beaver Pond Rd., Lincoln, Mass.

"DYNACORD" is a professional tape recorder for portable use, rack mounting, or console installation by The Pentron Corp., 221 E Cullerton St., Chicago, Ill. Capacity up to 10½ in. reels. Conforms to NARTB standards throughout.

MICROWAVE TESTING INSTRUMENT, offered by Kearfott Co., Inc., 14844 Oxnard St., Van Nuys, Calif. is designed for laboratory, production line, field testing and maintenance of X-band radar. Size, 17 x 10½ x 13 in.

INSULATION TESTER. Multipurpose instrument made by Associated Research, Inc., 3758 W. Belmont Ave., Chicago 18, Ill., features a range of 1-50,000 megohms at 500 VDC. For insulation resistance measurement Model 250 "Vibratest" is 115 VAC line operated.

POSITION SERVO ACTUATOR, model 205, by Summers Gyroscope Co., 2328 Broadway, Santa Monica, Calif., features torque-to-inertia ratio of 200,000 rad/sec² coupled with an acceleration time constant of 10 milliseconds.

3-GUN CR TUBE, type 53 RAP, is a 5 in. unit designed for multi-channel oscilloscopes which must display simultaneously up to three transient, random, or high frequency phenomena. Made by Electronic Tube Corp., 1200 E. Mermaid Lane, Philadelphia 18, Pa.

INDICATOR LIGHTS for slide base lamps announced by Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y. comprise a new series designed to employ any telephone-type slide base bulb. Require neither extractors or other tools.

VARIABLE INDUCTANCE COILS announced by North Hills Electric Co., Inc., 246-32 54th Ave., Douglaston 62, N. Y. (the series 120) cover the two microhenries to two millihenries range with eleven coils. Each coil is adjusted by a low loss core. Individually boxed and color-coded.

RELAYS, Part No. 8-4C, by Leach Relay Co., 5915 Avalon Blvd., Los Angeles 3, Calif., are of the miniature telephone type and are designed for all communication applications. Dimensions; 1-7/16 x 1-11/32 x 15/16 in. Hermetically sealed 9 or 14 pin plug-in or solder terminals available.

POTENTIOMETERS. A new line of subminiature trimmer potentiometers 0.530 in. diam., 0.281 in. deep for use as preset adjustable resistors in miniaturized equipment has been announced by Rockbar Corp., 215 E. 37th St., New York 16, N. Y.

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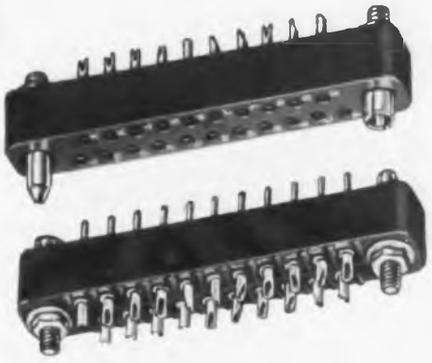

(At left) Miniaturized Micro Connectors that save space, weigh less and are more efficient . . . 14, 21, 34 and 50 contacts available in low loss material for chassis mounting applications.

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WASHINGTON
News Letter

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

NETWORK PROBE—Since the FCC already has certain regulatory powers over networks and especially over the stations affiliated with the major broadcasting and television networks, it is deemed unlikely that the projected full-scale investigation of the networks by the Senate Interstate Commerce Committee which is being advocated by Chairman Bricker (R., Ohio) will be productive of anything more than lengthy hearings, if the latter ever comes to pass. With Congress adjourning in early August, Senator Bricker was slated to cancel any plans for hearings at this session and was now considering the program of preliminary study of the issues, particularly the relation of the networks to UHF television expansion, during the recess until the next session of Congress in January.

UHF TELEVISION—The Senate Communications Subcommittee, headed by Senator Potter (R., Mich.), decided, in the closing days of this session of Congress, to persuade the radio manufacturing industry to reach an agreement to produce only all-channel receivers as a means of bringing relief to UHF television. In addition, the Potter subcommittee considered the establishment of an advisory group on UHF television to take up the various proposals—such as moving all TV to UHF, moving all TV to VHF, making the allocations more flexible, etc.—and to evaluate the various proposals as to engineering and economic feasibility. Multiple ownership of video stations, Senator Potter told Tele-Tech, would require more study by the subcommittee before a decision could be reached by his group. Elimination of the 10% federal excise tax on all-channel receivers to pave the way for increased UHF stations is to be pressed at the next session of Congress.

MANUFACTURERS' RADIO—Establishment of a system that will utilize frequencies which are now lying idle but which can be used in certain areas for the greatest benefit to all is being urged upon the FCC as "the next great constructive step to be taken in the development of mobile communications." This proposal was announced by the National Association of Manufacturers' Committee on Manufacturers Radio Use. The NAM body stressed that the FCC refusal to establish a manufacturers' radio service "does not alter the essential facts that radio communication is a valuable tool in productive manufacturing operations" and its full use and development are being severely restricted by the limited number of frequencies now available to the special industrial radio service. The committee was critical of the FCC's "rigid subdivision" for particular groups as an obstacle to effective frequency utilization.

JTAC PROPOSAL—Instead of adopting its spurious radiation suppression table, the FCC could make a periodic review of all new developments and the progress of the radio art so that the industry and the Commission might cooperatively formulate the best and most realistic methods of solving these problems. This was proposed to the FCC by the Joint Technical Advisory Committee, headed by A. V. Loughren of the Hazeltine Corp., who worked closely with the Institute of Radio Engineers' President W. R. Hewlett in formulating the JTAC views presented to the FCC.

HIGHWAY RADIO—A revised, nationwide geographical frequency assignment plan for the 14 frequency channels allocated by the FCC for state highway purposes in the 46-47 MC band, incorporating split-channels, is under intensive study by the two final groups of regional highway communications committees, western and southeastern, which are scheduled to meet in September. The two other regional meetings were held last spring. A national meeting of the American Association of State Highway Officials' Committee, to be held November 10 in Seattle, is slated to discuss progress on the split-channel assignment plan and other matters, including the use of 450 MC equipment, interference to television, the use of industrial television in highway operation and the use of induction radio systems in heavy traffic areas. Radio is considered all-important by the state and county highway departments in view of the $50 billion highway construction plan proposed by President Eisenhower at the recent governors' conference.

POLICE RADIO—The increased value of radio communications to the state and municipal police departments of the nation, as well as the vital role they play in civil defense, provided the highlights of the 20th annual conference of the Associated Police Communications Officers at Pittsburgh in mid-August. Top FCC officials and the Federal Civil Defense communications chief stressed these two themes in principal addresses at the four-day conference with Commission Safety & Special Radio Services Bureau Chief Edwin L. White outlining the rights and responsibilities of the police radio service. Improvements in equipment was a major theme at the conference with officials of General Electric, Radio Corp. of America, Motorola, Allen B. Du Mont Laboratories, Bendix Radio, Andrew Corp., Shure Bros. and Dictaphone Corp. describing new apparatus and operational developments of importance to the police radio services.

National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington Editor

CUES for BROADCASTERS

(Continued from page 75)

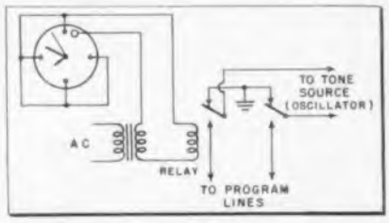
come the treble losses in the unequalized loop.

The monitor speaker level is adjusted by the 500 ohm "T" pad (Mallory T500 or equiv.) so that feedback does not occur when the microphone is in use. By placing the speaker at a reasonable distance from the microphone it is unnecessary to use a speaker muting switch. With the resistance values shown, the line level was about a plus 8 VU. A good quality hum free amplifier should be selected with a power rating of at least 10 watts.

Automatic Time Signal

F. H. FRANTZ, 610 College Drive, Starkville, Miss.

LISTENERS rely heavily on local radio stations for time. Unfortunately, programming does not always allow a time announcement precisely on the hour, half hour or quarter hour. An automatic time signal is the perfect answer to the problem. This is easily accomplished by inserting small insulated machine screws on the clock face at 12, 3, 6, and 9 so that the minute hand makes contact as it passes. These screws are tied together and form one switch terminal. A larger screw placed further out on the circumference of the clock face, beyond the minute hand, and extending far enough above the face to make contact with the second hand, forms the second switch terminal. This contact is placed in line with "12." The terminals are open at all times



Minute and second hands open and close this circuit to provide quarter-hour timing signals

except for the short interval when the second hand passes over "12" and the minute hand is on one of the four quarter hour contacts. This switch controls a low current relay that feeds a tone signal across the program line.

Broadcast to PA Transition

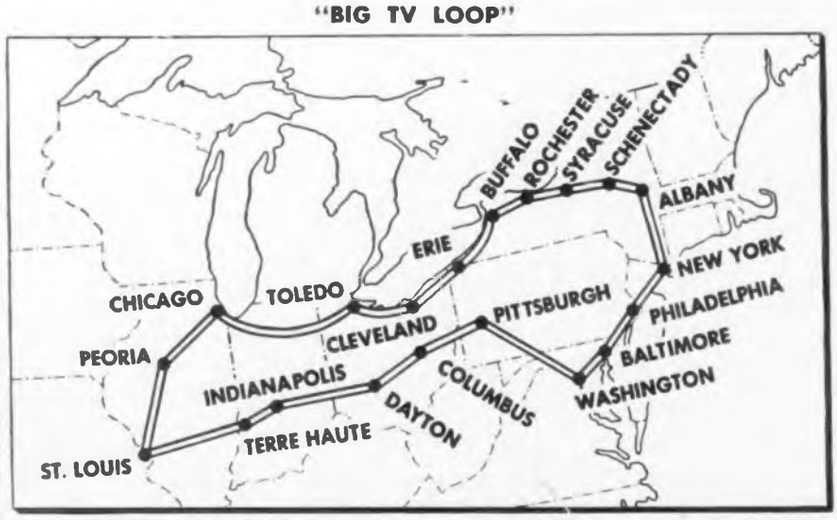
J. C. FRENCH, 5243 LaGrange Rd., LaGrange, Ill.

IT is often found desirable to feed into the PA, whatever program is on the air just prior to remotes.

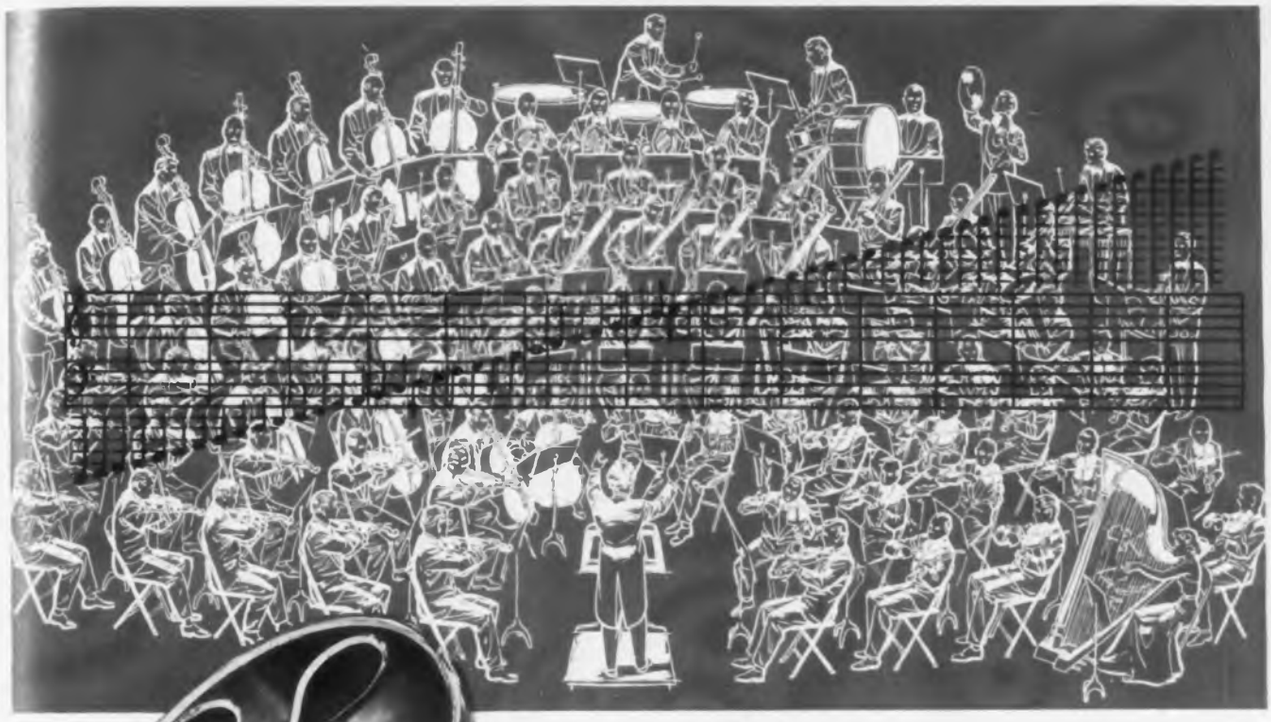
Economies dictated the use of only one loop, and it had to be used for talkback to the studio. A crystal receiver was built and the output terminated in a mike plug matching the PA. A short antenna provided ample volume.

On cue from the studio, the PA mike channel fed from the crystal receiver was faded out, and the mike channel on the remote unit faded in. Because the PA was also fed from the output of the remote unit on another mike channel, it was automatically connected.

"BIG TV LOOP"



New television pathway, 2,400 miles long, links stations in the northeastern quarter of the U.S. Network provides four video channels, two in each direction, along radio relay route extending from N.Y. to Chicago, via Buffalo and back through St. Louis, Pittsburgh and Washington. Any station in the loop can transmit to or receive programs from other loop stations with minimum of switching



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AUDIOTAPE'S oxide coating has been developed and perfected to provide maximum uniformity of response throughout the entire audible frequency range. This assures utmost realism in the reproduction of *every sound* — brings out the best in any tape recorder.

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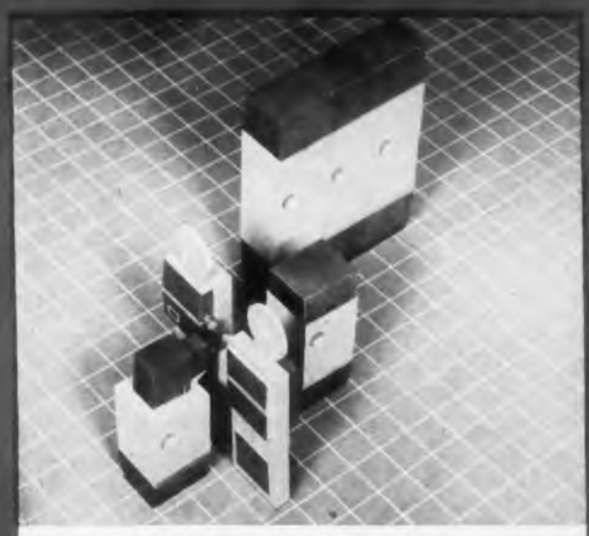
This Philco 16mm CineScanner and its companion, the 35mm model, provide the finest film reproduction in either color or monochrome.



Multiplexed arrangement of two 16mm CineScanner film units and automatic dual slide changer for four program sources in color.

CineScanner—superior for monochrome

. . . the only practical method for color!

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- **Smooth, Silent Operation — No Flutter**
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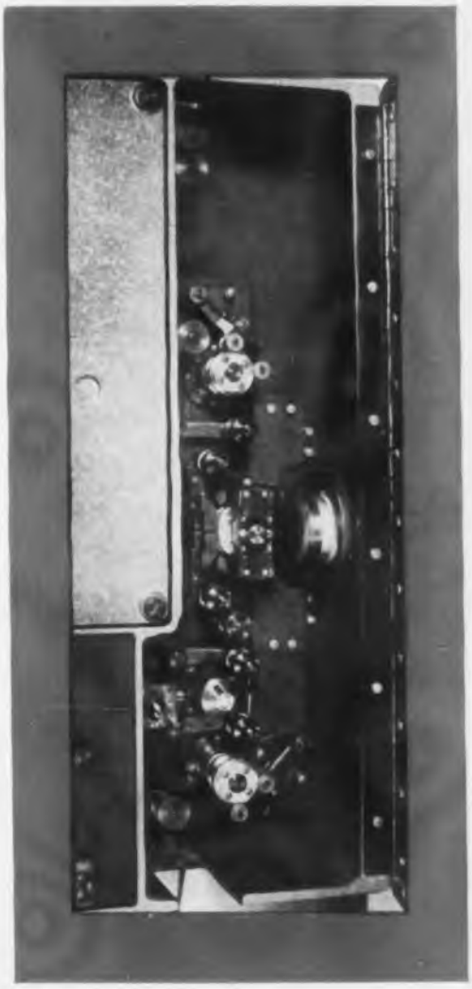
- **Color and Monochrome, 16MM and 35MM Models**

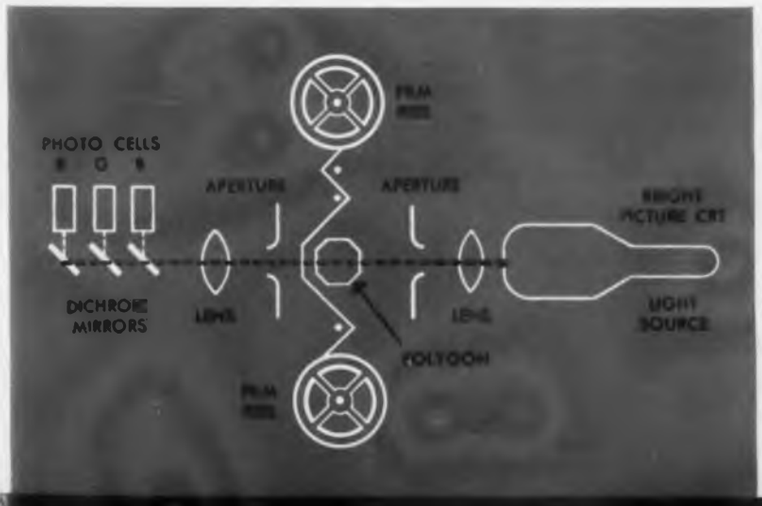
Once you've seen CineScanner operate—witnessed the clear, steady pictures and observed the smooth, silent performance—you will agree it's the only way to televise film—*in monochrome or color!*

There are good technical reasons why: The Philco CineScanner employs flying-spot scanning, a technique never equaled in producing high definition pictures. In CineScanner, there's no hot projection lamp to fail or burn the film. Only source of light is a long life, cathode-ray tube with dependable "cold" light harmless to film. CineScanner employs a special continuous-motion film transport mechanism designed by Philco and built by the Mitchell Camera Corporation of Hollywood . . . no noisy, film-damaging intermittents in the CineScanner! Most important of all to color Broadcasters, CineScanner uses economical photo tubes instead of expensive camera tubes . . . *and there are no color registration problems in CineScanner!*

With the Philco CineScanner, you can start today in monochrome, convert tomorrow to color—with no obsolescence of equipment! Get full technical data on this new and greatly improved method of televising films and slides. Contact Philco, Dept. "T" today.



Interior view of the film unit showing precision film transport mechanism, sound head and the simplicity of the optical system.



Simplified diagram showing the basic principles of CineScanner operation.

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In Canada: Philco Corporation of Canada Limited, Don Mills, Ontario

New Components & Equipment

RECTIFIER TUBE

Type 6508 mercury vapor rectifier tube, designed for relatively high voltage and current operation, has a peak inverse voltage rating of 21 kv and voltage drop of 14 volts. The cathode is directly heated and oxide coated. The

new unit is intended for use in applications where the initial and replacement costs of standard tubes are prohibitive. It is said that the new tube meets the demand for a comparatively inexpensive, long-life rectifier for industrial and communication service. Further information available at **Amperex Electronic Corp., Engineering Dept., 230 Duffy Ave., Hicksville, L.I., N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

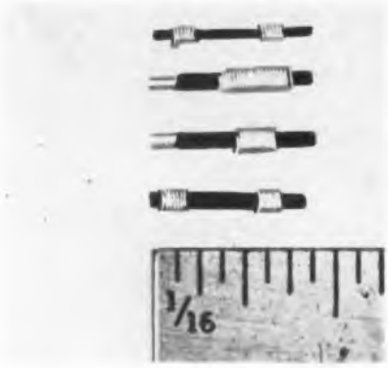
MAGNETIC CLUTCHES

A new line of magnetic clutching and braking devices, designed to meet military environmental specifications, are made from corrosion-resistant materials and have an operating tempera-

ture range of —65° to +165° F. They are also designed for a maximum torque of 16 oz.-in. and for intermittent duty at speeds to 1,000 rpm. Life expectancy, 200,000 cycles at 30 rpm with load inertia of 1 oz.-in. Weights, single clutch, 0.8 lbs., double clutch, 1.5 lbs., clutch brake 1.2 lbs. Electrical requirement 25 v dc. **Ford Instrument Co., Div. of Sperry Corp., 31-10 Thomson Ave., Long Island City 1, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

CAPACITORS

New capacitors, "Tekaps", are most practical in values of 0.5 μμf and 10 μμf. Extremely small, they are easily manufactured to close tolerances. The capacitors have a zero temperature coefficient from —60° to over 300° C. and a



dielectric constant of 2.0 at all operating frequencies. Power factor at all operating frequencies is 0.0005. Moisture absorption factor is zero. Silver plated terminals allow soldering directly into circuits, but leads can be furnished if desired. **Anchor Radio Corp., 2215 S. St. Louis Ave., Chicago 23, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES.

CARD RECEPTACLES

New printed card receptacles offer ease of removability and changeability, use of multi-wire connection to terminals, and dependable performance after repeated insertions. Card thicknesses range from 0.061 to 0.071. The contact, or polarizing insert, snaps in firm position into the molded body. It is easily removed or its position changed by pinching the tongue and pushing out. The insulating body is available in mineral-filled melamine, Alkyd 440 A, or Diallyl Phthalate. **U. S. Components Inc., 454-462 E. 148th St., New York 55, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

TELEPHONE SYSTEM

The "Telecom" 4A23 private, independent, automatic dial system, consists of an automatic switching unit housed in a 10 x 22 x 28 in. dust-tight cabinet, and the telephones. Operates from standard 115 v, 60 cps, ac power. A suitable transformer can be supplied where power source has a different voltage or frequency. No multi-pair cables or junction boxes. Single pairs of wires to each station can tie in up to 23 telephones. An added "Telecom" paging unit makes any telephone a "mike" for a public address system when a preset code number is dialed. **Telecom Inc., 1019 Admiral Blvd., Kansas City, Mo.**—TELE-TECH & ELECTRONIC INDUSTRIES.

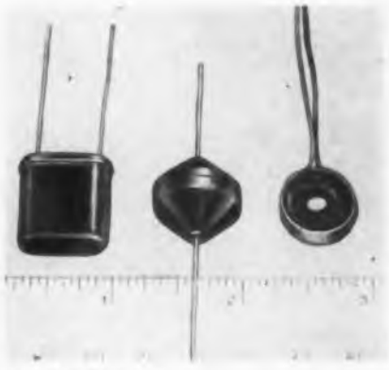
AMPLIFIER

The plug-in type "Uni-level" ampl fier can be used as an average aud level control device or a peak level co trol amplifier. Used as an average aud level control amplifier, with the avera program material set for a normal lev

the output will be compressed for in- coming signals exceeding the preset level and expanded for signals below it. Differences between recordings, film projectors, microphones, or network signals are automatically controlled so that the amplifier audio output level remains relatively constant without apparent sound distortion. **General Electric Co., Electronics Park, Syracuse, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

SUBMINIATURE TOROIDS

Three standard lines of subminiature toroids are available packaged for MIL-T-27: QL050 series, vacuum wax impregnated with flexible high temperature plastic leads. Size, $\frac{5}{8}$ in. O.D.,



$\frac{1}{8}$ in. I.D., $\frac{9}{32}$ in. high. MP 050 series, molded plastic units with axial wire leads suitable for point-to-point wiring or terminal board mounting. Size, $\frac{11}{16}$ in. high, $\frac{11}{16}$ in. O.D. HS050 series, in hermetically sealed, $\frac{5}{16}$ x $\frac{11}{16}$ $\frac{49}{64}$ in. cans with wire leads. Wired in subminiature sockets or soldered to printed circuit boards. **Communications Accessories Co., 110th St. & 71 Highway, Hickman Mills, Mo.**—TELE-TECH & ELECTRONIC INDUSTRIES.

for the Electronic Industries

QUARTZ CRYSTALS

The G-12A "Glasline" unit is a recently developed precision quartz crystal design, which, according to U. S. Government laboratory tests, varied in frequency less than 1 part in 100 million when measured continuously for two

weeks. This corresponds to a rate of change of less than 1 second in three years. The unit also employs new techniques in processing and packaging. It was developed to meet the demand for better frequency control necessary to minimize the increasing congestion in the radio spectrum. **James Knights Co., Sandwich, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES.

CONNECTORS

The series "FHL" 6-point connectors, with a sea level breakdown of 4,000 v RMS and a current rating of 5 amps, have an 8 oz. maximum disengagement force without sacrificing mv drop; thus reducing breakage encountered when

contact forces are too great. A rugged center key, plus a one-way contact arrangement, provides positive polarization. Two vibration rings with matching detent action provide a positive "lock" against accidental disconnection. Hoods are in aluminum (with cable clamps) or molded insulating material. **DeJur-Amsco Corp. 45-01 Northern Blvd., Long Island City 1, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

TRANSISTOR SOCKETS

A standard strip of transistor sockets for use in transistor circuits has been designed, and, after successful laboratory use, is now made available to the industry. It is said that the socket makes it possible to group transistors, particu-

larly in computer circuitry. Dimensions of the first model which has 10 sockets are 6 x 1 x ¼-in. Other models are being developed to accommodate 30 or more sockets in a single phenolic strip. Contacts are phosphor bronze. Solder contacts are copper. **Hydro-Aire, Inc., Electronics Div., 3000 Winona Ave., Burbank, Calif.** — TELE-TECH & ELECTRONIC INDUSTRIES.

GRID DIP OSCILLATOR

The Model 59-UHF megacycle meter is designed to measure the resonant frequencies of passive circuits. Also, to serve as an auxiliary signal generator, an oscillating or absorption marker for

use with a sweep-frequency generator, wavemeter or hetrodyne frequency meter and as a low sensitivity receiver or field-strength meter for tracing sources of spurious oscillations in receivers and transmitters. Rated at 30 w. Operates from 117 v, 60 cps. Employs separate power supply and indicating unit. **Measurements Corporation, Thomas A. Edison Subsidiary, 116 Monroe St., Boonton, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

RESISTOR

The new "Economy" resistor is wound on Mil grade Steatite forms in sizes and ohmages that are the same as vitreous enameled types of like wattage. The unit is coated with a silicone base compound that has withstood 2,000 hrs. in a continuing moisture chamber test. The insulation resistance of the coating has exceeded 100 billion ohms after 250 hours in an atmosphere of 120° and 90%-99% relative humidity. The coating on a 10,000 ohm 10 w resistor withstood 10 times rated load for 5 seconds without physical or electrical change. **Milwaukee Resistor Co., 700 West Virginia, Milwaukee 4, Wis.**—TELE-TECH & ELECTRONIC INDUSTRIES.

INDUSTRIAL TV TUBE

Staticon camera tube type C-931-B for industrial TV has an operational life of 500 to 1000 hours. Tube is designed to have window masked to have an aperture ½ x ⅜ in. **General Precision Laboratory, 63 Bedford Road, Pleasantville, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

More New Products on pages 90-96

PRESSURE TRANSDUCER

The model S-3 pressure transducer operates on the variable reluctance principle and is suitable for use with a wide variety of recording and tele-

metering systems. When the gage is connected in an electrical bridge circuit, the output signal is proportional to the input pressure. The unit features 50 μsec rise time, 1% or less non-linearity, 0.1 to 0.4% hysteresis, 0.3% acceleration sensitivity, 0.01%/° F. zero shift with temperature. Weighs 2 oz. and is ¾ x ¾ x 1 1/16 in. in size. **Ultradyne Engineering Labs., Inc., P.O. Box 8007, Albuquerque, New Mexico.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Sweep Generator (*Continued from page 61*)

strips of metal, easily reproducible to close tolerances. By placing the two thin inductive strips parallel and coplanar (Fig. 6), the stray capacity between inductances is kept extremely small.

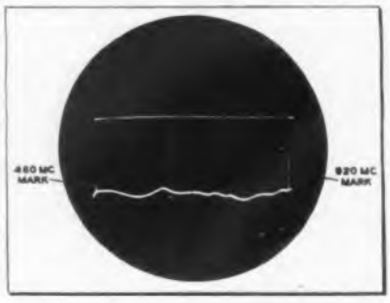


Fig. 6: Waveform of oscillator output

Drive Mechanism

At this point some consideration must be given to the mechanical drive requirements. The simplest technique is to attach the moving plate to a large speaker driving unit.

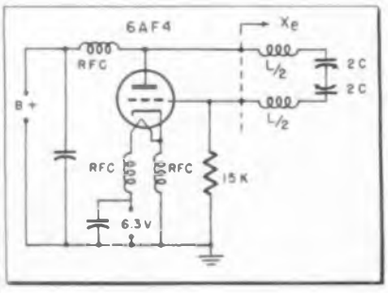


Fig. 7: Modified Colpitts oscillator circuit

Referring to Fig. 3, the plate would move against the stators in a reciprocating motion of total movement Δ, the spacing between plate and stators varying from h_{min} to $(h_{min} + \Delta)$. The smaller h_{min} can be made, the smaller the motion (Δ) required for a given percentage change in capacity. For reasons of planarity tolerances obtainable on fixed and moving plates, reproducibility of motion and elimination of danger of striking plates, the smallest practical choice of h_{min} was found to be .016 in.

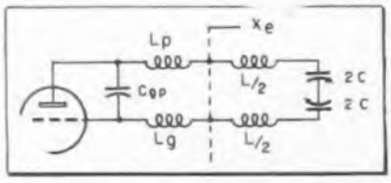


Fig. 8: Equivalent tank circuit of oscillator

Transmission Line Elements

The basic circuit, the mechanical technique, and the order of magnitude of components having been determined, it was necessary to choose an exact design capable of sweeping between 460 and 920 MC with as small a motion (Δ) and plate area ($b \times l$) as possible.

The capacity between stators and moving plate cannot be determined from simple plate capacitor formulae, since 1) the spacing h can become large with respect to the small plate dimension b, and 2) the dimensions of the plate (b, l or both) can become a relatively large fraction of a wavelength. The effective capacity can therefore be accurately determined only by transmission line techniques. Terman[2] gives the capacity per unit length vs b/h of long strips in parallel, where b is the strip width and h is the spacing. From this data, Z_0 vs b/h can be determined, assuming a TEM mode, from the relation

$$Z_0 = \sqrt{\mu\varepsilon/C}$$

where C is capacity per unit length, μ is permeability and ε is dielectric constant between plates. These are plotted in Fig. 2 for air dielectric.

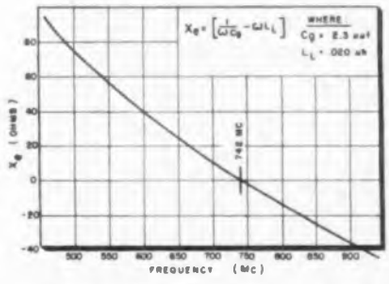
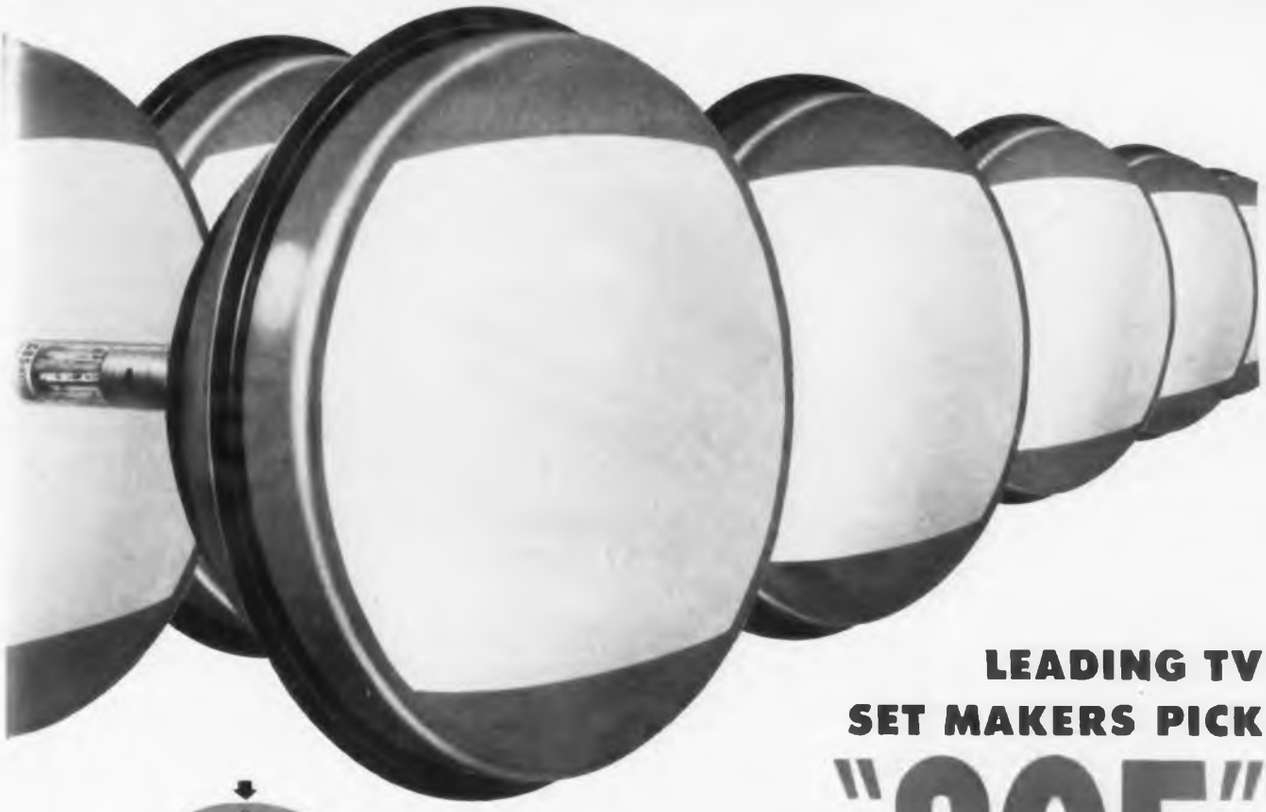


Fig. 9: External reactance required by 6AF4

By considering the plates to be open circuited transmission lines of length l, plate width b and spacing h, and using the relation

$$|X_c| = Z_0 \cot \beta l,$$

the curves of Fig. 8 were obtained. Curves of constant total series inductance (L) in the region of interest are plotted vs b and l assuming $h_{min} = 0.016$ in. and $f_{min} = 460$ MC. Also plotted are curves of constant total plate motion (Δ) for 920 MC maximum frequency. Operation is limited to the shaded region on Fig. 8, which is bounded by three limiting curves. The right hand bound is the curve of $\Delta = 3/8$ in., the maxi-



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. . . for Delivery NOW!

The CBS-Colortron "205" is *today* traveling in freight cars and trucks to the nation's leading TV set manufacturers. It was chosen by them, because of: The "205's" larger 205-square-inch screen. The "205's" over-all superior performance. The "205's" easier circuit adjustments. The "205's" absence of "pincushioning" and other distortion. And the "205's" availability in production quantities now!

BIG-SCREEN COLOR TV IS HERE . . . today . . . at CBS-Hytron. Original . . . simple . . . functional . . . advanced design of the "205" made this possible: 1. With its curved screen-mask construction. 2. With its maximum use of the screen area. 3. With its electromagnetically converged three-beam electron-gun assembly. And CBS-Hytron's huge, new Kalamazoo plant stands ready to step up the "205's" availability when needed. Yes, you can look to CBS-Hytron as the leader . . . and major producer of big-screen color picture tubes.

HOW "205" ACHIEVES BIGGEST PICTURE

As its name implies, picture area of "205" is a big 205 square inches. The "205" achieves this maximum utilization of screen area: 1. By photographic printing of tricolor screen directly on inside of curved face. 2. By using a simple, light-weight shadow mask. 3. By positioning the three mask supports above and below the desired screen area . . . where the screen is masked off anyway by the set maker to obtain the desired 4 x 3 aspect ratio. This permits full lateral use of screen.

IT'S CBS-HYTRON FOR NEW COLOR RECEIVING TUBES TOO

TYPE	DESCRIPTION
CBS-Hytron 3A3	Half-wave, high-voltage rectifier
CBS-Hytron 6AM8	Diode, sharp-cutoff pentode
CBS-Hytron 6AN8	Medium-mu triode, sharp-cutoff pentode
CBS-Hytron 6BD4A	Sharp-cutoff beam triode, high-voltage regulator
CBS-Hytron 6BD6	Sharp-cutoff r-f pentode color demodulator
CBS-Hytron 6BJ7	Triple-diode d-c restorer

NEW . . . FREE "205" DATA

Keep abreast of big-screen color TV. Four-page sheet on CBS-Colortron "205," RETMA type 19VP22, contains complete data on: Construction . . . operation . . . application . . . installation . . . adjustment . . . electrical and mechanical characteristics. Write for Bulletin E-227 today!

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RECEIVING • TRANSMITTING • SPECIAL-PURPOSE • TV PICTURE TUBES • CRYSTAL DIODES AND TRANSISTORS

Sweep Generator

(*Continued from page* 106)

mum motion obtainable with a reasonable size driving unit. The lower bound is the curve of L = 0.12 μh which was stated previously as being the largest inductance consistant with the minimum effective capacity requirement. The third boundary derives from the fact that the plates can also be considered transmission lines of length b, width l and spacing h, a condition which gives rise to a different oscillating frequency f_2. The tank will usually oscillate at the lower of the two resonant frequencies, since the magnitude of the negative resistance looking into the tube goes up with decreasing frequency[1]. Below and to the right of the curve b = l on Fig. 5, f_2 will be

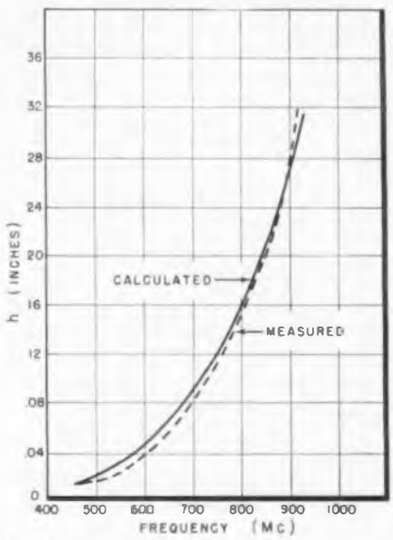


Fig. 10: Curves of frequency vs. plate spacing

higher than f_1, the desired frequency. The curve marked $f_2 = 1.2\ f_M$ is the condition for the value of f_2 to be 20% above 920 MC at h_{max}, and provides a reasonable safety factor, considering that the difference between f_2 and f_r becomes smaller with lower frequencies, f_2 being only a few megacycles above 460 at h_{min} for this boundary curve.

Experimental Results

The point marked * within the shaded area on Fig. 5 was chosen as the operating point, representing b = 5/16 in., l = 1-7/16 in., L = 0.065 μh, Δ = 19/64 in. d was chosen as 3 in., and the oscillator was constructed as shown in Fig. 4, the stators and inductors being supported by textolite. The moving plate was made from 1/16 in. thick aluminum, and mounted to the driv-

Sweep Generator

(*Continued from page* 108)

ing unit by a screw into a plexiglas block glued to the diaphragm. Fig. 1(shows the theoretical curve of spac ing h vs frequency for the abov conditions. Also plotted is a curv measured with the driving unit un excited and moved manually t various h values, measured with feeler gauge. The agreement wit theory is good.

Under operating conditions (driv ing unit oscillating at 60 cycle rate) the performance was the same a measured under static conditions Fig. 1 shows the oscilloscope trace o oscillator output under these condi tions, with marks at 460 and 920 Mc introduced by cavities in series with the output. The output amplitude is constant within 1 db.

1. J. M. Pettit, "UHF Triode Oscillator using a Series-Tuned Circuit," *Proc. IRE*, vol. 38, No. 6, pp. 633-635, June 1950.

2. F. E. Terman, *Radio Engineers' Handbook*, McGraw-Hill Co., New York, First Ed., p. 113.

Coefficient Tester

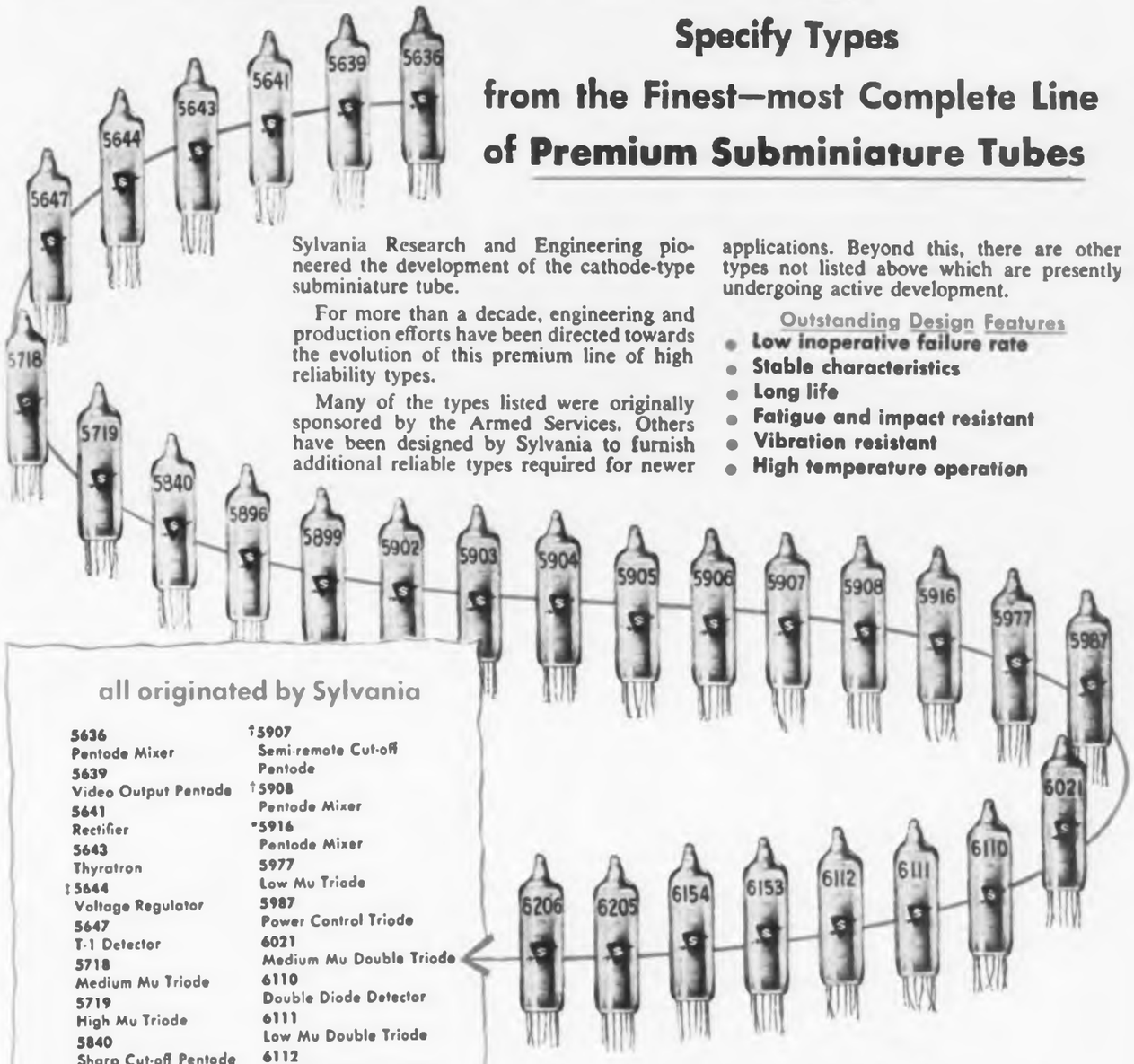
(*Continued from page* 64)

and the comparison arm. They cancel out in the balanced circuit arrangement. The isolation transformer allows for proper grounding of the apparatus which is otherwise sensitive to stray fields. Voltmeter V_2 allows for the setting of the power level in the resistor and V_1 is a vacuum tube voltmeter capable of reading 1 mv full scale. When observing the harmonics generated, the internal sweep can be used on the CRO and synchronized with the line. It is equally informative to apply to the horizontal deflection circuit the voltage V_o, since the resulting Lissajous figure is a picture of the nonlinearity amplified. The apparatus has been designed for resistors falling between 1,000 and 21,000 ohms, but can be readily modified to include a broader range. A small balancing condenser across the variable resistor is desirable to cancel its inductance. In the vicinity of 10,000 ohms, 150 μμf were sufficient for an excellent reactive balance and this capacitor is not at all critical.

Procedure

The procedure in using the apparatus is not involved. For a resistor under test, a voltage is applied so as to dissipate rated power. By adjusting the balancing arm, the error voltage as observed on the oscilloscope or voltmeter can be minimized

FOR YOUR EQUIPMENT-



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‡**5644**
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5718
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High Mu Triode
5840
Sharp Cut-off Pentode
5896
Double Diode Detector
5899
Semi-remote Cut-off Pentode
5902
Audio Power Pentode
*5903
Double Diode Detector
†5904
Medium Mu Triode
†5905
Sharp Cut-off Pentode
†5906
Sharp Cut-off Pentode
†5907
Semi-remote Cut-off Pentode
†5908
Pentode Mixer
*5916
Pentode Mixer
5977
Low Mu Triode
5987
Power Control Triode
6021
Medium Mu Double Triode
6110
Double Diode Detector
6111
Low Mu Double Triode
6112
High Mu Double Triode
6153
Sharp Cut-off Pentode
Low Cgp (Separate suppressor)
6154
Remote Cut-off Pentode
Low Cgp (Separate suppressor)
6205
Sharp Cut-off Pentode
(Separate suppressor)
6206
Semi-remote Cut-off Pentode (Separate suppressor)

‡6308 Voltage Reference Tube.

*26-volt heater †26 volts all elements ‡Cold Cathode Type
All other types are 6.3 volt heaters.

For complete data sheets and specifications concerning any of the above tube types and for application information, see your Sylvania Sales Engineer or write to: Sylvania Electric Products Inc., Dept. 4R-4409, 1740 Broadway, New York 19, N. Y.

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Coefficient Tester

(*Continued from page 110*)

and it is the minimum value which can be recorded for calculation purposes. If a resistor has a large temperature coefficient it is advisable to wait until thermal equilibrium is reached. By tracking the balance point a qualitative approximation as to the temperature coefficient can be obtained. The trimmer condenser C may be altered to get a complete cancellation of the fundamental signal.

Resistors of commercial manufacture were obtained in lots of five each. These are typical cylindrical rod-type units with wattage ratings between ½ and 1 watt. The group represents the typical stock of a wholesale distributor of resistor components in the resistance range under test. These units are designated by a code number. The first letter designates the manufacturer, the first number—the wattage, the second number—the type (one manufacturer may have several types), and the last number is the resistance in kilohms. Results based on the average value are given in Table I.

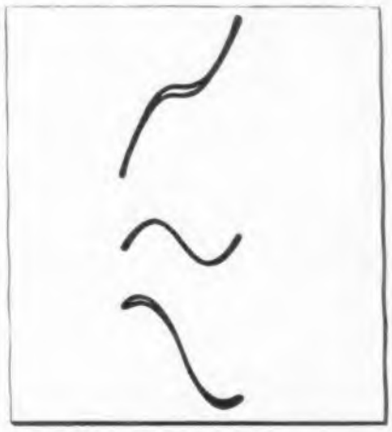

Fig. 5: Lissajous figures at balance point

Noise measurements on these resistors were also made as described later. Since the voltage coefficient may be a function of the mechanism which causes noise (e.g., internal arcing and breakdown), these data are presented for comparison.

For the small selection of resistors tested there is a wide range of voltage coefficients. The highest is over sixty times as bad as the lowest. Within a manufacturers group, there may be extreme variations indicating the degree of control achieved. For example, testing 10 units of manufacturer "A" gave a maximum deviation from the average of −6.5%

to +9.8% whereas resistors of manufacturer "B" fell between −38% to +68%. In respect to noise, it appears that for a given structure and geometry, noise is approximately proportional to voltage coefficient. When testing a single group, those resistors having large voltage coefficients were observed to have large noise values. The factor relating noise to voltage coefficient is not a constant between manufacturers. It is probably dependent on current densities and electric field concentrations within the resistor body.

It was also observed that the voltage coefficient varies inversely as the length of the resistor squared for a particular material.

All composition resistors tested indicated that the voltage coefficient decreases with rising temperature. Therefore operating a resistor at high ambient temperatures decreases its voltage coefficient. If a resistor were to have a β coefficient independent of temperature, the third harmonic generated would be proportional to the amplitude of voltage cubed. A Thyrite (GE's silicon carbide non-ohmic resistor) resistor which has an extremely high voltage coefficient behaved exactly that way. In Fig. 5 curves are plotted on log-log coordinates in order to show this variation in β with voltage. The Thyrite curve (A) has a slope of 3.0 whereas curves E and F (mfrs. A and B) have slopes of 2.4. This indicates the β is proportional to $1/V^{0.4}$ for these two resistor types. Other resistors of different manufacture are more extreme in the variation of β. Curves C and D compare the same resistor characteristic for free space cooling and when packed in "dry" ice (D).

The foregoing observations indicate that the conduction mechanism

TABLE I

Resistor*	Noise In μv/v	Voltage Coefficient 10^{-4}%
A ½-1-10	0.1	3.0
B ½-1-13	1.4	15
B ½-2-12	2.3	36
C ½-1-15	0.6	30
D ½-1-12	0.2	14
D 1-1-12	0.06	8.3
E ½-1-12	0.5	40
E 1-1-13	1.0	24
F ½-1-13	1.0	67
F ½-2-13	4.2	200
G ½-1-10	1.1	13

* A ½ wattage 1 type 10 Mfr. Resistance in Kilohms

Coefficient Tester

(*Continued from page* 113)

is far from simple in composition resistors. A detailed study of the various factors involved may be warranted at some future date but is beyond the scope of this article.

Noise measurements were made using the set-up of Fig. 7. A battery, by-passed with a 10 mfd. condenser, supplies 90 v to a 10,000 ohm wire wound matching resistor in series with the resistor under test. The noise voltage generated in the resistor is amplified (using the amplifier built into a Hewlett Packard 400 C voltmeter) and filtered before being measured with a voltmeter. A frequency response characteristic of the filter showed the response to be down by 3 db at 500 and 5,000 cps. The system was calibrated with a sinusoidal signal at 1500 cps and an output reading of 14 mv. was equivalent to 100 μv input. Residual noise in the system was equivalent to about 5 μv. It was observed on an oscilloscope that stable resistors had uniform noise levels whereas poorer resistors would generate large random spikes. The following equation was sufficiently accurate for the noise measurements made:

$$e_n = \frac{R_x + R_m}{R_m} \times \frac{100}{14} \times \frac{R_x + R_m}{R_x} \times \frac{e_{meas.}}{90},$$

where e_n is the generated noise voltage and the other factors are defined in Fig. 6. The measured noise is in millivolts and the result (e_n) has the dimensions μv/v. Although the applied voltage was not rated voltage, it was observed that for all practical purposes, the noise is proportional to applied dc voltage.

This noise test deviates slightly from that suggested in J.A.N. specifications R-11 section F3C (11) in order to use available equipment.

Automatic Production Proceedings Available

Proceedings of the Symposium on Automatic Production of Electronic Equipment held last April 19-20 in San Francisco, have been published by Stanford Research Institute. The symposium was jointly sponsored by the Air Force and SRI. The 119-page bound volume contains 17 papers and illustrations relating to the general aspects of automation, product design, construction techniques, materials, components and the design of automatic production lines. The proceedings may be obtained for $4.00 a copy by writing the Public Relations Office, Stanford Research Institute, Stanford, Calif.

"Maverick" usually spells trouble, on the production line as well as out on the range. Being an unknown quantity or a "Johnny-come-lately," it leaves room for genuine doubt both as to performance and quality. And that's the reason so many experienced buyers —production experts to supervisors—insist on Kester . . . the one "brand" that is synonymous with the best solder and solder products.

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Instrument Show

(Continued from page 81)

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Among the subjects covered by the Clinic are graphic panel components, electronic potentiometers, electric meters, pH instruments, combustion controls, thermocouples, pyrometers and gas analysis equipment. Enough instructors are being provided by instrument manufacturers to take care of about 400 students.

Technical paper sessions are open to members of cooperating societies and foreign visitors without payment of a fee. For others there is a registration fee of $5.00. Among the papers which are expected to be of special interest to the electronic engineer are the following.

Sept. 14

"Computing Machine Control of a Batch Chemical Process"—I. Lefkowitz, Case Inst.
"Some Differences Between Robots and Human Beings in the Process of Decision Making"—I. D. Trimmer, U. of Tenn.
"Analog Study of Interacting and Non-interacting Multiple Loop Control Systems for Turbojet Engines"—W. E. Phillips, Jr., Lewis Flight Prop. Labs.
"Medical Aspects of Radiological Defense"—E. G. Williams, M.D., Fed. Civil Defense Admin.
"Radiological Instrument Program of the Federal Civil Defense Administration"—J. C. Greene, Fed. Civil Defense Admin.
"The Use of a Pressurized Ion Chamber and Floating Grid Electrometer in a Wide Range Instrument for Civil Defense"—H. V. Neher, Jordon Electronic Mfg.
"Raman Spectrometer Assembled from Available Components"—H. Lawrence, Am. Cyanamid.
"The Self Indicating Dosimeter in Civil Defense"—C. R. Siebentritt, Jr., Bendix
"Evaluation Tests of Radilogical Instruments"—S. W. Smith, NBS.
"Requirements of Radiation Instrument Industry in National Emergency"—L. J. Deal, AEC.
"Automatic Data Reduction for Jet Engine Testing at the Arnold Engineering Development Center"—A. H. Hodges, ARO, Inc.
"The Synchro Timer and Its Application to Material Handling and Sorting Operations"—A. S. Burgoyne, Pratt & Whitney.
"Production Measurement and Recording"—L. W. Calkins, U.S. Steel.
"Survey of Analog-to-Digital Converters"—G. G. Bower, Naval Ordnance Lab.
"ADRAD: An Automatic Digital Recorder for Analog Data"—W. G. Deutsch, G E.

Sept. 15

"The Standardization of Automatic Control Terminology in Germany"—R. Oetker, Siemens & Kalske.
"A Decimal Registor Based on Frequency Memory"—W. A. Edson, Stanford U.
"An Instrument for the Rapid and Accurate Calibration of O-Meter"—J. T. Koppenhaver, RCA.
"An Electro Mechanically Stabilized dc Amplifier"—H. A. Riester, Fielden Inst.
"A Recording Amplitude-Distribution Analyzer"—I. H. Gerks, Collins Radio
"A Phase Meter for Ultra Low Frequency Range"—R. W. Houghton & R. E. Crosby, Jr., Technology Inst.
"An R. F. Linear Decelerator Mass Spectrometer"—W. Donner, Beckman Inst.
"Why Electronic Process Control"—D. M. Boyd, Jr., Universal Oil Prods.
"Integration of Concepts in the Terminology of Measurement and Control"—H. L. Mason, NBS.
"Microwave Calorimeters"—I. K. Munson, RCA.
"Vectorimeter for Color Television Measurements"—J. F. Fisher, Philco.
"A Broad Range Instrument for the Measurement of Capacitor Temperature Coefficient"—J. H. Ollis, RCA.
"Accurate Diode Switch for Use in Analog Computation"—T. H. Tuchepp, Columbia U.
"An R. F. Mass Spectrometer Utilizing Linear Accelerator"—M. K. Testermann, Beckman Inst.

Sept. 16
"Microwave Spectroscopy"—Van Zandt Williams, Perkin Elmer.
"Use of the Photomultiplier in Measuring Ultrashort Times and Ultra Small Light Intensities"—G. Morton, RCA.
"A New 12-Element Automatic Oscillograph and Applications on the Bonneville Power Systems"—C. M. Hathaway, Hathaway Inst. Co., W. L. Davis & J. R. Curtin.
"An Airborne Temperature Indicator"—W. R. Clark, W. G. Amey & G. C. Mergner.
"New Advances in Servo Type Systems"—Messrs. Kinard, MacIntoch & Hanson, G.E.
"Fundamental Properties of and Methods for Rating Noise"—L. L. Beranek, Bolt, Beranek & Newman.
"Special Problems in Noise Measurement"—S. M. Potter & G. L. Bonvallet, Armour Res.
"Nuclear Magnetic Resonance"—J. S. Waugh

Sept. 20
"Instrumentation for Vibration, Testing and Analysis"—A. Crawford, Internatl. Res. & Devel., Inc.
"New Types of Photoelectric Measuring Devices"—B. Lange, Berlin-Zehlendorf.
"Miniaturization of Transducer for Mobile Applications"—O. W. Sailer, Con. Engrg.

Sept. 21
"Aerobee Rocket Grenade Instrumentation"—J. R. Walsh, Evans SCEL.
"Use of an Analog Computer in Solving Problems"—J. Rodel, Pullman.
"A Magnetic Tape Recorder for Flight Recording Use"—R. L. Sink, Con. Engrg.

Sept. 22
"Dynamometers and Their Control for Torque Measurement"—H. Gibson, G.E.
"Thrust Dynamometers"—M. C. Tate, A. H. Emery Co.

Sept. 23
"Industrial Application of Electromagnetic Flow Meters"—Jan Boeke, Foxboro.
"Galvonometer Systems—Their Characteristics, Frequency Response and Sensitivity—C. A. Heiland, Heiland.
"Transducers: The Tools of Instrumentation"—L. Seldin, Du Mont.

Sept. 24
"Use of Meter Relays in Industrial Progress"—P. St. Amour, Assembly Prods.

Mass Production of Rate Grown Transistors

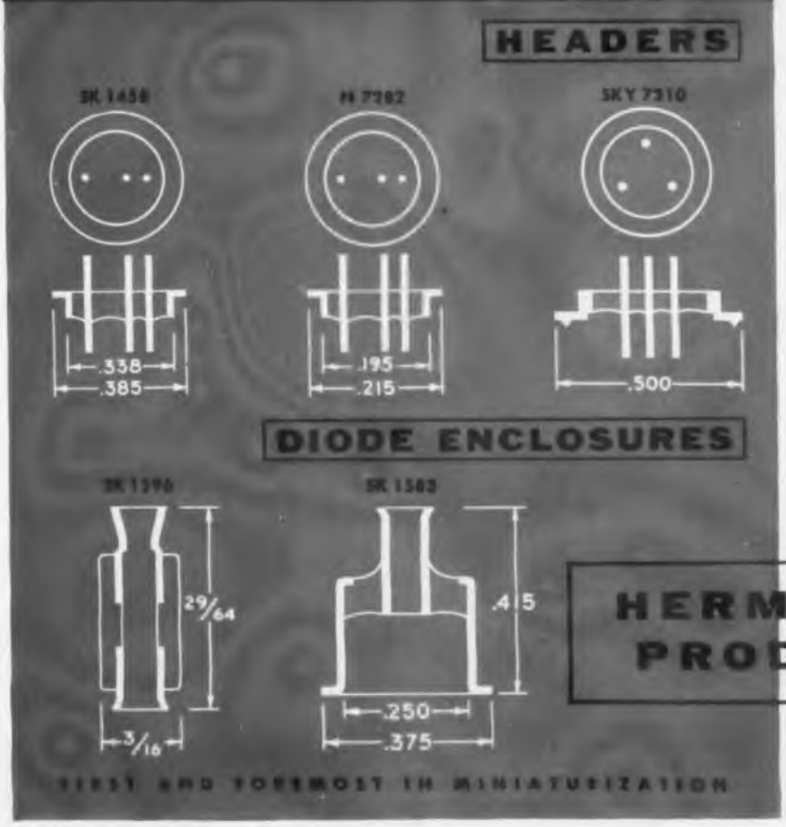
Rate grown transistor ingot is diced by means of ganged diamond saw at General Electric. Bars on glass plate will become transistors by simply attaching leads at ends and middle

Close-up shows how half-moon slice of split germanium ingot (upper left), 0.1 in. thick, is processed. It is sliced, 0.020 in. thick (upper right), and laid flat (lower left). Slices are then diced again (lower right)

Key to GE mechanization of transistor production lines is attachment of base lead wire to transistor bar, presently a hand operation. Close-up shows wire, half the thickness of a human hair, being attached to the bar

Header with rate grown transistor and attached end leads and base lead is placed in main seal welding machine to protect assembly. Later air will be exhausted from the device

G. H. Q. for Transistor Packaging



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BULLETINS

Capacitors

The recently released 48-page Catalog AC-4 presents complete listings and technical data on electrolytic, paper-foil, and metallized-paper capacitors. The catalog is available to engineers, purchasing agents, and service personnel at the Astron Corp., 2155 Grant Ave., E. Newark, N.J.

Variable Toroids

New technical bulletin on "Rotoroids" describes series of continuously adjustable toroids which may be varied over 3:1 inductance range with 180° shaft rotation. Write Burnell & Co., Dept. G, 45 Warburton Ave., Yonkers 2, N.Y.

Knobs

Two illustrated folders from Romar Plastics Inc., 1311 E. Main St., St. Charles, Ill. cover a complete line of plastic knobs designed for electronic equipment.

Microwave Tubes

Specifications on a line of travelling wave amplifiers, backward wave oscillators, and microwave gas control tubes, with descriptions of uses for which they are intended, are contained in a 3-page folder from Roger White Electron Devices Inc., Ramsey, N.J.

Potentiometers

Six basic models in a line of standard and power type potentiometers are described in a new 8-page brochure released by the Electronic Sales Div., DeJUR-Amsco Corp., 45-01 Northern Blvd., L.I.C., 1, New York.

BULLETINS

Synchros

A new 20-page, two-color brochure, "The Synchro Story," describes the materials, processes, and operations involved in the manufacture of precision synchro instruments. Mailed on request to Clifton Precision Products Co., Inc., Marple at Broadway, Clifton Heights, Pa.

Shock Mounts

A leaflet describes the shipment-protection use of "Barrymounts", compression-type shock mounts, made by The Barry Corp., 861 Pleasant St., Watertown, Mass., and describes the causes of shipment damage.

Transformers

Catalog 400-L, covering transformers and reactors made by Maguire Industries, Inc. Thordarson-Meissner Mfg. Divisions, 7th and Belmont, Mt. Carmel, Ill., features a TV replacement section and output transformer chart.

Relays

Leach Relay Co., Div. Leach Corp., 5915 Avalon Blvd., Los Angeles 3, Calif., has released a 44-page, 2-color, loose-leaf catalog which illustrates and describes standard stock relays, and suggests modifications that meet special requirements. Free on request.

Microwave Equipment

Bulletin 72B-P4 provides detailed engineering and applications information on the Type 72B microwave equipment produced by Lenkurt Electric Co., 1105 Old County Rd., San Carlos, Calif.

Flexible Shafts

Catalog 5494, released by Kupfrian Mfg. Co., 395 State St., Binghamton, N.Y., contains technical information on flexible shafts and couplings. Illustrates over 30 standard shafts and assemblies; more than 100 components.

Instruments

Catalog No. 28, published by The Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, O., presents 49 pages of illustrations, descriptions, and tables covering the more popular types of the company's electrical indicating instruments.

Crystals

"Crystals for the Critical", a 14-page catalog covering the application, ordering, and technical description of various classifications of crystals, and a discussion of basic piezoelectric resonator theory has been released by James Knights Company, Sandwich, Ill.

Mechanical Instruments

Catalog M-2-A, published by Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N.J. illustrates and gives complete basic information on the company line of mechanical instruments. The catalog and complete listing of 9, 10, and 12 inch circular recorder charts are available by writing directly to the company.

Capacitors

The 1954 edition of the "Hi-Q Ceramic Capacitor Catalog" has been released by Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.

SSB Filter

Detailed instructions on the installation of a single side band filter and the theory of its operation are contained in an 18-page informational bulletin released by Burnell & Co., Inc., 45 Warburton Ave., Yonkers 2, N.Y.

(*Continued on page* 155)

Military Contract Awards

See page 3 for cumulative statistics on electronic procurement.

Electronic products, dollar value, and names of manufacturing contractors receiving awards as reported by U.S. Dept. of Commerce

Electrode, welding-68,200—The McKay Co., Mc Kay Bldg., 1005 Liberty Ave., Pittsburgh, Pa.

Aluminum Conductor-47,939—Reynolds Metal Co., Louisville, Ky.

Cable-39,423—Clark Cable Corp., 3184 West 32nd St., Cleveland 9, Ohio.

Loudspeakers-65,617—Jensen Mfg. Co., 6601 S Laramie Ave., Chicago, Ill.

Loudspeakers-31,684—University Loudspeakers Inc., 80 S. Kensico Ave., White Plains, N.Y.

Jack Box Assy.-41,666—Palmer Elec. & Mfg Co., 24 Water St., Wakefield, Mass.

Transformer, synchro control-56,740—Kearfott Co., 1378 Main Ave., Clifton, N.J.

Motor-28,990—Electrical Engineering & Mfg Corp., 4612 W. Jefferson Blvd., Los Angeles 16, Calif.

Junction Boxes-70,222—Sunstrand Aviation Div., Sunstrand Mach. Tool Co., 2421 Eleventh St., Rockford, Ill.

Accelerometers-164,874—Bendix Aviation Corp., Teterboro, N.J.

Generators-249,927—Bendix Aviation Corp., Teterboro, N.J.

Frequency Meter-143,621—The Sperry Corp., Great Neck, L.I., New York.

Signal Generators-544,587—Transitron, Inc., New York, N.Y.

Rectifier Converters-27,500—Westinghouse Electric Co., Washington, D.C.

Controls, radio set-21,106—The Magnavox Co., Fort Wayne, Ind.

X-Ray Apparatus-463,785—Universal X-Ray Products, Inc., 1140 N. Western Ave., Chicago 22, Ill.

X-Ray Apparatus-565,500—Professional Equipment Co., 1401 North First Ave., Maywood, Ill.

Camera System-44,000—X-Ray Department, General Electric Co., Milwaukee, Wis.

Components, radar-217,480—Motorola, Inc., 2710 N. Clybourn Ave., Chicago 14, Ill.

Electron Tube-200,561—Sylvania Electric Products, 1740 Broadway, New York 19, N.Y.

Encoder-47,500—The Baldwin Piano Company, 1801 Gilbert Ave., Cincinnati, Ohio.

Countermeasures Repeater-83,901—Instruments for Industries Co., Old Country Rd., Mineola, N.Y.

Ultrasonic Visual Display-158,428—Freed Electronics & Controls Corp., 200 Hudson St., New York 13, N.Y.

Radio Set-31,141—Philco Corp., Wissahickon, Philadelphia 44, Pa.

Motor-33,500—Dalmo Victor Co., 141 El Camino Real, San Carlos, Calif.

Frequency Converter Comparator-643,571—National Co., Inc., Malden, Mass.

Antennas-284,941—Technical Appliance Corp., Sherburne, N.Y.

Radar Relay Systems-45,703—Motorola, Inc., Chicago, Ill.

Radio Transmitters-57,387—Stavid. Eng. Inc., Plainfield, N.J.

Analyzer-75,198—Sperry Corp., Great Neck, L.I., N.Y.

Radio Receiver Transmitters-5,155,320—Admiral Corp., Chicago, Ill.

Switch, thermostat-89,050—Airesearch Mfg. Co., Div. Garrett Corp., 9851-9951 Sepulveda Blvd., Los Angeles 45, Calif.

Oscilloscope, cathode ray-68,944—Laboratory for Electronics Inc., 75 Pitts St., Boston 14, Mass.

Modification Kits-247,057—Western Union Telegraph, 60 Hudson St., New York, N.Y.

Oscillator Unit, control tone-104,162—Espey Mfg. Co., Inc., 528 East 72nd St., New York 21, N.Y.

Course Centering Assy.-25,164—Alcor Electronics Corp., 180 Lafayette St., New York 13, N.Y.

(*Continued on page 125*)

PERSONAL

E. Finley Carter, v.p. and technical director of Sylvania Electric Products Inc., N.Y., has accepted the position of manager of research operations of Stanford Research Institute, Palo Alto, Calif. He will retain an association with Sylvania, assisting in contacts with the Dept. of Defense and consulting on major research and development contracts.

E. F. Carter

C. L. White

C. L. (Bob) White has been appointed chief liaison engineer of the Hammarlund Mfg. Co., New York, to coordinate engineering and sales activities.

Robert G. Scott has been named asst. sales manager of the Cathode-Ray Tube Div., Allen B. DuMont Labs Inc. Mr. Scott joined DuMont in 1948 as senior engineer on CRT development.

Donald H. Rogers, former chief engineer of Blonder-Tongue Labs, has joined the engineering department of Jerrold Electronics Corp., Phila., Pa., manufacturers of master antenna systems.

Aldo Lachman has joined the R. T. Bozak Co., loudspeaker manufacturer, as v.p. in charge of manufacturing.

Andrew S. Kariotis has been named to the field engineering staff of the Washington, D.C., office of the Sprague Electric Co.

Norman Rea has been appointed field engineer at Technical Appliance Corp., Sherburne, N.Y., manufacturers of antenna equipment.

Jay W. Forrester, director of the digital computer laboratory at M.I.T., was awarded an honorary degree of Doctor of Engineering by his alma mater, the Univ. of Nebraska.

Dr. Hans Erich Hollmann has joined the Engineering Staff, Electronics Div., of Hydro-Aire Inc., as Electronics Research Scientist.

Edgar W. Engle, manager of product and process development engineering at the Carboloy Dept. of G.E. in Detroit, has been named manager of cemented carbide products engineering.

(*Continued on page* 129)

ilitary Contract Awards

(Continued from page 122)

e, electron-150,010—Sylvania Electric Products, New York, N.Y.
er Testers-25,119—Square Root Mfg. Corp., 191 Saw Mill River Road, Yonkers, N.Y.
io Beacon-46,399—American Mach. & Foundry Co., 1085 Commonwealth Ave., Boston 15, Mass.
ctron Tube-30,794—General Electric Co., Schenectady, N.Y.
ctron Tube-284,750—General Electric Co., Elec. Division, 1 River Rd., Schenectady, N.Y.
e, electron-165,863—Kuthe Labs, Inc., 730 So. 13th St., Newark, N.J.
e, electron-173,352—Sylvania Electric Products, 1740 Broadway, New York 19, N.Y.
Capacitor Test Set-39,977—Sunshine Scientific Inst., 1810 Grant Ave., Philadelphia 15, Pa.
Battery-27,963—Ray-O-Vac Company, 212 E. Washington Ave., Madison 10, Wis.
Antenna Kit-66,161—Gar-Let Mfg. Co., Waltham, Mass.
Meter Test Equip-186,598—Dubrow Development Company, 225 Penn. St., Burlington, N.J.
Resistance Bridge-63,991—The Winslow Co., Inc., 9 Liberty St., Newark 5, N.J.
Battery Pack-418,500—The Eagle Picher Co., American Building, Cincinnati 1, Ohio.
Direction Finder-286,492—Parchester Mach. Corp., 204-206 Lafayette St., New York 12, N.Y.
Conduit Assy., elec—Johns-Manville Corp., Box 500, Hackensack, N.J.
Tube, electron-512,295—Sylvania Electric Products, Inc., 1740 Broadway, New York 19, N.Y.
Electron Tube-43,860—Radio Corp. of America, RCA Victor Div., Harrison, N.J.
Modification Kit-66,701—Times Facsimile Corp., 540 W. 58th St., New York 19, N.Y.
Battery, box-50,965—Kane Mfg. Co., Kane, Pa.
Electron Tube-200,000—General Electric Co., 1 River Road, Schenectady, N.Y.
Receiver, transmitter-498,682—Federal Telephone & Radio Corp., Clifton, N.J.
Electrodes-46,870—The McKay Co., 1005 Liberty Ave., Pittsburgh 22, Pa.
Handset-Headset-151,280—Roanwall Corp., 622 Pacific St., Brooklyn, N.Y.
Amplifier Unit-28,334—El-Tronics, Inc., Fifth & Noble Sts., Philadelphia 23, Pa.
Panoramic Adapter-30,419—Panoramic Radio Products, Inc., 10 South 2nd St., Mt. Vernon, N.Y.
Radio Set-177,120—Schutting & Co., Inc., 5005 Calvert Road, College Port, Md.
Battery-33,940—P. R. Mallory & Co., Inc., 60 Elm St., North Tarrytown, N.Y.
Battery-54,950—Olin Industries, Inc., 275 Winchester Ave., New Haven, Conn.
Tube, electron-167,896—Sylvania Electric Products, Inc., 100 Sylvan Road, Woburn, Mass.
Reperforator-31,949—Teletype Corporation, 1400 Wrightwood Ave., Chicago 14, Ill.
Cable and Reels-557,898—General Cable Corp., 123 S. Broad St., Philadelphia, Pa.
Cable and Reels-1,217,813—General Cable Corp., 123 S. Broad St., Philadelphia, Pa.
Control, transmitter-94,883—George Varan & Co., 835 North 19th St., Philadelphia 30, Pa.
Dummy Load-189,912—Polarad Electronics Corp., 100 Metropolitan Ave., Brooklyn 11, N.Y.
Tube, electron-25,152—Chatham Electronics Corp., 630 Mt. Pleasant Ave., Livingstone, N.Y.
Tube, electron-75,913—Raytheon Mfg. Co., 55 Chapel St., Newton 58, Mass.
Telemetering System-39,996—Bendix Aviation Corp., 186 West Olive St., Burbank, Calif.
Analyzer, spectrum-42,068—Polarad Electronics Corp., 100 Metropolitan Ave., Brooklyn 11, N.Y.
Waveguide, elbow-32,704—Sightmaster of Calif., Co., Gillespie Airport, Santee, Calif.
Relays-33,092—Guardian Electrical Mfg. Co., 1621 Walnut St., Chicago, Ill.

Calibrating Standard

(*Continued from page 88*)

are also insulated from the cart t prevent cross grounding when connecting to test panels.

The dc, filtered, full wave voltag supply uses four 1616 vacuum tub rectifiers and a multi-section filte with a tapped output resistor fo voltage between 0 and 1200 dc with a ripple content less than 0.2% High voltage for this supply is ob tained from the same instrumen potential transformer used for a voltage checks thus helping reduc cart cost and weight.

Rectifier

A center tapped copper oxide rectifier with filter provides dc current with a ripple content less than 2% for 0.06 to 12 a. This supply consists of a high current filament transformer with its primary and secondary windings in series to provide approximately 5-0-5 v out at 100 a. A half-wave 6 v 150 a plating rectifier was rewired to provide a center tapped rectifier. This complete assembly with filter condenser was approximately ⅓ the size of the nearest commercially available unit.

A multi-tap instrument potential transformer provides output taps from 1.2 to 1200 v for all ac voltage checks. Its ample capacity of 20 watts maximum permit checking as many as five voltmeters at a time if necessary.

The 400 CPS supply delivers up to 20 watts maximum power for all ac 400 CPS voltage checks. It consists of an isolation transformer, a General Radio 400 CPS vacuum tube tuning fork oscillator and a high quality audio amplifier. The output of this combination is fed to the instrument potential transformer with output taps of 1.2-1200 v.

AC, 60 CPS current is obtained from the transformer used in the dc current supply for the full range of 0-120 a.

Connections

The meters under test are connected to the standard with two-wire six-foot flexible cable with pin banana plug at the cart end and a jack plug at the test end. Jack receptacles for this plug are generally provided under each meter to be tested. On high voltage, high current, or on special circuits, a separate connection is made at the meter under test rather than through jack receptacles.

Standard Electric Time Co. high

The Only All Band

10 mc to 33,000 mc

Direct Reading Single Control

SPECTRUM ANALYZER

Model LSA

The Model LSA provides direct means of rapid, accurate measurement of spectral display of r. f. signals from 10 to 33,000 MCS

Saves Engineering Manhours

The Model LSA Spectrum Analyzer is Polarad's answer to rising engineering costs when high performance and economy are essential.

This unique engineering tool helps get results faster with fewer personnel and in less space. Because of its ultra simplicity, tremendous frequency coverage and remarkable instrumentation the Model LSA can handle almost any problem in the radio spectrum (10 mc to 33,000 mc) with the greatest of ease, reliability and accuracy.

How The Model LSA Cuts Production Costs

In the factory, Model LSA's simplicity of operation, direct reading and "GO-NO-GO" electronic display speeds production and cuts costs. Uniform quality and high performance of your complete equipment is assured by checking it with a Polarad Spectrum Analyzer.

Expensive personnel training programs are eliminated by the Model LSA, which often actually takes the place of the microwave specialist and frees engineers for other work. For further details contact your nearest Polarad representative or write direct to us.

FEATURES:

Frequency Range 10 mc-33,000 mc; 5 tuning heads
Accuracy Frequency Calibration—1%
Spectrum Display variable from 250 kc to 25 mc
Frequency Marker for measuring frequency differences of 0-25 mc
Broad Band R.F. Attenuators 10 mc-12,000 mc
Automatic Voltage selector for each tuning head
Single Dial Control
Direct Frequency Reading
Spectrum Displayed on 5" cathode ray tube

USES:

Examine pulse spectrum of magnetrons and klystrons
Measure noise and interference spectrum
Act as broad band receiver from 10 mc to 33,000 mc
Observe and measure harmonic frequency differences
Measure band width of microwave cavities
Calibrate microwave oscillators and preselectors

PROVEN RELIABILITY

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Available on Equipment Rental Plan

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Calibrating Standard

(*Continued from page* 126)

current jacks are provided on the side of the cart for dc and ac high current connections.

A four pin Jones plug in the control panel connects to a demagnetizing coil for adjustment of dc meters when necessary. A separate 5 a Variac provides power to this plug independent of the calibration circuits.

A two-connector 110 v receptacle is mounted in the lower front of the cart for connection to a soldering iron, test lamp or VTVM. It is connected to the ac line ahead of the cart circuit breaker to permit working on the cart with all the calibration circuits inactive.

Assembly System

(*Continued from page* 88)

secure the best "feeding" conditions. One machine has already been built for belting resistors, the basic design of which may be readily extended to other axial lead components. In this equipment resistors are fed automatically through lead straightening and taping stations.

At the conveyor, belted components are fed from reels into the inserting heads which automatically cut and form the wire leads and insert them through the pre-punched holes in the printed wiring boards. At the same station the lead ends protruding through the board are automatically clinched to hold each component in place until the board is dip soldered. To avoid damage to the bodies of components they are handled by their leads throughout the belting, inserting and clinching operations.

To insure uniformity in the completed product, United has built several safeguards into its experimental machine. Included are provisions to stop the machine when a station is empty, when a component is missing or not correctly inserted, or when an inserting head does not complete its cycle. It is expected that the first experimental conveyor will be operating on production assemblies in Sept., 1954.

See page 58 for more details.

Barry Publishes New "Shock" House Organ

A periodical devoted exclusively to shock, vibration and noise isolation is now being published by the Barry Corp., Watertown, Mass., called "Shock and Vibration Control Notes."

PERSONAL

(*Continued from page* 124)

James **M. Valentine** has been promoted to sales manager of the TV branch of Federal Telecommunications Labs., Nutley, N. J. Mr. Valentine has been with the IT&T corporation since 1951, and has supervised the installation of a number of TV stations in the U.S. and overseas.

Charles J. Adolph Jr. has been appointed manager of the West Coast office of Kollsman Instr. Corp., manufacturers of precision aircraft and optical instruments and systems. Mr. Adolph has been with Kollsman since 1937, as a member of the engineering staff, and, since 1939, as asst. manager of the Glendale, Calif. plant.

C. J. Adolph

M. C. Eliason

M. C. Eliason was appointed sales manager at the Electronic Equipment Div. of Air Associates Inc. in Orange, N.J. Immediately prior to the appointment, Eliason had been a Systems Engineer at Hughes Aircraft Corp. Earlier, he had spent seven years as an electronic engineer at Air Associates.

Rudolf Leopold has been named manager of the newly formed Specifications and Records Dept. of the Communications Products Div. Allen B. Du Mont Labs Inc. He will be in charge of drawing up the plans and specifications for the Dumont line of TV broadcast transmitters and studio equipment and the mobile communication products.

J. D. Webster, G.E. engineer, has been transferred to the company's X-ray dept. in Milwaukee as manager of industrial and non-allied sales. Since 1951 Webster has worked as sales engineer in the Apparatus Division industrial sales dept. in San Francisco.

R. R. Jenner, formerly chief radio and electronics engineer for Beech Aircraft Co., has been appointed to the newly created post of director of airborne products for Micro Switch, Freeport, Ill., division of Minneapolis-Honeywell Regulator Co. He will be directly responsible for the design and production of all Micro Switch products destined for use in the aircraft industry.

AUDIO ATTENUATORS

OVER 200 BASIC TYPES TO CHOOSE FROM

Do audio attenuator problems cost you money? Chances are Shallcross has a model to match your specifications exactly—and at moderate cost.

Shallcross attenuators are made in over 200 basic types. Each type can be supplied with a choice of attenuation characteristics . . . with a positive detent mechanism . . . and in numerous input and output impedances. Where calibration must be extremely accurate, Shallcross precision wire-wound resistors are used. For less critical applications, models with high grade composition resistors can be supplied—often at lower cost.

A complete description of all Shallcross attenuators — mountings, characteristics, and circuits is yours for the asking in Bulletin L-4A. SHALLCROSS MFG. CO., 518 Pusey Avenue, Collingdale, Penna.

QUICK DELIVERIES! Small quantities of popular 20 step Shallcross composition resistor potentiometers and wire-wound ladders without detents are immediately available.

Shallcross

News of MANUFACTURERS REPS

Abbett & Hustiss, 1105 Commonwealth Ave., Boston, Mass., have been appointed reps for Condenser Products Co., division of New Haven Clock & Watch Co., to cover all the New England States.

Lee H. Owens, 2331 W. Washington Blvd., Los Angeles, has been appointed Pacific coast representative for Measurements Corp., Boonton, N.J. Mr. Owens will handle the southern California territory.

Yewell Assoc., with offices at 75 Main St., Waltham, Mass., and 1101 Main St., Bridgeport, Conn., has been appointed the exclusive representative for the New England and eastern N.Y. area for Sensitive Research Instr. Corp., 9-11 Elm Ave., Mt. Vernon, N.Y. For the Philadelphia, eastern Pennsylvania and southern N.J. area, the company appointed the **I. E. Robinson Co.,** 7217 Marshall Rd., Upper Darby, and 37A Thomas St., Harrisburg, Pa.; for Indiana, **T. R. Law** of Law Instrument Co., N. Darling St., Angola, Ind.; in the Cleveland, Ohio area, the **S. Sterling Co.,** 4040 Mayfield Rd., Cleveland 21, Ohio. For export, the exclusive rep for the Sensitive line is **Ad. Auriema, Inc.,** 89 Broad St., N.Y.C.

News of MANUFACTURERS' REPS

Askania Regulator Co., 240 E. Ontario St., Chicago, has been appointed midwestern representative for Librascope Inc., manufacturer of computer components, and Geo. A. Philbrick Researches Inc., electronic analog computer manufacturer.

Gordon Dougherty, a former principal in the reps firm of **Hagerty-Scott Co.**, Detroit, has formed his own organization, **Gorden Dougherty Assoc.**, with offices at 2339½ S. Cedar St., Lansing, Mich.

Koessler Sales Co., 6907 Melrose Ave., Los Angeles, has added 750 sq. ft. of display space to their facilities, including a completely equipped sound room.

Thompson Engineering Service, 4378 Lindell Blvd., St. Louis, Mo. announces that they are specializing in representing West Coast electronic component manufacturers in the midwest. They currently represent fifteen West Coast manufacturers of aircraft and electronic equipment.

A. E. Heitner, formerly with the purchasing sections of Emerson, Tele-King and Video Products, will handle office sales and sales service for **Sydney H. Baum & Co.**, 70-15 Fleet St., Forest Hills 75, N.Y. **Lewis B. Carlan** has joined Baum as a sales engineer.

William S. Spring, 15 Elm Pl., New Canaan, Conn., has been appointed manufacturers rep for Boston, N.Y. and Philadelphia territories by Magnetics Inc., Butler, Pa.

Herb Erickson Co. of Atlanta, Ga. has been appointed southeastern rep for the Allen D. Cardwell Electronics Productions Corp., subsidiary of Chesapeake Industries, Inc., which manufactures meteorological equipment, capacitors, UHF converters, printed circuits, recorders and transmitters.

Tubergen Associates, formerly John B. Tubergen Co., Los Angeles, has been appointed West Coast rep for N.R.K. Mfg. & Engrg. Co., manufacturers of microwave assemblies, radar components, and mechanical assemblies.

A. J. Rissi, Monrovia, Cal. will cover Southern California and Arizona for Superex Electronics Corp., Yonkers, N.Y., manufacturers of electronic counter display items and Everlast Wire & Cable Co., Haverstraw, N.Y., manufacturing a line of specialties and TV wire.

Art Cerf & Co., of Newark, N.J., representing the Lowell Mfg. Co., St. Louis, Mo., aluminum ceiling baffle and grille manufacturer, in the Middle Atlantic States.

Sportscasts

(Continued from page 89)

complete schematic of Fig. 3, the pre-amplifier was designed to feed the limiter circuit, whose output is amplified to produce an audio level of up to + 15 dbm at the 500 ohm line terminals.

The unit was constructed with consideration for ease of wiring, servicing, operating and transporting. With the exception of the microphone jacks, all connections are made at the front panel. The knobs and switches are recessed so that there is no need for a cover, simplifying the set up at the remote site. The knobs can be recessed at the cost of accessibility because once set for a particular announcer and location (i.e., line loss) they need not be changed during the entire broadcast. The limiter will keep the output nearly constant, electronically, with input changes on the order of 15 to 20 db.

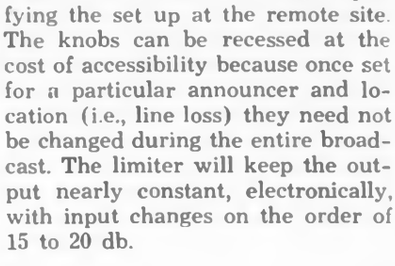

Fig. 4: Simply constructed remote equipment with recessed knobs ready for sportscast

The simple design of this type limiter makes it possible to build a remote amplifier that has no more controls than one without the compression feature. There are no particularly critical circuits to make construction difficult, and only the usual precautions need be taken. The use of a common ground wire, grounded to the chassis only at the input tube socket, is a must. Good quality, shielded audio transformers should be used, and placed as far as practical from the power transformer and chokes. The same applies to the input circuits. A metal 6J7 should be used as the input stage, with shielded wire connecting the microphone pads to the input transformer. If the power transformer is not electrostatically shielded, 0.001 μf capacitors should be used to by-pass each side of the AC line to the chassis. Naturally, the headphone jack should be insulated from the panel, as it is across the balanced output line.

Any number of inputs could be

sed, but since there is usually no eed for more than two, only two ere provided. Up to the point of ompression, this unit functions the ame as any remote amplifier, and hus can be used at reduced micro- hone input on any type program. t can even be used into the full ompression range, but on music, he compression may become notice- ble to the listener and therefore hould be avoided. On sportscasts, he average listener can only tell hat the level is pleasingly constant, and the compression does not in any way detract from the program.

The equipment pictured has been in use for nearly a year with no trouble of any kind encountered during that time.

PARTS LIST FOR FIGURE 3

R-1	1800 ohm	R-15	10,000 ohm
R-2	22,000 ohm	R-16	470,000 ohm
R-3	47,000 ohm	R-17	470,000 ohm
R-4	1 megohm	R-18	470,000 ohm
R-5	470,000 ohm	R-19	470,000 ohm
R-6	100,000 ohm	R-20	470,000 ohm
R-7	1,000 ohm	R-21	470,000 ohm
R-8	100,000 ohm	R-22	22,000 ohm
R-9	22,000 ohm	R-23	7500 ohm
R-10	15,000 ohm	R-24	22,000 ohm
R-11	470,000 ohm	R-25	470 ohm
R-12	470,000 ohm	R-26	100,000 ohm
R-13	470,000 ohm	R-27	680 ohm
R-14	15,000 ohm	R-28	470,000 ohm
C-1	50 μf 25 VDC	C-10	0.55 μf 600 VDC
C-2	0.5 μf 600 VDC	C-11	0.05 μf 600 VDC
C-3	16 μf 450 VDC	C-12	0.05 μf 600 VDC
C-4	0.05 μf 600 VDC	C-13	0.05 μf 600 VDC
C-5	0.05 μf 600 VDC	C-14	0.05 μf 600 VDC
C-6	0.05 μf 600 VDC	C-15	20 μf 20 VDC
C-7	8 μf 450 VDC	C-16	16 μf 450 VDC
C-8	8 μf 450 VDC	C-17	16 μf 450 VDC
C-9	20 μf 25 VDC	C-18	8 μf 450 VDC
T-1	microphone to grid	L-1, L-2	30 hy 50 ma
T-2	interstage		
T-3	plate-to-line	M	200 μamp meter.

New Link Radio Corp.

A new company, Link Radio Corp., 125 W. 17 St., New York 11, N.Y., has been organized, and taken over all assets of former Link Radio. Firm is under presidency of Murray Platt.

SNAKE CHARMER

New cage-by-cage electronic heating control made by Minneapolis-Honeywell and installed in the reptile house of New York's Bronx Zoo lures the snakes to the front of the cage where they can best be viewed. Grading up of temperatures toward front encourages comfort-seeking creatures to move forward

Magnetic Tape

(Continued from page 81)

nals may be due to any one or more of several different causes: 1) "Holes" in the magnetic coating due to omission or removal of coating, will cause a reduction in output of a signal recorded over such a defect, which will be dependent upon the size of the hole in relation to the wavelength of the signal being recorded, and to the track width. 2) Inclusions of foreign materials such as slivers of acetate, dust, etc., which do not extend physically above the surface of the surrounding oxide, but which have no magnetic properties, act upon the recording in the same way as do "holes." 3) "Nodules" are clumps of the oxide coating which rise above the surrounding oxide surface, which may be either conglomerates of oxide, or oxide surrounding a foreign particle. Such nodules cause a reduction in reproduced signal by physically lifting the medium momentarily from intimate contact with the gap in passing.

Importance of Defects

The importance of these tape defects differs greatly with the different types of recording. In the case of direct recording, when it is used principally for audio, such variations as would be caused by tape defects go virtually unnoticed excepting at the lowest tape velocities, with the narrowest tracks, or in the presence of abnormally low tape tension. When direct magnetic recording is used for the more critical purposes of handling data, tape defects may produce very objectionable amplitude variations, since amplitude reductions as great as 80% are frequently encountered from these causes, particularly at short wavelengths. The primary reason for the development of FM magnetic recording systems was to overcome the amplitude variations inherent even in highly refined tape. However, these defects, if gross, will still cause errors and increase noise in FM tape systems, since associated with amplitude modulation of the carrier is a related frequency modulation which appears as noise to some degree. Pulse width modulation systems suffer from dropouts in a different manner, since no effect is produced upon the reproduction until a pulse is completely dropped, at which, of course, the loss of information is total for that moment. This, in the case of PWM systems,

is generally not very serious since the data is usually of the analog type and integrated therefore over an extended time. Direct pulse digital recording systems, like pulse width modulation systems, suffer losses due to the various dropout causes which are either negligible or total; in the case of direct pulse recordings, however, this is of much greater consequence, since information points are often discrete and unrelated. The significance of such errors is readily realized when we consider that the error might be the zero which changes $60,000 to $6,000, as might occur in accounting systems. Errors of this kind may be minimized by various techniques such as changes in head geometry, pre-inspection of the tape, redundant recording methods, and electronic error-detecting techniques. With sufficient care in applying such measures, a digital recording system is obtainable wherein the first error will undoubtedly occur when the tape breaks, once again bringing the ultimate limitation of the recording method back to the characteristic of the medium itself.

New Berndt-Bach Plant

Berndt-Bach, Inc., manufacturer of Auricon sound-on-film cameras and kinescope recording equipment, has announced completion of a new plant at 6900 Romaine St., Hollywood 38, Calif.

Haydu to Burroughs

Burroughs Corp. has announced the acquisition of Haydu Brothers of New Jersey, Plainfield, N. J., manufacturers of electronic tubes and components. The company will continue its operations under George K. Haydu, formerly president, who has been named General Manager.

WEATHERPROOF ANTENNAS

UHF-TV transmitting antenna windows at Gabriel Co. are weatherproofed with solid sealer made by Minnesota Mining & Mfg. Absence of solvent eliminates possibility of shrinkage

Plating Indicator

(*Continued from page 77*)

waveguide and read the meter.

The schematic diagram of the indicator is shown in Fig. 2. The servomotor is geared to an autotransformer which controls the output of the current power supply consisting of a transformer, a dry-disc rectifier, and an R-C filter. The power supply feeds the current probes. A separate B supply is used to energize a cascaded arrangement of a voltage-regulator tube and voltage-reference tube. This arrangement provides a very stable reference voltage of approximately 220 μv across the 2½ ohm resistor. This reference voltage is in series with the potential probes and servo amplifier input. The servo loop is arranged so that the current flow through the current probes adjusts until the potential across the potential probes "bucks out" the reference voltage. The servo amplifier and motor combination is a propritary type which has a null sensitivity better than 1 μv. A dead spot error of this magnitude is of little significance in comparison with the errors associated with marking and reading the meter scale and the other sources of error previously discussed.

When current flow is interrupted by lifting the probe from the waveguide, a switch in the probe housing shunts the current flow and simultaneously operates a relay which disables the servo motor. Under these conditions the ammeter reading is maintained when the probe is removed from the waveguide. Thus a succession of readings can be taken along the waveguide in fairly rapid order since the meter needle does not respond from the zero mark at each reading. The chassis of the indicator contains a 100-K pot. which sets the reference voltage and which need be adjusted only when the type-5651 voltage-reference tube is replaced.

Use of the Instrument

Fig. 5 shows a measurement being taken on the outside wall of a section of L-band waveguide. In making measurements the probe points are kept in parallel alignment with the longitudinal axis of the guide. With this orientation, measurements can even be made directly on the corner bends. The main effort required on the part of the operator in the use of the instrument is the interpretation of the meter scale (Fig. 6). The numerical scale units, designated as "thickness units" are

in terms of thousandths of an inch (0.001 in.) of stainless steel base material which has a nominal conductivity of 0.0128 reciprocal microhm-centimeters. The nominal conductivities of nickel and silver exceed that of the stainless steel by factors of 10 and 48 respectively. Thus, if the incremental meter reading is divided by 10 in the case of nickel and by 48 in the case of silver the nominal thickness of either layer can be determined after the respective platings have been deposited. By using the instrument in this manner the plating process can be investigated without having to destroy the waveguide in order to discover the extent of plating non-uniformity within the guide.

For use as an inspection tool to determine if a finished waveguide is acceptable, the "Ag" mark on the meter scale may be used as the acceptance limit whereby readings below this mark indicate underplating. The "SS" and "Ni" marks on the meter scale indicate nominal readings for the unplated waveguide and the waveguide plated with 0.001 inch of nickel, respectively.

Corner and Edge Effects

It has been mentioned that conductivity measurements can be made directly on the corner bends of the waveguide when the probe is aligned longitudinally. This can be explained heuristically by observing that distortions of the shape of the waveguide cross-section which leave the wall thickness unchanged will have no effect on the longitudinal distribution of the equipotentials where they cross the line between the current probes.

The radius of the probe "circle of influence" is 3¾ in. The circle of influence is here defined as the size of a thin circular conducting sheet of given thickness which results in a conductance measurement error of —5% compared to a large conducting sheet of the same thickness and conductivity. The curve marked C in Fig. 7 shows the effect on conductance measurement of decreasing the radius of the conducting sheet. Correction factors can be obtained from this plot to determine the conductance of samples which are only slightly larger than the size of the probe itself. The plot further shows that the fact that the waveguide is a tubular surface instead of a plane surface will not affect the accuracy of measurement so long as the perimeter of the waveguide cross-section is much larger than the influence area radius.

The choice of a circle as a measure

Plating Indicator

(*Continued from page* 137)

of influence area actually is somewhat arbitrary since the configuration of the current flow field is longitudinally elongated in the probe region. This is seen by comparing curve A and curve B in Fig. 7 which illustrate edge effect. In curve A the probe is aligned parallel to the edge of the metal sheet while in curve B the probe is aligned transversely to the edge. The distance measurement in the latter case is taken from the current probe point nearest the edge. By obtaining correction factors from these curves conductance measurements can be made up to the end of the wave guide. However, that would hardly be necessary in practical situations since the errors due to edge effect assume importance only when approaching within 1 in. of the edge.

Limitations

The method of determining the thickness of metal sheet by measuring the dc conductivity has been previously applied in situations where a mechanical measurement could be made only by destructive means. The extension of the method to measure plating thickness is a logical one, especially in the situation in which a small variation in the thickness of plated material has a much larger effect on conductance than like or larger variations in the thickness of the base material.

Heretofore in this article the term "plating thickness" has been avoided because the conductance of a layer of plating is a function of its thickness and density. The conductivity of plated silver can easily vary downwards from the nominal handbook value by a factor of two depending on the multitude of variables which enter into the electrochemistry of the plating process. However, if the plated metal is reasonably pure the density decreases proportionally. Thus, if it is known only that the electrodeposition method plates reasonably uncontaminated metal the conductance method of plating measurement can be used to determine if an adequate quantity of plating has been deposited.

In addition to its use in measuring waveguide plating quantity the instrument can be used to determine thickness of homogeneous metal sheets, to sort metals, and as a rapid means of measuring conductivity (or resistivity) of conducting sheets of known thickness. In the latter ap-

dication the conductivity (or resistivity) can be computed by comparing the known thickness of the material with the instrument reading or the instrument can be calibrated to read conductance (or resistivity) directly for given thicknesses of material.

Thermal Relay

(*Continued from page 67*)

evacuation in order that a stable vacuum may be maintained during life. Furthermore, the materials employed in the relay must be carefully selected to have low vapor pressures at the maximum operating temperatures. We have found in practice that most metals, some metallic oxides, ceramics, glass and mica are suitable and that organic materials, phenolics and other plastics are unsatisfactory. The use of getters to clean up the small amounts of residual gases which may be liberated during continuous operation of the relay insures good stability during life.

Ambient Conditions

While the structure we have considered would make a simple and practical relay capable of providing time delays to about 2 min. for a bimetal 1½ in. long by ¼ in. wide and 0.030 in. thick, it would fall considerably short of meeting certain of the important operating requirements encountered in the field. For one thing, the operate time would be dependent upon the starting or ambient temperature and while this effect may be reduced by increasing the heater power, and thus the temperature of the bimetal at the operate point, a more adequate solution is necessary if the wide ambient temperature requirements called for in military specifications are to be met.

Operate Time

A simple and satisfactory way of making the operate time of a thermal relay independent of ambient temperature is to make its contact gap spacing independent of this variable. This means the employment of some type of temperature sensitive secondary element effecting the position of the "fixed" contact. When this approach is used in relays of practical form it is difficult to obtain complete thermal isolation from the primary element and this has the effect of reducing the maximum time to which the relay can be set. This effect is illustrated in Fig. 6. Curve 1 shows the heating characteristic of the pri-

Thermal Relay

(*Continued from page* 139)

mary element and curve 2 that for the compensating element. Since the contacts will now operate when a given temperature difference has been obtained between the two bimetals rather than at a fixed temperature we must subtract the ordinates of curve 2 from those of curve 1 in order to obtain the actual temperature-time characteristic.

Note that if we attempt to set the operate time to 2 min., a value readily attainable in the uncompensated relay, we would find that the contacts would close at time t_1 and then reopen at time t_2. This behaviour results from the fact that the time constant of the exponential heating curve of the compensating element must necessarily be longer than that for the primary element since the former is more loosely coupled to the heater winding. It is evident therefore that anything done in the design toward reducing the

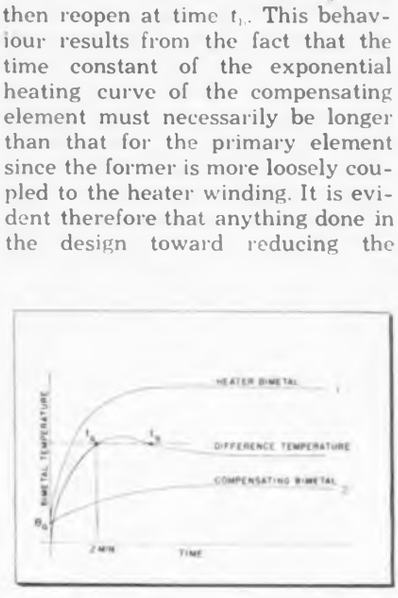

Fig. 6. Curve for ambient-compensated relay

thermal coupling between the two elements while allowing for their mutual coupling to the surroundings will minimize the reduction of the effective time constant of the relay.

For the optimum temperature compensation the change in gap spacing as a function of time as well as the initial gap must be independent of ambient temperature. It is important therefore that the deflection rates of the bimetals employed be both identical and linear over the widest temperature range to which the primary element will be subjected in operation.

Compensating Bimetal

In the Edison Type 501 Relay shown in Fig. 2 a compensating bimetal identical to the primary element is employed to maintain a uniform gap spacing with ambient temperature. Minimum thermal coupling between the elements is obtained through the use of a ceramic mount-

ing support, by a coplanar relationship of the two bimetals and by maximum possible separation between them. Both bimetal elements are punched from the same strip and separated by the assembly operator, who attaches them to the insulator, in order to insure matching.

Returning again to the simple structure of Fig. 3, the slow-make, slow-break contact action would cause contact arcing if operated in air thus limiting the contact handling capacity of the relay especially at higher voltages. This difficulty might be eliminated by resorting to some form of snap action mechanism and this was done in the relay shown in Fig. 1 by associating a magnet and pole shoe with the contacts. Another approach would be to seal the relay into a non-oxidizing and arc-quenching atmosphere or into a vacuum where contact arcing is not readily sustained. This method has the obvious advantage that the structure is not complicated by the addition of magnets or snap springs. The desirability of hermetically sealing the relay for a number of additional reasons and long years of successful experience with slow-make, slow-break glass sealed thermostats led to the adoption of this means of arc suppression for the Type 501 Relay.

Gas Flexibility

While gases with high thermal conductivity are usually employed at the low end of the timing range and high vacuum at the upper end, considerable flexibility exists and fills other than those used in the standard relay types may be desirable where some special characteristic is required. Thus, a high vacuum fill may be called for in shorter operating time relays where very long reoperate times are necessary, where higher contact voltages must be interrupted or where dielectric strength between the heater and contact circuits must be at a maximum. When such special fills are used, contact spacing on the one hand and safe critical voltage limits on the other must be carefully observed if reliable operation is to be obtained.

The dependence of the operate time of simple types of thermal relays upon the voltage applied to their heaters has already been touched upon. It is obvious that while the timing must always vary with the applied voltage, the magnitude of this effect will depend upon how high on the heating curve the operate point is placed. Thus, in a

Thermal Relay

(*Continued from page* 141)

relay having a low ratio of critical voltage to operate voltage the effect will be at a minimum and it will become proportionately greater as this ratio approaches unity.

It is possible in some cases to use a heater wire material having a high temperature coefficient of resistance to reduce the variation of timing with heater voltage and both nickel and certain special alloys have been so employed. When such heaters are used the power input and therefore the rate of temperature rise of the actuating bimetal varies to somewhat less than the square of the applied voltage, thus providing some degree of built-in regulating action.

Timing Characteristics

As a matter of interest, thermal relays may be constructed so that their timing characteristics are practically independent of applied heater voltage. A relay of this type is shown in Fig. 4. In this embodiment

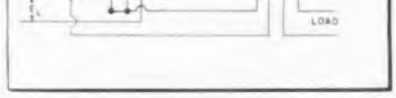

Fig. 8: Timing is made independent of voltage

two temperature compensated structures similar to shoe used in the relay of Fig. 2 are mounted in parallel to a ceramic supporting insulator and arranged circuit-wise as shown in Fig. 8. When so connected, unit (A) will act as a self-regulating current interrupter having the interesting characteristic that it will maintain the rate of electrical energy input to its heater at a constant value independent of variations in line voltage. Since the heater of the time delay unit (B) is connected in parallel with that of the current interrupter, the rate of energy input and therefore the timing of this unit will likewise be independent of line voltage. In order to insure adequate voltage compensation it is necessary that the period of the interrupter unit be short relative to the operate time of the time delay unit. A typical relay recently built showed less than a 10 sec. variation in operating time around a nominal value of 300 secs. over a voltage range from 85 to 150 v.

In discussing the application of ermal time delay relays we must gin by pointing out that these de- ces are not capable of providing e accuracy of synchronous motor iven timers. Thus, we have found at individual relays of the bimetal pe are capable of repeat operation an accuracy of plus or minus 3% the timing range between 30 secs. nd 5 mins. at rated heater voltage nd at room temperature. For the wer timing settings this percentage ill increase reaching about plus or inus 10% at 5 secs. The usual tol- rance on operate time on relays hich are produced in quantity is lus or minus 15% although closer limits are often feasible and may be btained in special relays.

The advantages of the thermal relay over other types lie in its inherent simplicity and reliability and in its low cost. In addition it will operate on either direct or alternating current and its timing characteristics are unaffected by line frequency over a very wide range. Furthermore, it is almost completely silent in operation, it is not position-sensitive, there are no bearings to cause difficulty at low temperature and its contacts are readily sealed against dust, dirt, oxidation and the effects of high altitude.

Compandors

(*Continued from page* 71)

are determined by the total power being transmitted. If both the high and low intensity signals described above were sent simultaneously, the action would be determined by their combined power or, since the weaker signal is so low, effectively by only the strongest signal. In this case the instantaneous noise improvement would be 2½ db when both signals are being transmitted; however, the noise would be attenuated immediately when signal transmission is stopped, so the circuit would still sound quiet in the absence of speech.

It is apparent, therefore, that the actual improvement in signal-to-noise ratio must depend on the volume of the speech being transmitted and on the amount of noise encountered.

An interesting point to note here is that the over-all noise improvement observed by a listener will generally be greater than the actual improvement when speech is present. This is caused by the fact that during quiet periods (between words) the expandor returns to the condition of maximum loss. There-

Compandors

(*Continued from page* 143)

fore, the noise improvement is maximum. Then, when the line is in use, the noise level to the listener may rise, but it is masked by the speech. Because the listener observes a quiet circuit when no speech is present, his ear tends to strike a balance between idle and talking periods. Determination of compandor noise improvement must be made by listening tests with various volume talkers and various noise intensities rather than by direct meter readings. Compandor advantage in noise reduction during speech has been quoted as 22 db, and this figure is generally used for planning purposes.

To help determine the practical noise advantage to be expected, extensive tests have been made under controlled conditions using both 1000 CPS tone and a 3 KC band of thermal noise as interference. Three typical expected talker volumes were used to approximate maximum, average, and minimum speech intensities.

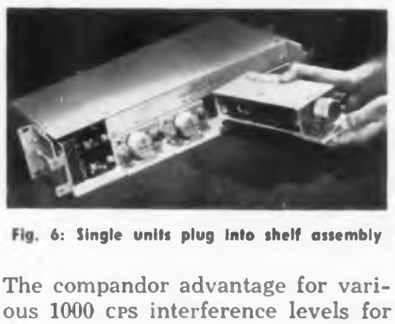

Fig. 6: Single units plug into shelf assembly

The compandor advantage for various 1000 CPS interference levels for the various speech intensities is shown in Table 1.

Table 1.

Magnitude of 1000 CPS Interference (dbm at 0 level)	Compandor Noise Advantage Speech volume at 0 level		
	—26 vu	—16 vu	0 vu
—30	27	25	24
—25	24	22	20
—20	22	19	18
—15	18	16.5	15
—10		14	11

These test results are the average of impressions by careful listeners whose judgment generally differed by less than 1 db. Although tests with a 3 KC band of thermal noise were less conclusive than those with the 1000 CPS interference, the average of individual observer's reactions agreed essentially with the tabulated results shown.

Use of a compandor will reduce the intensity only of interference arising in the compandored portion of the circuit. Any noise entering the compressor will be amplified and attenuated in the same manner

as the desired intelligence. For these reasons the principal benefits arising from compandor usage are reduction of crosstalk and reduction of any ambient noise caused by induction from power lines or any other sources of interference.

Generally speaking, compandors can be used to advantage on any physical, phantom, or carrier-derived telephone channel used for speech transmission. The method of application, and the advantages derived will vary depending on the type of transmission facility and communication plant concerned.

One other field of compandor application of particular interest, in view of current trends towards increased use of microwave systems, is their use with the radio channelizing equipment. In the past, multichannel point-to-point radio systems have often been limited to a small number of repeater sections because the radio noise and distortion products accumulate from each link. The same system using compandored carrier equipment can readily be extended through additional repeater sections without degrading system performance.

Economies achieved by compandor application to point-to-point radio systems include: (1) fewer repeater sections on long systems, (2) smaller antennas and tower structures for short links, (3) extension of the present system by being able to add more repeaters in tandem, and (4) reduced and simplified maintenance because of relaxed alignment limits.

Missile Firm Expands

Ramo-Wooldridge Corp., Los Angeles, guided missile and electronic firm, is adding a 150,000 sq. ft. facility on an 8-acre site, reports Dr. Dean E. Wooldridge, president. Also, a wholly-owned subsidiary, Pacific Semiconductors, has been formed, with Dr. Harper Q. North as president. This new firm will

(l to r) Drs. Wooldridge, North and Ramo, formerly top scientists for Hughes Aircraft, discuss plans for Pacific Semiconductors

manufacture transistors of advanced design and has the financial backing of Thompson Products, Inc., Cleveland, Ohio.

Geodimeter

(*Continued from page* 69)

electrical pulse half a wavelength is the same as to shift polarity or phase 180°.

In the geodimeter the remaining fractional wavelength is measured as outlined above, using a null detector. To account for inaccuracy in the delay line, the Kerr cell, the photomultiplier and the associated electrical network, the light beam is run through a variable internal light path, positioned above the instrument. The length of this light path is mechanically varied until the null detector again reads zero, and the actual length of the partial wave that had to be measured can now be read directly on the dials of the light path.

It will be remembered from above, that the distance to be measured had been divided into a number of whole waves and one partial wave, the latter now having been measured. The length of the whole waves is easily determined, knowing the frequency of the crystal oscillator. The number of whole waves also has to be determined. This is done by changing the crystal and repeating the measurements. If the distance to be measured is known within a quarter of a wavelength, 7.5 meters, this need not be done. If the distance is known within a few kilometers, two crystal frequencies must be used, and if the distance is not known at all, three frequencies are needed.

Oscillator and Amplifier

The two modulating frequencies are 10 MC and 10.1 MC ± 0.01%. The oscillator is working into a double-tuned band filter for elimination of unwanted harmonics and subharmonics.

The crystal oscillator is of the low impedance type. By supplying the grid bias for the oscillator tube from the grid circuit of the following tube, a simple kind of AVC action is obtained. The advantage of this method is that a very low r-f voltage across the crystal is obtained, meaning greater stability. At the same time the tube is working in class A without grid current and, consequently, with a minimum load on the crystal. Changes in frequency are smaller than 10^{-7} for changes of ± 20% in plate and heater voltages. This means that frequency stability is practically entirely determined by ageing effects of the crystals. As the frequency used is easily compared with stand-

ard signals, e.g. WWV, the ageing can be controlled and corrected for.

The power stage consists of two push-pull connected tetrodes, type QE 04/10, with a total power output of about 5 watts. The matching to the capacitive load of the Kerr cell is effected by a π-connected network tuned by a variable capacitor.

Receiver and Detector

The r-f voltage for the photocell plate is obtained inductively from the Kerr cell circuit. The variable delay is divided into two parts, one coarse adjustment in eleven steps, built up of series inductances and shunt capacitors, and a fine adjustment consisting of a slight detuning, by means of a variable condenser, of the tuned circuit transforming the relatively low voltage across the delay line to the photomultipliers plate. Close to resonance the amplitude change is negligible for phase shifts up to about $\pm$ 20 degrees, which is sufficient for covering the intervals between the positions of the coarse adjustment.

The photocell is of the multiplier type. Of the different types of this kind, 1P21 has been chosen because of its low dark current and high sensitivity. The supply voltage is about 800 volts, as this gives good sensitivity with high signal-to-noise ratio. Because of the low dynode voltages, about 75 volts, mean electron velocity is low and transit time not negligible. The supply voltage is stabilized by means of neon tubes not in order to keep amplification constant but only to make deviations in transit time harmless. As most of the information lies in a comparatively low frequency interval, say 50 to 150 cps, it is possible to use a high resistance in the photo-multipliers anode circuit, as this means higher voltage output. This resistance is directly connected between grid and cathode of the first amplifier, a low microphonic pentode, in series with a variable bias voltage for compensating changes in voltage drop across the anode resistance with changes in light level. Of course only small changes can be compensated for in this way.

Null Detector

The null detector, Fig. 4, consists of two high-slope pentodes, whose control grids are connected in parallel to the plate of the voltage amplifier. The suppressor grids are supplied with a part of the ac bias voltage in such a way that one tube is conducting during "positive" half

Geodimeter

(*Continued from page* 147)

periods and the other one during "negative" half periods. Large capacitors in the plate circuit of the tubes are discharged during conducting intervals, and the potential difference is measured with a highly sensitive dc instrument. If the control grid voltage only contains even harmonics of the bias frequency, the potential difference between the plates is zero and the instrument reading will be zero too. If, however, the bias frequency and/or odd harmonics thereof will appear, balance is disturbed and we get a deflection on the instrument, the sign and magnitude of which are dependent on the sign and amplitude of the unbalanced voltage. This device is of course very sensitive to disturbing voltages of the supply frequency, and special means are provided for eliminating an unbalance of this kind. A control is obtained by changing the connections to the suppressor grids. If there is an unwanted unbalanced voltage, instrument deflection will change with polarity switching.

Accuracy in most measurements is limited by noise of different kinds. In this case noise originates principally from the photocathode. There are three possibilities of diminishing noise of this type, firstly by selecting a material with a low noise factor, secondarily by decreasing the band width and, thirdly, by lowering the working temperature. Of these the first two have been used. The bandwidth is reduced to about 0.01 cps by choosing a very long time constant for the instrument (damping with silicon oil).

The choice of bandwidth is, in fact, an important one, as the accuracy obtained is, to a high degree, determined by the bandwidth. One can look upon the function of the indicating instrument from another angle. If direction springs are removed, the pointer of the instrument will constantly move with a velocity depending on the magnitude of current, the latter being the difference between currents during positive and negative half periods. The deflection of the pointer will thus be proportional to the time integral of the unbalance current (the instrument is supposed to be overdamped). Assuming a certain very small unbalance, it is evident that the instrument's mean deflection will be proportional to the time elapsed from application of current unbalance.

CW Magnetron

(Continued from page 79)

reservoir for the thoria. The 0.010 in. space between the two cylinders is packed with thoria paste. Cathodes have been made using two different base metals, tantalum and molybdenum. The tantalum cathodes require a brightness temperature of 1600 to 1650° C. for operation. Considerable difficulty with heater life was experienced at this cathode temperature. The molybdenum cathodes require a brightness temperature of 1600° C. for activation, but activation is very rapid and the brightness temperature may then be reduced to 1300 to 1350° C. The cathode is indirectly heated by a bifilar heater made of 0.040 inch tungsten wire. The heater power required to start the tube is 550 watts; after the tube starts oscillating the heater power is reduced to about 300 watts.

The cathode is supported and insulated from the top cover by a

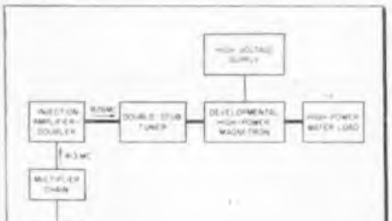

Fig. 9: Set-up for double-loop injection tests

cathode lead consisting of forsterite insulators which are sealed to 52-alloy cylinders by means of a tungsten-iron metalizing process using silver-copper eutectic solder. The cathode-cover assembly is sealed to the anode by means of a demountable copper-gasket seal formed by compression of a copper gasket between polished steel flanges.

A photograph of the completed tube is shown in Fig. 1.

Performance

Tentative operating data for this developmental high-power magnetron are given in Table I. When this tube is operated at an anode voltage of 6700 v., it is capable of producing a power output of 10 kw. at an efficiency of 50 to 55%. At an anode voltage of 9000 v., a power output of 20 kw. has been obtained at an efficiency of 60 to 65%. A performance chart for the tube is shown in Fig. 7, and a Rieke diagram in Fig. 8. The

tube has a tuning range of 60 MC with little variation in efficiency over this range.

The dynamic frequency pushing for power variation from 250 watts to 10 kw. is approximately 10 MC. The frequency pulling for a standing-wave ratio of 1.5 is approximately 5 MC.

This magnetron may also be operated in the low-frequency pi-mode with good efficiency over part of the tuning range. In this mode, however, the power output is limited to a few kilowatts by the upper current boundary of the mode. In addition, the diaphragm in the tuning cavity tends to overheat when the tube is operated in the low-frequency mode because of the changed current distribution.

Injection-Locking

Although injection-locking and modulation tests on the developmental high-power magnetron have not been completed, the tube shown in Fig. 1, which has two output connections, has been injection-locked (without modulation) with static locking ranges up to 10 MC. Considerable care is necessary in the adjustment of the locking circuit to prevent damage to the injection amplifier tube as a result of too much power being fed to it from the magnetron.

TABLE I
Tentative Data for the Developmental High-Power Magnetron

	Starting	Operating
Heater Voltage (ac)	15.0	12 v.
Heater Current	37.0	31 amps.
Frequency Range	785-845	MC
Maximum Frequency Pulling	6.0	MC
Cathode Anode Capacitance	25	μμf
Cooling — Water and Forced Air		
Typical Operation		
External Magnetic Field	360	Gauss
Anode Voltage (dc)	6600	v.
Anode Current	3.0	amps.
Power Input	19.8	kw.
Power Output	10.0	kw.
Efficiency	50	%

Test Setup

A block diagram of the test setup for the double-loop injection tests is shown in Fig. 9. An 8.6 MC crystal feeds the multiplier chain. The 413 MC output of the multiplier chain drives the injection amplifier, which operates as a frequency doubler to protect its grid circuit from power fed back from the magnetron. The injection amplifier is a UHF power tetrode. The output of the injection amplifier is fed through a double-stub tuner into one of the connec-

CW Magnetron

(*Continued from page* 151)

tions to the magnetron. The magnetron output is connected to a high-power water load.

This paper was presented at the 1953 National Electronics Conference held in Chicago.

1. L. L. Koros, "Frequency Control of Modulated Magnetrons by Resonant Injection System," *Proc. NEC*, vol. 7, pp. 39-45, 1951.
2. J. S. Donal, Jr., R. R. Bush, C. L. Cuccia, and H. R. Hegbar, "A One-Kilowatt Frequency-Modulated Magnetron for 900 Megacycles," *Proc. I.R.E.*, vol. 35, pp. 664-669; July, 1947.
3. G. B. Collins, *Microwave Magnetrons*, McGraw-Hill Book Co., New York, N. Y., Chapter 16, 1948.

Radio Propagation

(*Continued from page* 83)

the incipient standards work on high frequencies, radio counter-measures, and radiosondes.

Current activities are divided along research lines essentially according to the manner in which radio energy is propagated. The Ionosphere Research Laboratory investigates the physical phenomena affecting the ionosphere and radio propagation in and through the ionosphere. The Systems Research Laboratory is concerned with the characteristics of radio systems depending on propagation in the troposphere (up to about 10 mi. above the surface of the earth). The Measurements Standards Laboratory performs research and develops standards and methods of measurement for all electrical quantities used at radio frequencies. Finally, the CRPL propagation prediction services correlate the wide-spread observations made by CRPL and other laboratories (both foreign and domestic) and prepare propagation predictions for users of the radio spectrum.

AMF Acquires Potter & Brumfield

Option to acquire Potter & Brumfield Mfg. Co., Princeton, Ind., has been exercised by American Machine & Foundry Co., according to Morehead Patterson, AMF board chairman and president. R. M. Brumfield will remain president of P & B, which makes relays and motors.

TV Camera Tube Warranty Period Doubled

The warranty period for RCA vidicon TV camera tubes purchased for replacement has been doubled, and now extends to 500 hours. Types covered are 6198 and 6326.

BULLETINS

(*Continued from page* 121)

TV Broadcast Antennas

The RCA line of VHF Superturnstile Antennas is described in a new catalog—No. B. 739—which provides engineering specifications and a list of accessories, in addition to details on construction of antenna towers. Available from Engineering Products Div., RCA, Camden 2, N.J.

Metallizing

A reference folder describing the latest advances in vacuum metallizing has been prepared by the Tungsten Div., Bergen Wire Rope Co., Lodi, N.J.

Crystals

Specifications on the Heemco line of low-frequency crystals and circuits employing them are contained in a catalog just released by the Hill Electronic Engrg. and Mfg. Co., Inc., New Kingstown, Pa.

Germanium Diodes

Comprehensive data on the type 1N series germanium diodes, including standard types, replacement types, construction, dimensions, charts, etc. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

Aircraft Equipment

Fourth catalog in a series of seven which provides a most comprehensive and informative reference on aviation supplies, this volume deals with electrical and radio equipment used in aircraft. Write for Catalog 21D, on company letterhead, to Air Associates Inc., Dept AD, Teterboro, N.J.

Linear Slide Rule

2-page folder describes uses for and brief description of the linear scale slide rule as opposed to the logarithmic slide rule. Available from M. L. Groder, 2003 E. 12 St., Brooklyn 29, N.Y.

Computers

A 12-page illustrated product brochure decribes a line of electronic computers and plug-in components, including information on their new developments in mach computers, accelerometers, and positioning mechanisms. Write for copies to Servomechanisms Inc., Westbury Div., Post & Stewart Aves., Westbury, N.Y.

Transformers

A new 1954 catalog, listing more than 500 transformers, of which over 60 are new items, has just been released by Triad Transformer Corp., Venice, Calif.

Power Supplies

A new catalog provides information on the operating principles and specifications on each instrument in their line of voltage regulators, "B" supplies, frequency changers, inverters and magnetic-amplifier DC sources. Request Catalog 254 from Sorenson & Co., Inc., 375 Fairfield Ave., Stamford, Conn.

Mobile Unit

A data sheet released by Bendix Radio, Baltimore, Md. describes the Type MRT-10 ( ) Series Communication Unit 'Trafficmaster', a complete, self-contained, mobile communications unit for 25-50 MC. It may also be used for fixed station and other types of service.

Tape Recorder

Catalog B. 1700 available from the Engineering Products Div., RCA, Camden 2, N.J. describes the RT-11B Magnetic Tape Recorder, a professional unit designed for recording studios and broadcast stations.

(*Continued on page* 156)

BULLETINS

Pulse Transformers

A new catalog that lists the electrical and physical characteristics of the Utah line of blocking oscillators, or regenerative driver pulse transformers, has been announced by Utah Radio Products Co., 1123 E. Franklin St., Huntington, Ind. The catalog also lists a few high power pulse and guided missile transformers.

Tube Shields

Two free booklets, "Effect of Tube Shields on Miniature Electron Tubes" and "An Evaluation of Shields for Subminiature Electron Tubes" have been released by International Electronic Research Corp. 175 W. Magnolia Blvd., Burbank, Calif.

Industry

Highlights of Major Alexander P. de Seversky's address at the symposium on "Electronics in Air Power." Available from Mycalex Corp. of America, 30 Rockefeller Plaza, New York 20, N.Y.

Springs

Two new catalogs are available to users of copper springs and beryllium copper components. Catalog 8 contains design information, and Catalog 8A describes copper components designed specifically for the electronic industry. Available from Instrument Specialties Co., Inc. 275 Bergen Blvd., Little Falls, N.J.

Heating Controls

Full information on a complete line of heating controls, thermostats, thermometers, switches and valves is contained in the 1954 catalog of Minneapolis-Honeywell Regulator Co. 621 E. Hennepin Ave., Minneapolis, Minn.

Transformers

United Transformer Co., 150 Varick St., New York 13, N.Y. has released their 1954 Catalog A, which contains engineering specifications on their line of transformers, reactors and filters.

Industrial Recorders

Two publications are available without charge from the Sanborn Co., 195 Massachusetts Ave., Cambridge 39, Mass. for those whose work involves measurement-recording of pressure, temperature, stress, etc. One is a catalog of oscillographic recording systems, the other, a quarterly publication deals with industrial recording.

Batteries for Transistors

Burgess Battery Co. has made available a four-page folder describing developments in the field of transistor batteries. Write Transistor Engineers, Burgess Battery Co., Freeport, Ill.

Microwave

Technical Bulletin T-2600 enables the design engineer to evaluate all the available microwave balanced mixer designs as to mechanical packaging, electrical characteristics and adaptability to his particular requirements. Available from Airtron Inc., Dept., A., 1103 W. Elizabeth Ave., Linden, N.J.

Microwave

A line of microwave test equipment for Ku-band measurements is described in a 4-page illustrated brochure from Waveline Inc., Caldwell, N.J. Among items covered are variable shorts, attenuator pads, hybrid junctions, noise signal sources, and sliding load terminations.

Teflon Fabricating

A release from Halogen Insulator and Seal Corp, 10121 Franklin Ave., Franklin Park, Ill., describes properties of Teflon and applications in which it may profitably replace other insulators.

INDUSTRY NEWS

(*Continued from page 38*)

Clarence Harding has been promoted to general manager of Ircal Industries, California subsidiary of the International Resistance Co., Philadelphia, Pa. Mr. Harding has been asst. treasurer and controller at IRC for the past nine years.

Joseph B. Elliott has resigned his position as exec. v.p. of the Consumer Products Div., RCA, to become president of Schick Mfg. Co.

J. B. Elliott

W. R. Slaughter

Brig. Gen. Willis R. Slaughter, U.S.A. (Ret.), former head of the Ordnance Training Command, Aberdeen Proving Grounds, has joined the W. L. Maxson Corp., N.Y.C., as Plans and Programs Advisor.

William W. Wexler has been named advertising and sales promotion manager in the equipment sales division of Raytheon Mfg. Co., Waltham, Mass.

David A. Harkavy, former advertising manager at Harrison Radio Corp., has been appointed industrial advertising mgr. for DeJUR-Amsco Corp., Long Island City, N.Y.

Thomas H. Bay is the new sales manager of the Potentiometer Div., Fairchild Camera and Instrument Corp., Hicksville, N.Y., succeeding **Stuart Edgerly**, who resigned to take a similar position with Fenwal Inc., Ashland, Mass.

Ray W. MacDonald, general manager of international operations of Burroughs Corp., was recently named a vice-president. Mr. MacDonald is in charge of the corporation's sales and service operations outside the U.S. and Canada.

Hale P. Faris is the new general sales manager at Motordyne Inc., Monrovia, Cal., manufacturers of motors, dynamotors and inverters. Mr. Faris was formerly with Redmond Inc.

James R. Bradburn was elected president of ElectroData Corp., electronic computer affiliate of Consolidated Engineering Corp., Pasadena, Cal.

TELE-TECH ADVERTISERS — SEPTEMBER, 1954

While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

Time Delay

(Continued from page 73)

put reference points. If the time between these points is greater than the total time across the face of the oscilloscope, adjust the sync delay until the output pulse appears on the screen, counting the 1 μsec markers as they pass the vertical reference line. When the last, full 1 μsec interval has been counted, switch to the 0.1 μsec markers and identify the 0.1 marker that corresponds to this last 1 μsec marker. Count the number of full, 0.1 μsec intervals from this point. Set the last 0.1 marker on a vertical reference line with the fine sync control, point 3 in Fig. 4. Switch the marker selector to the off position and move the calibrated delay dial from zero until point B moves to point C on the graticule. Read directly from the calibrated dial the time that is to be added to the last full 0.1 μsec interval. If the total delay is less than 1 μsec proceed as before but use only the 0.1 μsec markers and the calibrated delay dial.

This same equipment may also be used to measure the rise or decay time of a pulse. Rise or decay time is defined as that time it takes a pulse to vary between its 10% and 90% amplitude points. Since measuring decay times is identical to measuring rise times, only a rise-time measurement is described.

Refer to Fig. 5, and with the fine pulse-trigger delay and fine sync delay, set a 0.1 μsec marker on the 10% amplitude point and a vertical reference line on the graticule, point A. Count the number of full 0.1 μsec intervals between the 10% and 90% amplitude points. With the fine sync delay set the last 0.1 marker on a vertical reference line, point D. Switch the marker selector to the off position and move the calibrated delay dial from zero until point B moves to point C, and add the time read from the calibrated dial to the last 0.1 μsec marker. If the total rise time is less than 0.1 μsec, proceed as before but use only the calibrated delay dial.

Job Opportunities for Engineers

A number of vacancies for electronic engineers now exist at the U.S. Naval Air Missile Test Center, Point Mugu, Calif. Salaries are to $8360 per annum. Information is available from R. A. Riebow, employment superintendent.

Do you want more information about PRODUCTS advertised in TELE-TECH & ELECTRONIC INDUSTRIES

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are using space in this issue to acquaint you with their products. Perhaps you want more information on some of them—on one or two, or possibly a score. You can cover all of your needs with the cards below. They are convenient and postfree.

Use the convenient postage-free cards below to get information quickly about products listed here—all advertised in this issue

301 Ace Engineering & Machine Co., Inc.—Shielded enclosures
302 Advance Electric & Relay Co.—Relays
303 Aircraft Radio Corp.—Signal generators
304 Aircraft Transformer Corp.—Hermetically sealed transformers
305 Airdesign, Inc.—Transformers
306 Alford Mfg. Co., Inc.—Stand-by TV transmitting antennas
307 Allied Radio Corp.—Electronic supplies
308 American Electrical Heater Co.—Soldering irons
309 American Lava Corp.—Ceramic components
310 American Microphone Co.—Microphones, phono cartridges
311 American Phenolic Corp.—Cable assemblies
312 Amperite Co., Inc.—Delay relays
313 Antara Chemicals Div., General Aniline & Film Corp.—Iron powders
314 Arnold Engineering Co.—Silicon Steel cores
315 Artos Engineering Co.—Automatic wire cutting machines
316 Atlas Sound Corp.—Microphone stands, booms
317 Audio Devices, Inc.—Magnetic recording tape
318 Bell Telephone Labs., Inc.—Pole-line construction
319 Bendix Aviation Corp., Redbank Div.—Electron tubes
320 Berndt-Bach, Inc.—Sound-on-film equipment
321 Blaw-Knox Co.—Antenna towers
323 Burnell & Co., Inc.—Variable toroids
324 Burroughs Corp.—Unitized pulse system
325 Bussmann Mfg. Co.—Fuses
326 Canoga Corp.—Sweep frequency generators
327 CBS-Hytron—Color TV picture tube
328 Ceco Distributing Corp.—All-directional dolly
329 Chester Cable Corp.—Wires & cables
330 Cinch Mfg. Corp.—Connectors
331 Cinema Engineering Co.—Equalizers
332 Cleveland Container Co.—Phenolic tubing
333 Clippard Instrument Laboratory—Aids to automation
334 Collins Radio Co.—Broadcast equipment
335 Columbian Carbon Co.—Ferric oxides
336 Communication Accessories Co.—Engineering personnel
337 Communication Accessories Co.—Toroids
338 Cornell-Dubilier Electric Corp.—Filters
339 Corning Glass Works—Fixed glass capacitors
339A Crosley Div., Avco Mfg. Corp.—Engineering personnel
340 Cunningham, Son & Co., Inc., James—Crossbar switches
341 Dage Electric Co.—Connectors
342 Dale Products, Inc.—Deposited carbon resistors
343 Daven Co.—Switches
344 Dudek & Bock Spring Mfg. Co.—Wire forms
345 DuMont Labs., Inc., Allen B.—VHF television transmitter
346 Edison Inc., Thomas A.—Magnetic relays
347 Eisler Engineering Co.—Tilting turntables & positioners
348 Eitel-McCullough, Inc.—Reflex klystrons
349 Electro Motive Mfg. Co.—Capacitors
350 Fairchild Recording Equipment Corp.—3-speed turntables
351 Federal Telecommunication Laboratories—Engineering personnel
352 Ford Instrument Co.—Engineering
353 Freed Transformer Co., Inc.—Magnetic amplifiers, transformers
354 Garde Manufacturing Co.—Barrier strips
355 General Electric Co.—TV receiving tubes
356 General Electric Co.—lamps
357 General Electric Co.—Uni-level amplifiers
358 General Electric Co.—Stacked germanium rectifiers
359 General Precision Lab., Inc.—Miniature TV camera tube
360 General Radio Co.—Frequency measuring equipment

Listings continued on next page ▶▶▶

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Listings continued from preceding page

361 Graphite Metallizing Corp.—Brushes contacts
362 Helipot Corp.—Free technical paper
363 Heppner Mfg. Co.—Flybacks
364 Hermetic Seal Products Co.—Hermetic headers
365 Hewlett-Packard Co.—TV monitor
366 Houston-Fearless Corp.—Cradle heads
367 Hubbell, Inc., Harvey—Connectors
368 Hughes Aircraft Co.—Germanium diodes
369 Hughes Research & Dev. Labs.—Engineering personnel
370 Hycon Mfg. Co.—Digital VTVM
371 Ilsco Copper Tube & Products, Inc.—Connectors
371A Industrial Hardware Mfg. Co., Inc.—Anode connectors
372 International Rectifier Corp.—Selenium rectifiers
373 Johnson Co., E. F.—Capacitors, jacks, lights, knobs
374 Jones Div., Howard B., Cinch Mfg. Corp.—Terminal strips
375 Kahle Engineering Co.—Transistor production equipment
376 Kanthal Corp.—Resistance wire
377 Kearfott Co., Inc.—Microwave testing equipments
378 Kester Solder Co.—Solder
379 Keystone Products Co.—Transformers
380 Knights Co. James—Crystals
381 Kollsman Instrument Co., Inc.—Sweep generator
382 Loral Electronics Corp.—Electronic military equipment
383 Magnecord, Inc.—Tape recorder
384 Magnetics, Inc.—Tape wound cores
385 Measurements Corp.—Megacycle meter
386 Melpar, Inc.—Engineering personnel
387 Methode Mfg. Co.—Printed circuits
388 Midland Mfg. Co.—Crystals
389 Minnesota Mining & Mfg. Co.—Magnetic recording tape
390 Mitchell Industries—Soldering iron
391 Mueller Electric Co.—Alligator clips
392 National Co.—Dials & knobs
393 Onan & Sons, Inc., D. W.—Stand-by electric plants
394 Onandaga Pottery Co.—Multiple capacitors-resistor
395 Peerless Div., Altec Lansing Corp.—Repeating coil
395A Permag Corp.—Permanent magnets
396 Phaostron Co.—Custom panel instruments
397 Phelps Dodge Copper Products Corp.—Coaxial cables
398 Philco Corp.—TV film Scanner
399 Polarad Electronics Corp.—NTSC color TV equipment
400 Polarad Electronic Corp.—Spectrum analyzers
401 Polytechnic Research & Development Co.—Klystron power supplies
402 Potter Co.—Filters
403 Precision Paper Tube Co.—Paper tubes
404 Pyramid Electric Co.—MIL capacitors
405 Radio Corporation of America—TV picture tubes
406 Radio Materials Corp.—Disc capacitors
407 Radio Receptor Co., Inc.—Selenium rectifiers
408 Raypar, Inc.—High voltage tube sockets
409 Raytheon Mfg. Co.—Microwave accessories
410 Reeves Soundcraft Corp.—Magnetic recording tape
411 Resinite Corp.—Embossed coil forms
412 Rust Industrial Co., Inc.—Transmitter remote-control system
413 Shallcross Mfg. Co.—Resistors
414 Shallcross Mfg. Co.—Audio attenuators
415 Sigma Instruments, Inc.—Photoelectric light control
416 Specific Products Co.—WWVR receiver
417 Sprague Electric Co.—Wirewound resistors
418 Sprague Electric Co.—Tantalum electrolytic capacitors
419 Standard Piezo Co.—Crystals
420 Stoddart Aircraft Radio Co.—Frequency measuring equipment
421 Stone Paper Tube Co.—Paper tubes
422 Superior Instruments Co.—CRT tube tester
423 Sylvania Electric Products Inc.—X-band duplexer tubes
424 Sylvania Electric Products Inc.—Subminiature tubes
425 Synthane Corp.—Plastic cam blanks
426 Technicraft Labs., Inc.—Microwave assemblies
427 Tektronix, Inc.—Oscilloscopes
428 Telechrome, Inc.—Video transmission test equipment
429 Tel-Rad Mfg. Co., Inc.—Deflection components & coils
430 Thermador Electrical Mfg. Co.—Transformers
431 Transradio Ltd.—Coaxial cable
432 Tung-Sol Electric Inc.—TV receiving tubes
433 Turner Co.—Lapel microphone
434 Waterman Products Co.—Cathode ray tubes
435 Wechesser Co.—Plastic cable clips
436 Weston Electrical Instrument Corp.—TV test equipment
437 White Dental Mfg. Co., S. S.—Molded resistors
438 Wiley & Sons, John—Book on TV engineering
439 Williams & Co., Inc., C. K.—Ferric oxides

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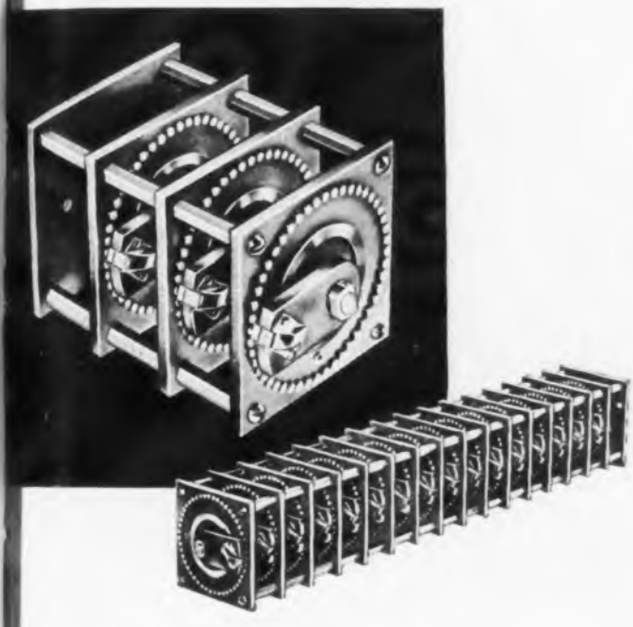
New Switch on SWITCHES by DAVEN



DAVEN not only supplies switches from its hundreds of standard units, but can also effect *quick changes* from standard units to special switches by using components at hand.

As a result, you are able to select, from thousands of variations, the right switch for your particular requirements.

And . . . here's a *new switch* for problems that defy solution with standard components. If your prototype is that of an unusual piece of equipment and requires a switch not yet developed, DAVEN will engineer it for you.

This is a service which DAVEN is singularly well qualified to perform by reason of its skilled engineering staff and exceptional facilities. For more than a generation, DAVEN has built up a Development Department that is second to none in solving difficult switch problems.

Furthermore, because only DAVEN has the patented "knee-action" rotor, units can be produced with a greater number of switch positions and poles in a smaller space than was ever possible before.

Why not call on DAVEN today to assist with your development project, especially if you need switches that must render maximum performance in minimum space.

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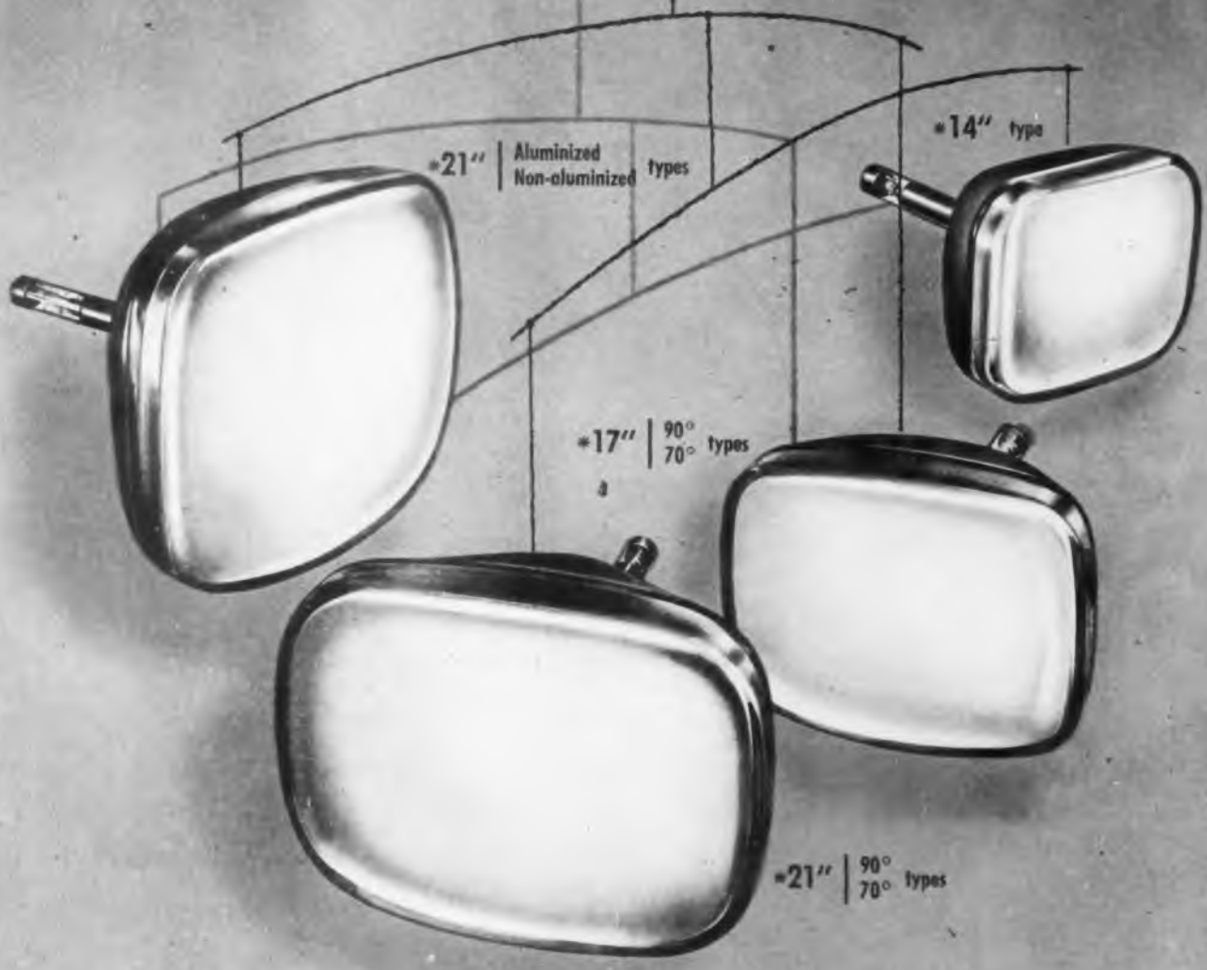

Choose from RCA's "Balanced" Line for your new TV designs—

- **21-inch types**—aluminized or non-aluminized—for your "de luxe" line.
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